Can school breakfast improve academic achievement?

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Abstract

I investigate whether the introduction of school breakfast have an impact on academic achievements in Swedish public compulsory schools. I collect information on the timing of the introduction of school breakfast from 123 municipalities and link it to panel data on academic achievement in sixth and ninth grade for the school years of 2012/2013 to 2022/2023. Using a staggered and heterogeneity robust difference-in-differences design I show a three percent increase in the final grade point after four years of exposure to the policy. Furthermore, I find evidence of an eight percent increase in the proportion of pupils with a passing grade in all subjects after the implementation of school breakfast, suggesting larger effects in the lower tail of the grade distribution. The effects seem to be driven by an increase in boys' academic achievement. I find no effect for the outcomes in sixth grade or any evidence for a difference in outcomes between schools with different socioeconomic conditions.

Keywords: *School breakfast, academic achievement, difference-in-differences, heterogenous treatment effects, Sweden.*

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1. Introduction

Breakfast has often been said to be the most important meal of the day. Moreover, research has shown a clear advantage for those who regularly consumes breakfast in terms of higher cognition and other positive effects (e.g. Benton and Parker (1998), Pollitt, (1993), Pollitt (1995), Pollitt and Mathews (1998), Pollitt, Leibel and Greenfield (1981), Pollitt, Lewis, Garza and Shulman (1982), Wesnes, Pincock, Richardson, Helm and Halis (2003)). Even though this fact can be seen as common knowledge, many do not eat breakfast regularly. In Sweden, 66 percent of 15-year-old boys and 60 percent of 15-year-old girls eat breakfast at least four to five times every week. Meanwhile, 16 percent of the boys and 18 percent of the girls in the same age category do not consume breakfast at all. Additionally, the consumption of breakfast has decreased in the last 20 years (The Public Health Agency, 2023).

The decision of not eating breakfast can stem from multiple reasons, including having to wake up early to have the time to eat. Another plausible explanation, which has been discussed more lately with the rising food prices, is food insecurity at home. At the same time, more pupils than before state that they are stressed due to schoolwork and fewer pupils feel safe in school (Swedish Schools Inspectorate, 2021). Only three percent of children eat and exercise in accordance with the recommendations (Generation Pep, 2024).

One policy used to increase the consumption of breakfast is to provide it in schools. Federal school breakfast programs which provide pupils with either fully subsidized breakfast or reduced-priced breakfast have existed in the US for over 50 years (Bernstein, McLaughlin, Crepinsek and Daft, 2004). In Sweden, universal free school lunches have been served since the sixties (Lundborg, Rooth and Alex-Petersen, 2021) but there has not been a national school breakfast program. Instead, the decision of providing free or partly subsidized breakfast has in many cases been made by the principal at the school level. This would suggest that school breakfast has been implemented in a mostly staggered fashion in Sweden, implicating variation both between and within municipalities over time.

The most credible approach to study the causal relationship between school breakfast and academic achievement would be a Random Control Trial (RCT). The idea would be to randomize the provision of breakfast to schools and compare the differences in the outcomes of the pupils' achievements. Randomization would imply that the treatment would be independent of unobserved characteristics correlated with the outcome of interest.[1]

Trying to estimate the causal relationship through a standard OLS regression would presumably be severely limited by omitted variable bias as unobserved school characteristics (e.g. average pupil ability and teacher quality) would be correlated with the outcome i.e. academic achievement. Additionally, selection bias can be a concern. The US-focused literature has therefore often utilized different state rules or the staggered roll-out of the breakfast programs to estimate the causal effects.

Some researchers, using difference-in-differences (DID), regression discontinuity (RD) and instrumental variables (IV) methods find positive effects of school breakfast in terms of higher test scores in math and in reading (e.g. Dotter (2013), Frisvold (2014), Bartfeld, Berger, Men and Chen (2019), Norwood (2020)). Additionally, Norwood (2020) find a decrease in truancy, fewer fights and less substance abuse following the introduction of free breakfast. Other scholars, using comparable methods and data, find small or no effects of school breakfast on academic achievement (e.g. Bernstein et al., (2004), Leos-Urbel, Schwartz, Weinstein and Corcoran (2013), Ribar and Haldeman (2013), Schanzenbach and Zaki (2014)). The mechanisms discussed are primarily focused on the nutritional advantage of eating breakfast in school, but other explanations such as higher attendance rates and positive income shock exist (e.g. Leos-Urbel et al., (2013), Frisvold (2014)). To the best of my knowledge, there are no studies on the subject

[1] There have been multiple pilot projects of school breakfast in Sweden where breakfast has been provided in just a few schools in a municipality, potentially lending itself to a RCT design. One often cited project was done in the municipality of Botkyrka where two schools served breakfast in the classroom (BIC) for all pupils in seventh to ninth grade (von Lochow and Grundqvist, 2018). However, the schools were not chosen at random. I have via email confirmed this with the municipality. The schools were selected according to how well they represent the various parts of the municipality and according to the school's own interest and commitment to testing school breakfast. From my understanding of other similar projects this seems to hold generally in Sweden.

in a Swedish setting. Therefore, many have called for a credible study that investigates the effectiveness of providing breakfast in school (e.g. Swedish Food Agency (2021) and Lagergren Jernselius (2023)).

I contribute to the literature in three ways. Firstly, I collect data on the implementation of school breakfast in compulsory public[2] schools ("Grundskolan") in Sweden for the school years of 2012/2013 to 2022/2023. Secondly, this extensive data collection and the staggered implementation process, allow me to provide causal estimates of the relationship between school breakfast and academic achievement. Thirdly, in contrast to the previous literature exploiting staggered roll-out, I employ the newly developed heterogeneity robust DID estimators (Borusyak, Jaravel and Spiess (BJS) (2021), de Chaisemartin and D'Haultfoeuille (dC&DH) (2020), Callaway and Sant'Anna (CS) (2021)) to account for the negative weighting problem that can arise in staggered DID settings.

Using four DID estimators (BJS, dC&DH, CS and Two Way Fixed Effect (TWFE)), I show a three percent increase in the final grade point after four years of exposure to the policy. Quantitatively the effect is around nine final grade points which roughly could correspond to an increase in one subject's grade from "E" to "A", an increase from "F" to "E" in one subject or a one grade step increase in four subjects. Furthermore, I find evidence of an eight percent increase in the proportion of pupils with a passing grade ("E" to "A") in all subjects after the implementation of school breakfast, suggesting a larger effect in the lower tail of the grade distribution. The results strongly indicate that the effects are driven by an increase in boys' academic achievement as the estimated effects for girls are not statistically significant. Restricting the sample of schools with breakfast to those who provide it free of charge does not change the results. I find no effects in relation to any sixth grade

[2] Due to time limitations, I do not study private schools ("Friskolor"). Around 16 percent of pupils in compulsory school are enrolled in a private school (Swedish National Agency for Education, 2024). I have contacted the Swedish Association of Independent Schools ("Friskolornas riksförbund") and the Association of idea driven schools ("Idéburna skolors riksförbund"). It seems that some private schools offer school breakfast to their pupils but there is no clear pattern.

related outcomes. Contrary to some earlier findings, I estimate no difference in outcomes between schools with different socioeconomic status (SES).

The rest of the thesis is organized as follows. Section two discusses potential mechanisms. Section three presents a literature review. Section four describes the institutional background. Section five lists the data and describes the data collection process. Section six introduces and discusses the empirical strategy. Section seven presents the results. Section eight discusses the results and Section nine concludes the thesis. Additional tables, figures and other material are in the Appendix.

2. Mechanisms

If introducing school breakfast has a positive effect on academic achievement it is of interest to discuss the potential mechanisms.[3]

Frisvold (2014) discusses three[4] potential channels for why providing school breakfast can improve academic achievement: *better nutrition*, *higher attendance rates* and *positive income shock* (visualized in Figure 1).

Better nutrition means that pupils eat healthier when consuming breakfast in school compared with not eating breakfast at all or even at home. The US breakfast programs have nutritional requirements that follow the Dietary Guidelines for Americans (USDA, 2024). Based on the guidelines local school authorities choose the specific food offered. Studies show that eating breakfast is associated with better cognition. Leos-Urbel et al., (2013) writes that "Several studies, some using controlled experiments, have shown positive effects of breakfast on recall, episodic memory, short and long-term memory, visual attention and concentration, as well

[3] Due to limited data availability, I have no credible way of testing these mechanisms. The Swedish Schools Inspectorate (Skolinspektionen) has done a survey ("Skolenkäten") sent to pupils, teachers and parents from 2010 with data available at the school level. The survey consists of questions about for example if the pupils/teachers feel safe at school and if they can focus in the classroom (Swedish Schools Inspectorate, 2023). This survey is not sent to the same schools every year, so it is not possible to add survey answers as outcome variables in the thesis.

[4] Proponents of free school breakfast usually lists reducing stigma as another mechanism. This compared with school breakfast programs that are dependent on the household income. However, this is not as important in Sweden as most of the schools that offer breakfast do so at no cost for the pupils. There could additionally be other mechanisms.

as decreases in impulsivity among school children" (p. 91). According to Frisvold (2014) consumptions of vitamins, minerals, iodine, iron, folate, choline, lecithin, tyrosine and high-fibre foods seem to be important. Additionally, research show that deficits in thiamine, vitamin E, and iron can lead to worse concentration and lower cognition. Improved cognition can on the other hand lead to better study performance by pupils which can result in higher test scores and grades. However, it should be noted that it is unclear how the findings from small experiments generalize when implemented at a scale. Moreover, there could be a difference in how better nutrition affects academic achievement. Imberman and Kugler (2014) points out that test scores may improve but that grades and learning not necessary increases. This is due to that the effects of better nutrition may be restricted to the day of the test.

Higher attendance rates mean that introducing a school breakfast program can incentivize pupils to come to school earlier, or even to come to school at all, which may have a positive effect on academic achievement as more pupils attend school. Bartfeld et al., (2019) results show both an increase in attendance and in academic achievement after breakfast in the classroom was introduced. Furthermore, Frisvold (2014) proposes that improved nutrition indirectly could increase attendance as pupils are healthier and therefore less absent from school.

Positive income shock is the last mechanism proposed by Frisvold (2014). Receiving breakfast at no cost could be seen as an increase to the household income. Frisvold (2014) assumes the program transfer to be around 25 USD per month and child. Using changes in the Earned Income Tax Credit (EITC) Dahl and Lochner (2012) show, with an IV-strategy, that an increase in household income by $1 000 lead to an increase in test scores in math and reading by six percent of a SD. An increase in family income and by that an increase in food security can therefore have positive effects. Howard (2011) finds that food insecurity at home negatively impacts classroom behavior. Food insecurity can therefore have negative peer effects. Thus, providing free or subsidized school breakfast could perhaps mitigate some of these externalities by improving the classroom environment which may

help pupils to better focus on learning. The results from Norwood (2020) supports this claim, as he estimates a 16 percent lowered rate of code of conduct violations, following the implementation of free school breakfast. This may contribute so that teachers can spend more time teaching and less on monitoring pupils.

|Figure 1| Mechanisms

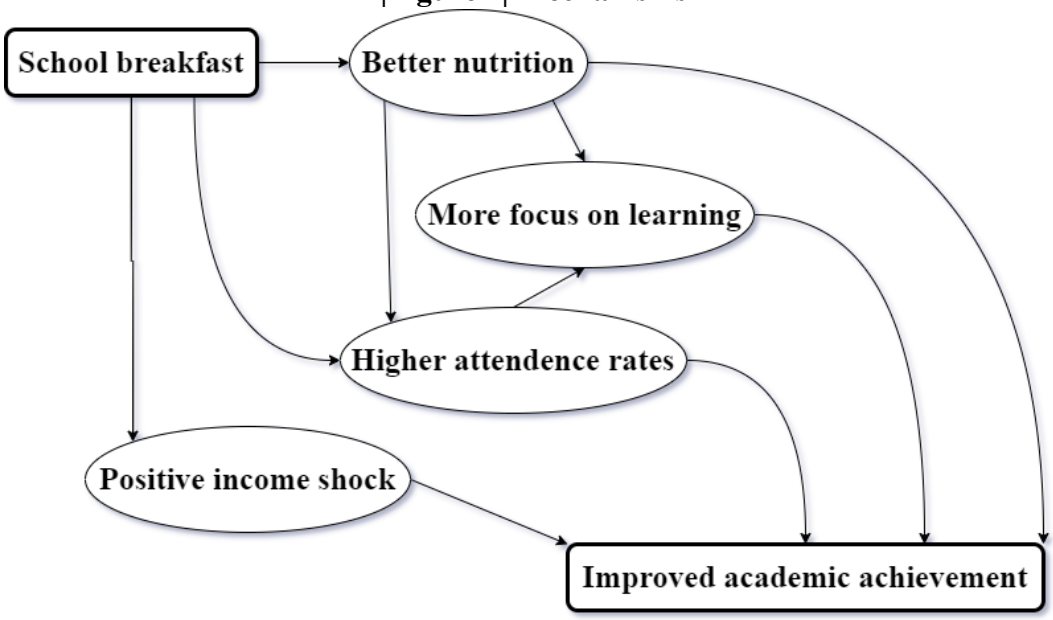

Figure 1. The figure visualises the mechanisms and channels discussed.

3. Literature review

3.1. School breakfast and academic achievement

As previously mentioned, there are concerns related to estimating the causal relationship between school breakfast and academic achievement. Studies based on observational data and OLS estimation lack credibility due to unobserved school and pupil characteristics impacting the outcome of interest. Selection bias may additionally be a problem. For example, Murphy, Pagano, and Nachmani (1998) find a positive correlation between the variables, but this does not imply a causal relationship. Due to the difficulties associated with estimating the causal relationship scholars often utilize variation in rules between and within states and the staggered implementation of school breakfast to improve credibility.

The existing research on the potential causal effects of school breakfast on academic achievement is predominantly focused on the two US school breakfast programs.[5] The School Breakfast Program (SBP) introduced in 1966 which provides free breakfast for pupils that are eligible based on household income.[6] The other, the Universal Free Breakfast Program (UFB) provides free breakfast for all pupils regardless of family income.[7]

For this thesis, the most relevant study would be when a universal free breakfast program is introduced (or removed) in a school that did not participate in a breakfast program before. However, the majority of studies (the exception is Frisvold (2014)) analyse the effects of changing from one of the programs to the other.

Bernstein et al., (2004) studies the introduction of UFB in six school districts and compares outcomes with schools that continued with the SBP. The authors find no effects on academic achievements and concludes that there are few added benefits with having breakfast free for all. Leos-Urbel et al., (2013) studies the same change, that is from SBP to UFB, in New York City and find, using a DID design, limited effects on academic achievement. The reform saw an increase in participation, but the authors argue that it was too small to impact academic achievement. Furthermore, Bartfeld et al., (2019) conclude that introducing UFB increases participation but in contrast to Leos-Urbel et al., (2013) they find positive effects on academic achievement for both programs. For SBP the effect is only found among boys with an increase in reading scores with 0.08 of a standard deviation (Bartfeld et al., 2019). For UFB the math scores increase with 0.07 SD and reading scores increase with 0.04 SD. The effect is not dependent on SES.

[5] In the discussion on the breakfast programs there is additionally a discussion on whether it is best to provide breakfast in the classroom (BIC) or in the school cafeteria (e.g. Dotter (2013), Imberman and Kugler (2014)). The evidence suggests benefits from BIC mainly in terms of participation but in some cases also in terms of academic achievement. Providing breakfast in the classroom (BIC) is very uncommon is Sweden.

[6] Below 130 percent of federal poverty guideline = free, between 130 and 185 federal poverty guideline = reduced price, above 185 percent of federal poverty guideline = full price, (Bernstein et al., 2004).

[7] The schools that are eligible for UFB are decided differently in US states.

Dotter (2013) studies the transition from SPB to UFB using a DID design and find an increase in math and reading scores by 15 and 10 percent, respectively. Dotter argues that providing UFB is a relatively cost effective way to improve academic achievement, especially in schools where students come from weaker SES backgrounds. He estimates the returns to be around 12 to 21 times the investment. In contrast to Dotter (2013), Schanzenbach and Zaki (2014) find no effects of UFB on academic achievement using an IV-design on experimental data. They argue that the increase in breakfast participation, is a shift from eating breakfast at home to eating in school. Using a DID and a RD design Norwood (2020) find that UFB increases test scores more than SBP. Interestingly, Norwood studies the effects of school breakfast on school discipline and find less truancy, less substance abuse and fewer fights in schools with UFB compared with SBP. Ribar and Haldeman (2013) investigates the change from UFB to SBP using a DID design. The authors find that breakfast participation decreased but find no effects on academic achievements.

Frisvold (2014) exploits state mandates on SBP and studies the introduction of SBP using a fuzzy regression discontinuity and a DID design. He finds an increase in math scores with eight percent of a SD with one year of exposure to the program. Based on the results the author argues that breakfast programs can positively impact cognition and by that academic achievement.

Mhurchu, Gordon, Jiang, Michie, Maddison and Hattie (2012) find no effect of school breakfast on academic achievement using a Cluster randomized trial (CRT) in a New Zealand setting.

3.2. Long term effects of school meals in the Nordics

I investigate short term outcomes but there are studies on the long term effects of school meals. For example, Bütikofer, Mølland and Salvanes (2018) investigates the expansion of the "Oslo breakfast" in Norwegian compulsory schools during the 1920s and 1930s. The reform replaced a hot school meal at the end of the school day with a breakfast with similar caloric value but less micronutrients than the hot meal. Using a staggered DID design the authors find that being exposed to the

breakfast increased earnings and educational attainment, the length of exposure is important for the former but not the latter outcome.

Lundborg et al., (2021) studies the introduction of universal free school lunches in compulsory schools in Sweden between 1959 and 1969. Using a DID design, the authors exploit the staggered implementation of the reform and look at long term outcomes. They find that the pupils who were exposed to free school lunches during their entire compulsory school period have three percent higher lifetime income, better health and more years of schooling. The effects are larger for pupils from poorer households and for those exposed to the lunches in younger years.

Thus, both studies provide evidence of the potential positive effect of introducing nutritious and universal school meals. Being exposed to these reforms early is seemingly of importance which lends credence to the theory of high returns on early life investments proposed by Cunha, Heckman, Lochner and Masterov (2006).

4. Institutional background

4.1. The Swedish school system

From the age of one, children are allowed to start in preschool ("Förskolan") and from the year the child turns six it is required by law to begin compulsory school ("Grundskolan") and its reception class ("Förskoleklass"). Compulsory school lasts for ten years with the pupils progressing from reception class to ninth grade.[8] There are both publicly[9] and privately[10] run schools that parents can choose from. After compulsory school pupils progress to the upper secondary school ("Gymnasieskolan"). Pupils are matched to the schools based on their own application and ranked by the final grade point ("Meritpoäng") received at the end of the ninth grade. Upper secondary school has two separate educational tracks, higher education preparatory programmes ("Högskoleförberedande program") and

[8] It is in some municipalities possible for pupils to continue in the same school all ten year but more often pupils have to change schools between sixth and seventh grade. Sometimes this change also/instead occurs between third and fourth grade. There also exists more variation than this in the data. For example, some municipalities have schools with pupils from reception class to fifth grade and others have pupils from sixth to ninth grade.
[9] Since 1991 the public schools are run by the municipalities.
[10] There is no tuition fee associated with the private schools.

vocational programmes (“Yrkesprogram”) (Swedish National Agency for Education, 2023).[11]

Since the school year of 2012/2013 pupils receive grades from the sixth to the ninth grade. The grading scale have six levels from “F” to “A” where “F” signifies that the pupil has not fulfilled the basic requirements of the subject. In the sixth and ninth grade pupils participate in standardized national tests (“Nationella prov”).[12] According to the law, the test score should have an impact on the final grade (Swedish National Agency for Education, 2024). Thus, the final grade is a combination of several types of assessments and not based on one examination. The final grade point is the sum of all subject grades, where F is 0, E is 10, D is 12,5, C is 15, B is 17,5 and A is 20 points, with the maximum at 340 points with 17 subjects.

4.2. School meals in Sweden

The education act (“Skollagen”) stipulates that “The pupils must be offered nutritious school meals free of charge” (Education act (2010:800), Ch. 10, §10). The law has been revised at some points. The addition of “nutritious” was made in 2011 and the condition that “meals are free for pupils” was added in 1997[13] (The Swedish Association of Local Authorities and Regions, 2022). The law is interpreted as that schools must offer school lunches free of charge, but they do not have to offer other meals such as breakfast or a snack in the afternoon (“Mellanmål”) (Swedish Food Agency, 2021, p. 22).

Consequently, all compulsory schools offer school lunches. However, the law does not forbid providing other types of meals, either free of charge or for a fee. For example, it is standard practice that the afterschool care (“Fritidsverksamhet”)

[11] The requirements differ between the two tracks as the vocational programmes requires the grade “E” in Swedish, Mathematics, English and five other subjects. For the higher education preparatory programmes, the requirement is nine other subjects with some subjects being required for specific programmes in the track.
[12] Three subjects in sixth grade (Swedish, Math and English) and five in ninth grade (Swedish, Math, English, Science studies (“NO”) and Social study subjects (“SO”).
[13] Free and nutritious school lunches has been served for a far longer time (Lundborg et al., 2021)

serves both breakfast before school starts and a snack in the afternoon.[14] The majority of pupils from reception class to the third grade are enrolled in the afterschool care (Swedish National Agency for Education, 2023, p.10).[15] Thus, younger pupils often consume more than the lunch in school.

4.3. School breakfast in Sweden

The information is limited on the availability of school breakfast in Sweden due to the absence of any legal requirements. I aim to expand our understanding of school breakfast but there has been some work on the availability of school breakfast (e.g. The Swedish Food Agency 2016, 2021, 2021).

In the Swedish Food Agency (SLV) ("Livsmedelsverket") latest survey[16] (2021) 107 of the 224 municipalities[17] that answered say that they, at least to some degree[18], provide breakfast in compulsory schools three to five times a week. 20 percent of the municipalities in the survey say that they provide breakfast to all pupils in all compulsory schools. This share is, in fact, greatly overestimated and the share of municipalities where all schools provide breakfast is actually around three percent, which I show in Section five. The reason for the disparity is presumably that municipalities have included breakfast provided in the afterschool care in their answers. The report from the SLV (2021) does not take this source of error into account.[19] The survey, done by the same agency, in 2016 finds that 25 percent of the 250 municipalities that answered the survey at least to some degree provide breakfast in compulsory school one or more times a week. A survey, by the agency

[14] The afterschool care is for pupils from reception class to sixth grade. The afterschool care is not obligatory, and parents/guardians have to pay an enrolment fee based on the household income (Swedish National Agency for Education, 2023, p.10).
[15] After the third grade enrolment in the afterschool drops sharply (Swedish National Agency for Education, 2023, p.10).
[16] A new survey is planned for the autumn of 2024.
[17] There are 290 municipalities in Sweden.
[18] The survey question was "What percentage of municipal compulsory schools usually (3-5 days a week) offer breakfast?" (my translation). 17 municipalities answered 1-25 %. 4 municipalities answered 26-50 %. 10 municipalities answered 51-75 %. 32 municipalities answered 76-99 %. 44 municipalities answered 100 %. 99 municipalities answered 0 %. 17 municipalities answered that they did not know or that they could not answer.
[19] I have been in contact with Swedish Food Agency, and they agree that breakfast provided in the afterschool care could be the source of the error. Others have voiced concerns about the validity of the survey by the Swedish Food Agency (e.g. Schneider, 2023).

(2021), sent directly to schools with pupils in seventh to ninth grade find that 17 percent of the 258 schools that answered provide breakfast for all pupils. Seven percent provides breakfast to some pupils. Moreover, the survey found that providing breakfast was more common in schools with weaker SES conditions than in schools with average or strong SES conditions. Additionally, around 50 percent of the schools assesses the nutritional contents of the breakfast.

There is little knowledge about the proportion of pupils taking part in the school breakfasts. For example, the reports by SLV do not discuss this. Ten percent seems to be a valid rough estimation (Lagergren Jernselius, 2023). Furthermore, low participation is often stated as one of the strongest arguments against providing breakfast in school. In the US there have been successful attempts to increase participation by moving the breakfast from the school restaurant to the classroom. BIC is uncommon in Sweden.

We know little about whether the school breakfast offered is free or if it comes with a fee. 66 percent of the compulsory schools that provide breakfast do it without cost for the pupils (Swedish Food Agency, 2021). Therefore, it would seem that the school breakfast is free more often than not, but the evidence is limited.

Finally, the cost for providing school breakfast varies depending on the participation rate and the quality of the breakfast. Around 10 to 15 SEK per pupil per day seem to be the range most municipalities work with (Lagergren Jernselius, 2023).[20] Recent estimations and budgets by the municipalities of Bollnäs, Botkyrka and Huddinge find the cost to be around 10 SEK (Bergbro, 2023). If school breakfast were to be offered for free to all pupils in the sixth to ninth grade, that is in the grades where the afterschool is either not available or very few pupils participate, the cost would be roughly 880 million SEK per year.[21]

[20] Something to note about the costs is that the introduction of school breakfast can be associated with increased demand for hours worked by school staff and that is rarely included in the calculations (Lagergren Jernselius, 2023).

[21] In the school year of 2022/2023 there were 496 602 pupils in 6th to 9th grade (Swedish National Agency for Education, 2024). The cost is therefore 496 602 * 10 SEK * 178 school days = 883 951 560 SEK. A lower and more realistic participation rate would decrease the cost substantially.

5. Data

5.1. School breakfast

To the best of my knowledge, there is no data available at the school level, which is my unit of observation. Therefore, I have collected information on the availability of school breakfast including year of introduction, participation rate and whether the breakfast is fully subsidized or not. The starting point for the data collection is the survey by SLV (2021). The data collection process is visualized in Figure 2.[22][23]

|Figure 2| Flowchart of data collection process

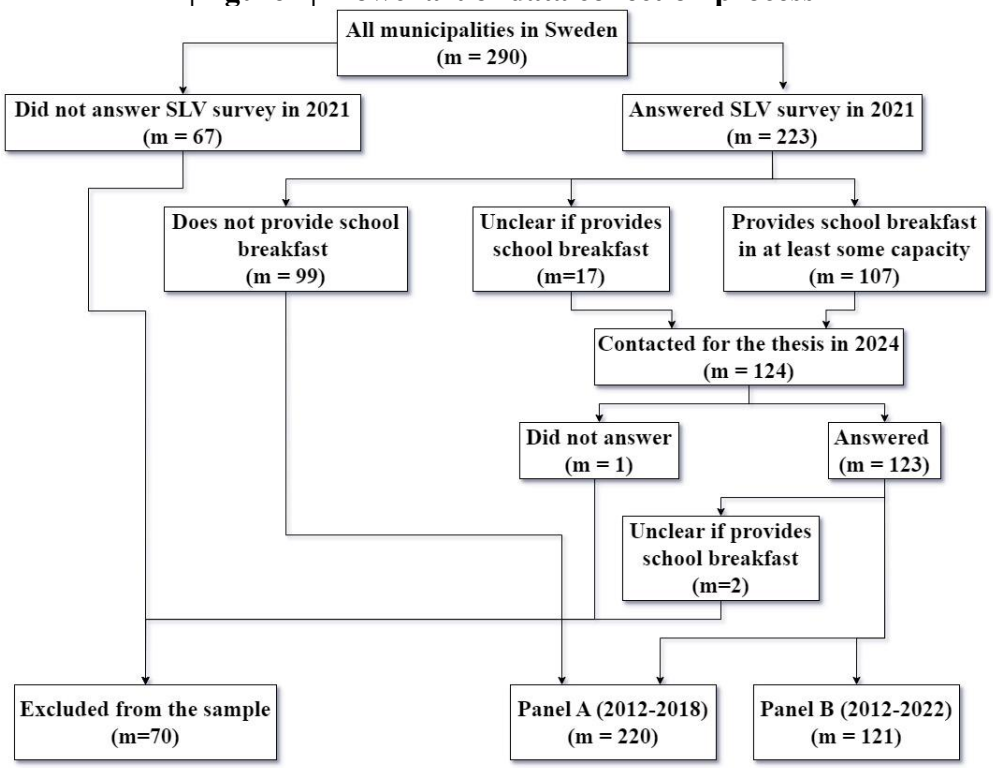

Figure 2. This figure visualizes the data collection process.

[22] The data was collected between January and March 2024. Due to the time restriction, I have decided to not contact municipalities that did not answer the SLV survey or that answer that they do not provide school breakfast. I assume that the 99 municipalities that answered that they do not serve breakfast have not served breakfast any time before 2021 aside from smaller pilot projects. For the municipalities that serve breakfast regularly i.e. not pilot projects, no one answered that they had stopped serving breakfast. The 67 municipalities that did not answer the survey are excluded from the analysis as the availability of breakfast in these municipalities are unclear. Around 17 percent of the pupils in public compulsory schools are enrolled in these municipalities (own calculations).

[23] I have sent at least three emails and made at least two phone calls to all 124 municipalities. The municipality of Arvika did not answer any email or phone calls and is therefore excluded from the sample. The municipality of Huddinge is also excluded as the year school breakfast was introduced in the schools is unclear. Four schools in the municipality of Malmö are included but the rest of the municipality is excluded for the same reason. A few schools in the municipalities of Stockholm, Gothenburg, Tyresö, Haninge, Mark and Karlstad are excluded due to the same unclarity.

The majority of the municipalities answered my questions directly, but some referred me to the principals whom I in some cases contacted for further information and clarification.[24] In general, it was possible to receive a year when school breakfast was introduced from the municipalities, but some could only answer if it happened before or after the start of my time period i.e. 2012. For the municipalities of Kumla and Värmdö, information on school breakfast was gathered using official documents found in the archives of the municipalities.

The data collection (Table 1, Row 2 and 3) show that some schools have offered breakfast for over 20 years and that many have started to offer breakfast in more recent years. There is variation both between and within municipalities. Five municipalities offer school breakfast at all schools but most, that answer to me that they offer breakfast, delegate this decision to the respective principal. Some decide on school breakfast at a higher level (e.g. local politicians in a committee). It is more common that schools fully subsidize the meal than imposing a fee (Table 1, Row 5).[25] The participation rate estimated by the municipalities and/or schools who offers school breakfast varies greatly, between 0 percent to 60 percent, with the mean at 11 percent (Table 1, Row 4).[26]

|Table 1| School Breakfast in Sweden

	Panel A (2012-2018)	Panel B (2012-2022)
Number of schools with breakfast	76	121
Introduced breakfast before 2012	62 %	39 %
Year of introduction of breakfast (mean)	2015	2019
Participation rate (2024)	12 %	11 %
Free breakfast (2024)	58 %	69 %

Table 1. The table shows descriptive statistics for school breakfast. For a complete list of schools with breakfast in the sample see Appendix Table 2.

Anecdotally, more municipalities said that the participation rate decreased with time since the introduction of breakfast and that the participation rate varies throughout the week. Some municipalities had tried serving school breakfast in pilot projects

[24] In the case where the municipality could give me a list of schools currently offering breakfast but not give any other information, I contacted the principals. In cases where the municipality had no information on breakfast and/or did not want to help me, I did not contact school principals. The email sent to schools and principals is found in the Appendix.

[25] The fee depends on the quality of the breakfast but seems to be around 5 to 10 SEK.

[26] This estimation is mostly based on the schools that offer breakfast free of charge as the municipalities that impose a fee in many cases have no information on participation.

but stopped due to low participation and/or lack of funding. One school said that they provide free breakfast to all pupils on days of standardized national tests.

In the dataset I use a binary variable indicating if a school offers breakfast to all pupils (0 = no breakfast offered, 1 = breakfast offered). This variable switches from 0 to 1 if a school introduces breakfast during the time period. If a school provides breakfast the entire period, the variable always takes the value 1 and vice versa. Additionally, I create a variable indicating if the breakfast provided is free. Schools with pilot projects shorter than one school year are excluded from the analysis. Some schools only offer breakfast to specific pupils or groups of pupils. These are considered as not having breakfast.

5.2. Outcome variables and covariates

All variables in this subsection are collected from the Swedish National Agency for Education database (2024). I consider a set of outcome variables indicating academic achievement in the short run. This includes the school average final grade point in ninth grade (0-340 points), the share of pupils in ninth grade with at least the grade "E" in all subjects and the share of pupils in ninth grade eligible for vocational programmes at upper secondary school. Additionally, I consider the average grade points in Mathematics, English and Swedish in sixth grade (0-20 points). For all variables, it is possible to restrict the sample to either boys or girls.

The database contains other variables at the school level that are of interest as covariates. This includes the share of pupils who have a parent with higher education, the share of pupils born in another country and/or with both parents born in another country, the share of female pupils at the school and the number of pupils per teacher. These variables are for the school in total. The variables are matched together in one dataset using the school code ("Skolenhetskod").[27]

[27] I make three changes to the data mentioned in this subsection. Firstly, I replace observations taking the value (.) or (..) with a blank observation. One dot (.) means no information is available. Two dots (..) means that the information is based on less than 10 pupils and therefore the data is anonymized. Secondly, observations with the value (~100) are changed to the value 100. ~100 means that one to four pupils in ninth grade are not eligible for vocational programmes at upper secondary school. Thirdly, I transform all variables defined as shares into the unit interval.

5.3. Panels and summery statistics

Data is collected for all variables from the school year of 2012/2013 until the school year of 2022/2023. The school year of 2012/2013 was the first year with the current grading system and the first year when pupils received grades in sixth grade.

The corona pandemic (COVID-19) hit Sweden in March of 2020. Although Swedish compulsory schools were not closed and the pandemic would have impacted treatment and control schools in the same way, I am for transparency reasons using two panels, Panel A (2012-2018) and Panel B (2012-2022).[28] I consider estimations run on the data in Panel B to be my main dataset as many schools have introduced school breakfast in the school years after 2018/2019 (See: Table 1). Removing these years would decrease the number of schools with breakfast considerably and by that lower the statistical power of the estimations.

Panel A contains data for 7 school years up to 2018/2019. Included are the municipalities that answered the 2021 SLV survey with some exceptions mentioned earlier. 83 percent of the public compulsory school pupils are a part of this panel. Panel B contains data for 11 school years up to 2022/2023. This panel includes the 123 municipalities that are a part of my data collection process for the treatment variable, as I cannot be sure that the 99 municipalities, which answered that they did not offer breakfast in 2021, have not introduced breakfast afterwards. 60 percent of the public compulsory school pupils are a part of this panel. Neither panel is balanced. Figure 3 shows a map of the municipalities included in the two panels.

Summary statistics for Panel A and Panel B, including a t-test comparing schools with and without school breakfast, are in Appendix Table 1. Schools with and without school breakfast are statistically different in most variables (Appendix Table 1). This supports the results of the survey, by SLV (2021), that suggested that breakfast is more frequently introduced in school with pupils with a weaker SES-background.

[28] Only two schools mentioned that they stopped serving breakfast during the pandemic. These schools are not included in the dataset for three of four DID estimators.

|Figure 3| Municipalities in the sample

Figure 3. The figure shows the municipalities included in the sample. Panel A (2012-2018) and Panel B (2012-2022).

6. Empirical strategy

6.1. Staggered difference-in-differences

The main idea of DID is a comparison of outcomes over time of different groups where some but not all groups have been exposed to an intervention (e.g. a policy such as school breakfast).

The key identifying assumption in DID is parallel trends in absence of the intervention i.e. the treatment. This implies that if there were no intervention the difference in the outcome between the groups would have stayed the same. Parallel trends before the intervention can be formally tested by comparing trends, most often by plotting estimates before the intervention date.

Other assumptions in DID design include the stable unit value assumption (SUTVA) (Rubin, 1980) and the assumption of no anticipation effects. SUTVA enforces two conditions. First, that the potential outcome of one group does not vary with the invention given to another group. This assumption can be seen as that there can be no spillover effects. Second, that for every group there are no alternate versions of each treatment level that lead to different potential outcomes. I would argue that it is likely that it holds, as there is possibly no spillover between schools and there are probably no "hidden" versions of the treatment. The assumption of no anticipation means that untreated groups should not change their behavior in the time periods prior to being treated. I find it unlikely that academic achievement would increase in anticipation of the introduction of school breakfast.

A potential threat to the internal validity would be if the introduction of school breakfast was paired with a change in the other resources to the school. For example, an increase in teachers. In my main specifications, discussed in Subsection 6.2, I include the pupils per teacher ratio as a covariate. This could be seen as a measure of the resources to the school as the cost for personnel is the largest part of the total costs. Another concern would be if a school that introduces school breakfast also starts to grade pupils more generously. There is an ongoing discussion about schools grading pupils more generously than intended in Sweden, but I find it unlikely that it would correlate with the introduction of school breakfast.

There is a possibility that there could be other interventions correlating with the introduction of school breakfast i.e. decision taken by the principal or the municipality with the aim to increase grades. However, due to a lack of data and knowledge of the conditions at the specific schools I am unable to include covariates of these types of interventions.

6.2. Estimation and main specification

Staggered DID models are often estimated using a dynamic Two Way Fixed Effect regression (TWFE) with group and time fixed effects. Recently, researchers have shown that TWFE estimates are not robust when the treatment is implemented in a staggered way and the treatment is assumed to be heterogenous, both in terms of the time dimension and by the group dimension (e.g. de Chaisemartin and D'Haultfoeuille (2020), Borusyak et al., (2021), Goodman-Bacon (2021), Sun and Abraham (2021), Callaway and Sant'Anna (2021) and Athey and Imbens (2022)). In regard to these findings Roth, Sant'Anna, Bilinski and Poe (2023) conclude that "The intuition is that, as in the static case, the dynamic OLS specification does not aggregate natural comparisons of units and includes ''forbidden comparisons'' between sets of units both of which have already been treated" (p. 2226). The implication of this is that the TWFE coefficient, due to a negative weighting problem, might have the opposite sign to the "true" estimated coefficient[29]. Furthermore, this issue can lead to an over-rejection of not having parallel trends.

My treatment, i.e. school breakfast, is presumably heterogenous both with respect to the time dimension, as implementation occurred at different points in time which then may imply different effects, and with respect to the school dimension, as the participation rate and the costs associated with the treatment varies greatly between different schools i.e. the contents of the breakfast is not the same across schools. It is also possible that the treatment effects are different for girls and boys respectively, as the literature show a gender difference. Furthermore, the

[29] Running TWFE diagnostics with the Stata package twowayfeweights (de Chaisemartin and D'Haultfoeuille 2020a) and the outcome final grade point with covariates show that around 25 percent of ATTs receive negative weights in Panel B. This suggests that the negative weighting problem can arise in my setting.

implementation process is staggered. Therefore, in addition to the standard dynamic TWFE model, I provide results from three heterogeneity robust DID estimators, discussed later in this subsection.

The dynamic TWFE model can be expressed as,

$$Y_{s,t} = \alpha_s + \phi_t + \sum_{r \neq 0} 1[R_{s,t} = r]\,\beta_r + \boldsymbol{X_{s,t}} + e_{s,t} \quad (1)$$

where Y is the outcome variable, the subscript s is the group indicator i.e. the school, the subscript t is the time indicator, α are the school fixed effects, ϕ are the year fixed effects, R is the time relative to the treatment year[30], β is the parameter of interest, **X** are a set of covariates including the share of pupils who have a parent with higher education, the share of pupils born in another country or with both parents born in another country, the share of female pupils at the school and the number of pupils per teacher, e is the error term. The reported standard errors are clustered at the school level allowing for arbitrarily correlated errors within schools over time.

Due to the issues with the dynamic TWFE model, I also provide results from the heterogeneity robust DID estimators proposed by Callaway and Sant'Anna (2021) (CS), Borusyak et al., (2021) (BJS) and de Chaisemartin and D'Haultfoeuille (2021) (dC&DH).[31] There are other heterogeneity robust DID estimators available (e.g. Sun and Abraham (SA) (2021)) but covariates are not implemented in the SA estimator. I argue that the CS, BJS and dC&DH complements each other as there are differences between them and they have different strengths and weaknesses.

[30] I use three periods before and four periods after treatment. As the panels are relatively short and the number of treated schools is fairly low, I think this is the optimal choice of periods considering statistical power.

[31] CS is implemented in Stata using the package csdid (Sant'Anna and Zhao, 2020, Callaway and Sant'Anna, 2021). BJS is implemented in Stata using the package did_imputation (Borusyak et al., 2021). dC&DH is implemented in Stata using the package did_multiplegt (de Chaisemartin and D'Haultfoeuille 2020a). A newer and faster package did_multiplegt_dyn is available but do not work with the package used for figures. TWFE models are estimated using the package reghdfe (Correia, 2014). For the package to work properly the period before treatment is dropped.

However, it should be mentioned that there is currently no consensus about which estimator is best to use.

CS and BJS differs in that CS makes all comparisons relative to the last pre-treatment period while BJS makes comparisons relative to the pre-treatment periods (Roth et al., 2023). In relation to the assumption of parallel trends, BJS requires it to hold for all groups and time periods while CS consider post-treatment parallel trends. Roth et al., (2023) argues that implication of this is that BJS might be better in settings where the serial correlation in the outcome is low, and the researcher is sure that parallel trends hold in all time periods while CS might be preferable with high serial correlation and lower confidence in parallel trends in all time periods. In a staggered setting CS and dC&DH are similar but dC&DH is more flexible allowing switching in and out of the treatment group. Covariates are incorporated differently in the estimators, where BJS and dC&DH considers covariates in a linear manner. In contrast, CS uses a method combining outcome regression and inverse probability weighting to form a doubly robust estimator (Sant'Anna and Zhao, 2020).

In conclusion, I consider CS to be my preferred estimator as the parallel trend assumption is weaker and its inclusion of covariates is more robust to misspecification. I then prefer dC&DH for its similarities to CS and its flexibility in the ability to include schools that stops with school breakfast. Lastly, I prefer BJS less than CS and dC&DH due to the high probability of serial correlation across school years and the stronger parallel trend assumption.[32]

[32] Figures are made using the event_plot package (Borusyak et al., 2021). Because of differences between the estimators the number of observations varies somewhat.

7. Results

7.1. Main results

|Figure 4| Final grade point in ninth grade

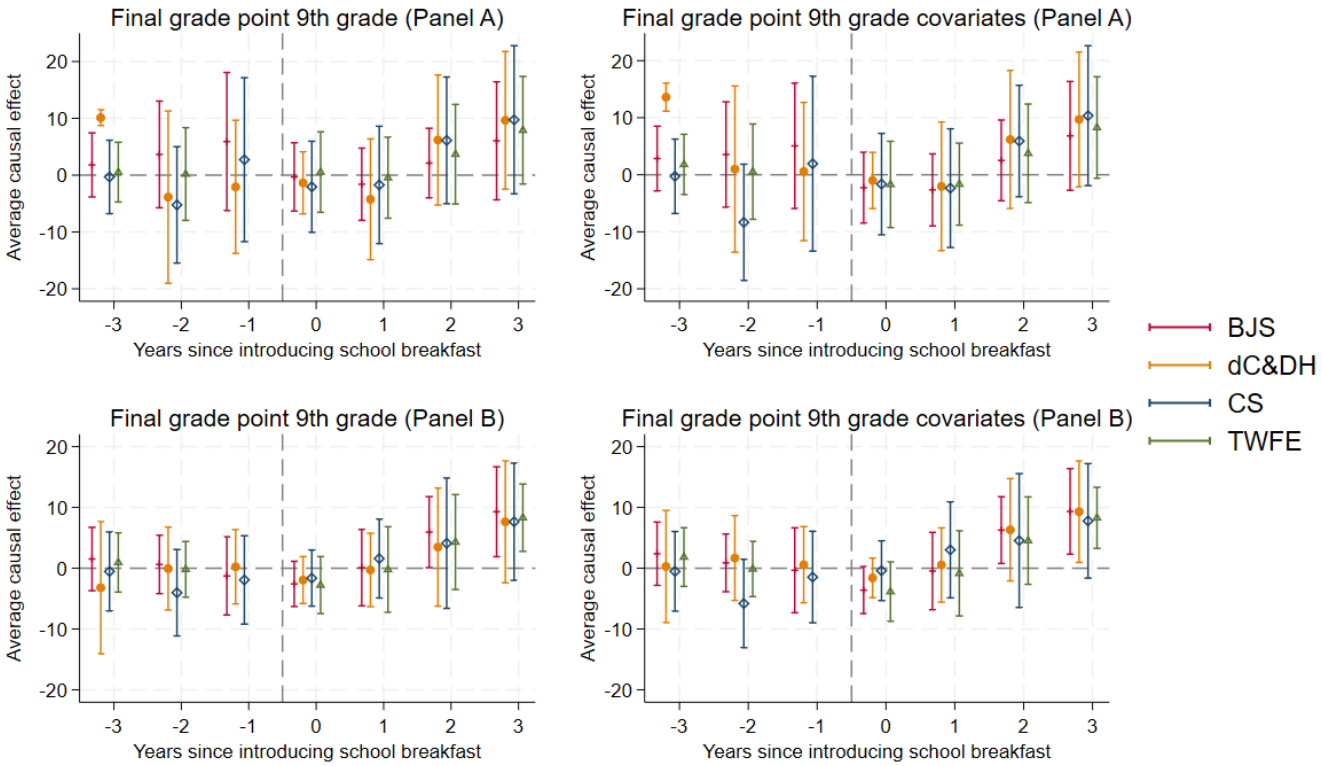

Figure 4. This figure provides BJS, dC&DH, CS and TWFE estimates for the outcome variable final grade point in ninth grade. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. The first row is for Panel A (2012-2018) and the second row is for Panel B (2012-2022). The first column is without covariates and the second column is with covariates. The number of clusters is around 1050 (Panel A) and 900 (Panel B). The number of observations is around 5700 (Panel A), 5400 (Panel A with covariates), 6300 (Panel B), 5900 (Panel B with covariates).

From the graphical evidence in Figure 4, the main identifying assumption of parallel trends appear to hold as almost all confidence intervals before the introduction of school breakfast contains the value zero. With the larger number of treated schools in Panel B the precision increases. Figure 4 (Column 2, Row 2) suggest that there could be an effect of school breakfast on the final grade point after being exposed to the policy for a few years. Both the BJS and the dC&DH estimator indicate this and there is a positive trend in the estimates after the treatment for both panels. Quantitatively the effect is around nine points which roughly could correspond to an increase in one subject's grade from "E" to "A", an increase from "F" to "E" in

one subject or a one grade step increase in four subjects (Appendix, Table 3. Column 1). This also corresponds to an increase in the final grade point with 3 percent or 35 percent of a standard deviation.

|Figure 5| At least grade "E" in all subjects in ninth grade

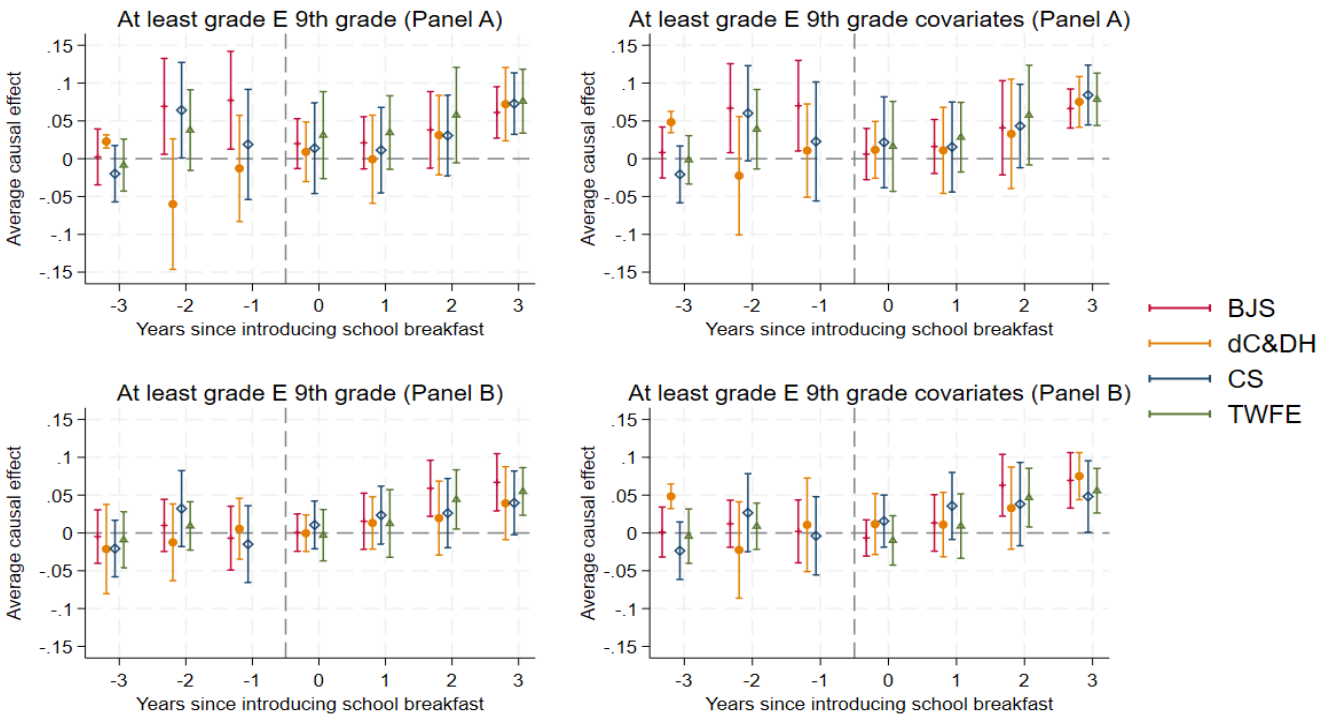

Figure 5. This figure provides BJS, dC&DH, CS and TWFE estimates for the outcome variable at least grade "E" in all subjects in ninth grade. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. The first row is for Panel A (2012-2018) and the second row is for Panel B (2012-2022). The first column is without covariates and the second column is with covariates. The number of clusters is around 1040 (Panel A) and 890 (Panel B). The number of observations is around 5700 (Panel A), 5400 (Panel A with covariates), 6000 (Panel B), 5800 (Panel B with covariates).

The second outcome in ninth grade, at least grade "E" in all subjects, provides evidence for an effect of school breakfast. Parallel trends appear to hold even though the precision in the estimations before treatment is low in Panel A (Figure 5, Row 1). As with the previous outcome there is seemingly a positive trend after the introduction of breakfast (Figure 4). In the last period, for the specifications with covariates, all estimators indicate a positive effect (Figure 5, Column 2). Quantitatively this effect corresponds to an increase in the proportion of pupils with a passing grade in all subjects with around 6 percentage points (or roughly 8 percent) than before the policy was implemented or an increase of 43 percent of a

standard deviation in the outcome (Appendix, Table 3, Column 2). This suggests larger effects on the lower tail of the grade distribution.

|Figure 6| Eligible for vocational programmes at upper secondary school

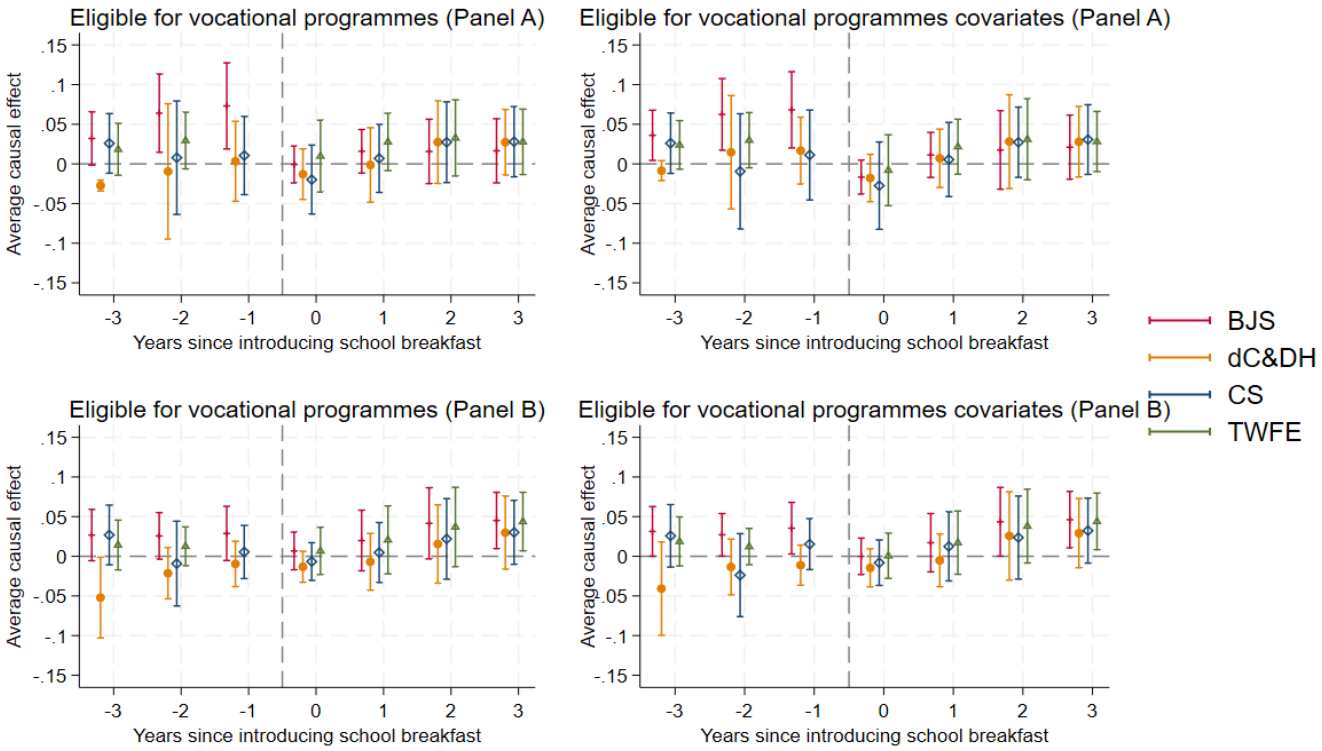

Figure 6. This figure provides BJS, dC&DH, CS and TWFE estimates for the outcome variable eligible for vocational programmes at upper secondary school. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. The first row is for Panel A (2012-2018) and the second row is for Panel B (2012-2022). The first column is without covariates and the second column is with covariates. The number of clusters is around 1040 (Panel A) and 890 (Panel B). The number of observations is around 5600 (Panel A), 5400 (Panel A with covariates), 6200 (Panel B), 5900 (Panel B with covariates).

For the third outcome in ninth grade, eligible for vocational programmes at upper secondary school, the assumption of parallel trends seems to hold (Figure 6), but in contrast to the previous outcomes, there is more noise and the BJS estimator is statistically significant from zero before treatment, in most estimations. Again, there is a positive trend after the introduction of breakfast but only the BJS estimator is statistically significant in the last school year (Figure 6, Column 2, Row 2). Therefore, this result does not suggest an effect in relation to eligibility for vocational programmes at upper secondary school (Appendix Table 3. Column 3).

|Figure 7| Grade point in Mathematics in sixth grade

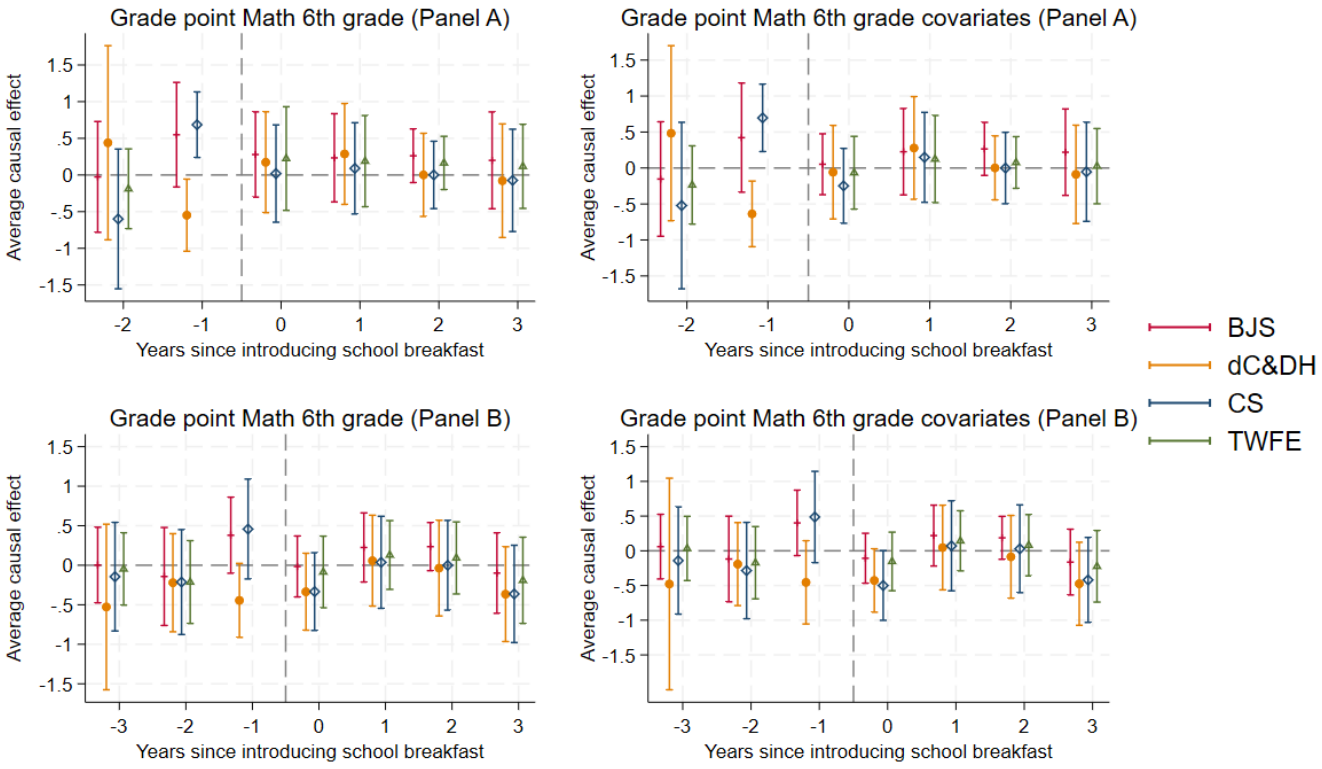

Figure 7. This figure provides BJS, dC&DH, CS and TWFE estimates for the outcome variable grade point in Mathematics in sixth grade. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. The first row is for Panel A (2012-2018) and the second row is for Panel B (2012-2022). The first column is without covariates and the second column is with covariates. The number of clusters is around 1970 (Panel A) and 1670 (Panel B). The number of observations is around 11 200 (Panel A), 8900 (Panel A with covariates), 12 500 (Panel B), 10 400 (Panel B with covariates).

For the grade point in Mathematics, the estimates before treatment periods[33] are imprecise in Panel A (Figure 7, Row 1). Precision increases in Panel B but there is still variation, especially in the period before treatment (Figure 7, Row 2). The estimates after treatment do not indicate any effect on the grade point in Mathematics (Figure 7 and Appendix Table 3. Column 4).

Considering the grade point in English, parallel trends seem to hold (Appendix Figure 1). The BJS estimator show an immediate positive effect in the period when school breakfast was introduced, but this goes away in later periods (Appendix

[33] For Panel A only two pre-treatment periods could be used for sixth grade outcomes as the dC&DH estimator did not work with three periods with the limited variation in the treatment variable.

Figure 1, Column 2, Row 2). Thus, there is no evidence for an effect in relation to the grade point in English (Appendix Table 3, Column 5).

Regarding the grade point in Swedish, estimates are imprecise prior to the treatment, especially in Panel A (Appendix Figure 2). Similar to the grade point in Mathematics estimations, precision increases in Panel B and parallel trend appear to hold. Almost all estimations after the introduction of breakfast have estimates that cannot be distinguished from zero (Appendix Figure 2). The second to last period for Panel A with covariates could suggest a negative effect but as earlier and later estimates differ from this, there is presumably no effect here (Appendix Figure 2, Column 2, Row 1 and Appendix Table 3, Column 6).

7.2. Heterogeneity and additional findings[34]

Considering if there are any differences in outcomes between girls and boys, the results suggest that boys could benefit more from consuming school breakfast than girls (Compare: Figure 8 and Appendix Figure 3). Quantitatively the estimated effects are larger for all ninth grade boy outcomes. For example, there is a clear positive effect for the outcome at least grade "E" in all subjects (Figure 8, Column 3, Row 1 and Appendix Table 4, Column 2). This outcome measured for girls is not statistically different from zero at the 95 percent confidence level (Appendix Figure 3, Column 3, Row 1 and Appendix, Table 4, Column 1). These results suggest that the impact on boys could be driving the positive and statistically significant results found in Subsection 7.1. Regarding outcomes in sixth grade the conclusion of no effect made previously can also be made here as estimates vary without pattern and rarely are statistically different from zero (See: Figure 8, Row 2 and Appendix Figure 3, Row 2).

[34] All estimations in this subsection use Panel B with covariates as the specification estimated. Some data with treated schools have been dropped in order to make the BJS estimator work in this subsection. The rest of the estimators use the same data as in the previous subsections.

|Figure 8| All outcomes (Boys)

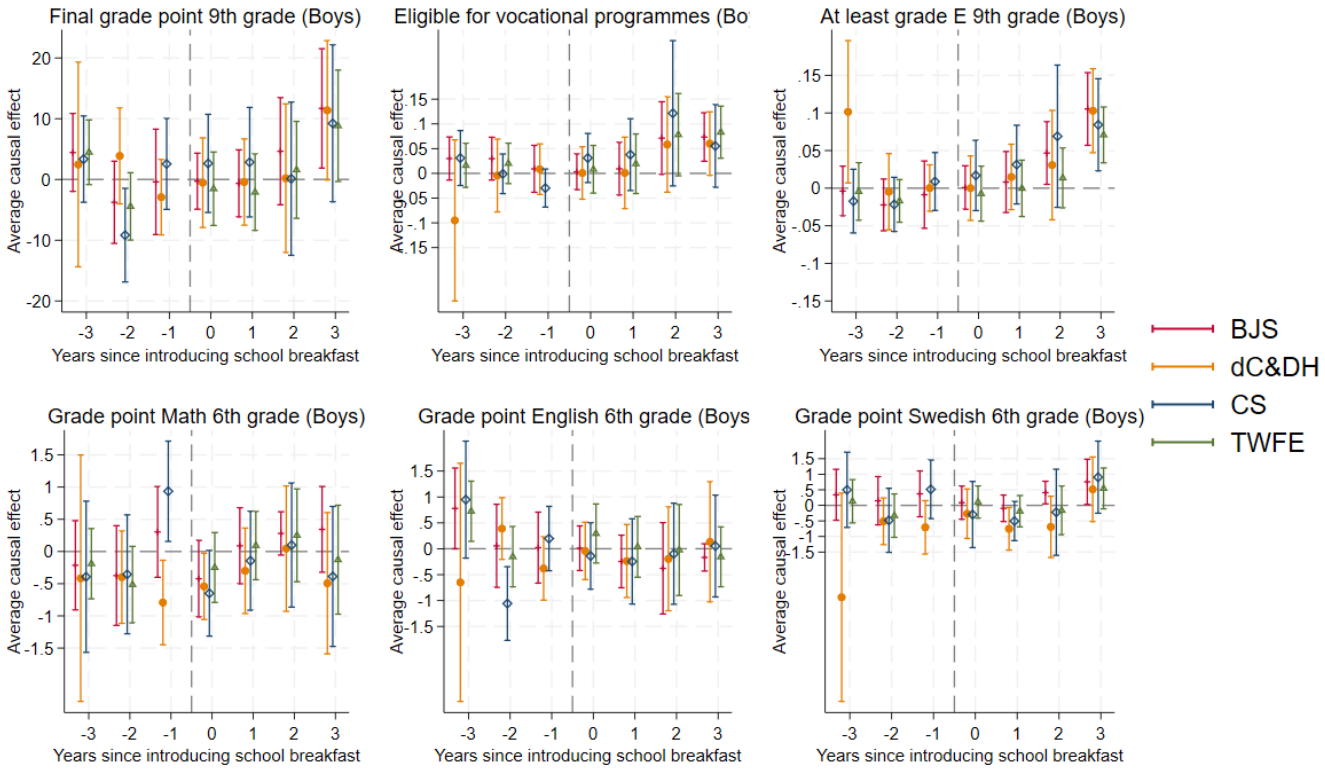

Figure 8. This figure provides BJS, dC&DH, CS and TWFE estimates for all outcome variables with the sample restricted to boys. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. The number of clusters is around 840 (ninth grade outcomes) and 1410 (sixth grade outcomes). The number of observations is around 5400 (ninth grade outcomes) and 8900 (sixth grade outcomes).

One could hypothesize that the introduction of school breakfast could have different effects based on the characteristics of the pupils. For example, that school breakfasts could have an effect in schools where students have a weak SES-background but not have an effect in schools where students have a stronger SES-background. Therefore, I have split the sample in two, where one group consists of schools where parents have an education lower than the median and where the proportion of pupils and/or parents with a foreign background is higher than the median, and vice versa.[35] Effects measured for pupils, from schools where parents have lower

[35] This combination of two variables can be seen as a proxy for SES. Income data is not available. The precision in these estimations is low as the number of observations is around half compared to earlier estimations (Appendix Figure 4 and 5). The lower number of treated schools in each group is contributing to the decrease in power.

education and pupils or/and parents have a more foreign background, seem to be somewhat higher than in the other group, but the low precision makes it hard to draw any larger conclusions (Appendix Figure 4, Row 1, Appendix Figure 5, Row 1 and Appendix Table 4, Column 3-4). Again, the sixth grade outcomes are not statistically significant (Appendix Figure 4, Row 2 and Appendix Figure 5, Row 2).

|Figure 9| All outcomes (Free school breakfast)

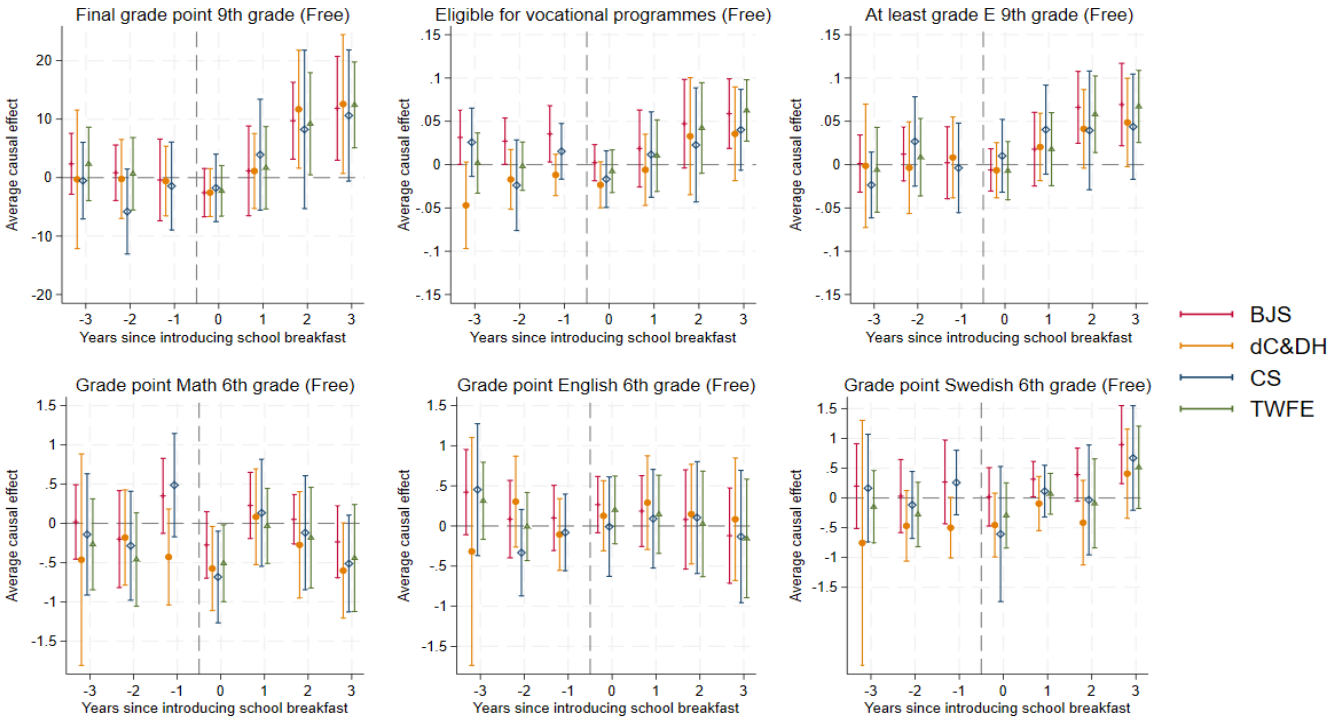

Figure 9. This figure provides BJS, dC&DH, CS and TWFE estimates for all outcome variables where the treatment schools have been limited to those offering school breakfast for free. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. The number of clusters is around 860 (ninth grade outcomes) and 1520 (sixth grade outcomes). The number of observations is around 5900 (ninth grade outcomes) and 10 000 (sixth grade outcomes).

70 percent of the schools in Panel B provide school breakfast free of charge (Table 1). It is plausible that free school breakfast could be more beneficial to pupils compared to when the pupils have to pay a fee. The results, provided in Figure 9, show similarities compared to results obtained with the full sample (Compare: Figure 9 and Figure 4-7, Appendix Table 4, Column 5). This evidence is not conclusive but does suggest that free school breakfast can have a positive impact

on ninth grade outcomes.[36] As with earlier estimations no effect is found for sixth grade outcomes (Figure 9, Row 2).

8. Discussion

8.1. Results and mechanisms

There are multiple possible mechanisms underlying the results. The primary mechanism according to the literature is the better nutritional intake that school breakfast allows for. I have not systematically collected information on the contents of the breakfast that are served in Sweden. However, sometimes the municipality told me about what they serve. From this there is seemingly a large variation in the contents. According to the SLV survey (2021) 50 percent of the schools offering breakfast make nutritional considerations. Better nutrition could therefore be a valuable mechanism explaining some of the result.

Another mechanism from the literature is that increased school attendance leads to higher academic achievement. This potential channel of effect is difficult to evaluate as there is no data available on attendance rates at the school level. The low participation rate in the data could suggest that few pupils take advantage of the breakfast, but the participating pupils might on the contrary be the ones where attendance increases due to the provision of the breakfast.

The last mechanism, discussed in the literature, is the positive income effect that could improve investment in children by parents, and in that way reduce some of the adverse behaviour in school, which is caused by food insecurity. As with the previous mechanism, the lack of data on for example, household income and classroom environment, makes it challenging to assess the importance of this mechanism. The decrease in food insecurity, that the introduction of school breakfast might bring, could explain at least parts of why time of exposure seem to matter, as pupils from poor households would know that they will always receive breakfast in school. The main finding of Norwood (2020), that school breakfast

[36] The number of treated schools with school breakfast introduced during the time period and that have a fee are too low (clusters = 11) to be estimated with any credible statistical power. Therefore, I do not provide equivalent results for these schools.

decreases truancy and leads to fewer fights, could hold in the Swedish context meaning that the school breakfast improves academic outcomes as pupils can focus more on learning as the classroom environment is calmer. Additionally, this implies that pupils that did not consume breakfast at school could benefit from the policy, i.e. that the classmates that consume school breakfast are calmer and more focused.

Furthermore, there could be other potential explanations or mechanisms. One that could explain the difference, in outcomes between sixth and ninth grade outcomes, is that younger pupils eat breakfast more regularly[37], meaning that the provision of school breakfast might not be as important in lower grades as more pupils consume breakfast before going to school. This could be due to that parents monitor younger children more than older children. The older children might therefore be more independent. It could additionally be the case that pupils in both control and treatment schools receive breakfast at the afterschool in fourth grade. This could explain why there is no time trend for the sixth grade outcomes. Another reason could be that the increase in academic achievement, due to school breakfast, comes from other subjects than the three I consider.[38] Moreover, it is possible that there is no effect of school breakfast in sixth grade as have been shown in the literature.

8.2. Results in relation to earlier findings

This is, to the best of my knowledge, the first study to investigate the causal relationship between school breakfast and academic achievement in Sweden. Therefore, I am unable to directly compare my results to others in this setting. It is nonetheless possible to discuss the results in relation to literature.

My result of both there being an effect, seemingly in two ninth grade outcomes, and there not being an effect, in sixth grade outcomes mainly, is somewhat contradictory to the literature where scholars either find an effect (e.g. Dotter (2013), Frisvold (2014), Bartfeld et al., (2019), Norwood (2020)) or not (e.g. Bernstein et al., (2004), Leos-Urbel et al., (2013), Ribar and Haldeman (2013), Schanzenbach and Zaki

[37] According to The Public Health Agency (2023), 77 percent of 11 year olds, 69 percent of 13 year olds and 55 percent of 15 year olds consumes breakfast five times a week.
[38] From the ninth grade outcomes I cannot observe if there is a difference between subjects in the effects of school breakfast.

(2014)). It should however be noted that previous studies mostly pool academic achievement outcomes for multiple grades and report one combined coefficient.[39] Ribar and Haldeman (2013) and Imberman and Kugler (2014) do report academic outcomes divided by grades but they either do not find any statistical significance or there is no difference between grades. Schanzenbach and Zaki (2014) find some difference in test scores in math were younger pupils, in first grade, were negatively affected but this does not hold for pupils in later grades. Thus, the literature cannot explain the difference between sixth and ninth grade outcomes that I estimate.

A key component of my results is that years of exposure to the school breakfast seems to matter for the outcome. Exposure can be seen both as that the school has been exposed, i.e. serving breakfast for multiple years, but I argue that the interpretation is that pupils have been exposed in years prior to ninth or sixth grade. The literature provides few answers on the potential importance of length of exposure for short-term outcomes as most studies only uses a panel with a couple of years. Furthermore, the DID estimators used does not in most cases take dynamic effects into account. There are exceptions, Dotter (2013) find that the effect is consistent with time. This finding is supported by Imberman and Kugler (2014) and Bernstein et al., (2004). Somewhat contrary to this, Bartfeld et al., (2019) find that attendance rate increases with exposure time to school breakfast. Frisvold (2014) underlines the importance of persistent exposure but does not provide statistical evidence of this. Thus, in contrast to my result, it is unclear in the literature if exposure time is important for the academic outcomes.

Relating the heterogeneity in outcomes, that I observe, to the literature I find the same gender difference as Leos-Urbel et al., (2013) and Bartfeld et al., (2019) with a larger gain for boys than for girls. This is surprising as boys in Sweden, in all age groups, eat breakfast more regularly than girls (Public Health Agency, 2023). Dotter (2013) argues that disadvantaged pupils would benefit more from school breakfast than others. Due to the limited number of treated schools, it is difficult for me to

[39] The most frequent US grades that are studied are from first to sixth grade. The literature often uses test scores as the academic achievement measure.

fully substantiate this claim. If free school breakfast is important or not for the academic outcomes is heavily debated in the literature and in the public debate. My findings show that free school breakfast does increase some ninth grade outcomes but should not be seen as conclusive in the discussion on free school breakfast.

As scholars in the literature have noted (e.g. Bartfeld et al., 2019), the DID estimates of the impact of school breakfast should be seen as lower bound estimates as participation is often low. This holds true for my study as the average participation rate in Panel B is 11 percent (Table 1). Thus, estimates are intentions to treat effects (ITT) and not treatment on the treated (ToT). A larger participation rate might therefore in turn increase the benefits of school breakfast as the estimates would be increased by a factor of 9 if assuming 100 percent participation in the school breakfast. A more realistic increase in the estimate, with the participation rate at 25 percent, would suggest an increase by a factor of 2.3. This would suggest that the increase in the final grade point would be around 7 percent and the increase in the share of pupils with at least the grade "E" in all subjects would be 18.4 percent.

Finally, the treatment of school breakfast is heterogenous therefore I opt for DID estimators that incorporate heterogeneity into the estimation procedure. For the results (See Section 7 and Appendix Figures) it is visible that the standard TWFE estimator frequently coincide with the BJS estimator. On the contrary, the CS and the dC&DH estimator are repeatedly almost identical. The latter result is not surprising as the pair of estimators are similar with the difference stemming from the incorporation of covariates and the flexibility of the treatment variable. On the other hand, the similarities in estimates between TWFE and BJS is unexpected considering their differences. In the way I implement these estimators I find no answers on why this is the case, but it should be noted for the ongoing discussion in the DID literature about the most credible way to uncover causal estimates from policy interventions. One conservative suggestion is to use more than one of the estimators in order to strengthen the internal validity of the results.

8.3. Economic significance of the results

Dotter (2013) proposes that the returns from introducing free breakfast are around 12 to 21 times the investment. The cost in my setting seems to be around 10-15 SEK per pupil per day which puts the cost at around 2200 SEK per school year per pupil. Four years of exposure to school breakfast would suggest a total cost per pupil at 10 000 SEK meaning that a gain of more than 10 000 SEK would make the investment profitable. It is difficult to fully assess the returns to the investment, but it is plausible that the introduction of school breakfast is profitable for the society. The increase in final grade point with three percent (0.35 SD) and the increase in the proportion of pupils with a passing grade in all subjects with eight percent (0.43 SD), that I find, does improve the pupils' options when it comes to choosing an upper secondary school. This could have effects on later in life outcomes, such as earnings and educational attainment, if the quality of the upper secondary education differs greatly between schools.[40]

Comparing my results with other school interventions, Dahl and Lockner (2012) find an increase in math and reading scores with 0.06 SD after a EITC reform that increased the income by 1 000 USD. Krueger (1999) estimates an increase in test scores for younger pupils (kindergarten to third grade) with five percent (0.22 SD) following a reduction in class size. Fredriksson, Öckert and Oosterbeek (2013) find that a reduction of the class size by one pupil increases cognitive test scores by 0.02 SD. Although the outcome measures are different compared with the ones that I use, this comparison suggests that school breakfast could be a competitive school intervention, both in terms of costs and in terms of the effect. From the results it is not apparent where on the grading scale the increase occurs even though the relatively substantial increase in the proportion with a passing grade in all subjects suggests an increase from "F" to "E" to be common. Additionally, my results should be seen as lower bound estimations as participation in breakfast is low.

[40] This could be the case if the quality of the teachers is higher in schools with more pupils with higher compulsory school grades. That is, if these schools also are more popular among teachers.

There could be other non-academic benefits from providing breakfast in school. Bütikofer et al., (2018) show an increase in earnings for pupils exposed to school breakfast in Norway in the 1930s. However, it is unclear to what extent it is possible to directly compare that intervention to a breakfast intervention in 2020s. Lundborg et al., (2021) find an increase in earnings after being exposed to free school lunches. They conclude that the intervention returns around four times the investment. It should however be noted that the participation rate is much larger for school lunches than for school breakfasts making the comparability more difficult.

Improvements in health could be an additional benefit, provided that the school breakfast is nutritious. The idea is that, by providing breakfast in school, children in a relatively young age learn to eat healthier which may improve their health in both the short and the long term. This could in turn reduce the need of costlier health interventions later in life. Furthermore, a calmer classroom environment, due to school breakfast, may decrease the stress level for both teachers and pupils which may lead to an improved mental health which also could decrease future costs.

9. Conclusion

I investigate the causal relationship between the staggered introduction of school breakfast and academic achievement. I collect information on the timing of the introduction of school breakfast from 123 municipalities and link it to panel data on academic achievement in sixth and ninth grade for the school years of 2012/2013 to 2022/2023. I make use of the recently developed DID estimators (BJS, dC&DH and CS) that are robust to heterogeneity in treatment and find evidence for a positive effect in ninth grade after four years of exposure to the breakfast. This seems to be driven by an increase in boys' academic achievement. I find no effects in relation to sixth grade outcomes. I do not find any difference in outcomes between schools with different SES conditions although effects seem larger in the lower tail of the grade distribution. Overall, this study adds new knowledge about the availability and the effects of school breakfast in Sweden. My results suggest that there are benefits from introducing school breakfast. Furthermore, I add a practical example with heterogenous DID estimators to the discussion about causal inference.

There are multiple avenues that could be explored in future research. Firstly, I study most of the municipalities but not all of them. I do not study private or upper secondary schools. By including these schools even more knowledge could be gathered about the relationship between school breakfast and academic achievement in Sweden, which could help to mitigate some of the issues with low statistical power that I have encountered. Secondly, long-term effects of being exposed to school breakfast could provide more answers about the often presumed importance of early-life interventions. Thirdly, if providing breakfast in the classroom were to be the practice used in Sweden it would be interesting to compare outcomes between the types of breakfast provision. Finally, there are other outcome dimensions (e.g. health, crime, inequality and study environment) that could be studied to further evaluate the effectiveness of providing breakfast in school.

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Since January of 2023 I have been an ordinary member (“Ledamot”) of The Education Committee (“Utbildningsnämnd”) in the municipality of Stockholm. This has not influenced the work with the thesis.

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Appendix

A.1. Email sent to municipalities and in some cases to principals[41]

Municipalities

My name is Simon, and I am a student in the master's program in Economics at Stockholm University. This spring semester I am writing my master's thesis on the relationship between school breakfast and academic achievement in compulsory schools.

In order to do this, I need to collect data on which schools in your municipality offer their pupils breakfast and in which academic year they started doing so.

I would be very grateful if you could help me answer the questions below.

My questions:

- Which of your schools offer their pupils breakfast?
- In which school year did the schools start offering pupils breakfast?
- Has any school that previously offered pupils breakfast stopped doing so, and if so, in which academic year?
- Does the municipality have any idea what percentage of pupils regularly take part in the school breakfast?
- Is the breakfast served free of charge or for a fee for the pupils?
- Is school breakfast offered to all pupils or only to certain grades/groups?

[41] Emails were sent in Swedish. This is a translation.

If you have any questions, please do not hesitate to contact me at this email address or by phone at the mobile number in the signature. I will of course share my thesis with you when it is finished. I have also attached a document with more information about my thesis.

I hope for your participation.

Principals

My name is Simon, and I am a student in the master's program in Economics at Stockholm University. This spring semester I am writing my master's thesis on the relationship between school breakfast and academic achievement in compulsory schools.

In order to do this, I need to collect data on which schools offer their pupils breakfast and in which academic year they started doing so. I have been in contact with the education administration, who informed me that your school offers school breakfast.

I would therefore be very grateful if the school could help me answer two questions.

My questions:

- In which school year (year) did the school start offering pupils breakfast?
- Do you have any idea what percentage of pupils regularly take part in the school breakfast program?

If you have any questions, please do not hesitate to contact me at this email address or by phone at the mobile number in the signature. I will of course share my thesis with you when it is finished. I have also attached a document with more information about my thesis.

Thank you in advance for your help.

A.2. Additional figures

|Figure A.1| Grade point in English in sixth grade

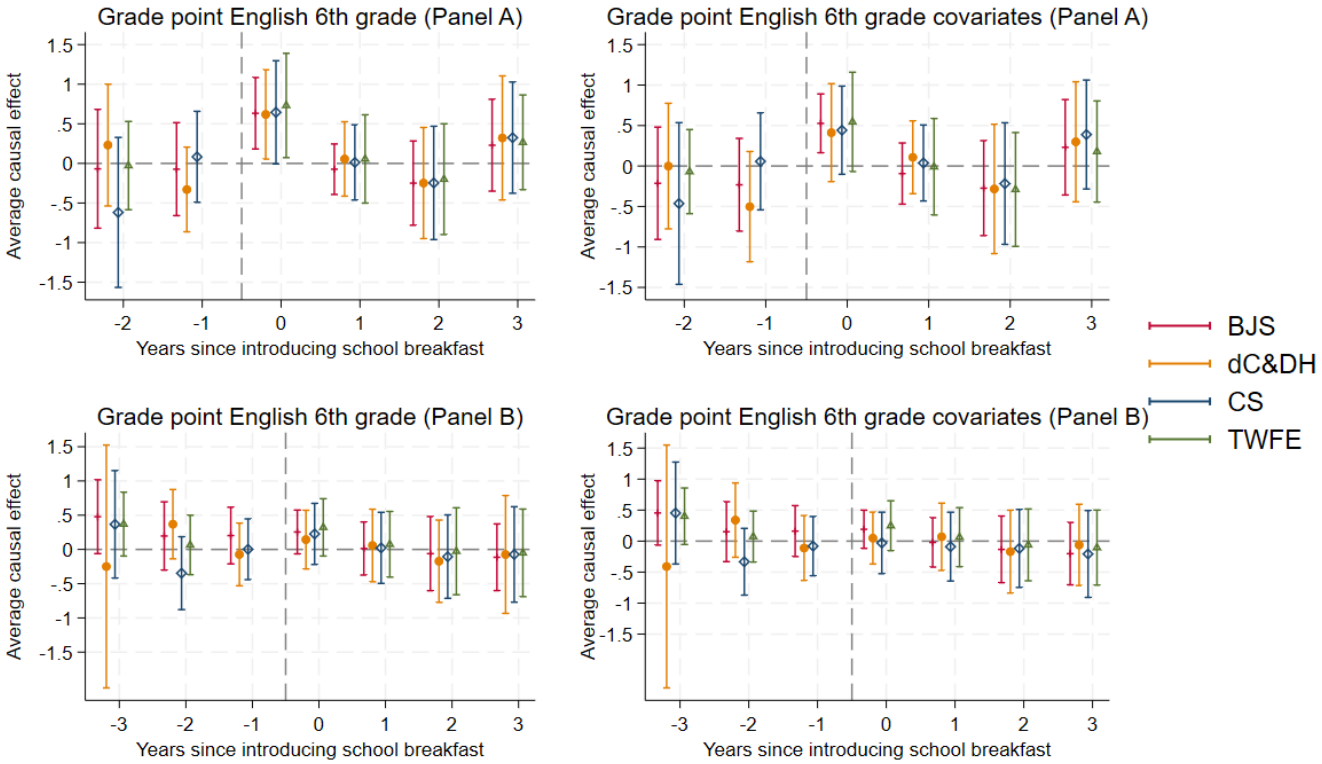

Figure A.1. This figure provides BJS, dC&DH, CS and TWFE estimates for the outcome variable grade point in English in sixth grade. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. The first row is for Panel A (2012-2018) and the second row is for Panel B (2012-2022). The first column is without covariates and the second column is with covariates. The number of clusters is around 1960 (Panel A) and 1670 (Panel B). The number of observations is around 11 000 (Panel A), 9000 (Panel A with covariates), 12 500 (Panel B), 10 400 (Panel B with covariates).

|Figure A.2| Grade point in Swedish in sixth grade

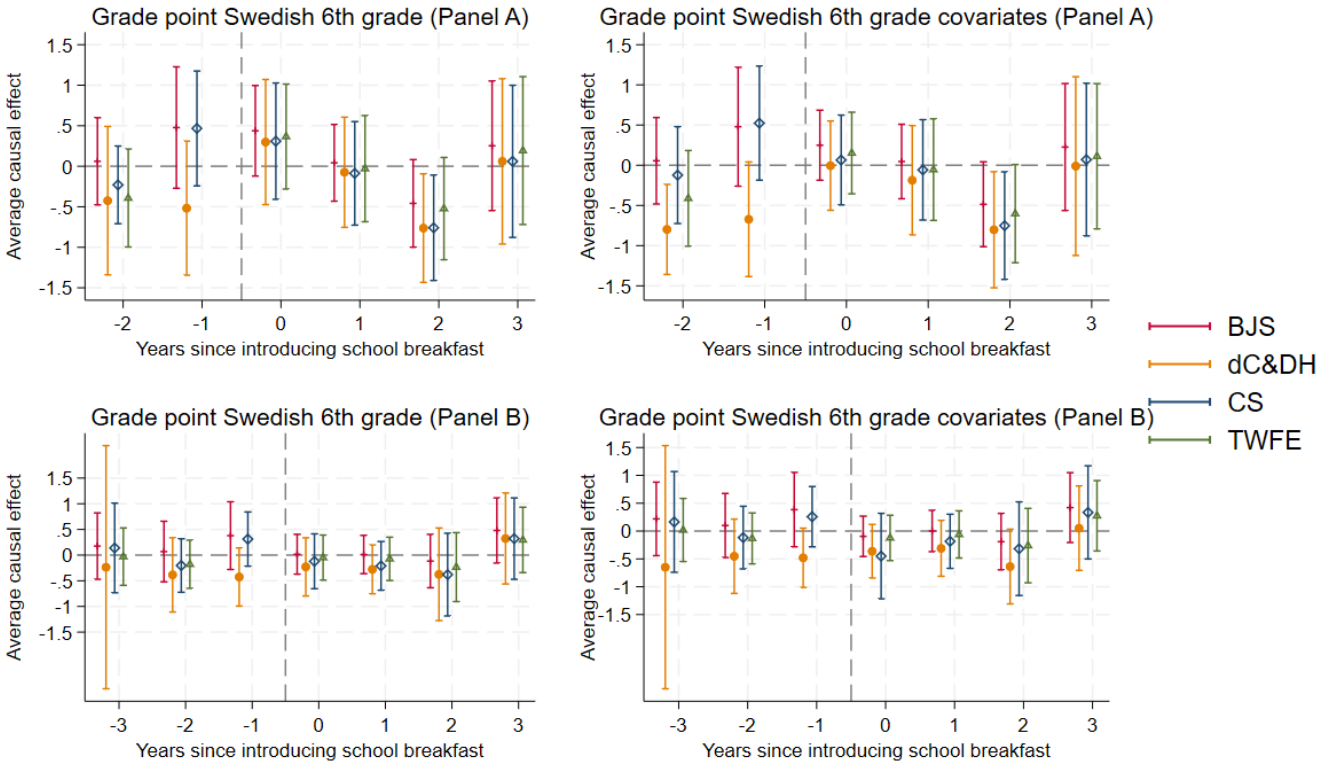

Figure A.2. This figure provides BJS, dC&DH, CS and TWFE estimates for the outcome variable grade point in Swedish in sixth grade. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. The first row is for Panel A (2012-2018) and the second row is for Panel B (2012-2022). The first column is without covariates and the second column is with covariates. The number of clusters is around 1880 (Panel A) and 1600 (Panel B). The number of observations is around 10 700 (Panel A), 8900 (Panel A with covariates), 11 700 (Panel B), 9700 (Panel B with covariates).

|Figure A.3| All outcomes (Girls)

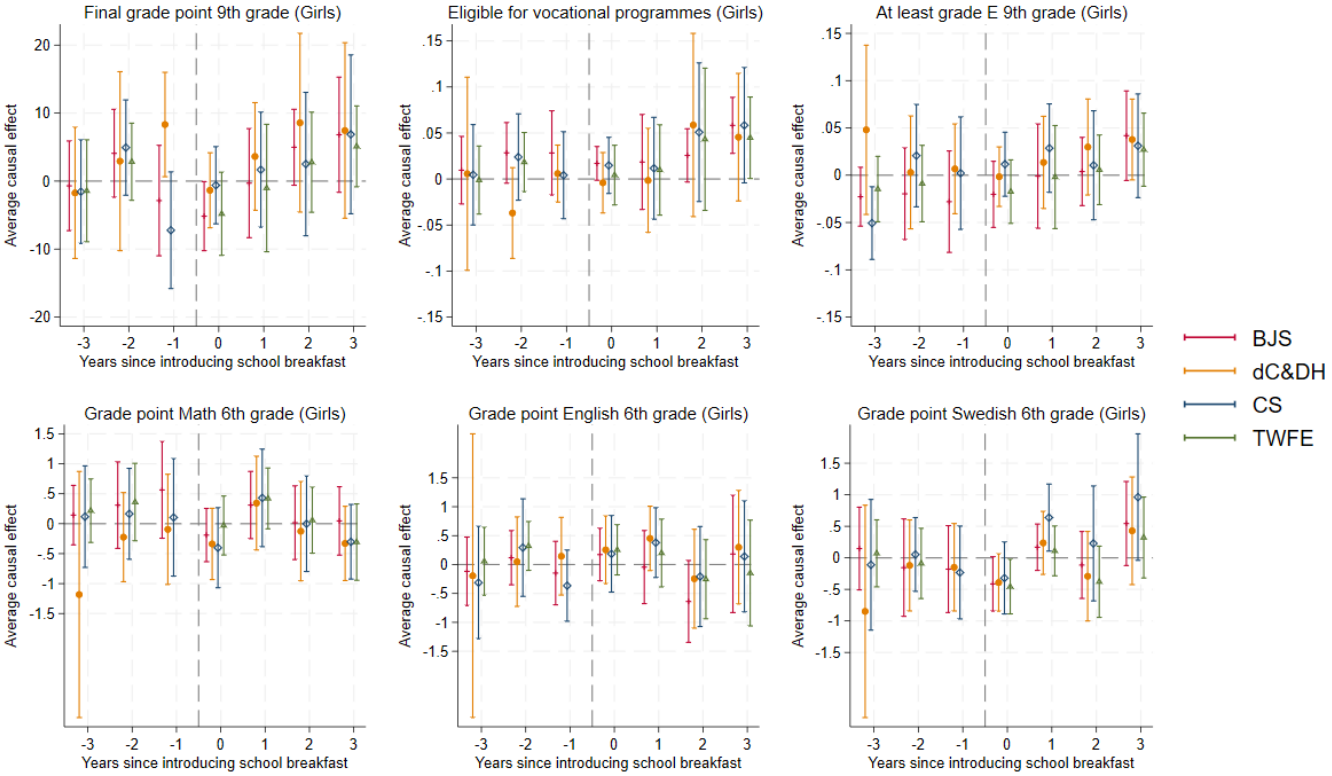

Figure A.3. This figure provides BJS, dC&DH, CS and TWFE estimates for all outcome variables with the sample restricted to girls. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. The number of clusters is around 840 (ninth grade outcomes) and 1400 (sixth grade outcomes). The number of observations is around 5600 (ninth grade outcomes) and 8700 (sixth grade outcomes).

|Figure A.4| All outcomes (Lower edu, higher foreign)

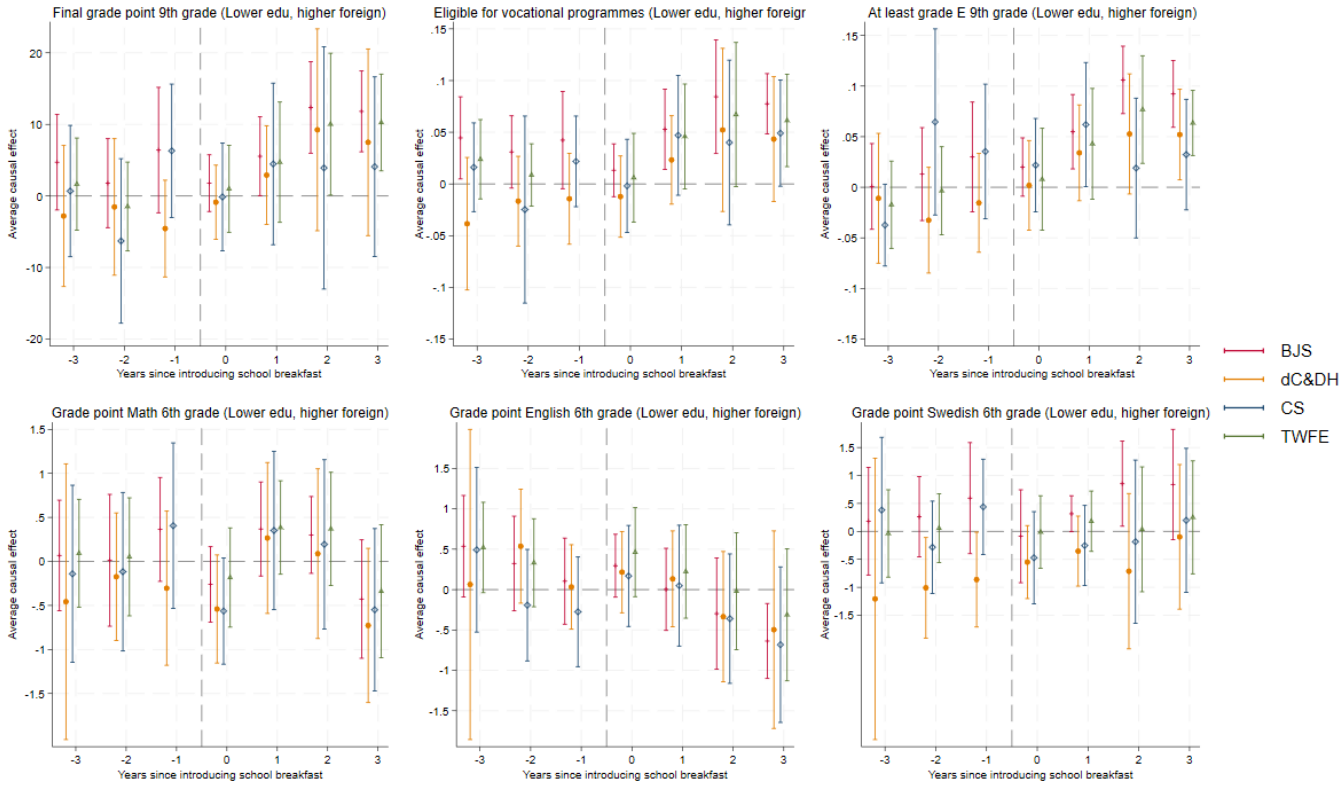

Figure A.4. This figure provides BJS, dC&DH, CS and TWFE estimates for all outcome variables with the sample restricted to the 50 percent of schools where pupils have parents with lower education and higher proportion with a foreign background. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. The number of clusters is around 480 (ninth grade outcomes) and 750 (sixth grade outcomes). The number of observations is around 2900 (ninth grade outcomes) and 4500 (sixth grade outcomes).

|Figure A.5| All outcomes (Higher edu, lower foreign)

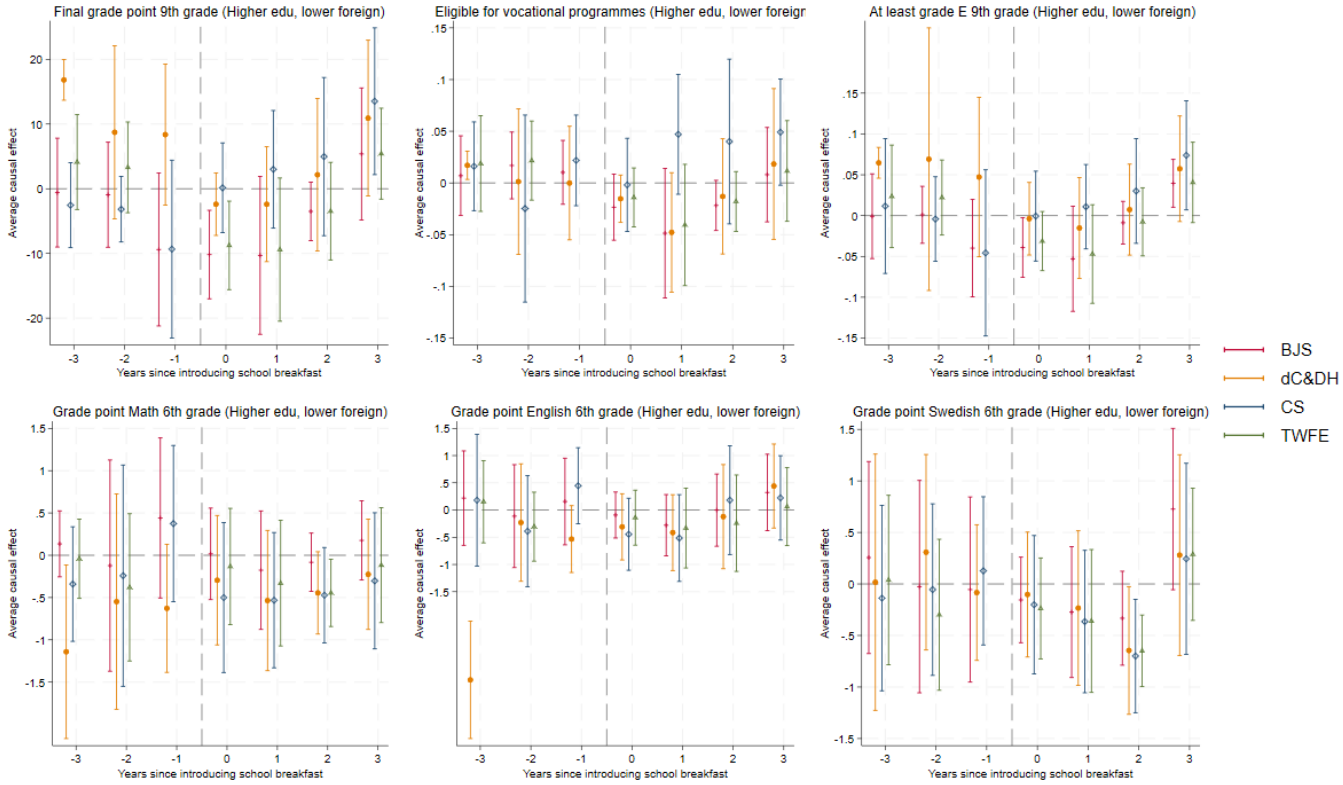

Figure A.5. This figure provides BJS, dC&DH, CS and TWFE estimates for all outcome variables with the sample restricted to the 50 percent of schools where pupils have parents with higher education and lower proportion with a foreign background. The symbol is the point estimate, and the line represents the 95 percent confidence interval. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. The number of clusters is around 480 (ninth grade outcomes) and 910 (sixth grade outcomes). The number of observations is around 3100 (ninth grade outcomes) and 5600 (sixth grade outcomes).

A.3. Additional tables

|Table A.1| Summery statistics

Panel A 2012-2018	N	Mean	SD	Dif (C -T)	SE
Outcomes					
Final grade point in 9th grade	6070	220.664	25.462	4.471**	1.881
Final grade point in 9th grade (F)	5811	231.118	27.012	4.103**	2.018
Final grade point in 9th grade (M)	5877	203.493	28.092	3.91*	2.107
Eligible for vocational programs	6024	.846	0.128	.049***	.009
Eligible for vocational programs (F)	5396	.903	0.131	.051***	.01
Eligible for vocational programs (M)	4592	.856	0.162	.067***	.014
Grade “E” in all subjects in 9th grade	5989	.742	0.142	.048***	.011
Grade “E” in all subjects in 9th grade (F)	5525	.786	0.133	.049***	.01
Grade “E” in all subjects in 9th grade (M)	5490	.717	0.152	.044***	.012
Grade point in English in 6th grade	11811	13.652	1.932	.411***	.119
Grade point in English in 6th grade (F)	9059	13.841	2.071	.419***	.142
Grade point in English in 6th grade (M)	9450	13.606	2.170	.468***	.147
Grade point in Math in 6th grade	11820	12.67	1.999	.548***	.122
Grade point in Math in 6th grade (F)	9081	12.929	2.153	.661***	.146
Grade point in Math in 6th grade (M)	9473	12.406	2.198	.631***	.148
Grade point in Swedish in 6th grade	11143	13.315	1.534	.269***	.103
Grade point in Swedish in 6th grade (F)	8041	14.643	1.475	.349***	.115
Grade point in Swedish in 6th grade (M)	8360	12.163	1.771	.212	.139
Covariates					
Female pupils at school	21153	.484	0.051	-.005*	.003
Pupils with foreign background	15539	.263	0.220	-.084***	.011
Pupils with parents with higher education	20989	.527	0.163	.085***	.008
Pupils per teacher	21708	12.71	6.471	.598*	.316
Panel B 2012-2022	N	Mean	SD	Dif (C - T)	SE
Outcomes					
Final grade point in 9th grade	6656	222.513	26.190	6.194***	1.375
Final grade point in 9th grade (F)	6461	233.206	27.647	5.179***	1.468
Final grade point in 9th grade (M)	6511	207.965	28.858	4.625***	1.543
Eligible for vocational programs	6618	.841	0.128	.04***	.007
Eligible for vocational programs (F)	5925	.893	0.136	.036***	.007
Eligible for vocational programs (M)	5202	.856	0.159	.044***	.009
Grade “E” in all subjects in 9th grade	6590	.732	0.147	.051***	.008
Grade “E” in all subjects in 9th grade (F)	6133	.77	0.139	.051***	.007
Grade “E” in all subjects in 9th grade (M)	6109	.716	0.153	.051***	.009
Grade point in English in 6th grade	13045	13.861	1.931	.422***	.085
Grade point in English in 6th grade (F)	10554	14.068	2.079	.358***	.1
Grade point in English in 6th grade (M)	10910	13.795	2.175	.523***	.104
Grade point in Math in 6th grade	13054	12.534	2.059	.712***	.089
Grade point in Math in 6th grade (F)	10569	12.691	2.236	.766***	.107
Grade point in Math in 6th grade (M)	10926	12.378	2.242	.829***	.106
Grade point in Swedish in 6th grade	12189	13.247	1.608	.395***	.077
Grade point in Swedish in 6th grade (F)	9210	14.578	1.544	.451***	.086
Grade point in Swedish in 6th grade (M)	9501	12.121	1.828	.446***	.102
Covariates					
Share of female pupils at school	22026	.484	0.049	-.005***	.002
Pupils with foreign background	17301	.285	0.231	-.086***	.009
Pupils with parents with higher education	22035	.558	0.168	.095***	.006
Pupils per teacher	22549	12.848	4.065	.946***	.141

Table A.1. The table show descriptive statistics, including number of observations, mean and standard deviation, for the outcome variables and covariates. Dif(C-T) show the difference in means between schools with and without school breakfast. The stars show statistical significance, *** p<0.01, ** p<0.05, * p<0.1.

|Table A.2| List of schools in sample with school breakfast

Schools with breakfast			
Name of school	Municipality	Name of school	Municipality
Gäddgårdsskolan	Arboga	Ängskolan	Mark
Åvestadalskolan	Avesta	Morkarlbyhöjdens skola	Mora
Alirskolan	Bollnäs	Noretskolan	Mora
Slottsskolan	Borgholm	Alsteråskolan	Mönsterås
Åkerboskolan	Borgholm	Fliseryds skola	Mönsterås
Hagaskolan	Dals Ed	Krungårdsskolan	Mönsterås
Nyhemsskolan	Finspång	Ljungnässkolan	Mönsterås
Grosvadsskolan	Finspång	Mölstadskolan	Mönsterås
Stenhammarskolan	Flen	Parkskolan	Mönsterås
Gullstensskolan	Gullspång	Skytteanska skolan	Mönsterås
Regnbågsskolan	Gullspång	Tillingeskolan	Mönsterås
Vättnedalskolan	Göteborg	Perslundaskolan	Ockelbo
Frejaskolan	Göteborg	Oxelöskolan	Oxelösund
Lövgärdeskolan	Göteborg	Akalla Grundskola	Stockholm
Höglundaskolan	Haninge	Bredängsskolan	Stockholm
Kvarnbäcksskolan	Haninge	Gullingeskolan	Stockholm
Dalarö skola	Haninge	Hjulsta grundskola	Stockholm
Muskö skola	Haninge	Högalidsskolan	Stockholm
Ornö skola	Haninge	Magelungsskolan	Stockholm
Utö skola	Haninge	Rinkebyskolan	Stockholm
Måsöskolan	Haninge	Sköndalsskolan	Stockholm
Nakterhusskolan	Haninge	Östbergaskolan	Stockholm
Vega skola	Haninge	Askebyskolan	Stockholm
HagaLyckebyskolan	Haninge	Katarina södra skola	Stockholm
Vendelsömalmsskolan	Haninge	Lillholmsskolan	Stockholm
Svartbäcksskolan	Haninge	Bandhagens skola	Stockholm
Ribbybergsskolan	Haninge	Matteusskolan	Stockholm
Ribbyskolan	Haninge	Snösätraskolan	Stockholm
Åbyskolan	Haninge	Enbacksskolan	Stockholm
Altorpskolan	Herrljunga	Oxhagsskolan	Stockholm
Albäcksskolan	Hultsfred	Söderholmsskolan	Stockholm
Smedbyskolan	Kalmar	Hagsätraskolan	Stockholm
Lindsdalsskolan	Kalmar	Bäckahagens skola	Stockholm
Tallhagsskolan	Kalmar	Bjurtjärns skola	Storfors
Norrstrandsskolan	Karlstad	Vargbroskolan	Storfors
Järvenskolan	Katrineholm	Grönkullaskolan	Sundbyberg
Ekeby skola	Kumla	Spångholmsskolan	Svedala
Fylsta skola	Kumla	Klågerupskolan	Svedala
Hagaskolan	Kumla	Aggarpsskolan	Svedala
Hardemo skola	Kumla	Naverlönnskolan	Svedala
Kumlaby skola	Kumla	Njupkärrs skola	Tyresö
Malmens skola	Kumla	Tyresö skola	Tyresö
Skogstorpsskolan	Kumla	Blidsbergs skola	Ulricehamn
Stene skola	Kumla	Bogesundsskolan	Ulricehamn
Tallängens skola	Kumla	Dalums skola	Ulricehamn
Vialundskolan	Kumla	Gällstad skola	Ulricehamn
Apelgårdsskolan	Malmö	Hökerums skola	Ulricehamn
Munkhätteskolan	Malmö	Hössna skola	Ulricehamn
Hermodsdalskolan	Malmö	Marbäcks skola	Ulricehamn
Lindängeskolan	Malmö	Stenbocksskolan	Ulricehamn
Gränbyskolan	Uppsala	Timmele skola	Ulricehamn
Gottsundaskolan	Uppsala	Tvärreds skola	Ulricehamn

Stora Hammars skola	Vellinge	Ulrikaskolan	Ulricehamn
Djurö skola	Värmdö	Vegby skola	Ulricehamn
Viks skola	Värmdö	Ätradalsskolan	Ulricehamn
Ösbyskolan	Värmdö	Haganäs	Åstorp
Kyrkskolan	Värmdö	Strövelstorp skola	Ängelholm
Hemmestaskolan	Värmdö	Geneskolan	Örnsköldsvik
Brunns skola	Värmdö	Björnaskolan	Örnsköldsvik
Kvarnbergsskolan	Värmdö	Sörbyskolan	Valdemarsvik

Table A.2. The table list all schools with school breakfast, for at least one school year, in the sample.

|Table A.3| Summary of main results

	Outcomes in 9th grade			**Outcomes in 6th grade**		
	FGP	**AEAS**	**EVO**	**Math**	**Eng**	**Swe**
BJS	9.35***	0.069***	0.046**	-0.16	-0.20	0.42
	(3.59)	(0.019)	(0.018)	(0.24)	(0.26)	(0.32)
dC&DH	9.30**	0.075***	0.029	-0.48	-0.06	0.05
	(4.26)	(0.016)	(0.022)	(0.31)	(0.33)	(0.39)
CS	7.79	0.048**	0.032	-0.42	-0.21	0.33
	(4.80)	(0.024)	(0.021)	(0.31)	(0.36)	(0.43)
TWFE	8.29***	0.056***	0.044**	-0.22	-0.10	0.27
	(2.57)	(0.015)	(0.018)	(0.26)	(0.31)	(0.32)
N	5900	5800	5900	10400	10400	9700
Cluster	900	890	890	1670	1670	1600

Table A.3. Summary of main results. This table provides BJS, dC&DH, CS and TWFE estimates and standard errors for all outcome variables measured three years after the introduction of breakfast. This corresponds to the effects estimated in the year 3 in the figures. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. FGP is final grade point, AEAS is At least grade "E" in all subjects and EVO is eligible for vocational programmes at upper secondary schools. The stars show statistical significance, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

|Table A.4| Summary of some heterogeneity results

		Final grade point (FGP)			
	Girls	**Boys**	**SES low**	**SES high**	**Free**
BJS	6.82	11.7**	11.8***	5.38	11.9***
	(4.32)	(5.01)	(2.88)	(5.20)	(4.53)
dC&DH	7.44	11.4*	7.50	10.9*	12.6**
	(6.59)	(5.85)	(6.66)	(6.14)	(6.06)
CS	6.87	9.22	4.09	13.52**	10.6*
	(5.96)	(6.59)	(6.40)	(5.79)	(5.73)
TWFE	5.11*	8.84*	10.26**	5.42	10.7***
	(3.03)	(4.68)	(3.45)	(3.59)	(2.77)
		At least "E" in all subjects (AEAS)			
BJS	0.042*	0.105***	0.092***	0.040***	0.069***
	(0.024)	(0.025)	(0.017)	(0.015)	(0.024)
dC&DH	0.038*	0.103***	0.052**	0.057*	0.049*
	(0.022)	(0.028)	(0.023)	(0.033)	(0.026)
CS	0.031	0.084***	0.032	0.074**	0.044
	(0.028)	(0.031)	(0.028)	(0.034)	(0.031)
TWFE	0.027	0.071***	0.064***	0.041	0.060***
	(0.020)	(0.019)	(0.016)	(0.025)	(0.019)
N	5600	5400	2900	3100	5900
Cluster	840	840	480	480	860

Table A.4. Summary of some heterogeneity results. This table provides BJS, dC&DH, CS and TWFE estimates and standard errors for the outcome variables Final grade point and At least grade "E" in all subjects measured three years after the introduction of breakfast. This corresponds to the effects estimated in the year 3 in the figures. Standard errors are robust and clustered at the school level. Panel B (2012-2022) and covariates are used for all estimations. The stars show statistical significance, *** p<0.01, ** p<0.05, * p<0.1.

A.4. Online appendix with point estimates from regressions.

As I estimate a total of 216 separate regressions[42] with estimates for multiple pre and post periods, I have decided to not include more tables with point estimates in the text. The output log-files, with point estimates, from Stata are found in the Online appendix.

[42] 16 specifications per figure for each figure in subsection 7.1 and Figure A.1 – A.2 in the Appendix. 24 specifications per figure in subsection 7.2 and Figure A.3-A.5.