NHH

INSTITUTT FOR SAMFUNNSØKONOMI

DEPARTMENT OF ECONOMICS

SAM 15 2016

ISSN: 0804-6824

October 2016

Discussion paper

Childhood Nutrition and Labor Market Outcomes: Evidence from a School Breakfast Program

BY

Aline Bütikofer, Eirin Mølland AND **Kjell G. Salvanes**

Norges Handelshøyskole

NORWEGIAN SCHOOL OF ECONOMICS

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Aline Bütikofer Eirin Mølland Kjell G. Salvanes

August 18, 2016

Abstract

While a growing literature documents the short-term effects of public programs providing children with nutritious food, there is scarce evidence of the long-term effects of such programs. This paper studies the long-term consequences of access to nutritious food using the rollout of a free school breakfast program in Norwegian cities. This program provided children with nutritious food and replaced a hot school meal at the end of the day with similar caloric value but less micronutrients. Our results indicate that access to a nutritious school breakfast increases education by 0.1 years and earnings by 2–4 percent.

1 Introduction

A large body of evidence shows that early-life exposure to disease and malnutrition has long-term consequences for adult health, education, and labor market outcomes (for an overview, see Barker, 1992; Almond and Currie, 2011). A nutritious diet may therefore enhance cognitive development and, ultimately, academic success and post school productivity. While there is support from experimental interventions that highly nutritious food supplements affect educational outcomes (see Maluccio et al., 2009), there is scarce evidence of long-term effects of

*The authors thank the Norwegian Research Council for financial support (grant number 240321). We gratefully acknowledge comments from Na'ama Shenhav, Gordon Dahl, David Figlio, and seminar participants at University of California Davis, the Norwegian School of Economics, the Essen Health Conference, the SDU Workshop on Applied Microeconomics, the Nordic Summer Institute in Labor Economics, and the Annual Conference of the European Society for Population Economics. Arn-Tore Haugsdal provided excellent research assistance. Aline Bütikofer, Department of Economics, Norwegian School of Economics, Helleveien 30, 5045 Bergen, Norway. Email: aline.buetikofer@nhh.no. This paper was written while Eirin Mølland was employed at the Norwegian School of Economics and she has since moved to Agderforskning: Eirin Mølland, Agderforskning, Gimlemoen 19, 4630 Kristiansand S, Norway. Email: eirin.molland@agderforskning.no. Kjell G. Salvanes, Department of Economics, Norwegian School of Economics, Helleveien 30, 5045 Bergen, Norway. Email: kjell.salvanes@nhh.no.

policy-induced improvements in early-life nutrition. An exception is Hoynes, Schanzenbach, and Almond (2016) who present evidence that access to the food stamp program during early childhood improved adult health. In addition, there is a growing literature documenting short-term effects of public programs providing children with nutritious food. Examples include Belot and James (2011) and Figlio and Winicki (2005) who show that providing children with school meals with better nutritional or caloric content improves test scores. This evidence demonstrates that policy-induced changes in the provision of appropriate nutrition, such as free nutritious breakfast, might have the potential to mitigate the negative effects of poverty or other adverse early-life circumstances in the long-run.

In this paper, we exploit a staggered implementation of the so-called "Oslo breakfast"—a nutritious breakfast including vitamin-rich foods such as whole grain bread, milk, cod liver oil, and unprocessed fruit and vegetables—in 26 Norwegian cities in the 1920s and 1930s to determine the long-term impacts of improved nutrition on educational attainment and labor market performance. In addition, the rollout of the policy in combination with the abrupt ending because of food rationing during World War II allows us to analyze both at what age breakfast provision in schools was most influential and whether the length of exposure to the policy matters. The Oslo breakfast had a long-lasting impact on Norwegian eating behavior. Whereas the traditional breakfast in the 1920s consisted of coffee, plain bread and cold porridge, the Oslo breakfast taught children healthy eating habits and even today Norwegian breakfast preferences reflect the content of the Oslo breakfast (see Schiøtz, 1926; Evang and Galtung Hansen, 1937). For these reasons, Norway provides an ideal laboratory for this type of analysis.

Our analysis is based on historical data documenting the rollout of the Oslo breakfast, which are linked to Norwegian register data. This allows us to evaluate the impact of access to school breakfast 30 or more years after the breakfast program was implemented. Our estimation strategy is a differences-in-differences approach, comparing cohorts that finished school before the program was implemented in their city of residence (control group) to cohorts that were in school after the breakfast was offered in their city of residence (treatment group). We find that access to free school breakfasts increased the completed years of schooling by 0.1 years and earnings by 2–4 percent. Moreover, we find that men who had access to free school breakfasts are more likely to have skilled and semi-skilled occupations and less likely to have low-skilled occupations. The estimated effects are not significantly different for men and women or for individuals attending school in cities with high or low poverty levels. In addition, we find empirical evidence that early exposure matters most, however the effects at different ages are not significantly different from each other. Moreover, there is no significant difference between the effect of being exposed for only one or two years or during all seven primary school years.

The remainder of the paper is structured as follows. Section 2 provides an overview of

the recent literature on school breakfast programs and nutritional interventions. Section 3 reviews the history of the Norwegian school breakfast program. Section 4 outlines the empirical strategy. We discuss the data and provide descriptive statistics in Section 5. We discuss our results and analyze whether there were heterogeneous effects by individual characteristics in Section 6. Section 7 provides different sensitivity tests. Section 8 explores potential channels behind the results and links our results to the previous literature. Section 9 provides a brief conclusion.

2 Literature Review

As noted above, the Oslo breakfast program intended to provide children with nutritious food. An increasing number of studies focus on the effects of a nutritious diet on educational outcomes. For example, Glewwe, Jacoby, and King (2001) and Alderman, Behrman, Lavy, and Menon (2001) document the correlations between malnutrition and educational outcomes. Maluccio et al. (2009) examine the causal effect of a randomized early childhood nutritional intervention in rural Guatemala during 1969–1977 on educational outcomes. They find that the intervention increased the number of years of education for women by 1.2 and reading comprehension and nonverbal cognitive ability test results for both women and men by one-quarter of the standard deviation of the test results. Belot and James (2011) investigate the effect of nutritional changes in school meals in Britain. In particular, they exploit the "Feed Me Better" campaign conducted in 2004–2005 by the British chef Jamie Oliver, which aimed to improve the nutritional standards of school meals in Britain. They find that healthier food improves test scores in English and science significantly. Furthermore, Figlio and Winicki (2005) show that if schools increase the calorie content of school lunches on test days, there is a significant improvement in scores on examinations that take place after lunch. Hence, nutritious food—as provided by the Oslo breakfast program—may have positive impacts on educational outcomes.

One can think of several ways by which a nutritious school breakfast may affect educational attainment. First, participation in a school breakfast program may enhance the daily nutrient intake and improve students' academic performance and psychosocial functioning directly (Kleinman, Hall, and Green, 2002). Moreover, a free breakfast at school may affect the incentives to go to school and thereby increase attendance rates among students (Murphy, Pagano, and Nachmani, 1998). Furthermore, free breakfasts at school may decrease household expenditure on food among the poor (Long, 1991). As Dahl and Lochner (2012) find a causal impact of income on poor children's math and reading achievement, breakfast provision at school may affect educational outcomes indirectly through family income.

Recent research studying the causal impacts of free school breakfasts focuses primarily on two different school breakfast programs in the United States. The first series of papers analyze

the introduction of universal free breakfasts in certain school districts, while the second series of papers focuses on the so-called Breakfast in the Classroom program that provides free school breakfasts to all children during class time in the classroom.

The universal free breakfast allows children to participate in the school breakfast program (commonly served in the school's cafeteria) at no charge regardless of parental income. Thus, children that are not eligible for free or reduced-price school meals may participate for free. Leos-Urbel, Schwartz, Weinstein, and Corcoran (2013) study the introduction of a program providing free universal school breakfasts in New York City in 2003. Using a difference-in-difference estimation strategy, they show that the introduction of free breakfasts for all students led to a small increase in breakfast participation both for students who experienced a decrease in the price of breakfasts as well as for students who experienced no price change. Hence, they provide evidence that the price change explains part of the increase in program participation. However, they do not find that the policy affected academic outcomes. Ribar and Haldeman (2013) study the introduction of a similar free universal school breakfast program in Guilford County, North Carolina during the 2007–2008 school year and its discontinuation one year later. Their findings show that the removal of the free universal breakfast reduced participation substantially in particular among students who were not eligible for free breakfasts after the program's discontinuation. As in Leos-Urbel, Schwartz, Weinstein, and Corcoran (2013), Ribar and Haldeman (2013) do not find any effects of the policy change on test scores or school attendance.

A second group of studies analyzes the effects of the Breakfast in the Classroom program, which provides free school breakfasts to all children to be eaten in the classroom during the first few minutes of the school day. Exploiting the staggered implementation of the program in a large urban school district, Imberman and Kugler (2014) find that moving the free breakfast from the cafeteria to the classroom increases math and reading achievement substantially, in particular for children from a low socioeconomic background. Similarly, Dotter (2013) uses the rollout of a free in-classroom breakfast program in San Diego elementary schools and finds that the implementation of free universal breakfasts increases math and reading test scores. In addition, the study presents evidence that the gains in student achievement are higher among students with lower achievement levels and in schools where fewer students were previously participating in school breakfast programs. On the other hand, the effect is not significant in schools with a preexisting universal breakfast program. Schanzenbach and Zaki (2014) use experimental data to analyze the effect of both universal free school breakfasts and the Breakfast in the Classroom program and find that both policies raise program participation. However, they also present evidence that this increase in program participation does not indicate that more children eat breakfast, but that breakfast consumption is shifted from home to school. In addition, they find only small effects of the policies on nutritional intake, health, behavior, or

achievement. Hence, the literature using quasi-experimental and experimental data shows that providing free breakfasts either in the classroom or in the cafeteria increases school breakfast attendance. The effects of school breakfasts on student achievement, however, are debated.

Furthermore, Frisvold (2015) studies the so-called School Breakfast Program, a federal entitlement program that offers breakfasts to all students who attend a participating school. The breakfasts are however only free for children from households with income equal to or below 130 percent of the poverty guidelines. Frisvold (2015) exploits that many states mandate that schools must offer breakfasts if the percent of free or reduced-price eligible students in a school exceeds a specific threshold. He uses these different thresholds as a source of identifying variation in access to school breakfasts and finds that the availability of the program increases student achievement. In the context of developing countries, Vermeersch and Kremer (2005) analyze the effects of subsidized school breakfasts using data from a randomized trial in preschools in Western Kenya. The trial was run in 25 preschools between 2000 and 2002, which were randomly chosen from a pool of 50 schools. The program provided a fully subsidized in-school breakfast each school day to all pupils attending preschool. The findings provide evidence that children's school participation and test scores increased in schools where the teacher was relatively experienced prior to the program.

As most of the breakfast programs studied previously are recent programs, all studies focus on program participation, school attendance, and student achievement. There is no study, to the best of our knowledge, that analyzes the effect of a free school breakfast program on longer-term outcomes. As discussed by Chetty, Friedman, Hilger, Saez, Schanzenbach, and Yagan (2011) in the context of Project STAR, short-term and long-term outcomes may not necessarily be the same. In addition, there is evidence that participation in school lunches affects educational attainment substantially in the long-run. Hinrichs (2010) uses an instrumental variables strategy that exploits a change in the formula used by the federal government to allocate funding to the states for the National School Lunch Program in the middle of the 20th century. He finds that program participation as a child has small long-run effects on health and sizable effects on completed education.[1] Parallel with our work, Petersen, Rooth, and Lundborg (2016) analyze the long-term health effects of a universal school lunch pro-

[1]Most other research on the National School Lunch Program has focused on the program's effects on dietary intake and obesity (see Hoynes and Schanzenbach, 2015, for a survey). The National School Lunch Program was found to increase the consumption of fat, protein, and six types of vitamins and minerals and reduce the rate of food insecurity (Gleason and Suitor, 2003). The relationship between participation in the National School Lunch Program and childhood obesity is less clear and differs for different data sources. Whereas Schanzenbach (2009) finds that school lunch participants become comparatively heavier as their exposure to school lunches increases, Mirtcheva and Powell (2013) find that the National School Lunch Program has no effect on body weight, and Gundersen, Kreider, and Pepper (2012) provide evidence that lunch improves child health and substantially reduces obesity rates.

gram in Sweden, which was introduced in the late 1950s and 1960s. The authors show that those exposed to school lunches during their entire primary school period have a higher income and adult height and better non-cognitive skills. Our paper aims to extend the literature on free school breakfasts by studying their long-term impacts on educational and labor market outcomes.

Little is known about whether school meals are more important for younger or for older students. Starting with Barker (1992), there is an emerging scientific consensus that early life exposure to deprivation affects the body's long-term survival outcomes. Most studies focus on the in utero period (see, e.g., Painter, Roseboom, and Bleker, 2005). An exception is a study by Hoynes, Schanzenbach, and Almond (2016) analyzing the relationship between a child's access to the Food Stamp Program and adult health and human capital outcomes. The authors find evidence that access to better nutrition in utero and in early childhood reduces obesity, high blood pressure, heart disease, and diabetes. Hoddinott et al. (2008) exploit the same experiment as Maluccio et al. (2009) in a randomized early childhood nutritional intervention in rural Guatemala during 1969–1977 and study the effect of nutritional intervention on adult labor market outcomes. They find that men who receive additional nutrition before the age of three have higher hourly wages. The intervention had, however, no effect on wages for women and individuals who receive the treatment at three years of age or older. Hence, a second goal of our paper is to determine whether the duration and the age at which an individual is exposed to school breakfasts matters.

3 Institutional Background

In the last quarter of the 19th century, European philanthropists were the first to promote the idea of school meals as a way to fight childhood hunger.[2] Between 1900 and 1906, the Netherlands, Switzerland, and Britain were the first countries to establish national provision of school meals and the idea of publicly-provided school meals soon spread across the globe as a central tool of welfare programs (Andersen and Elvbakken, 2007). Since the 1890s, many Norwegian cities have served hot meals at school (Elvbakken and Lindstrøm, 2003). These hot meals were served at the end of the school day. In the 1920s, these hot meals were increasingly criticized for their lack of nutrition and vegetables (Andersen and Elvbakken, 2007). Carl Schiøtz, the medical officer responsible for the schools in Oslo from 1919 to 1931, was one of the greatest opponents of the hot school meal. Schiøtz was inspired by the discovery of vitamins in the early 1920s and the new knowledge that vitamins were largely present in unprocessed fruit and vegetables. He was concerned that the lack of vitamins and minerals in hot school meals would not improve the health of the often undernourished schoolchildren in Norway (Schiøtz,

[2] In the 1870s, local philanthropic school meals services began to emerge in Germany, France, and Britain.

1926). Schiøtz and other researchers conducted experiments in the three largest Norwegian cities (Oslo, Bergen, and Stavanger) where they showed that undernourished children who were fed breakfast instead of a hot meal gained more weight (Lyngo, 1998). Schiøtz, therefore, reorganized the school meal provision. He suggested to abolish the hot meal at the end of the school day and to introduced a nutritious breakfast served in the morning before school started instead. The breakfast consisted of buttered whole grain bread, milk, cod liver oil and unprocessed fruit and vegetables (primarily apples, carrots, and oranges).[3] The consumption of milk was of particular concern. Surveys indicated that 45% of schoolchildren were not served milk at home but instead drank coffee in the morning. By serving the school children breakfast early in the morning, the authorities ensured that the children would eat nutritious food containing important vitamins, minerals, and proteins prior to the start of school and that the children would be better prepared to learn.[4] Note that the intake of calories at school was approximately the same when switching from the hot meal at the end of the school day to the Oslo breakfast. In addition, the authorities intended to teach children to eat healthily based on the latest nutritional knowledge, thereby promoting healthy eating behavior among the children's families and influencing the children's eating habits in their adult lives (Evang and Galtung Hansen, 1937). The usual breakfast, before the Oslo breakfast was introduced, consisted of coffee, plain bread, and cold porridge—a meal with low vitamin and nutritional content (Schiøtz, 1926; Evang and Galtung Hansen, 1937). In the years after the introduction of the Oslo breakfast, Norwegian eating habits changed and up to today the breakfast includes buttered whole grain bread, milk, unprocessed fruit and vegetables, and cod liver oil.

During the late 1920s and 1930s, several Norwegian cities started serving schoolchildren breakfasts at school. Large shares of the population were malnourished in 1920 and approximately 10% of the population depended on welfare (Elvbakken and Lindstrøm, 2003). Hence, providing children with a school meal was a way to fight malnutrition among children. In this period, Norway was a poor country compared with the period after World War II and in particular compared with the period after 1960. However, gross domestic product (GDP) per capita in Norway was comparable with GDP per capita in Sweden, lower than GDP per capita in Denmark, and higher than GDP per capita in Finland (Grytten, 2014). Although the standard of living in Norway in the 1920s and 1930s was low compared with today, when looking at other indicators of economic development and living standards, such as adult height, longevity, infant mortality, and educational attainment, Norway was similar to other countries in Northern Europe and in some dimension also comparable to the United States (see, e.g., van

[3]For further details about the historical development of the school meal in Norway see Andersen and Elvbakken (2007).

[4]The change of school meals constitutes a change both in micronutrients such as vitamins from unprocessed fruit and vegetables and macronutrients such as proteins from the milk.

Zanden, Baten, d'Ercole, Rijpma, Smith, and Timmer, 2014).[5]

By 1938, 25 out of 65 Norwegian cities served schoolchildren versions of the Oslo breakfast at school (Rustung, 1940).[6] Table 1 provides a summary of the years in which the breakfast was introduced in the different urban municipalities throughout Norway. The decision to implement the breakfast was made by the local municipalities, which also incurred the costs of the school breakfast. In some municipalities, philanthropy organizations helped fund breakfast provision. The central government, however, provided no funding for school meals. There may be a concern that the access to the Oslo breakfast occurred around the same time as women gained increased representative in politics or the left-wing parties gained political power. We address this concern in Section 7 and provide evidence that the introduction of the school breakfast does not coincide with sharp increases in female participation in local politics, the political power of left-wing parties, or school expenditures.

In most municipalities, the breakfast was limited to children with particular needs for extra nutrition. Children could participate in the breakfast programs if their parents applied to the school board or if school doctors assigned them to participate in the program. Only two cities, Oslo and Skien, had a universal program in 1937 (Rustung, 1940). In Oslo, where the universal school breakfast program was introduced in 1935, the participation rates were highest in 1937, 46% of the schoolchildren in Oslo ate breakfast at school, while the average participation rate in all cities was 25% (Rustung, 1940). The average cost of the Oslo breakfast per child per day was about NOK 0.31 in 1937.[7] This corresponds to a value of approximately NOK 10 or about

[5]Adult height, which is an indicator of nutrition and standard of living during early childhood, was relatively high in Norway. In 1930, Norwegian men were, for instance, 1.5–3 cm taller than men in the other Nordic countries, 3 cm taller than men in the United Kingdom, and 4 cm taller than men in the United States. Furthermore, longevity, which is another indicator of health and standard of living, was relatively high for both Norwegian men and women. In 1930, longevity for Norwegian men was on average almost 63 years, which is slightly above the average longevity in Sweden, and one year above the average in Denmark, almost four years above the average in the United States, and more than 10 years above the average in Finland. Infant mortality, an indicator of health and longevity, was in general very high in the first half of the 20th century. In the 1930s, about 0.42% of live births died within the first year of life in Norway. This number is comparable to the 2015 values from countries such as Ghana, Malawi, and Senegal. However, this infant mortality rate was similar to Sweden's infant mortality rate. The other Nordic countries and the United Kingdom had an infant mortality rate that was almost twice as high. The average years of education serves as a measure of human capital investment. In the 1930s, the average years of education in Norway was seven years, which corresponds to the mandatory years of schooling. This number is comparable to the United Kingdom and other Nordic countries (except for Finland where people only had three years of education on average in 1930). The average years of education in the United States was however substantially higher in the 1930s. The data source for all statistics presented in this footnote is Clio Infra, www.clio-infra.eu.

[6]Halden served the Oslo breakfast during the school year 1929–30. Although the breakfast was very popular, it was abolished again after one year (Rustung, 1940).

[7]To but the cost of the breakfast into into perspective consider that the yearly income of men living in cities in 1930 was NOK 3807 (SSB, 1930).

USD 1.10 today. Breakfast provision was, however, less expensive than the school dinner it replaced.

In this paper, we analyze the effect of school breakfasts at the city level because schools in urban and rural municipalities were organized differently in the early 1930s. Prior to the school reforms in 1936, the length of the school year varied from 42 weeks in cities to 12 weeks in some rural municipalities (Pekkarinen, Salvanes, and Sarvimäki, 2015). There were also differences between urban and rural municipalities in school meal provision. Food scarcity, in particular the scarcity of milk, fruit and vegetables, was largest in cities. Authorities in rural municipalities, where many children grew up on farms, put less focus on school meal provision. In 1938, only three rural municipalities served the Oslo breakfast (Rustung, 1940). Nevertheless, many rural municipalities supported the so-called Sigdals breakfast. That is, children from rural municipalities would bring the content of the Oslo breakfast from home to school and eat it during lunchtime.[8] The schools provided information and recommendations to the mothers on what the packed lunch should contain. Some rural municipalities provided milk at school. Because of the fundamental differences between urban and rural municipalities in school meal provision, we focus on the effect of the Oslo breakfast in the urban municipalities. In addition, we focus on the period before World War II because the extensive food rationing during the war prevented the provision of the Oslo breakfast. Nevertheless, some municipalities were able to serve some food (mostly soups) to schoolchildren during the war with philanthropic contributions from Denmark and Sweden. After the war, many cities started serving the Oslo breakfast again, however, it never gained the same popularity as it had prior to World War II.

The Oslo breakfast was copied in other countries. For example, the British School Breakfast Club, which provides a healthy breakfast in a safe environment before the first class, was inspired by the Oslo breakfast (Cross and MacDonald, 2009).

Note that we have studied all laws and reforms during the 1920s and 1930s that may have had an impact on schools or child outcomes. The only relevant one we found was the increase in number of mandatory school days in rural municipalities discussed above (see Pekkarinen, Salvanes, and Sarvimäki, 2015). As this paper focuses exclusively on individuals going to school in cities, the school reform in rural municipalities does not affect our sample and our results.

4 Empirical Approach

The goal of this study is to analyze the long-term effects of access to a nutritious free school breakfast. Our identification strategy aims to overcome the inherent endogeneity between access to nutritious food, health, and adult outcomes. We use a differences-in-differences set-

[8] As many children had a long distance to walk to school, having breakfast before the start of school was less practical.

up exploiting the staggered introduction of the Oslo breakfast across cities over time. We estimate the following reduced form model:

$$y_{icm} = \alpha_0 + \gamma D_{icm} + \beta X_{icm} + \delta_c + \theta_m + \epsilon_{icm}, \tag{1}$$

where y_{icm} are the outcomes of interest for individual i born in municipality m in cohort c. D_{icm} is an indicator variable equal to one if an individual was enrolled in primary school (aged 7 to 14 years) in the year of, or after, the breakfast was introduced in the municipality of birth, and zero otherwise. θ_m is a set of municipality fixed effects and δ_c is a set of cohort fixed effects. Hence, common time shocks are controlled for by the year fixed effects. In addition, unobservable determinants of the long-term outcomes, which are fixed at the municipality level, are absorbed by the municipality fixed effects. Our preferred specification includes X_{icm}, a vector of individual and municipality level control variables, such as gender, student–teacher ratio in the year of school start and the average number of doctors per 100 inhabitants while individuals were enrolled in primary school. The municipality level controls are included to control for local differences in public infrastructure. The variable of interest is γ, which shows the effect of living in a municipality where the Oslo breakfast was provided on various outcomes. The standard errors are clustered at the municipality level as education and earnings are likely to be serially correlated within cities over time.

Our empirical strategy relies upon the idiosyncratic nature of the timing of the introduction of the Oslo breakfast. Hence, the social, political, and cultural characteristic of each city should not be predictive of the year the city introduced the Oslo breakfast. Confounding variation must be sharply discontinuous in the year the Oslo breakfast was introduced in a city. Smooth changes within cities will be absorbed in the econometric specification. There are no major policy changes, such as suffrage or child labor laws, that might influence breakfast provision in schools and thereby harm the identification strategy. Women's political rights or child labor laws were effective at the same time nationwide in Norway and introduced before the rollout of the school breakfast program. The concern that the implementation of the Oslo breakfast coincides with a sharp increase in the political representation of women, the rise of the left-wing parties or a sharp increase in school spending per child are addressed in Section 7.

To distinguish the effect of the breakfast provision from differential secular trends, we use a specification that allows for municipality-specific time trends:

$$y_{icm} = \alpha_0 + \gamma D_i + \beta X_{icm} + \delta_c + \theta_m + \rho_m f(t) + \epsilon_{icm}, \tag{2}$$

where ρ_c is the coefficient of a linear, quadratic, or cubic function of a municipality-specific time trend variable, t. The identification of γ is determined by whether the implementation of the school breakfast program led to deviations from a preexisting linear, quadratic, or cubic municipality-specific time trend.

In addition, we estimate a specification allowing for differential effects of the policy by age of exposure. Hence, we exploit the fact that some individuals have access to the Oslo breakfast at a very young age whereas others have access as teenagers. In particular, we estimate:

$$y_{icm} = \alpha_0 + \sum_{a=1}^{7} \mu_a \mathbb{I}(AgeTreat_{cm} = a) + \beta X_{icm} + \delta_c + \theta_m + \epsilon_{icm}, \tag{3}$$

where $AgeTreat_{cs}$ is the age of individual i in the year that the school breakfast program was implemented in municipality m. This equation allows us to estimate whether the effect of the school breakfast is different for individuals who had access to the Oslo breakfast in the 1st, 2nd, ..., and 7th grade (i.e., when the individuals were aged 7 to 14 years). Using a similar specification, we also analyze whether the number of years an individual was served the free school breakfast has a different impact. This measure varies between one and seven years and depends on year of birth as well as the start year for the breakfast and the end of breakfast provision because of World War II.

In order to shed some light on the mechanisms by which school breakfasts may affect educational attainment, we also estimate the effect of school breakfasts on the percentage of missed school days. Data on missed school days are available at the municipality level. We estimate the following reduced form model:

$$y_{jm} = \alpha_0 + \lambda D_{jm} + \beta X_{jm} + \delta_j + \theta_m + \epsilon_{jm}, \tag{4}$$

where y_{jm} denotes the percentage of missed school days in municipality m in year j. δ_j denotes year dummies and θ_m denotes municipality fixed effects. The coefficient of interest, λ, represents the effect of the provision of the Oslo breakfast on the percentage of missed school days.

5 Data and Descriptive Statistics

We link aggregate data on school breakfasts with individual administrative data and census data from Statistics Norway. Our primary data source is the Norwegian register data. This is a linked administrative data set that covers the entire population of Norway up to 2010. These data are maintained by Statistics Norway and are a compilation of different administrative registers. The data provide information about place of birth and residence, educational attainment, labor market status, earnings and a set of demographic variables.

For our analysis, we include cohorts of individuals born between 1910 and 1932 in Norway.[9] The early cohorts in our sample finished school prior to the introduction of the Oslo breakfast. We limit our sample to individuals who entered school before 1939, the year the breakfast

[9] As the Norwegian register data is based on the 1960 Census, individuals had to be alive in 1960 for them to be part of the sample. That is, we lack information about all individuals who deceased before 1960. Nevertheless, we still have a substantial number of observations from the earliest cohorts.

program was stopped because of the German occupation of Norway during World War II. As discussed in Section 3, we focus on individuals born in cities. Summary statistics of the control variables as well as the various outcome variables are provided in Table 2.

5.1 Register Data

The population register contains the municipality of birth. We allocate a municipality of residence while in school to each individual by assuming that they were still residing in their municipality of birth.[10] Mobility after birth may imply that individuals are assigned to the treatment group even if they should not be and vice versa. This might cause measurement error that will tend to bias our estimates downward. However, mobility in Norway was rather low in the 1930s. Considering Norwegians born from 1930 to 1945 with younger siblings, Bütikofer and Salvanes (2015) find that more than 90 percent had younger siblings born in the same municipality.[11] In addition, Bütikofer and Peri (2015) find that only 15% of the male cohorts born in 1932 and 1933 are living in a different municipality in the year of military enlistment (at age 18) than their municipality of birth. Hence, we argue that municipality of birth is a good approximation of the municipality of residence during primary school age.

Information about educational attainment is obtained from the Census conducted in 1970. These education data are self-reported. Nevertheless, this information is considered very accurate (see Black, Devereux, and Salvanes, 2005). We consider two educational outcomes: the completed years of education and a variable indicating whether an individual has finished high school (i.e. 11 years of schooling or more). The average number of years of education is 8.89 for women and 10.07 for men. On average, 18.0% of women have finished high school, while the corresponding number for men is 38.9%.

The earnings register contains information about yearly earnings starting in 1967. That is, the earnings of the oldest cohorts in our sample are measured from age 57 years and onwards. For the youngest cohorts, earnings information is measured at age 35 years and onwards. Based on this information, we construct different variables to measure the effect of having access to breakfast on earnings. We consider the average discounted earnings for ages 50–55 and 56–61. In addition, we consider average discounted earnings over the period 1967–1980. The earnings data are not top coded and include all pension earnings.[12]

Data on occupational status are obtained from the Census conducted in 1960. Occupations are classified into three broad categories: self-employed individuals, which also includes business

[10] The central population register provides the municipality of residence in each year only from 1967 onwards.

[11] As we lack sufficient information about the parents for a substantial proportion of our sample, we cannot compute the percentage of individuals born in cities between 1910 and 1932 who have younger siblings born in the same city.

[12] To obtain a consistent sample we drop all individuals for whom we have information about earnings, but lack information about education.

owners, skilled and semi-skilled individuals, and unskilled individuals. Occupation data are reported for about half as many women as men. About 11 percent of individuals are self-employed, about 42 percent are skilled and semiskilled individuals, and about 45 percent are unskilled individuals.

5.2 Municipality Level Data

To control for local trends in the public infrastructure, we use municipality level control variables. Statistics Norway's historical school statistics provide yearly information about total number of school days in each municipality as well as the total number of missed school days. These data allow us to calculate the total percentage of schooldays that were missed in primary schools each year from 1920–1939 in each city.[13] In addition, the school statistics include information about the yearly student–teacher ratio in each municipality. On average, the student–teacher ratio when individuals enter primary school was 30. However, this ratio varies from 14 students per teacher to 46.5 students per teacher in different cities. Moreover, we use the school statistics to calculate the school expenditures per student from 1920–1935. The school expenditures per student from 1935 to 1939 are calculated from the yearly publications on municipalities' budgets (Norges Kommunale Finanser).

The total number of doctors in each medical district is collected from Statics Norway's historical yearly health statistics. Based on these data, we can calculate the average number of doctors per 100 inhabitants while the individuals are enrolled in primary school. The number of doctors per 100 inhabitants in urban municipalities varies from 0.02 to 0.4 and was on average 0.1. As a measure of poverty within a city, we calculate how many inhabitants of a city are below the poverty level.

In addition, we collect information about the number of women in each city parliament for the period 1910–1937 and the percent of representatives of left-wing parties in city parliaments for the period 1910–1939 from the Norwegian Social Science Data Services (NSD) and Statistics Norway.[14] All women gained (active or passive) voting rights nationwide in 1913, some eight years before the first city implemented the Oslo breakfast. On average, the percentage of women in the city parliaments that implemented school breakfasts is almost 8% and the average percent of representatives of the left-wing parties in the city parliament is approximately 39%.

[13]These statistics also include information about the total number of school days that were missed because of the outbreak of World War II during the school year 1939/1940. This allows us to exclude the number of school days missed because of the war from the analysis.

[14]NSD is not responsible for the interpretations and analysis in this paper.

5.2.1 School Breakfast Data

We have gathered information about the Oslo breakfast in all cities from various archives in Norway, including both local municipality archives as well as national archives. The data include information about the year of implementation of the Oslo breakfast, what type of food was served and the participation rate. The breakfast was introduced in different municipalities in different years. Skien, a municipality in the eastern part of Norway, replaced the school dinner with a school breakfast including sandwiches, milk and carrots in 1921 (Rustung, 1940). Some cities introduced the Oslo breakfast only shortly before World War II. Table 1 illustrates the staggered implementation of the Oslo breakfast. In total, 26 out of 65 urban municipalities introduced the Oslo breakfast, covering about half of the individuals in our sample (see Table 2).

6 Results

6.1 Long-term Effects on Education and Earnings

In this section, we analyze the long-term effects of access to school breakfasts. In Table 3, we present the estimated effects of being enrolled in a school that serves breakfast on educational attainment and labor market outcomes. Each estimate is from a different regression. The first row shows the estimates of γ in Equation 1 for the completed years of education (Column 1), the likelihood of finishing high school (Column 2), and different earning measures (Columns 3–7). Panel A provides the results from our preferred specification where we control for an individual's gender, the student–teacher ratio in the year of school start and the average number of doctors per 100 inhabitants while individuals are enrolled in primary school. Panel B provides the results without individual or municipality specific control variables. We find that access to school breakfasts increases the completed years of education, on average, significantly by 0.1 years. This corresponds to an increase in completed years of education of approximately 1% compared with the preintervention level. In addition, we find a significant increase of 1.7 percentage points in the likelihood of finishing high school. Without individual and municipality specific control variables, the estimated effects for the two educational outcomes are slightly larger (see Panel B). We find that access to school breakfasts increases the average log earnings at ages 50–55 years, the average earnings at ages 50–55 years, the average earnings at ages 56–61 years, and the average earnings from 1967–1980. The effect ranges from 2–4% compared with the preintervention level. Note that the sample is restricted to individuals with nonmissing information on education. When dropping the individual and municipality-specific control variables, the results remain similar (see Panel B). Hence, we find that access to the Oslo breakfast increased, on average, an individual's educational attainment

and earnings significantly.[15]

6.2 Heterogeneity by Gender and Poverty Level

As the labor market opportunities for men and women in the cohorts under consideration were different, we consider heterogeneous effects by gender. Panels A and B of Table 4 presents the estimated effects of having access to school breakfasts for men and women separately. For the educational outcomes, the effects for men are as precisely estimated and larger in magnitude than the baseline estimates. The effects on educational outcomes for women are smaller and we only find a significant effect on the likelihood of finishing high school. For the earnings outcomes, the effects for men are mostly significant and the effects on the average earnings at ages 50–55 years, the average earnings at ages 56–61 years, and the average earnings from 1967–1980 are larger in magnitude than the baseline estimates, whereas the effects on the average log earnings at ages 50–55 years are smaller than the baseline estimates. For women, the estimated effects are mostly smaller than the baseline results and not significant. An exception is the effect on log earnings at ages 50–55 years, which is significant and larger than the baseline results. The effects for men and women do not differ significantly, with the exception of the average earnings at ages 50–55 years. The preintervention levels of earnings and years of education are larger for men than for women. Hence, the gain in earnings and years of education relative to preintervention levels are similar for both genders (although not significant for women in most cases).

As poor children might benefit more from the extra nutrition, the benefits from free school breakfast might differ by the level of poverty in each city. We use the percentage of inhabitants, which are blow the poverty level, as a proxy for the overall poverty status in a city. In Panels C and D of Table 4, we split our sample into individuals born in municipalities with above- and below-median poverty rates. The results show that the effects are larger for individuals living in municipalities with above-median poverty rates. However, the effects are not significantly different for individuals living in poorer or richer municipalities.

[15]The effect of access to the Oslo breakfast on lifetime earnings is larger than the effect on education would suggest. However, improving child health may not only raise the marginal benefit of education, it may also makes a child a more productive worker and thereby raise the marginal cost of education (see Bleakley, 2010, for a discussion). Hence, the greater importance of physical labor for individuals born in the early 20th century in Norway may have depressed the effect on education and the effect on lifetime earnings might be a better indicator for the overall impact of the provision of a nutritious school breakfast (see also Bleakley, Costa, and Lleras-Muney, 2014).

6.3 Age at Treatment and Treatment Duration

As discussed in Section 2, there is empirical evidence that additional nutrition at young ages has larger long-term effects on educational and labor market outcomes than the same extra nutrition for older children (Hoddinott et al., 2008). There are several potential explanations for this pattern: first, Heckman (2007) and Cunha and Heckman (2007) suggest a model of child investments, which includes complementarities between early investments and later investments. That is, children exposed at younger ages benefit more because the marginal return to investment is higher. Hence, children that are enrolled in schools serving breakfasts experience improvements in nutrition status at a young age, which lead to improved learning. In addition, recent empirical work on childhood investment shows that interventions at early ages, in particular at critical stages of development, may be more effective (see, e.g., Hoynes, Schanzenbach, and Almond, 2016). On the other hand, children who were provided with the Oslo breakfast at early ages may simply have had more time to experience better nutrition. The staggered introduction of the Oslo breakfast and the fact that breakfast provision was stopped in 1940 because of wartime food rationing, allows us to distinguish between the age at treatment and duration of the exposure. First, we can look at what age individuals benefit most from breakfast provision. We estimate Equation 3 using three age bins: 1st and 2nd grades; 3rd and 4th grades; and 5th, 6th, and 7th grades. We present the results of this estimation in Figures 1 and 2, where we plot the estimated coefficients as well as their 95% and 90% confidence intervals against the age of treatment. Although the effect is largest for the individuals exposed to the school breakfast early, the effects are not significantly different. Figures 3 and 4 plot the estimated coefficients as well as their 95% and 90% confidence intervals against the duration of treatment. The estimated effects are higher for individuals who had access to the school breakfast for a longer duration. The effects are, however, not significantly different from each other. Hence, we do not find significantly different effects of being treated at different ages or for a different duration. As described in Section 2, most of the previous studies analyzing nutritional intake focus on the in utero period (see, e.g., Painter, Roseboom, and Bleker, 2005) or on the first five years of life (Hoynes, Schanzenbach, and Almond, 2016). Here, children were exposed to extra nutrition at age seven years or later. It may be the case that the marginal return to investment does not vary much between ages seven and 14 years as it does for younger ages. On the other hand, as described in Section 3, an important part of the school breakfast was also to teach children healthy eating behavior. Nutritional research shows that children's early experiences with healthy food influence their eating behavior as an adult (Cooke, 2007). Over the years, the introduction of the Oslo breakfast changed the breakfast eating behavior in Norway and the content of the Oslo breakfast remain the most important components of Norwegian breakfasts today. Hence, a few years of school breakfast treatment may be sufficient to reach the goal of teaching health citizenship and change children's and

families' eating behavior in the longer-run.

6.4 Occupation

Table 5 reports evidence that occupational standing is higher for men with access to the Oslo breakfast. We use occupation data from the 1960 census, where occupations are classified into three broad categories: self-employed individuals, which also includes business owners, skilled and semi-skilled individuals and unskilled individuals. For men, we find that exposure to the Oslo breakfast significantly decreased the likelihood of being an unskilled worker and significantly increased the likelihood of being self-employed or in a skilled or semi-skilled position. These findings are consistent with the findings on wages that men with access to the Oslo breakfast had better opportunities in the labor force than those without access. As far fewer women than men were employed in 1960, the number of observed occupational statuses for women is substantially smaller. For women, we find that access to school breakfasts has no effect on occupational status. These findings correspond well with our findings in Section 6.2 that the effect of school breakfasts on wages is smaller for women (although not significantly smaller in most cases).

7 Robustness and Sensitivity Analysis

In this section, we present a variety of sensitivity test results. First, we allow for municipality-specific linear, quadratic and cubic time trends. Second, we drop cities where the reform was introduced over a longer period. In practice, this means that we drop some of the biggest cities in the sample. Finally, we check whether sharp changes in the share of women or left-wing representatives in the city parliament or school expenditures per student coincide with the introduction of the school breakfast.

7.1 Municipality-Specific Time Trends

Our empirical strategy relies upon the idiosyncratic nature of the timing of the introduction of the Oslo breakfast (see Section 3 for a discussion). We, therefore, estimate Equation 4 in which we include both linear, quadratic and cubic municipality-specific time trends. Here, the identification is determined by whether the implementation of the school breakfast program led to deviations from a preexisting linear, quadratic, or cubic municipality-specific time trend. Table 6 presents the results. Focusing on educational attainment (Columns 1 and 2), our findings are robust to the inclusion of municipality-specific time trends. When including linear municipality-specific time trends (Panel A), the estimated effect on both completed years of education and the likelihood of finishing high school is slightly smaller compared with our baseline results in Table 3. The effect on the likelihood of finishing high school is only significant

at the 10% significance level. When we control for quadratic or cubic municipality-specific time trends (Panels B and C), the magnitude of the estimates on both years of education and the likelihood of finishing high school are identical or larger than the baseline results. They are also significant at the 1% significance level. The results for the earnings outcomes (Columns 3 to 7) are relatively robust to the inclusion of municipality-specific time trends. When including linear municipality-specific time trends, the estimated effect on average earnings at ages 50–55 years and at ages 56–61 years are smaller and no longer significant. On the other hand, the effects on log earnings at ages 50–55 years and average earnings from 1967–1980 are similar to our baseline results. When including quadratic or cubic municipality-specific time trends (panels B and C), the results are consistent with our baseline results and equally precisely estimated. Thus, the inclusion of municipality-specific time trends does not change our baseline results to a large extent.

7.2 Instantaneous vs. Staggered Implementation

In some of the biggest cities including, Oslo, Bergen, Trondheim, Stavanger, and Haugesund, the Oslo breakfast was not introduced in all schools in the same school year. The implementation was staggered over two to four years and the staggered implementation occurred mainly because schools had to build big enough rooms to facilitate the breakfast. One concern might be that school breakfasts are introduced in selective neighborhoods first and thus might bias our results.

We first collected historical documentation containing the date of implementation in each school in Oslo and Bergen. In Oslo, most schools implemented the Oslo breakfast in 1931. The four schools that had already implemented the Oslo breakfast in 1929 and 1939 were inner city schools, which were located in neighborhoods with a relatively low mean average income. The first two schools implementing the Oslo breakfast in Bergen were both in a poorer and in a wealthier neighborhood, respectively. Hence, the results should not be driven by a systematic implementation in specific neighborhoods.[16]

As an additional robustness test, we limit our sample to individuals born in cities where school breakfasts were introduced in all schools at the same time. Panel A of Table 7 presents the results. In practice, this means that only somewhat smaller cities are included in our treatment group. Hence, the sample size is less than half of the baseline sample when we focus on the smaller cities that implemented the Oslo breakfast instantaneously within one school year. Nevertheless, our results indicate a positive effect on completed years of education, which is significant at the 5% significance level and larger in magnitude compared with our baseline

[16] As we only know the municipality of birth and not the school district in which individuals lived in the 1930s, we cannot use the information on the rollout of the breakfast provision within cities to estimate the effect of breakfast provision on long-term economic outcomes.

estimates. The effect on the likelihood of finishing high school is also larger in magnitude compared with our baseline estimates and significant at the 1% significance level. The estimated effect on average earnings measured at ages 50–55 years, at ages 56–61 years and between 1967 and 1980 are slightly larger in magnitude compared with our baseline results. We, however, only find a significant effect on average earnings from 1967–1980. When considering log earnings at various ages, the estimated effects are substantially smaller and insignificant. Taken together, we find that for most educational and labor market outcomes the baseline results are not driven mainly by the potentially selectively-staggered breakfast implementation in the bigger cities.

7.3 Women's Suffrage

A further concern is that the start of the school breakfast program coincides with women gaining political power in Norway. The recent literature has shown that women's enfranchisement increased funding for social programs directed toward children. In particular, Lott and Kenny (1999) exploit the decentralized process of female enfranchisement in the United States and find that the passage of state laws increased state government expenditures on social programs by 36%. Using the same source of identification, Miller (2008) establishes that states' health spending rose by 24% following women's suffrage, Carruthers and Wanamaker (2015) document that suffrage laws led to higher spending on schools by local governments in the south of the United States, and Kose, Kuka, and Shenhav (2015) find that women's suffrage led to a one-year increase in educational attainment. In Norway, general suffrage for men and women was introduced in 1913. Prior to 1913, men's right to vote depended on their level of income and the amount of taxes paid and women's right to vote depended on their husbands' income (Larsen and Øksendal, 2013). By 1901, many women were able to vote in the municipality elections and could be elected as representatives to the city parliaments for the first time. Although women's suffrage laws were established in 1913, the number of female representatives in city parliaments started increasing substantially only in the 1920s and 1930s. If a sharp increase in the political power of women is aligned with the implementation of the Oslo breakfast, our estimates do not necessarily measure the effect of access to the Oslo breakfast but the effect of women's enfranchisement.

We address the concern that a sharp increase in the political power of women might be aligned with the implementation of the Oslo breakfast by analyzing whether the share of female representatives in city parliaments was increasing substantially immediately prior to the breakfast implementation.[17] Figure 5 shows the share of female representatives in city parlia-

[17] As discussed in Section 3, the decision to implement the Oslo breakfast was made by local city governments, who also provided the funding. Hence, female representation in the local city parliaments is most important in our context.

ments from 1913 to 1940.[18] The vertical line in each figure indicates the year the breakfast was implemented in each city. In most cities, the share of female representatives in the city parliament does not increase substantially immediately prior to the Oslo breakfast implementation. Only in Larvik and Tromsø, there was a sharp increase in the share of women in the city parliament in the 1937 election, which is the same year as the breakfast was implemented. However, the implementation decision was made by the parliaments prior to the elections in which female representation in the local parliaments was increased. Hence, the increasing female representation in city parliaments is unlikely to be the main mechanism explaining our results.

7.4 Share of Representatives from Left-Wing Parties in City Parliaments

As with women's suffrage, sharp increases in the power of the left-wing parties might be an additional concern. Hence, if the implementation of the Oslo breakfast coincides with the left-wing parties gaining majority political power, our estimates may not necessarily measure the effect of access to the Oslo breakfast, but rather the effect of a left-wing majority government. Figure 6 shows the share of left-wing representatives in city parliaments from 1913 to 1940. The vertical line in each figure indicates the year the breakfast was implemented, the horizontal line represents 50% of the seats in the local parliament. The cities Drammen, Kristiansund, and Harstad experienced a majority left-wing city parliament (for the first time) shortly before the school breakfast is implemented. As a further test, we, therefore, drop these three municipalities from the sample and rerun our main specifications. The results are presented in Panel B of Table 7. The estimated effects are slightly larger compared with the main results in Table 3 and still significant. The estimated effects on the earnings outcomes are, however, less precisely estimated when excluding Drammen, Kristiansund, and Harstad. However, the increasing number of left-wing representatives in the city parliaments is not likely to be the main mechanism explaining our results.

7.5 School Costs per Student

An additional concern is the large differences in spending on schools, which coincide with the implementation of the Oslo breakfast. School resources or changes in class size may affect student performance and educational achievements. Figure 7 shows the school expenditures per student from 1920–1939. The vertical line marks when school breakfasts were first offered. In several municipalities, school expenditures per child increased sharply after 1935. The increase in per child expenditures is not caused by increasing school investment spending or the change in the data source, but rather by decreasing cohort sizes. Although the increase in school

[18] For parsimony, we only report this for the municipalities that introduced school breakfasts.

expenditures per child occurred after the introduction of the Oslo breakfast, some cohorts that benefited from the breakfasts may also benefit from higher per student spending. We, therefore, include a robustness test where we exclude cities that implemented the Oslo breakfast either in 1935 or subsequently. Panel C of Table 7 presents the results. The estimated effects on the educational and earnings outcomes are slightly larger compared with the main results in Table 3 and still significant. Hence, the sharp increases in school expenditures per student is not likely to be the main mechanism explaining our results.

8 Discussion

In this section, we discuss through which channels the Oslo breakfast affected educational attainment and wages and we link our results to the previous literature.

8.1 Potential Channels

As discussed above, there are several ways by which a nutritious school breakfast may affect educational attainment. First, participation in a school breakfast program may improve students' academic performance directly through enhanced daily nutrient intake (Kleinman, Hall, and Green, 2002). Second, school breakfast provision may increase the incentives to go to school (Murphy, Pagano, and Nachmani, 1998). Last, free breakfasts at school may decrease household expenditure on food among the poor and affect educational outcomes indirectly through family income (Long, 1991). In this subsection, we discuss these potential channels.

A potential mechanism through which school breakfast provision affects educational attainment is increased school attendance. We therefore analyze the effects of the Oslo breakfast on the percentage of missed school days per municipality to analyze whether the policy had an immediate effect on school attendance. As noted above, we base this analysis on municipality-level data. The results from estimating Equation 4 are presented in Table 8. None of the estimated coefficients are significant at the 10% significance level. This finding is consistent with papers analyzing the effect of free breakfast provision in recent years in the United States (see, e.g., Leos-Urbel, Schwartz, Weinstein, and Corcoran, 2013; Dotter, 2013). Nevertheless, the sample size is small. Hence, we might lack precision in identifying the true effects of Oslo breakfast provision on school attendance.

In addition, breakfast provision at school may affect educational outcomes indirectly through family income. However, the counterfactual to the Oslo breakfast is a hot school meal at the end of the school day with a low vitamin contain and a breakfast at home with low vitamin contain. What the reform changes is the type of meal the city provides and the vitamin contain of the food served. In cities, which introduced the Oslo breakfast, families had to provide dinner at home instead of breakfast. Hence, Oslo breakfast provision at school is unlikely to

improve educational outcomes indirectly through family income.

It is therefore likely that the enhanced nutrient intake improve students' academic performance directly. Analyzing the introduction of the Oslo breakfast allows us however not to disentangle whether the effect is mostly driven by the amount of nutrients in the school meal or the change in the timing of the food provision.

8.2 Comparison with Previous Studies

As this is the first paper, to our knowledge, that measures the long-term economic consequences of a free school breakfast program, it is not straightforward to compare our results to the existing literature. However, we can compare our results with other studies that analyze the long-term effects of the school lunch program or programs providing children with extra nutrition.

Hinrichs (2010) finds that a 10 percent increase in exposure to the National School Lunch Program results in an average increase in education of 0.365 years for women and 0.942 years for men. Petersen, Rooth, and Lundborg (2016) analyze the long-term effects of a universal school lunch program in Sweden, which was introduced in the late 1950s and 1960s and they find that those exposed to school lunches during their entire primary school period have a 4 percent higher income. In addition, the authors find that the magnitude of the effects are somewhat larger among males. These result are similar to our findings. Maluccio et al. (2009) find that an early childhood nutritional intervention in rural Guatemala increased women's education by 1.2 years. Hoddinott et al. (2008) exploit the same intervention and find that the adult wages of men who received extra nutrition early in life (from zero to two years) increased by 46%. The effects of the nutrition intervention in Guatemala are substantially larger than our findings. The program was however targeted at much younger children.

9 Conclusion

In this paper, we present evidence that access to health food during primary school can improve long-term economic outcomes. In particular, we exploited the staggered change from hot meals at the end of the school day to school breakfasts in urban municipalities in Norway during the 1920s and 1930s. Switching the type of meal did not affect the calorie intake but most importantly the amount of vitamins, minerals, and proteins children consumed as well as the timing of food provision. We find that access to nutritious school breakfasts leads to a significant increase in education and earnings and a shift in occupational status. The results are robust to several sensitivity tests. In general, the results imply that better nutrition from age seven to 14 years has long-term effects on human capital accumulation and labor market success.

The age at which children are exposed to the breakfast program and the duration of the treatment, do not alter the effects significantly. That is, the effect of extra nutrition at age

seven and eight years on education and earnings is not significantly larger than the effect of extra nutrition at ages 12, 13, and 14 years. The previous literature finds that the effects of nutrition interventions on adult wages diminish after the age of two years (Hoddinott et al., 2008). This might explain why the estimated differences are small. In addition, a goal of the breakfast provision was to teach children and their families healthy eating habits and set an example for eating behavior later in life. This might explain why the effect of extra nutrition for six or seven years on education and earnings is not significantly larger than the effect of extra nutrition for one or two years. The goal of changing eating behavior is still visible in today's Norwegian breakfast. The most important components of the Oslo breakfast are still components of current breakfast habits.

We add to the existing literature on access to nutritious food and in particular to access to free school breakfasts, which has focused mainly on the short-term effects of school breakfast provision, as we are able to study the long-term effects of free school breakfasts. This is a strength of our analysis; however, this also represents a drawback. The reform happened in the 1920s and 1930s in Norway. This makes it difficult to generalize the results to current policies (see Ludwig and Miller, 2007, for a discussion). However, similar to the hot school meal in the 1920s in Norway today's school meals in the United Kingdom and the United States are often criticized for the lack of micronutrients and the amount of sugar and fats they contain (see Schanzenbach, 2009; Belot and James, 2011). Although the situation is different today than in the 1920s in Norway and policy makers today are mostly concerned about the increasing number of obese children, our results might still shed some light on potential long-term benefits of serving nutritious food at school and simultaneously teaching children healthy eating habits. In addition, we note that malnutrition and in particular the lack of proteins and vitamins is still a large issue in developing countries and it is, therefore, likely that infants in developing countries would benefit from nutritious school meals in the long-run.

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10 Tables and Figures

Table 1: Rollout of the Oslo breakfast

Year	Municipalities
1921	Skien
1929	Halden
1930	Oslo, Sarpsborg, Tønsberg, and Trondheim
1931	Bergen and Harstad
1932	Haugesund and Sandefjord
1933	Kristiansand and Stavanger
1934	Bodø and Kopervik
1935	Arendal, Hamar, and Kristiansund
1936	Fredrikstad, Horten, Porsgrunn, and Vardø
1937	Ålesund, Drammen, Larvik, and Tromsø
1938	Mo
Observations	26

Note: Year of Oslo breakfast implementation in different urban municipalities.

Table 2: Descriptive Statistics

	Men	Women	Whole Sample
School Breakfast	0.560	0.510	0.532
	(0.496)	(0.500)	(0.499)
Outcomes			
Years of education	10.21	8.990	9.527
	(3.106)	(2.208)	(2.709)
High school	0.389	0.180	0.271
	(0.487)	(0.384)	(0.445)
Log earnings ages 50–55	12.26	10.98	11.64
	(0.755)	(1.532)	(1.354)
Earnings age 50–55 in NOK	241833.1	89898.4	163202.0
	(119160.8)	(85399.1)	(128019.4)
Log earnings ages 56–61	12.15	10.89	11.54
	(1.003)	(1.690)	(1.517)
Earnings ages 56–61 in NOK	232279.8	89070.4	157862.2
	(193212.9)	(89678.9)	(165017.2)
Earnings in 1967–1980	232903.0	77616.2	152209.5
	(99404.5)	(73360.4)	(116457.3)
Self-employed	0.127	0.0561	0.109
	(0.333)	(0.230)	(0.312)
Skilled and semi-skilled	0.370	0.574	0.421
	(0.483)	(0.495)	(0.494)
Low-skilled	0.487	0.354	0.454
	(0.500)	(0.478)	(0.498)
Municipality level controls			
Student teacher ratio	30.12	30.11	30.11
	(3.958)	(3.939)	(3.947)
Number of doctors per	0.120	0.116	0.118
100 inhabitants	(0.0495)	(0.0488)	(0.0492)
Observations	69112	88512	157624

Note: Mean coefficients and standard deviations in parentheses.

Table 3: Long-Term Effects of School Breakfast Availability on Education and Labor Market Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A: Baseline						
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.095**	0.017***	0.041**	2782.3**	0.031	3259.6*	2782.7***
	(0.036)	(0.005)	(0.018)	(1348.9)	(0.023)	(1705.9)	(970.7)
Observations	157419	157419	123083	134805	126513	142427	142427
	Panel B: No Control Variables						
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.104***	0.019***	0.041**	2622.8*	0.024	3552.8**	2490.1*
	(0.036)	(0.005)	(0.019)	(1534.0)	(0.026)	(1738.3)	(1327.1)
Observations	157419	157419	123083	134805	126513	142427	142427

Note: Each parameter is from a separate regression of the outcome variable on access to school breakfasts. Robust standard errors adjusted for clustering at the level of the municipality are shown in parentheses. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects. Additional control variables in Panel A: gender, student–teacher ratio, and doctors per 100 inhabitants. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Long-Term Effects of School Breakfast Availability on Education and Labor Market Outcomes by Gender and Poverty Status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Men							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.135**	0.021***	0.027**	5022.5**	0.015	4223.7*	3937.2***
	(0.054)	(0.007)	(0.013)	(1999.2)	(0.017)	(2475.7)	(1354.6)
Observations	69042	69042	63857	65039	65326	68416	68416
Panel B: Women							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.059	0.013**	0.057**	695.3	0.048	1962.7	1632.2
	(0.040)	(0.006)	(0.028)	(1163.0)	(0.040)	(1368.9)	(1168.7)
Observations	88377	88377	59226	69766	61187	74011	74011
Panel C: Above-median Poverty Rate							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.122**	0.020**	0.037*	2732.120	0.039	4776.222**	3830.767**
	(0.048)	(0.007)	(0.020)	(1754.5)	(0.031)	(2090.1)	(1538.5)
Observations	112175	112175	88434	96517	91065	102194	102194
Panel D: Below-median Poverty Rate							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.083	0.025**	0.045	2417.809	0.021	3352.299	2141.155
	(0.065)	(0.009)	(0.047)	(3115.8)	(0.051)	(4247.3)	(1691.5)
Observations	44700	44700	34180	37777	34987	39722	39722

Note: Each parameter is from a separate regression of the outcome variable on access to school breakfasts. Robust standard errors adjusted for clustering at the level of the municipality are shown in parentheses. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, gender (Panel C and D only), student–teacher ratio, and doctors per 100 inhabitants. Panel A provides the estimated effects for men only; Panel B provides the estimated effects for women only. Panel C provides the estimated effects for individuals living in cities with above-median poverty rates; Panel D provides the estimated effects for individuals living in cities with below-median poverty rates. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Long-Term Effects of School Breakfast Availability on Occupational Status in 1960

	Panel A: Men		
	(1)	(2)	(3)
	Self-employed	Skilled and semi-skilled	Low-skilled
School Breakfast	0.019**	0.014*	-0.029***
	(0.007)	(0.007)	(0.009)
Observations	68515	68515	68515
	Panel B: Women		
	(1)	(2)	(3)
	Self-employed	Skilled and semi-skilled	Low-skilled
School Breakfast	0.008	0.002	-0.010
	(0.009)	(0.013)	(0.014)
Observations	23011	23011	23011

Note: Each parameter is from a separate regression of the outcome variable on access to school breakfasts. Robust standard errors adjusted for clustering at the level of the municipality are shown in parentheses. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, student–teacher ratio, and doctors per 100 inhabitants. Panel A provides the estimated effects for men only. Panel B provides the estimated effects for women only. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Sensitivity Analysis: Municipality-Specific Time Trends

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Linear Municipality-Specific Time Trends							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.067**	0.010*	0.045***	1447.6	0.034	1406.1	2388.0**
	(0.031)	(0.006)	(0.014)	(1052.1)	(0.022)	(1433.2)	(1084.2)
Observations	157419	157419	123083	134805	126513	142427	142427
Panel B: Quadratic Municipality-Specific Time Trends							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.104***	0.017***	0.047***	2026.4**	0.033	2503.1*	2888.5***
	(0.032)	(0.005)	(0.014)	(974.4)	(0.021)	(1290.2)	(1039.6)
Observations	157419	157419	123083	134805	126513	142427	142427
Panel C: Cubic Municipality-Specific Time Trends							
	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.125***	0.021***	0.045***	2426.4**	0.031	3172.9**	3121.0***
	(0.033)	(0.005)	(0.014)	(960.5)	(0.021)	(1246.1)	(1008.8)
Observations	157419	157419	123083	134805	126513	142427	142427

Note: Each parameter is from a separate regression of the outcome variable on access to school breakfasts. Robust standard errors adjusted for clustering at the level of the municipality are shown in parentheses. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, gender, student–teacher ratio, and doctors per 100 inhabitants. Panel A includes municipality-specific linear time trends. Panel B include municipality-specific quadratic time trends. Panel C include municipality-specific cubic time trends. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Sensitivity Analysis: Staggered Implementation, Political Parties, and School Cost

Panel A: Instantaneous vs. Staggered Implementation

	(1) Years of education	(2) High school	(3) Log earnings 50–55	(4) Earnings age 50–55	(5) Log earnings age 56–61	(6) Earnings age 56–61	(7) Earnings 1967–1980
School Breakfast	0.133**	0.021***	0.021	3219.3	0.010	3836.4	3037.1**
	(0.052)	(0.007)	(0.022)	(2232.2)	(0.037)	(3006.6)	(1468.4)
Observations	65873	65873	50985	56156	52229	59104	59104

Panel B: Excluding Cities where the Share of Left-Wing Parties in City Parliament is Increasing Prior to the Breakfast Implementation

	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.115***	0.020***	0.038*	3404.4**	0.024	3697.8*	3077.4***
	(0.040)	(0.006)	(0.021)	(1532.9)	(0.026)	(1847.4)	(1091.0)
Observations	147231	147231	115287	126203	118458	133311	133311

Panel C: Excluding Cities Implementing the School Breakfast in 1935 and After

	Years of education	High school	Log earnings 50–55	Earnings age 50–55	Log earnings age 56–61	Earnings age 56–61	Earnings 1967–1980
School Breakfast	0.105**	0.022***	0.044*	3556.6**	0.028	4329.6**	3006.6**
	(0.049)	(0.007)	(0.025)	(1586.3)	(0.025)	(1667.7)	(1246.5)
Observations	134377	134377	105446	115376	108364	121878	121878

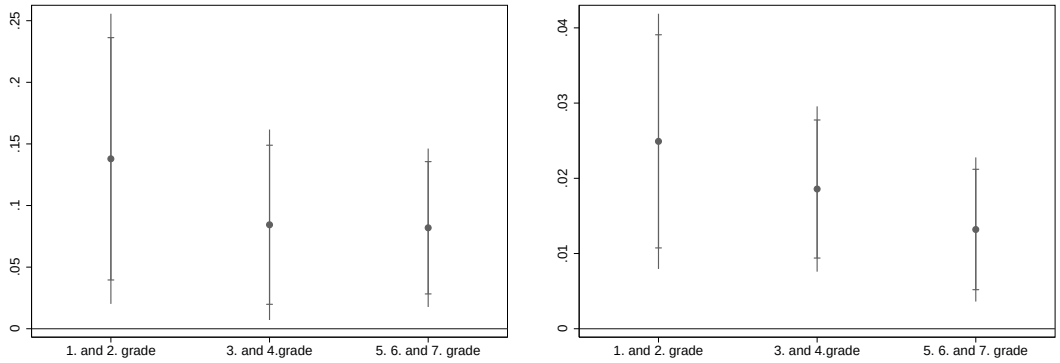
Note: Each parameter is from a separate regression of the outcome variable on access to school breakfasts. Robust standard errors adjusted for clustering at the level of the municipality are shown in parentheses. The sample includes individuals born in cities between 1910 and 1932. In Panel A, individuals born in cities where the implementation of the reform was staggered is dropped (Oslo, Bergen, Trondheim, Stavanger and Haugesund). In Panel B, municipalities that experienced a majority left-wing city parliament shortly before the school breakfasts were introduced are dropped from the sample. These municipalities include Drammen, Kristiansund, and Harstad. In Panel C, municipalities that introduced school breakfasts in 1935 and subsequently are dropped from the sample. All specifications include a full set of cohort and municipality fixed effects, gender, student–teacher ratio, and doctors per 100 inhabitants. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Effect of School Breakfast Provision on Percentage of Missed School Days

	(1) Mean prereform	(2) Missed School	(3) Missed School	(4) Missed School
School Breakfast	5.238	-0.028	-0.008	-0.030
		(0.168)	(0.168)	(0.172)
Control Variables				
Student teacher ratio			x	x
Doctor per 100 capita				x
Observations		1287	1287	1279

Note: Each parameter is from a separate regression of the outcome variable on access to school breakfasts. Robust standard errors adjusted for clustering at the level of the municipality are shown in parentheses. The sample includes individuals born in cities between 1910 and 1932. Column (1) provides the results without additional control variables, in Column (2) we control for student–teacher ratio and in Column (3) we control for student–teacher ratio, and doctors per 100 inhabitants. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

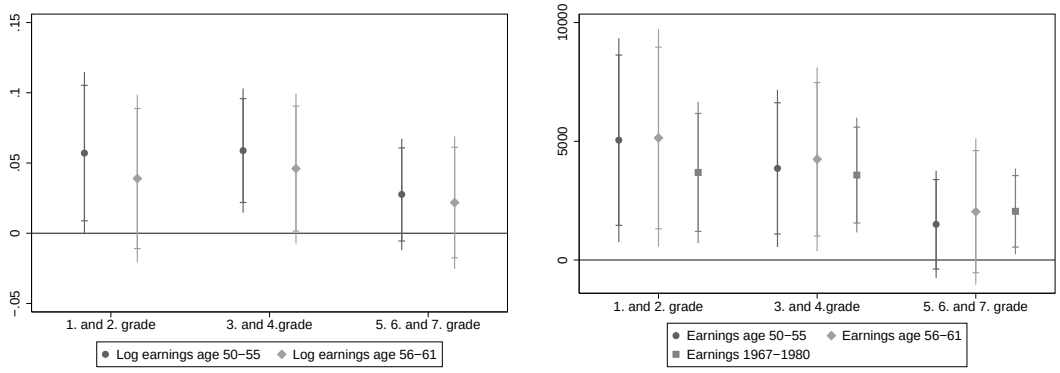
Figure 1: Age at Treatment: Effect on Education



(a) Years of Education (b) High School

Note: The figures plot the estimated coefficients of μ_a in Equation 3 as well as the 90% and 95% confidence intervals for the outcome variables. Standard errors are clustered at the municipality level. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, gender, student–teacher ratio, and doctors per 100 inhabitants.

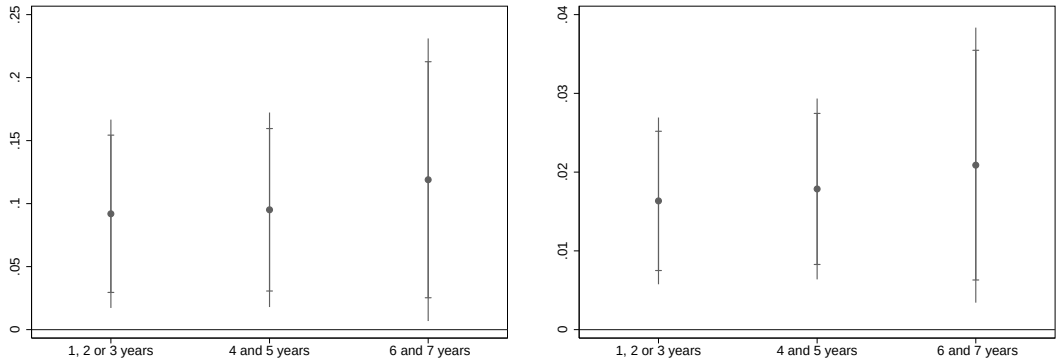
Figure 2: Age at Treatment: Effect on Earnings



(a) Log Earnings (b) Earnings

Note: The figures plot the estimated coefficients of μ_a in Equation 3 as well as the 90% and 95% confidence intervals for the outcome variables. Standard errors are clustered at the municipality level. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, gender, student–teacher ratio, and doctors per 100 inhabitants.

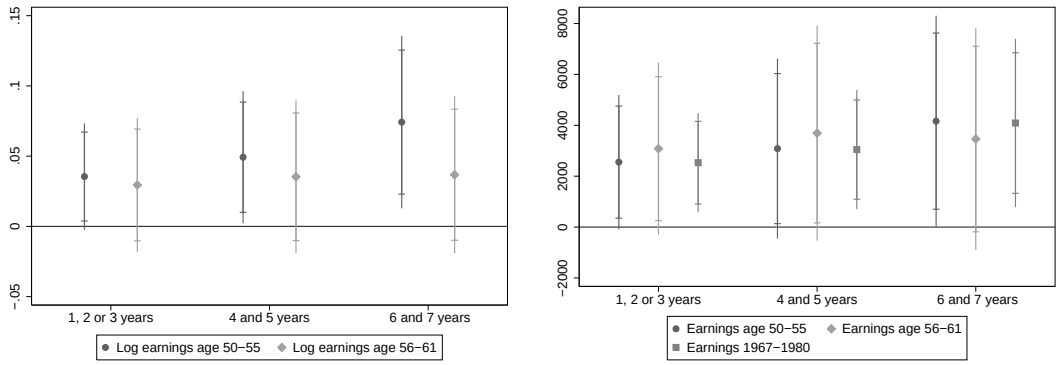
Figure 3: Years of Treatment: Effect on Education



(a) Years of Education (b) High School

Note: The figures plot the estimated coefficients of μ_a in Equation 3 as well as the 90% and 95% confidence intervals for the outcome variables. Standard errors are clustered at the municipality level. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, gender, student–teacher ratio, and doctors per 100 inhabitants.

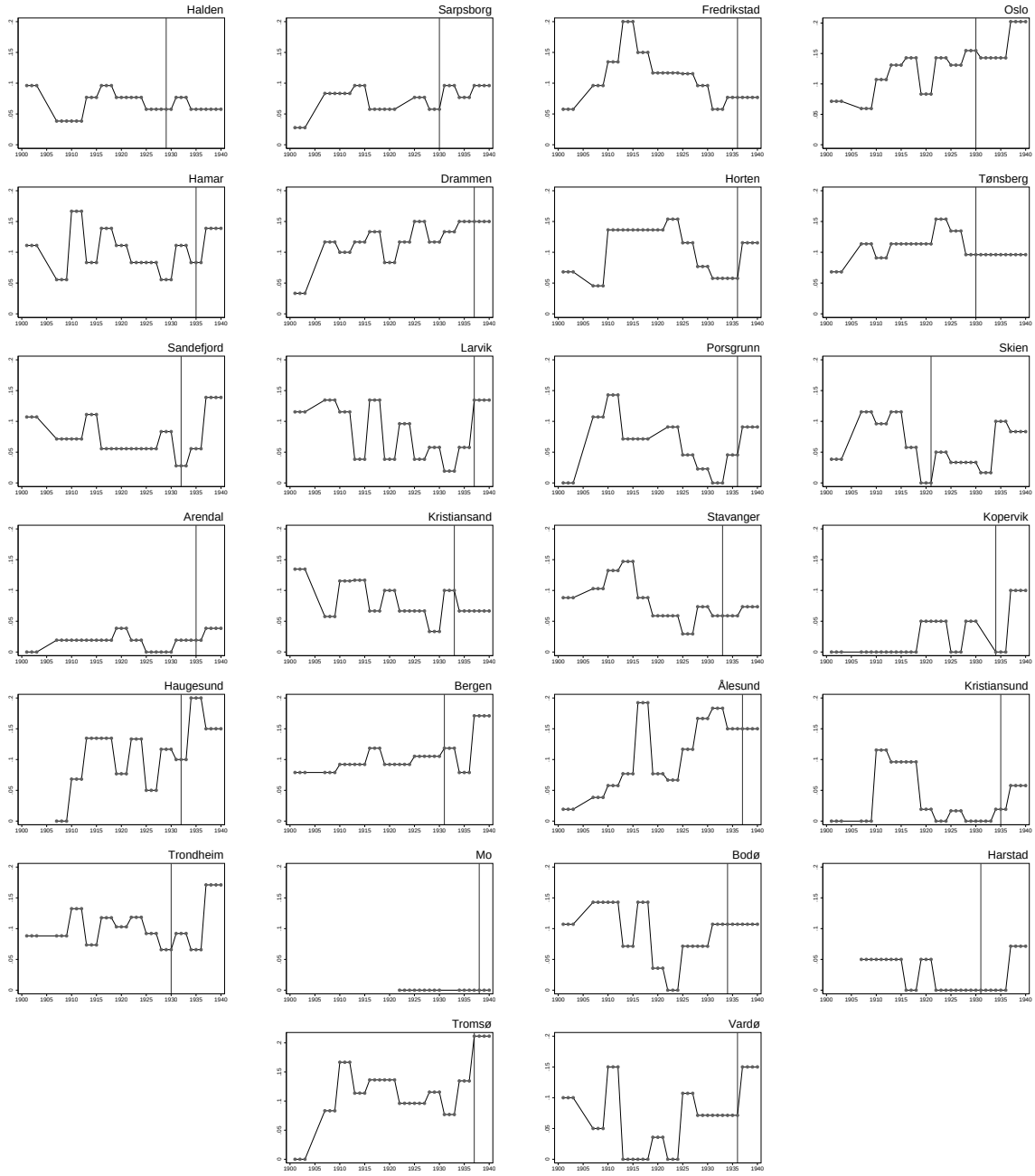
Figure 4: Years of Treatment: Effect on Earnings



(a) Log Earnings (b) Earnings

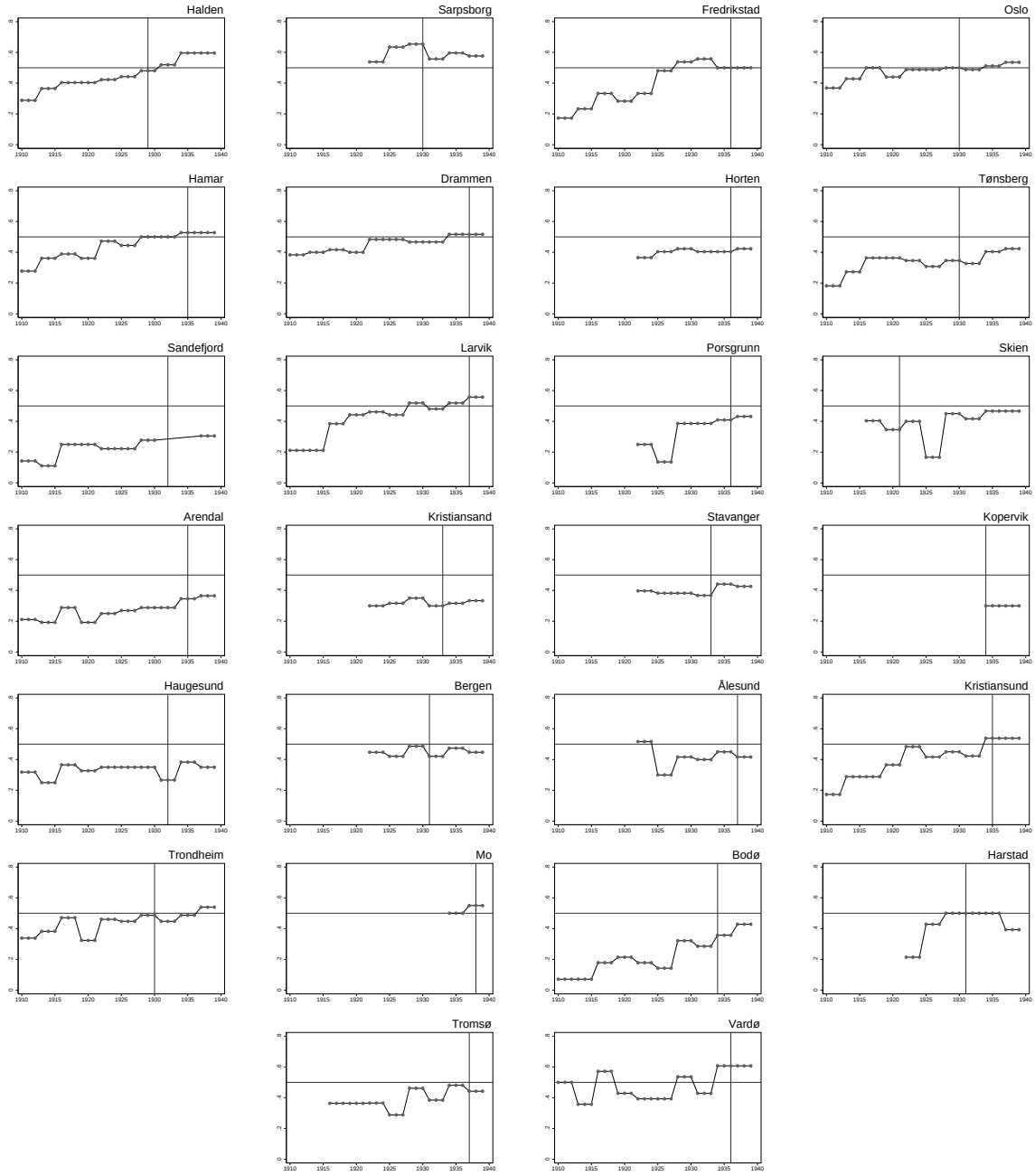
Note: The figures plot the estimated coefficients of μ_a in Equation 3 as well as the 90% and 95% confidence intervals for the outcome variables. Standard errors are clustered at the municipality level. The sample includes individuals born in cities between 1910 and 1932. All specifications include a full set of cohort and municipality fixed effects, gender, student–teacher ratio, and doctors per 100 inhabitants.

Figure 5: Share Women in the City Parliament



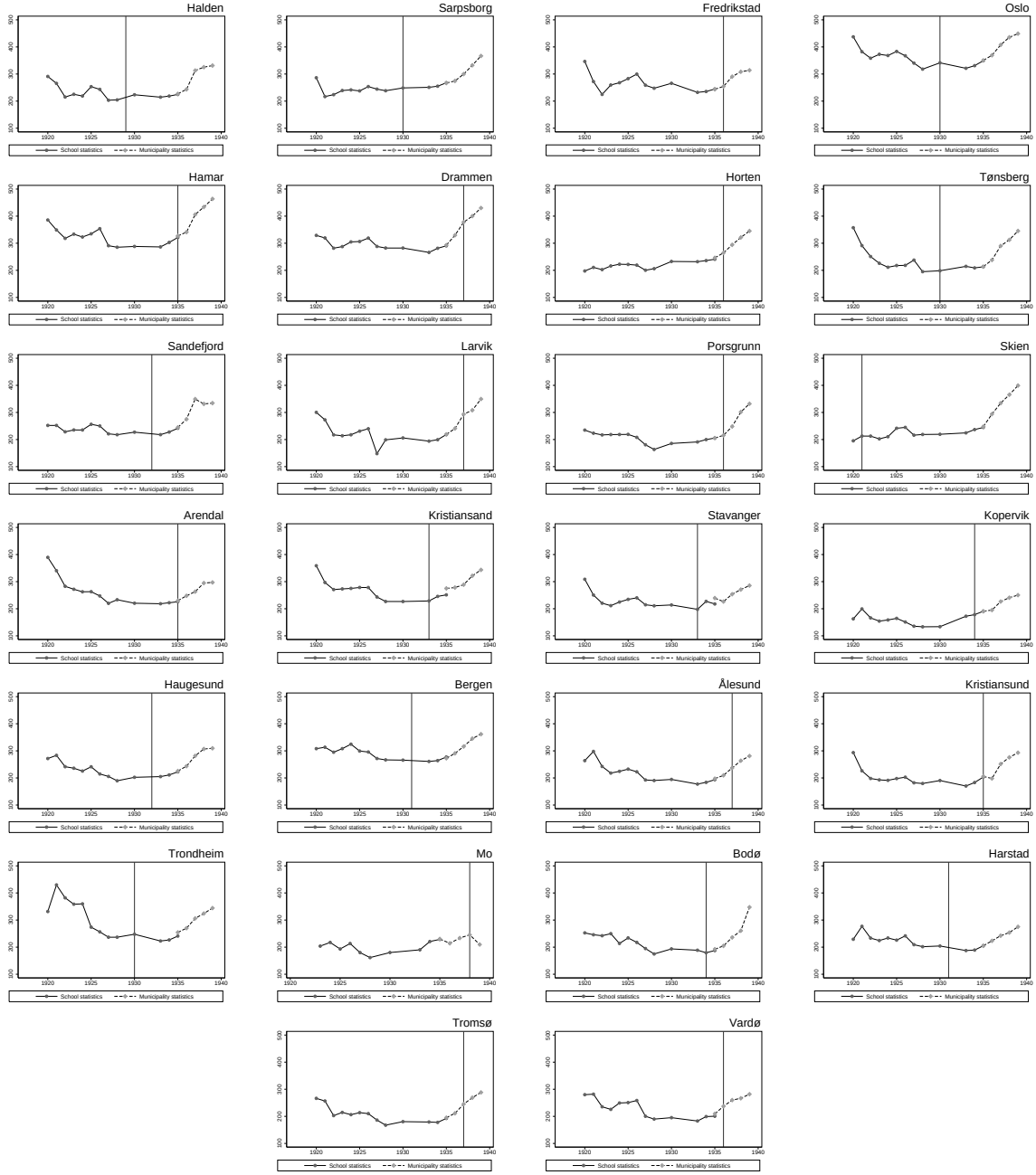
Note: Each figure presents the share of women in city parliaments in each year in the period from 1913–1940 in the cities where the breakfast was implemented. The vertical line marks the year the school breakfast was implemented. *Data Source:* Data on women in the city parliament were made available by Norwegian Social Science Data Services (NSD).

Figure 6: Share of Representatives from Left-Wing Parties in the City Parliament



Note: Each figure presents the share of left-wing representatives in city parliaments in each year in the period 1913–1940 in the cities where the breakfast was implemented. The vertical line marks the year school breakfasts were first introduced. *Data Source:* Data on left-wing representation in the city parliament are made available by Norwegian Social Science Data Services (NSD).

Figure 7: School Expenditures per Child



Note: Each figure presents the school expenditures per student in each year in the period 1920–1939 in the cities where the breakfast was implemented. The vertical line marks the year school breakfasts were first introduced. *Data Source:* Data on school expenditures from 1920–1935 are gathered from the annual publication *Skolestatistikk*. Data on school expenditures for 1935–1939 are gathered from the annual publication *Norges Kommunale Finanser*.

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NHH

Norges Handelshøyskole

Norwegian School of Economics

NHH
Helleveien 30
NO-5045 Bergen
Norway

Tlf/Tel: +47 55 95 90 00
Faks/Fax: +47 55 95 91 00
nhh.postmottak@nhh.no
www.nhh.no