The Work-to-School Transition: Job Displacement and Skill Upgrading Among Young High School Dropouts*

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Abstract

While employment is becoming increasingly skilled over time, 20–30% of a cohort will not graduate high school. This paper examines how adverse employment shocks cause low educated workers to reevaluate the importance of high school education and upgrade their skills. Involuntary job loss among young high school dropouts in Norway increases formal certification of vocational skills under the Practical Candidate Scheme and leads to additional investment in higher education. The paper finds that the availability of second chance opportunities matters: workers displaced after an expansion of the Scheme certify at significantly higher rates and exhibit stronger income recovery relative to those displaced pre-expansion. While cognitive ability matters in the decision to skill upgrade, all workers can benefit from certification as workers with an average IQ also certify. Twenty years later, early career displacement impacts occupational choices, reduces routine task intensity, and increases service and social task intensity. The paper reveals that policy-induced variation in the certification of vocational skills increases future job stability, mitigating the adverse consequences of early career employment shocks among the lowest educated.

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1 Introduction

Employment has become increasingly skilled over time: total hours worked by the non-college educated has fallen from over 70% in the 1960s to just 40% by 2017 (Autor, 2019). Though facing an increasing lack of relevant skills, 20–30% of recent birth cohorts will not graduate high school on-time (OECD, 2017). While dropout remains problematic across the OECD, a substantial fraction of dropouts either return to high school or take second chance options such as the General Educational Development (GED) at young ages.[1] Why do dropouts reverse their decision to drop out so soon after leaving high school and what makes them reevaluate the importance of a high school degree?

Despite the increasing importance of skills over time, there exists little evidence on what causes workers to go back to the education system after dropping out. This paper examines how adverse labor market shocks lead to skill upgrading among young, high school dropouts in Norway. I assess how early career workers—through an out of classroom certification scheme available to dropouts—certify their vocational skills following job separations of an involuntary nature—displacement due to a mass-layoff or closing event. In a triple difference framework, I exploit an expansion of the certification scheme to assess how the decision to certify after job loss depends on the availability of opportunities within the education system. The paper is the first to document the importance of the "work-to-school" transition after drop out, contributing to the education literature emphasizing the distinction between academic and vocational education in the "school-to-work" transition (Ryan, 2001).[2] While an extensive literature on job displacement documents the adverse consequences of job loss (Jacobson, LaLonde, and Sullivan, 1993), far less is known about how to foster recovery from such shocks. This paper documents how displacement causes dropouts to reevaluate the importance of a high school degree

[1] 7% of young adults aged 20–24 are enrolled in high school across the OECD and 14% of dropouts aged 19–24 in the US take second chance options such as the General Educational Development (GED) program. Data on enrollment in OECD from OECD (2017), Table C1.3. Data on the GED from the National Center for Education Statistics, Tables 219.73 and 219.60. GED data does not distinguish between attempts and persons taking, and assumes that any re-takers do not re-take in the same year.

[2] For evidence on the impacts of academic education relative to vocational education, see Oosterbeek and Webbink (2007); Malamud and Pop-Eleches (2010); Hall (2012); Hanushek, Schwerdt, Woessmann, and Zhang (2017); Bertrand, Mogstad, and Mountjoy (2019).

and return to the education system.

Isolating the causal determinants of returning to second chance options in the education system presents an empirical challenge. Not only is the choice to certify skills an endogenous decision, but the timing of at what age to certify is also likely determined by endogenous factors. To overcome the endogeneity of the certification decision, I compare the certification rates of high-tenured early career workers who lose their job during a mass-layoff or closing event to similar non-displaced high-tenured early career workers. The job displacement literature establishes such an approach isolates job loss which is unanticipated and involuntary, and that standard definitions of displacement closely correspond to alternative measures based on survey data (Flaaen, Shapiro, and Sorkin, 2019). In addition, exploiting the sudden expansion of vocational fields covered by the certification scheme in combination with job displacement enables the comparison of certification before and after the expansion in order to assess how the availability of opportunities impacts the decision to transition back into the education system.

Previous evidence from the job displacement literature establishes that job loss during a mass-layoff event causes persistent earnings losses (Jacobson, LaLonde, and Sullivan, 1993; Couch and Placzek, 2010)[3]. Job displacement leads early career workers to certify their skills, and certification significantly reduces the long-run earnings penalty due to job loss. In contrast to the lack of labor market return found for the GED in the US (Tyler, Murnane, and Willett, 2000; Heckman, Humphries, and Mader, 2011; Jepsen, Mueser, and Troske, 2016), the certification scheme examined formally documents occupation-specific vocational skills and candidates under the Practical Candidate Scheme (PCS) receive the exact same degree as on-time vocational high school graduates.

The paper finds that being laid off leads young high school dropouts to certify existing work experience by attaining a vocational high school degree under the PCS. Exploiting an expansion of the PCS to incorporate fields such as health care, social work, and retail

[3]An extensive literature also documents the non-economic impacts of job displacement with adverse impacts on health and mortality (Sullivan and von Wachter, 2009; Black, Devereux, and Salvanes, 2015), family structure and fertility (Charles and Stephens Jr., 2004; Del Bono, Weber, and Winter-Ebmer, 2012; Huttunen and Kellokumpu, 2016), child outcomes (Oreopoulos, Page, and Stevens, 2008; Rege, Telle, and Votruba, 2011), and geographic mobility (Huttunen, Møen, and Salvanes, 2018; Gathmann, Helm, and Schönberg, 2018).

sales, which traditionally employ a large fraction of women, reveals that women displaced after the expansion of the PCS certify at significantly higher rates compared to women displaced pre-expansion. Men displaced post-expansion, who are largely unimpacted by the inclusion of new fields, remain largely unchanged compared to their pre-expansion counterparts. Such stark gender differences highlight that the availability of second chance opportunities within the education system matters considerably for the skill upgrading of early career displaced workers. While recent work concludes that a large fraction of adults who drop out of education return to graduate later in life (Albæk, Asplund, Barth, Lindahl, Strøm, and Vanhala, 2019; Bennett, Blundell, and Salvanes, 2020), this paper emphasizes that job loss causes early career workers—who only recently dropped out of high school—to document their vocational qualifications.

While there is no additional impact of the expansion of the PCS on the completion of higher education, displaced workers continue in the education system and complete higher education at significantly higher rates than their non-displaced counterparts. Importantly, dynamic selection into displacement is not of concern: future displaced and non-displaced workers have similar trends in education prior to displacement and estimated pre-displacement coefficients are not significantly different from zero. Selection into displacement on factors such as worker ability, which may be particularly problematic among a sample of early career workers, is also not of concern and results are robust to alternative choices of counterfactual groups as well as sample selection.

Consistent with previous work emphasizing a strong correlation between cognitive ability and education (Heckman and Vytlacil, 2001), differences in cognitive ability matter in the decision to return to education. While high school dropouts have, on average, lower levels of IQ, those with higher levels of cognitive ability certify at significantly higher rates after job loss. However, displaced workers with average levels of cognitive ability are also on the margin of returning to education and certify after job loss at significantly higher rates. Thus, while cognitive ability matters for returning to education, differences in IQ cannot explain all of the decision to return to education.

In a standard school choice framework as in Becker (1975), job displacement lowers

the opportunity cost of returning to education by significantly reducing income among displaced workers. At the same time, displacement may lead workers to update their expectations about the labor market returns to being a high school dropout or directly impact individual preferences. Important differences across who is at the margin of returning to education post-displacement suggest that dropouts may have previously had wrong expectations about the future returns to education over the life cycle. Indeed, the impact of displacement on certification is particularly strong among high school dropouts who experienced favorable employment opportunities at young ages, especially among those who have a parent co-worker. Such differences in certification across workers of different ability levels and favorable employment opportunities imply that dropouts leave education too soon (Oreopoulos, 2007) and reevaluate the importance of a high school degree in the aftermath of job loss.

Consistent with the job displacement literature, young displaced workers experience sizable and strong declines in income and employment in the short-run. However, 10 years after displacement, labor market outcomes recover such that the income and employment of displaced workers is not significantly different from non-displaced workers. Such rapid recovery suggests that certification plays a causal role in the recovery of income following adverse labor market shocks. Consistent with the importance of certification in income recovery, women displaced after the expansion of the PCS, who certify at significantly higher rates, have significantly stronger income recovery compared to women displaced pre-expansion. Lachowska, Mas, and Woodbury (forthcoming) show that both reductions in wages and hours worked are important sources behind the long-run earnings losses of displaced workers. As the probability of working full-time is the same among women displaced both before and after the expansion of the PCS, this suggests that certification mitigates income losses after job loss by combating reductions in the wage level.

In addition, early career displaced women post-expansion have significantly more stable income in adulthood well after displacement. Thus, while certification fosters income recovery among displaced women in the period following job loss, certification also decreases the volatility of earnings far later in life. This finding is consistent with Delaney

and Devereux (2019), showing that increases in education decrease the volatility of earnings.

At the same time, early career displaced workers make substantially different occupational choices in adulthood well after displacement. Throughout the United States and Europe, the job polarization literature emphasizes the increasing importance of high-skilled occupations, with a shift away from middle- to low-skilled work (Goos and Manning, 2007; Autor, Katz, and Kearney, 2008; Goos, Manning, and Salomons, 2009, 2014). Both women and men displaced at young ages are more likely to enter skilled and service oriented occupations and less likely to be employed in routine clerical jobs, whose importance is declining over time (Autor, Levy, and Murnane, 2003). Linking occupations to measures of tasks as in Deming (2017), displaced workers are employed in occupations which perform significantly lower levels of routine tasks and significantly higher levels of service and social tasks. Occupational choices later in life matter for resilience to future shocks: plants which have mass-layoff or closing events perform significantly more routine tasks and significantly less service and social tasks, and certification at young ages has important consequences far later in the life cycle.

The paper proceeds as follows. Section 2 describes the Norwegian Register Data used throughout the paper, provides a comprehensive overview of the education system in Norway, and details the PCS and its expansion. Section 3 describes the sample of high-tenured high school dropouts and defines displaced workers impacted by mass-layoff or closing events. Section 4 estimates the impact of job displacement on certification, how the opportunities available in the education system impact the decision to certify, the robustness of the displacement methodology, and provides evidence on which workers are at the margin of returning to high school. Section 5 examines the causal channel of certification on labor market outcomes and how displacement impacts long-run occupation choices. Finally, Section 6 concludes.

2 Norwegian Register Data and Education in Norway

2.1 Norwegian Register Data

To analyze the importance of job loss for returning to the education system, this paper makes use of detailed Norwegian Register data provided by Statistics Norway. Interlinked by an anonymized personal identification number, the panel data tracks individuals over time and irrespective of employment status. The population register provides data on demographic characteristics such as age, gender, birth year, and municipality of residence. The data also contains the identity of a child's parents, permitting the construction of the number of children. Data is recorded for the entire population, that is, any individual who is legally residing in Norway.

Earnings are measured as pre-tax income, which includes annual labor income as well as any taxable benefits earned such as parental leave, unemployment, or sickness benefits. To the extent that displaced workers receive public transfers after job loss, the magnitude of the estimated earnings losses post-displacement will be smaller than if earnings were measured as only labor income.[4] Norway has a generous safety net of unemployment benefits, and the sample of workers defined in section 3.1 are all eligible for unemployment benefits. Throughout the paper, earnings are measured in year 2015 Norwegian kroner (NOK).

Data on education comes from the education register and schools are legally required to report any information on student enrollment and graduation to Statistics Norway. The data includes information on the years of education an individual has completed as well as the exact qualification attained including information on field of study. Additionally, any ongoing education is also recorded for each student, including information on field of study. The completion of educational qualifications and ongoing student status are measured at the start of October. Throughout the paper, education is defined as the

[4] Appendix A provides a comparison of post-displacement income losses between income measured with and without benefits for the cohorts of workers for whom data on labor income is available.

completion of high school, separately for academic and vocational high school, and the completion of higher education, any tertiary education. Further details of the Norwegian education system are discussed below.

Crucially, the data provides a linkage between workers and their employers, where both plant and firm identifiers are observed. Such data is available from 1986–2015 and enables the construction of the number of employees in the plant/firm as well as tenure with the same employer. Throughout the paper, the focus is on plants, and the terms employer and plant are used interchangeably. Additional information such as employment status—employed, unemployed, or outside the labor force—and the industry of employment is also recorded. Prior to 1994, data on employment is measured as matches between workers and plants at the end of May while from 1995 onwards, such information is recorded at the end of November.

Finally, data on cognitive ability is extracted from compulsory military testing data performed at the age of 18. Military testing was compulsory for all men of the birth cohorts considered throughout the paper. Cognitive ability is measured as an IQ test, an aggregate score of tests in arithmetic, word similarities, and figures.[5] IQ is measured on a 9 point scale, with an average value of 5 and a standard deviation of 2.

2.2 Education in Norway

For all birth cohorts considered in this paper, compulsory schooling is 9 years of education.[6] This is comprised of 6 years of primary schooling and 3 years of lower secondary education. As such, all individuals are able to join the labor force from 16–17 after the completion of compulsory schooling.

After the completion of compulsory schooling, a student decides whether to enroll in high school, which is non-compulsory. High school education lasts for 3–4 years and is structured into vocational programs as well as academic programs. Vocational high school emphasizes a theoretical and practical component in the classroom and is, pri-

[5]The first two exams are similar to the Wechsler Adult Intelligence Scale (WAIS) test while the figures test is similar to a Raven Progressive Matrix test.

[6]See Black, Devereux, and Salvanes (2005, 2008) for further details of the change in compulsory schooling.

marily, geared towards professional employment in a particular vocation rather than post-secondary education. Typical vocational high school programs last 3–4 years, beginning with the theoretical classroom component and finishing with practical training. Practical training may be done either at the school itself or as an apprenticeship with an employer. To complete the vocational high school program, students must pass exams in both the theoretical and practical components.

The completion of the academic high school typically takes 3 years and enables students to continue into university education. Prior to a reform in 1994 examined in Bertrand, Mogstad, and Mountjoy (2019), the system was very divided between academic and vocational education with little progression to university education from the vocational track. All birth cohorts considered in this paper are enrolled in education under the divided pre-reform system, as the reform defined eligibility according to birth year.

Tertiary education is comprised of university colleges (høgskole), which specialize in shorter programs in subjects such as nursing and teaching, and universities. The direct cost of higher education is close to zero in Norway, as there is no tuition and most students will qualify for student loans and direct subsidies from the government. In addition, technical colleges (teknisk fagskole) offer non-tertiary, post-secondary education in vocational subjects. Such programs are short, spanning a minimum of 6 months to 2 years. The completion of a post-secondary education at a technical college conveys the status of a vocational technician, and is tailored as further education among those who already have a considerable background in a particular vocation. Admission to technical colleges requires a vocational high school degree and at least two years of experience in the vocation, though students at technical colleges may be admitted on the basis of other factors such as extensive work experience (Farstad, 1999). Throughout the paper, higher education is defined as the completion of tertiary education, following the International Standard Classification of Education (ISCED) definition.

2.3 The Practical Candidate Scheme

The PCS enables those who previously dropped out of high school to certify their on-the-job knowledge with a formal vocational high school education diploma. Unlike the GED program in the United States, students are awarded the exact same qualification as if they had completed vocational high school. The content of the examination in the PCS is equivalent to the final year examination as students in vocational education, and practical candidates do not need to have completed any other subjects such as Norwegian, English, math, science, or history to be issued the vocational education certificate.

Eligibility to register under the PCS mirrors the vocational high school system and includes both a theoretical component and a practical component. If a candidate had previously completed the theoretical portion of vocational high school while enrolled in formal education in the past, this qualifies the student under the first eligibility criteria. Any candidate who lacks the theoretical qualifications under the PCS is required pass an examination in vocational theory, and counties offer free preparation courses for the theoretical examination under the PCS.[7] However, applicants to the PCS are not classified as formal students enrolled in an educational institution unless they return to formally enroll in high school.

To fulfill the second eligibility criteria, an applicant must describe, in detail, the nature of their professional employment which provides them with a sufficient level of knowledge in the practical components of their vocation. Typically, the candidate must detail their tasks and responsibilities as well as how long they have been working in an industry corresponding to their vocation. The candidate must submit an application with their detailed on-the-job competencies to the county, who is responsible for assessing the eligibility of the candidate. If the county deems the candidate's description to be inadequate, they may seek further documentation and clarification from the individual. Practical candidates must apply to the PCS in the county they reside in.

Should the county deem a PCS applicant to satisfy both eligibility criteria, the indi-

[7] Counties have a large amount of responsibility for their educational programs. There were 19 counties during the time period considered in this paper.

vidual is responsible for registering with the county to take an examination demonstrating their on-the-job competence. Throughout the process, the individual is responsible for taking the initiative in qualifying under the PCS and the individual must pay a fee to sit the examination set by the national government annually.[8] The length of the examination under the PCS is subject dependent, but lasts roughly one day where the candidate demonstrates, to an evaluation committee, their competence in the skills of that specific trade. Importantly, an individual may apply for the PCS irrespective of employment status provided they fulfill both eligibility criteria. As such, both workers in employment and workers out of employment may be examined under the PCS. If an individual fails to pass the PCS, the candidate must wait a minimum of another 6 months should they wish to try again. Pass rates are also subject dependent, but tend to be high, roughly 80–90% at the time (Kirke-, utdannings- og forskningsdepartementet, 1999).

2.3.1 The Expansion of the PCS

Prior to 1997, many vocational fields which traditionally employ a high fraction of women were not eligible for certification under the PCS, as the scheme historically covered vocational subjects traditionally dominated by men. The expansion of newly recognized vocations such as health care, social work, and retail allowed workers in these jobs to certify their skills under the PCS (Michelsen, Olsen, and Høst, 2014; Tangen, 2000; Farstad, 1999). Farstad (1999) points to the lack of possibility of formal certification in these vocations as an explanation for a lack of females completing vocational high school, which has historically been dominated by men in Norway. Consistent with this, following the inclusion of these additional fields, there was a dramatic increase in certification under the PCS in the end of the 1990s (Michelsen, Olsen, and Høst, 2014).[9] Section 4 examines how the expansion of the PCS impacted certification among displaced workers, comparing not only those displaced before and after the expansion but also contrasting

[8] In 2019, the fee for the PCS examination was 951NOK.

[9] A point emphasized in the GED literature is that it induces students to drop out of high school (Heckman, Humphries, LaFontaine, and Rodríguez, 2012). The expansion of the PCS does not seem to have had any such effects: as women are impacted more by the expansion, it stands to reason that their dropout would increase relative to men following the expansion if this had any impacts. If anything, female dropout relative to male dropout decrease over the period.

women, who are disproportionately impacted by the expansion, to men, who are largely impacted. Since men are largely unimpacted by the expansion of the PCS, they offer an opportunity to understand how the balance between academic and vocational education evolves over time irrespective of the expansion. For instance, comparing the outcomes of women and men post-expansion informs whether there is a general shift away from academic to vocational education over time.

3 Defining Involuntary Job Loss

3.1 Isolating a High-Tenured Sample

By combining a definition of job loss which is plausibly involuntary with a sample of high-tenured workers for whom job loss is unanticipated, the job displacement literature estimates the impacts of job loss among displaced workers. This paper follows a similar approach to isolate a smaple of high-tenured young workers. Sample restrictions are defined relative to the year $b = 1990, \ldots, 1999$, where a worker is employed in b but might transition into non-employment one year after in $b+1$. Several sample restrictions ensure that the sample of early career workers, who are aged 21–27 in year b, are high-tenured workers who dropped out of high school.

First, young workers must have at least one year of tenure in their employing plant in b.[10] Second, they must be attached to the labor force in all years from $b-3$ to b, defined as having minimum level of income in a given year (one grunnbeløpet).[11] Third, they must have dropped out of education from the ages of 16–18 having not completed high school. Age of dropout is defined as the age a student was when they were first not enrolled in education in the current as well as the subsequent year. Non-enrollment in two subsequent years eliminates students who take a gap in their studies and return to

[10] See Appendix Table L in Bennett and Ouazad (2019) for an overview of tenure restrictions in the displacement literature.

[11] A grunnbeløpet is an amount of income which corresponds to a basic amount in the National Insurance scheme. The amount of income which constitutes one basic amount (1G) changes from year to year with inflation. At the start of the sample period in 1990, 1G corresponded to 34,000kr (in 1990 NOK) and in 1999, 1G corresponded to 46,950kr (in 1999 NOK).

education in the next year.

Fourth, young workers must be employed in a plant with at least 10 employees in b.[12] Such a restriction eliminates the possibility of very small changes in employment classifying as a mass-layoff event, as defined in section 3.2. Finally, workers must not be enrolled in education prior to the sample period in $b-4$. Note that future displaced and non-displaced workers are subject to the exact same sample criteria, and that all workers are followed unconditionally after year b.

Table 1 describes the final estimation sample in year b separately by gender. The sample pools all years $b = 1990, \ldots, 1999$, resulting in a sample of 76,791 men and 56,666 women. While workers span the ages 21–27, they are, on average, aged 25 in year b. The sample of high school dropouts is of lower cognitive ability, as only 40% of men have an IQ score at or above the median.

High-tenured workers have, on average, 4 years of tenure. As such, a sizable share of high-tenured workers are still employed in their first job after entering the labor market and dropping out of high school. While all almost men are employed full-time, only 75% of women are working full-time in year b. High-tenured men earn considerably more than women (313,986kr vs 231,420kr), though high school dropouts of both genders are high earners for their age: in 1994, median income among all workers aged 18–54 was 308,067kr for men and 201,826kr for women. There are considerable differences in the industry men and women work in: 43% of high-tenured men are employed in manufacturing, while 32% of women are employed in the public sector and 29% employed in retail and service jobs.

The vast majority of the sample dropped out of education having completed only compulsory education, though roughly 20% dropped out having completed some high school. As the sample definition does not restrict the education of high-tenured workers from $b-3$ to b, a considerable portion of men (12%) have already completed vocational high school by year b. Women return to complete high school in the same period to a lesser degree, and only 3% of women have completed vocational high school by b. Less than 1% of both men and women have completed academic high school by b.

[12] See Appendix Table J in Bennett and Ouazad (2019) for an overview of employer size in the displacement literature.

Table 1: Descriptive Statistics of Estimation Sample in year b

	(1) Men	(2) Women
Demographics		
Age in base year	24.9	24.7
	(1.7)	(1.8)
Has children (%)	32.8	47.4
	(46.9)	(49.9)
Median or above IQ (%)	39.1	
	(48.8)	
Employment		
Earnings, year 2015 NOK	313985.7	231419.6
	(80182.3)	(68878.0)
Years of Tenure	4.1	3.9
	(2.3)	(2.2)
Employed (%)	100.0	100.0
	(0.0)	(0.0)
Employed full-time (%)	95.6	74.5
	(20.5)	(43.6)
Manufacturing (%)	42.9	19.5
	(49.5)	(39.6)
Wholesale & Retail Trade, Restaurants, Hotels (%)	19.3	28.9
	(39.4)	(45.3)
Public Sector (%)	6.1	31.5
	(24.0)	(46.5)
Same employer as father (%)	10.9	3.7
	(31.1)	(18.9)
Same employer as mother (%)	3.8	7.8
	(19.2)	(26.8)
Education		
Age dropped out	17.2	17.3
	(0.8)	(0.8)
Dropped out with compulsory education (%)	80.0	82.1
	(40.0)	(38.3)
Dropped out with some HS (%)	20.0	17.9
	(40.0)	(38.3)
Completed vocational HS (%)	11.5	2.9
	(31.9)	(16.7)
Completed academic HS (%)	0.2	0.5
	(4.5)	(7.0)
Completed higher education (%)	0.6	0.6
	(8.0)	(7.7)
Number Individuals	76791	56666
Fraction Displaced	0.047	0.055

Sample of high-tenured workers defined as in Section 3.1. All variables measured in base year $b = 1990, \ldots, 1999$. Earnings measured in constant year 2015 Norwegian kroner. Public sector defined as employment in public administration, public security, education, and health and social work.

3.2 Defining Mass-Layoff Events and Job Displacement

The paper combines idiosyncratic mass-layoff events at the plant level with employee job transitions (either job-to-job or employment to non-employment) to define displaced workers. At the worker level, a job transition is defined as an employee who transitions to a new plant or to non-employment between b and $b+1$. At the plant level, a mass-layoff event is defined as a plant in year b which satisfies one of two criteria: (i) closed between b and $b+1$ or (ii) plant reduced employment by 30% or more between b and $b+1$. Plant closures address potential administrative closings or mergers, and exclude false closings where over 80% of workers employed in the same plant in year b are employed together in the same plant in $b+1$.

Combining these two definitions, a displaced worker is one who loses their job and is employed in a plant in year b which has a mass-layoff event or closes in the next year. Such a definition is similar to existing measures of displacement used throughout the displacement literature as well as those used in the context of Norway (Huttunen, Møen, and Salvanes, 2018). Flaaen, Shapiro, and Sorkin (2019) validate the methodology of the displacement literature: combining survey and administrative data reveals that conventional definitions of job displacement produce similar displacement rates and estimates to alternative methodological approaches. However, as there may be particular concerns with displacement defined among a sample of young workers (Von Wachter and Bender, 2006), section 4.3 examines in detail the potential issue of selection into displacement.

Throughout, displaced workers are compared to similar high-tenured workers who are non-displaced; that is, those who did not have a job transition during a mass-layoff event. As such, non-displaced workers may continue to be employed in the same plant, transition between jobs, leave their job for voluntary reasons, or even be displaced in a future year (but not between b and $b+1$). Indeed, Krolikowski (2018) emphasizes the importance of defining a non-displaced group which is both similar prior to displacement and followed unconditionally for the post-displacement period for the estimated impacts of job displacement on earnings.

4 The Impact of Job Displacement on Certification and Higher Education

4.1 Empirical Specification

To understand the causal role that job loss has on certification, and how the availability of opportunities in the education system impact certification after job loss, the paper combines job displacement with an expansion of the PCS in the late 1990s. Such an expansion permits the comparison of the education of displaced workers pre-expansion to displaced workers post-expansion (both relative to their respective non-displaced counterparts). Prior to 1997, many vocational fields which traditionally employ a large fraction of women were not eligible for certification under the PCS. After the expansion of the PCS, fields such as health care, social work, and retail sales were incorporated (Michelsen, Olsen, and Høst, 2014; Tangen, 2000).

Pooling all base years $b = 1990, \ldots, 1999$, equation (1) estimates the impact of job displacement on education for worker i in base year b employed in industry j in municipality m at time t, differentially for those displaced post- and pre-expansion:

$$\begin{aligned} Y_{ibjmt} = \; & \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \sum_{k=-3}^{+10} \delta_k \cdot (D_{ib} \times time_t)^k \times expansion_b \\ & + \theta \cdot D_{ib} + \eta \cdot expansion_b + \zeta \cdot D_{ib} \times expansion_b + \phi \cdot expansion \times time_{b,t} \\ & + municipality^{t=0} \times time_{mb,t} + tenure^{t=0} \times time_{ib,t} + \pi_b + \varepsilon_{ibjmt}. \end{aligned} \tag{1}$$

Time relative to displacement is measured by $t = y - b$, the calendar year y relative to the base year b. Workers are followed from -3 to $+10$, where displacement, as defined above, occurs at some point between $+0$ and $+1$. Y_{ibjmt} corresponds to two education outcomes, measured as the completion of vocational high school or the completion of higher education. By construction, all variables are base year specific, that is, the outcome

of individual i in time t depends on what base year b they are in.

Cohorts displaced after the expansion of the PCS are defined as:

$$expansion_b = \begin{cases} 1, \text{ if } b = 1996, ..., 1999 \\ 0, \text{ if } b < 1996. \end{cases}$$

As the 1996 cohort is displaced between 1996 and 1997, they are the first cohort to be displaced into the post-expansion years. While those displaced prior are also eventually impacted by the expansion of the scheme, they are not eligible to certify under the PCS in the expanded vocational fields immediately following displacement.

$(D_{ib} \times time_t)^k$ is equal to one k years after a worker is displaced. The coefficients of interest, δ_k, correspond to the difference in the impact of displacement on education after the expansion of the PCS. As such, they estimate the difference in outcomes between those displaced after the expansion and those displaced before the expansion, both relative to their respective non-displaced counterparts. For $k = +1, \ldots, +10$, δ_k corresponds to the post-displacement difference in the impact of displacement after the expansion of the PCS.

The impact of displacement pre-/post-expansion estimated in equation (1) corresponds to a triple difference. Compared to the standard double difference regression in the displacement literature, the triple difference framework requires that the displaced/non-displaced difference in education between pre-/post-expansion cohorts would be stable in the absence of the expansion of the PCS. If this assumption holds, then those displaced pre-expansion represent a valid counterfactual for those displaced post-expansion.

While such an assumption is inherently untestable, the coefficients $\delta_{-3}, \ldots, \delta_{+0}$ provide a direct test of the similarity of trends in education between future displaced and non-displaced workers before and after the expansion of the PCS *prior* to the displacement event. Indeed, Table 1 reveals that a considerable fraction of the high-tenured high school dropout sample has already certified prior to displacement. The placebo coefficients test if future displaced and non-displaced workers post-expansion certified in the time leading up to displacement at similar rates as the same workers pre-expansion.

Throughout the paper, equation (1) is estimated separately by gender. The inclusion of municipality-time fixed effects ($municipality^{t=0} \times time_{mb,t}$) control for municipality specific confounders which may vary over time such as school quality. Likewise, the inclusion of tenure-time fixed effects ($tenure^{t=0} \times time_{ib,t}$) allow workers with different levels of labor market experience to have different trends in education. Municipality and tenure are measured prior to displacement in the base year and, as such, are (on their own) time-invariant.

The inclusion of base year fixed effects (π^b) compare displaced and non-displaced workers within the same base year. By pooling all base years, the relevant panel dimension is base year-person, and standard errors are clustered at the person level. Both γ_{-1} and δ_{-1} are set to zero by convention, and the estimated γ_k and δ_k coefficients are interpreted relative to the omitted difference in time -1.

4.2 The Impact of Job Displacement on Education After the PCS' Expansion

As a starting point, Figure 1 plots the unconditional certification rates across four different groups: non-displaced workers pre-expansion, displaced pre-expansion, non-displaced post-expansion, and displaced post-expansion. Prior to displacement, all four groups have similar trends in certification. Over time, all groups see increases in certification. However, comparing post- to pre-expansion cohorts reveals that this increase in certification is far greater after the expansion of the PCS. This is true among both displaced as well as non-displaced workers.

The triple difference exploits the difference in certification rates between displaced and non-displaced workers post-expansion, compared to the same difference pre-expansion. Indeed, there is a considerable difference between the certification rates of displaced and non-displaced workers post-expansion, where those displaced certify at even higher rates relative to those non-displaced. At the same time, those displaced pre-expansion eventually go on to certify at marginally lower rates. Such considerable differences suggest that the expansion of the PCS had a considerable impact on certification and that displace-

ment has an additional impact on certification over and above this.

Figure 1: Post-displacement Certification Pre- and Post-Expansion of the PCS, Female Workers

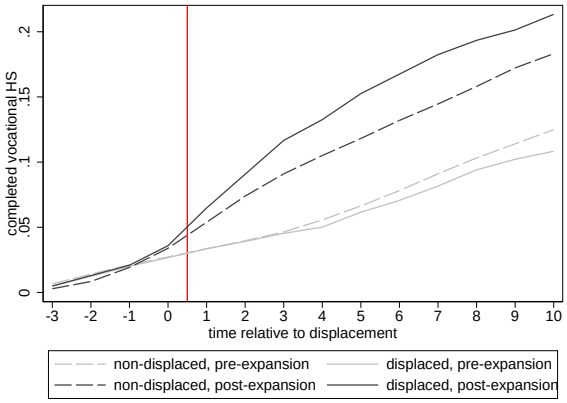


Figure plots the unconditional average completion of vocational high school across four groups relative to the displacement event: non-displaced workers before the PCS expansion, displaced workers before the PCS expansion, non-displaced workers after the expansion, and displaced workers after the expansion. Expansion cohorts are those in base years 1996 onward. Sample of high-tenured workers defined as in Section 3.1.

Figures 2a and 2b plot the estimated difference in certification rates between post- and pre-expansion displaced women and men relative to their respective non-displaced counterparts (δ_k from equation 1). The estimated interaction coefficients for women (Figure 2a) confirm the descriptive patterns above: the impact of displacement on certification is greater for women displaced post-expansion relative to women displaced pre-expansion. From three years after displacement, women displaced post-expansion certify at significantly higher rates relative to the fixed difference in certification in time -1. Such differences are large in magnitude, and correspond to a 3–4 percentage point increase in certification relative to the pre-expansion difference. Relative to the average probability of certification among all non-displaced workers in +10 of 0.136, the post-expansion increase in certification among displaced women corresponds to roughly a 30% increase in certification. Prior to displacement, women displaced post- and pre-expansion have similar trends in certification, and these differences in certification are stable pre-displacement.

In contrast to women, the certification rates of men displaced post-expansion (Figure 2b) are slightly lower post-displacement. While not significantly different from zero by +10, the estimated difference in +10 corresponds to an 8% decline in certification rel-

Figure 2: Post-displacement Certification Pre- and Post-Expansion of the PCS

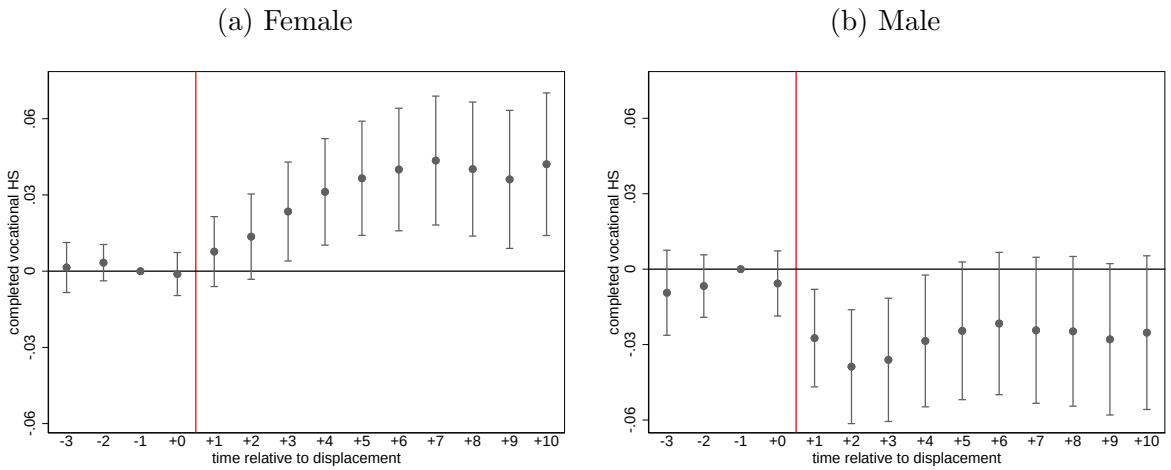


Figure plots the interaction between $Expansion_b$ and $D_{it}^{k \text{ years after displacement}}$ from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Post-expansion cohorts are those from 1996 onward. Coefficients interpreted at the difference between displaced workers post-expansion and displaced workers pre-expansion (both relative to their respective non-displaced counterparts). Average completion of vocational high school among non-displaced workers in +10 (both pre- and post- expansion cohorts): 13.6% for women and 31.2% for men. γ_{-1} set to zero by convention. Full results reported in Appendix B. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1.

ative to the average certification of non-displaced workers. As the expansion of the PCS disproportionately impacts fields which traditionally employ a large fraction of women, the lack of an increase in certification among men suggests that the expansion of the scheme, rather than a general shift away from academic towards vocational education, drives the increase in post-expansion certification among women.[13]

While there is no additional impact of displacement on certification after the expansion of the PCS among men, there is a significant impact of displacement on certification among men, the γ_k coefficients from equation (1). Such increases in certification correspond to a 1.5–3 percentage point increase in the probability of completing vocational high school. Such stark differences in the certification rates of women after displacement and after the expansion of the PCS indicate that the opportunities available for gradu-

[13]Appendix C reveals that, if anything, there is a slight tendency towards academic education over time, as post-expansion displaced men have slightly higher completion of academic high school relative to pre-expansion displaced men. At the same time, the academic high school of women displaced pre- and post-expansion are virtually identical, and increases in vocational high school post-expansion do not come at the expense of academic high school.

ating high school matter considerably. Indeed, while the negative shock of displacement leads workers to reevaluate the importance of a high school degree, Table B.1 reveals that displaced women only certify their vocational skills when they have the opportunity to do so.

Figure 3: Post-displacement Higher Education Pre- and Post-Expansion of the PCS

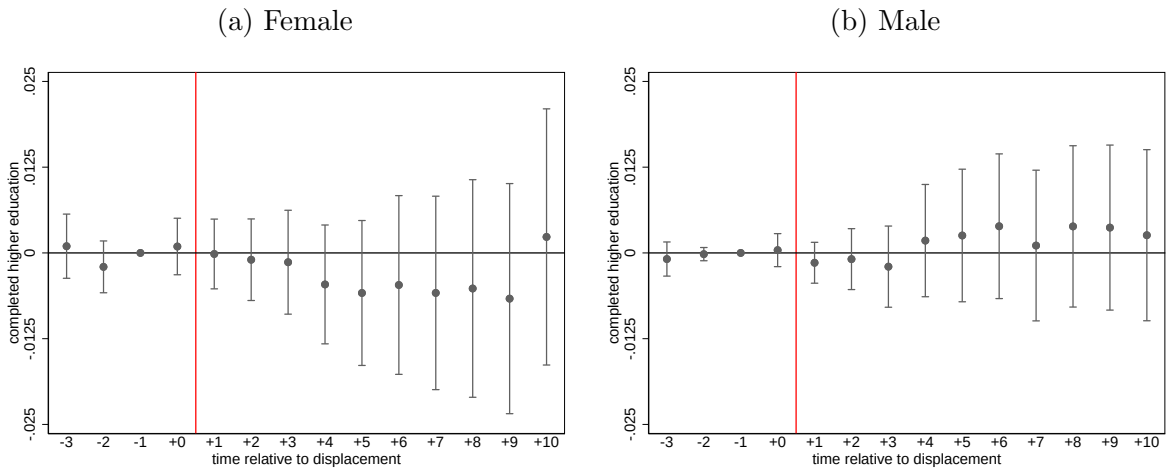


Figure plots the interaction between $Expansion_b$ and $D_{it}^{k \text{ years after displacement}}$ from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed higher education. Post-expansion cohorts are those from 1996 onward. Coefficients interpreted at the difference between displaced workers post-expansion and displaced workers pre-expansion (both relative to their respective non-displaced counterparts). Average completion of higher education among sample in base year (both displaced and non-displaced): 0.6% for women and 0.6% for men. Long-run average completion of vocational high school among non-displaced workers in +10 (both pre- and post-expansion cohorts): 5.2% for women and 4.3% for men. γ_{-1} set to zero by convention. Full results reported in Appendix B. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1.

The increase in certification among displaced women post-expansion may also translate into increases in higher education. Indeed, the completion of vocational high school leads to additional opportunities in the education system, as described in Section 2.2, to further invest and refine specialist skills. In contrast to Figure 2a, there is no differential impact of displacement on the completion of higher education between post- and pre-expansion cohorts (Figure 3a).

Tables B.3 and B.4 reveal that while there is no differential impact on the completion of higher education before and after the PCS' expansion, displacement does translate into increases in higher education among displaced workers. Indeed, the estimated γ_k coefficients are positive and statistically significant after displacement. Thus, while the

availability of opportunities matters for those at the margin of certifying, increases in certification do not translate into gains in higher education among displaced women at the margin post-expansion.

4.3 Validity of the Displaced Worker Methodology

4.3.1 The Combined Impact of Displacement for Both Pre- and Post-Expansion Cohorts

The validity of the displaced methodology hinges on the fact that non-displaced workers represent a valid counterfactual for displaced workers. An important remaining question is whether *all* future displaced workers, combining pre- and post-expansion cohorts, have similar trends in education as non-displaced workers prior to displacement. In particular, it might be that returning to education leads to voluntary job transitions among workers. While the triple difference relies on the similarity in trends of displaced/non-displaced workers between pre- and post-expansion cohorts, it remains informative to understand how education evolves before job loss among all displaced workers.

Estimating the impact of displacement among all workers, both those displaced pre- and post-expansion, reveals that while displacement leads to significant increases in both certification (Figures D.3a and D.3b) and higher education (Figures D.4a and D.4b) among women and men. Prior to displacement, the estimated coefficients when $k \leq 0$ are small in magnitude and not significantly different from zero. The lack of significant differences prior to displacement reveals that while future displaced and non-displaced workers do certify prior to displacement, they do so at similar rates over time.

For both women and men, the estimated impact of displacement on certification fades out over time, and non-displaced workers eventually certify in the longer run. In contrast, the impact of displacement on higher education does not fade out over time. As such, the age of certification matters considerably for the probability of continuing into higher education: while non-displaced workers eventually do certify over time, they do not continue into higher education. Similar patterns are seen in Bennett, Blundell, and Salvanes (2020), where women who return to high school at younger ages also complete

higher education at significantly higher rates than those who return at older ages.

Figure D.5 shows that there is no impact on enrollment in high school education. Indeed, displaced workers complete vocational high school without returning to the classroom, pointing to the importance of certification rather than returning to the classroom. In addition, there is no impact of displacement on the completion of academic high school (Figure D.6), suggesting young displaced workers certify rather than return to full-time high school education.

4.3.2 Robustness of Displacement Definition, Choice of Counterfactual, and Sample Selection

Four key challenges to the job displacement methodology can be addressed at this stage, and results are presented in Appendix D. First, Appendix D.3 confirms that selection into who is laid off is not of concern for the results. Indeed, there could be selection into which workers plants layoff and which workers plants retain, though this is not the case. Figure D.7a compares the cognitive ability of displaced workers by whether they are displaced in a mass-layoff or plant closing event. If, for instance, plants lay off their least capable workers while retaining their more productive workers, then there would be large differences in cognitive ability in Figure D.7a as while there may be choice in who to retain during a mass-layoff event, this is not the case during a plant closing as all workers are laid off. Reassuringly, those displaced during a mass-layoff event have similar levels of IQ compared to those displaced during a plant closing, and such differences are not statistically significant.

Second, there may be selection of young workers into different plants, as discussed in Von Wachter and Bender (2006). If lower ability workers self-select into plants (or industries) with higher levels of turnover, and plants with higher turnover are more prone to mass-layoff events, then displaced workers will be negatively selected on ability relative to non-displaced workers. Appendix D.4 confirms that, if anything, displaced workers have slightly *higher* levels of cognitive ability relative to their non-displaced counterparts (Figure D.8a) and results are robust to accounting for these small differences in the levels of cognitive ability between displaced and non-displaced workers (Figure D.9).

Third, and related to the point above, results are robust to altering the counterfactual group of non-displaced workers. While non-displaced workers are, by definition, not displaced between b and $b+1$, they may be displaced in future years from $b+1$ and onward. Indeed, young workers are particularly prone to displacement relative to older workers (Farber, 2015). The sample of high-tenured young workers is no exception: 46% of the non-displaced sample is employed in a plant which, in a future year $b+1, \ldots, b+10$ experiences a mass-layoff or closing event. Though non-displaced workers are not necessarily displaced during such an event, that is, they do not necessarily transition to non-employment or another employer, such a counterfactual represents a group of workers whose plants will eventually downsize and are, arguably, more similar to displaced workers. Results in Appendix D.5.1 reveal similar estimates of the impact of displacement. Interestingly, the fade out in certification occurs slightly earlier, particularly for women, suggesting that future displacement events lead non-displaced workers in year b to certify later in life. Similarly, results are robust to excluding non-displaced workers whose plants are growing between b and $b+1$ (Appendix D.5.2).

Finally, results in Appendix D.6 are robust to increasing the number of workers in year b to 50 workers as is standard among the displacement literature in the United States (Jacobson, LaLonde, and Sullivan, 1993; Lachowska, Mas, and Woodbury, forthcoming). While restricting the sample to 10+ employees limits the scope for small changes in employment being classified as a layoff event, this is even more true among a sample of 50+ employee plants. As the average plant in Norway is smaller compared to the US, imposing the restriction of 50+ employees reduces the total sample by over 40%. Despite this, certification and the completion of higher education remains significantly higher among displaced workers compared to non-displaced workers, reinforcing the validity of the displacement methodology.

4.3.3 How does certification of younger workers compare to older workers?

Figure D.16 compares certification post-displacement between the sample of young workers, those aged 21–27, with a sample of even older workers, those aged 28–30. While older workers also certify post-displacement, the increase in certification is considerably smaller

among older workers. The smaller magnitude of the increase in certification among older workers suggests that the work-to-school transition is a more important avenue among those who recently dropped out and that older workers are less likely to certify vocational skills.

4.4 Who is at the margin of returning to high school?

4.4.1 Does cognitive ability matter for returning to education?

How important is cognitive ability in the decision to return to graduate high school by certifying vocational skills under the PCS? Fundamental to the literature estimating the labor market returns to education is the need to abstract from potential biases due to ability differences of workers with different levels of education. Indeed as Heckman and Vytlacil (2001) emphasize, if the correlation between ability and education is reasonably strong, then it is impossible to distinguish between the effect of education on earnings and the effect of ability on earnings.[14] Recent work concludes that while everyone benefits from graduating high school irrespective of ability level, the returns to high school education are larger among those with lower ability (Heckman, Humphries, and Veramendi, 2018).

Making use of data available for men measuring cognitive ability at the age of 18, Table 2 reveals that while cognitive ability does matter for the probability of certifying and completing higher education post-displacement, workers with the sample average IQ also return to education post-displacement. Table 2 presents the combined impact of displacement on certification and higher education (columns 1 and 3 respectively) and the estimated interaction between the displacement indicators and IQ (columns 2 and 4 respectively) among both pre- and post-expansion cohorts. IQ scores are demeaned, such that the estimated impact of displacement on certification and higher education in columns 1 and 3 corresponds to the impact of displacement on education for a worker with the average level of IQ in the sample.

[14] Unsurprisingly, there is a strong relationship between cognitive ability and dropout. However, while on average, dropouts are negatively selected from the IQ distribution, there is substantial variation in IQ (see Figure D.8a).

Immediately after displacement, displaced workers with average levels of IQ certify their vocational skills at significantly higher rates than non-displaced workers. Those displaced with higher levels of IQ are even more likely to certify after job loss, as the interaction between displacement and IQ is positive and statistically significant. In the first few years after job loss, a displaced worker with a one point higher IQ (a 0.5 standard deviation change in IQ) is 0.8–1 percentage points more likely to certify. As the impact of displacement on certification fades out due to non-displaced workers also eventually certifying, so too does the additional impact on certification among those with higher levels of IQ.

Similar patterns are seen for the completion of higher education after displacement. However, IQ matters less for the completion of higher education in the longer run as while the completion of higher education remains significant 10 years after displacement, the estimated interaction term becomes insignificant. While those with higher levels of cognitive ability do return to the education system more, the possibility to certify is an important second chance option which also benefits the typical worker with the sample average, lower level of IQ.

4.4.2 Who returns to education?

While displaced workers reevaluate the importance of completing high school after job displacement, it is less clear what underlying factors change between dropout and eventual certification. While differences in cognitive ability matter, further understanding precisely *who* decides to certify is crucial to shed light on such factors. Previous work (Cascio and Narayan, 2019; Carrillo, forthcoming) emphasizes the importance of economic conditions during adolescence for education decisions: during positive shocks, students complete less education.

Appendix F presents a standard school decision for those deciding whether to restart education as in Becker (1975). In addition to directly impacting the opportunity cost of returning to education, displaced workers may update their expectations about the labor market returns to being a high school dropout as a direct result of job loss. Indeed, previous literature points to the importance of expectations about the benefits of education

Table 2: Does IQ Matter for Certification and Returning to Higher Education?

	Vocational HS		Higher Education	
	(1) Base Disp. Term	(2) × IQ	(3) Base Disp. Term	(4) × IQ
-3	-0.0012	0.0007	0.0007	-0.0005
	(0.0041)	(0.0027)	(0.0010)	(0.0012)
-2	0.0005	0.0008	0.0004	-0.0005
	(0.0028)	(0.0019)	(0.0008)	(0.0010)
-1	ref.	ref.	ref.	ref.
$+0$	0.0018	0.0028	0.0001	0.0002
	(0.0030)	(0.0020)	(0.0008)	(0.0007)
$+1$	0.0223***	0.0078***	0.0007	0.0008
	(0.0046)	(0.0030)	(0.0012)	(0.0010)
$+2$	0.0229***	0.0097***	0.0034*	0.0032**
	(0.0051)	(0.0034)	(0.0018)	(0.0016)
$+3$	0.0190***	0.0085**	0.0039*	0.0031
	(0.0056)	(0.0036)	(0.0022)	(0.0020)
$+4$	0.0157***	0.0081**	0.0057**	0.0045**
	(0.0059)	(0.0038)	(0.0025)	(0.0022)
$+5$	0.0157**	0.0068*	0.0058**	0.0046**
	(0.0063)	(0.0041)	(0.0027)	(0.0024)
$+6$	0.0144**	0.0066	0.0056*	0.0059**
	(0.0066)	(0.0043)	(0.0029)	(0.0026)
$+7$	0.0094	0.0082*	0.0056*	0.0046*
	(0.0068)	(0.0044)	(0.0030)	(0.0026)
$+8$	0.0070	0.0088*	0.0063*	0.0046*
	(0.0071)	(0.0046)	(0.0032)	(0.0028)
$+9$	0.0081	0.0071	0.0084**	0.0040
	(0.0072)	(0.0047)	(0.0034)	(0.0029)
$+10$	0.0074	0.0068	0.0086**	0.0040
	(0.0073)	(0.0047)	(0.0035)	(0.0029)
N	981344	981344	981344	981344
avg. outcome, -1	0.117	0.117	0.006	0.006
avg. outcome, non-disp. $+10$	0.317	0.317	0.040	0.040

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between demeaned IQ scores and $D_{it}^{k \text{ years after displacement}}$ from equation 1 as well as base coefficients from $D_{it}^{k \text{ years after displacement}}$ for men. Regression equation includes complete set of interaction terms between IQ, displacement, and time. Outcome variable equal to 1 if an individual has completed vocational high school (columns 1 and 2) and equal to 1 if an individual has completed higher education (columns 3 and 4). Odd columns report to the estimated impact of job displacement on education while even columns report the interaction between displacement and demeaned IQ score. Average IQ score among sample is 3.89, while an IQ of 5 corresponds to the national median. Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1, restricted to those who have a non-missing IQ score. Regression equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \sum_{k=-3}^{+10} \psi_k \cdot (D_{ib} \times time_t)^k \times IQ_i + \theta \cdot D_{ib} + \zeta \cdot IQ \times time_{i,t} + municipality^{t=0} \times time_{mb,t} + tenure^{t=0} \times time_{ib,t} + \pi_b + \varepsilon_{ibjmt}$.

in major education decisions and that students may have wrong expectations (Jensen, 2010; Wiswall and Zafar, 2014). At the same time, displacement might directly impact how much an individual discounts the future. In addition, preferences may change with age such that, later in the life cycle, the same individual may be more mature or patient than their younger self (Lavecchia, Liu, and Oreopoulos, 2016).

Results in Appendix G provide a detailed understanding of who decides to certify after job loss. Section G.1 finds that the presence of a parent working in the same employer prior to displacement matters considerably for the probability of certifying skills. Networking through parental connections matters when entering the labor market (Corak and Piraino, 2011; Kramarz and Skans, 2014), and men who are employed in the same plant as their father prior to job loss certify at much higher rates than those without a paternal coworker. Section G.2 exploits area-cohort variation in local employment rates, showing that certification is higher among those whose local area had stronger employment opportunities available at age 15, though such differences are not significant. Finally, Section G.3 suggests that the presence of children in the household prior to displacement does not matter for certification, but that parents are considerably less likely to continue into higher education after certification.

Such differences suggest that economic conditions prior to displacement matter: displaced workers who certify are those who had favorable employment opportunities available at young ages. The importance of employment opportunities prior to displacement in certification suggests that young individuals are willing to sacrifice higher future earnings for immediate benefits and that favorable labor market opportunities may lead dropouts to leave education too soon (Oreopoulos, 2007). While such differences are consistent with students having wrong expectations about the future returns to education over the life cycle and that shifts in expectations matter for the decision to certify after dropping out, the importance of changing preferences cannot be excluded.

5 The Causal Impacts of Certification on Labor Market Outcomes

5.1 How do Income and Employment Recover Post-Displacement?

As a starting point, Figure 4 presents the impact of job displacement on income (Figures 4a and 4b) and full-time employment (Figures 4c and 4d) among all workers, both those displaced before and after the expansion of the PCS. Rather than using the log of income, which by construction excludes those with zero income post-displacement, the inverse hyperbolic sine of income is used (Ravallion, 2017; Bellemare and Wichman, 2020). Such a transformation has a similar interpretation as a log transformation. The probability of having zero income post-displacement increases considerably (Figure H.22) and it is important to include those who have zero income as a result of displacement. In addition, not only does this differ drastically by gender but young workers may be more prone to having zero income post-displacement.

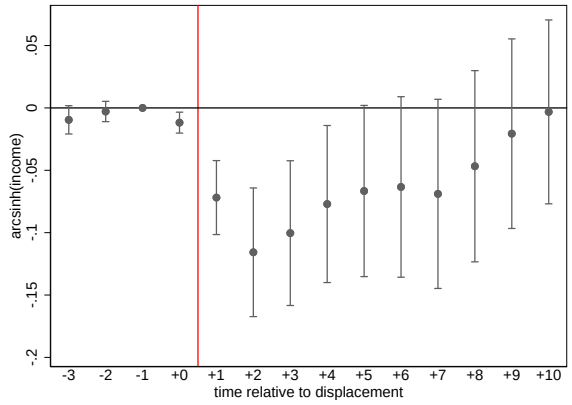
While all workers are employed prior to displacement in +0, they may differ in their working hours. Figures 4c and 4d reveal that future displaced workers have similar working hours to non-displaced workers, as differences in the probability of working full-time are not statistically significant pre-displacement. However, future displaced workers begin to experience a slowdown in income just prior to displacement in +0. As is frequently observed in the job displacement literature (see e.g. Jacobson, LaLonde, and Sullivan, 1993), this "Ashenfelter dip" (Ashenfelter, 1978) suggests that the income of future displaced workers begins to decline just prior to displacement. While statistically significant, the decline in earnings is small in magnitude and is, at least in part, due to the fact that workers may be displaced in the later months of +0 after employment status is recorded.[15]

Consistent with other papers in the job displacement literature, displacement is a pronounced adverse shock leading to significantly lower earnings in the short-run. Income declines for both women and men, by around 6–12%. However, income losses are much

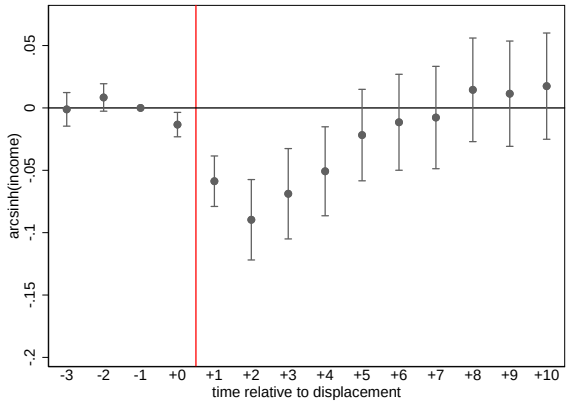
[15]Employment is measured in May for all displacement cohorts 1994 and prior and in November for cohorts after.

Figure 4: The Estimated Impact of Displacement on Labor Market Outcomes

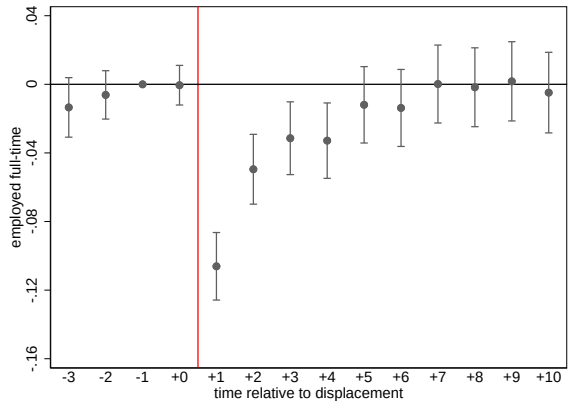
(a) Female—Income



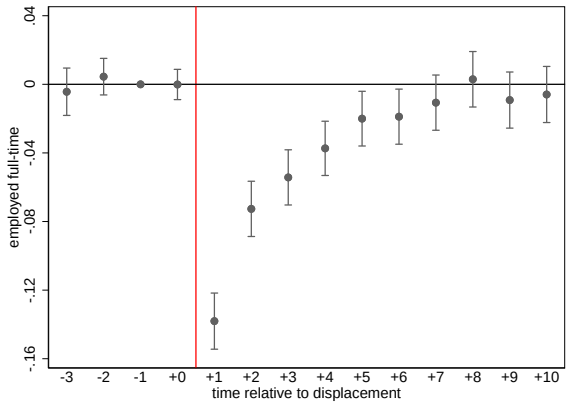
(b) Male—Income



(c) Female–Full-time Employment



(d) Male–Full-time Employment



Outcome variable inverse hyperbolic sine (arcsinh) of income in panels (a) and (b), equal to 1 if an individual is employed full-time (30+ hours/week) in panels (c) and (d). Displacement event occurs between +0 and +1. 95% confidence interval reported. Average full-time employment among sample in base year (both displaced and non-displaced): 74.5% for women and 95.6% for men. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

shorter lasting than previously found. Indeed, the income of young displaced workers quickly recovers such that 10 years after displacement, there are no significant differences in earnings between displaced and non-displaced workers. Similar patterns are observed for full-time employment, which substantially declines immediately after displacement but then rapidly recovers.

5.2 Does Certification Causally Impact Income?

Such rapid recovery of income and employment after job loss stands in contrast to not only the job displacement literature, but also the literature on the scarring effects of unemployment at young ages (Gregg and Tominey, 2005). Combined with the significant impacts on both certification (in the short-run) and higher education, the recovery of income suggests that certification among displaced workers fosters recovery after job loss. However, young workers may simply be more resilient than older workers post-displacement: Kletzer and Fairlie (2003); Von Wachter and Bender (2006) suggest that the earnings losses of young displaced workers are lower relative to older displaced workers.

Figure 5 directly tests the causal role of certification in the recovery of post-displacement income, combining the displaced worker methodology with the expansion of the PCS. Estimating equation (1), the Figure asks whether the income recovery of women displaced after the expansion of the PCS—who certify at significantly higher rates compared to their non-displaced counterparts—is greater relative to women displaced before the expansion of the PCS. Indeed, if certification causally impacts labor market outcomes, then the recovery of income post-displacement should be greater among women displaced post-expansion.

Figure 5a confirms that certification fosters income recovery post-displacement: while the short-run income losses of women displaced post-expansion are similar to those displaced pre-displacement, income in the long-run is significantly higher among post-expansion women. Indeed, income begins to increase precisely when post-expansion displaced women certify at significantly higher rates in Figure 3a. Ten years after displacement, women displaced after the expansion of the PCS have income 15% higher

Figure 5: Post-displacement Income Pre- and Post-Expansion of the PCS

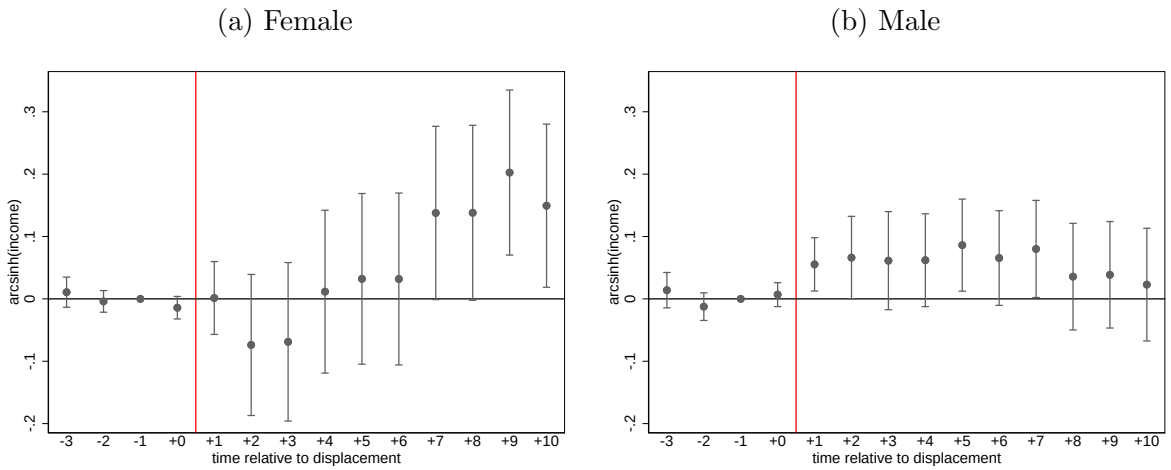


Figure plots the interaction between $Expansion_b$ and $D_{it}^{k \text{ years after displacement}}$ from equation 1, separately for women (panel a) and men (panel b), with the outcome variable the inverse hyperbolic sine (arcsinh) of income. Post-expansion cohorts are those from 1996 onward. Coefficients interpreted at the difference between displaced workers post-expansion and displaced workers pre-expansion (both relative to their respective non-displaced counterparts). γ_{-1} set to zero by convention. Full results reported in Appendix B. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1.

despite similar income losses immediately following displacement. In addition, Table B.5 reveals that those displaced pre-expansion experience persistent and significant declines in income as a result of displacement.

While income recovery is significantly stronger among women displaced post-expansion, this may be due to an increase in wages relative to those displaced pre-expansion, an increase in hours worked, or some combination of the two forces. Lachowska, Mas, and Woodbury (forthcoming) emphasize that both reductions in wages and hours worked are responsible for long-run earnings declines, with declines in hours worked explaining slightly more of lost earnings. Figure I.23 tests the competing explanations of wages and hours worked in the stronger income recovery post-expansion, showing that the probability of being employed full-time is not significantly different among women displaced post- and pre-expansion. As hours worked are similar, this suggests that certification combats declining wage levels among women displaced post-expansion.[16]

The significant differences in post-displacement income trajectories after the expan-

[16]Unfortunately, more detailed data on hours worked is unavailable during the period.

sion of the PCS confirm that certification plays an important causal role in recovery from adverse shocks. Indeed, certification fosters the recovery of income losses among women displaced post-expansion. The importance of certification for the recovery of income losses is further established by examining the difference in income between men displaced post- and pre-expansion in Figure 5b. Men displaced post-expansion lose slightly less income immediately following displacement, as income is higher in the short-run. However, male income is not significantly different from its -1 value in the long-run. As post-displacement certification is unchanged among men after the expansion of the PCS, the lack of significant differences in long-run income recovery supports the fact that certification is behind the strong recovery of income of women displaced post-expansion.[17]

5.3 The Persistent Impacts of Early Career Displacement into Adulthood

Early career displaced workers experience short-run income losses which recover rapidly after job loss. Certification, and the completion of further higher education, plays an important role in such recovery and 10 years after displacement, there are no differences in the employment and income between displaced and non-displaced workers. A remaining question is how labor market outcomes later in life, when workers are far removed from displacement at young ages, are impacted by displacement and the resulting increase in certification. Section 5.3.1 finds that young displaced workers, who return to education after job loss, make substantially different occupational choices and, as a result, perform significantly different day-to-day tasks. Section 5.3.2 shows that young displaced men have significantly higher levels of income later in life, and young displaced women have more stable income as a result of certification post-displacement.

[17]To the extent parallel trends holds between men and women, such a regression pooling men and women and estimating the interaction between $Expansion_b$, $D_{it}^{k \text{ years after displacement}}$, and gender would correspond to a quadruple difference.

5.3.1 Occupational Choices and Task Composition of Work

Education is an important factor in occupational choices and the tasks performed within an occupation: higher skilled college educated workers have an advantage in performing non-routine tasks compared to non-college educated workers who traditionally specialize in routine tasks (Autor, Levy, and Murnane, 2003). A remaining question is to what extent does early career job displacement, which leads young workers to educate, impact the occupational choices and tasks performed later in the life cycle.

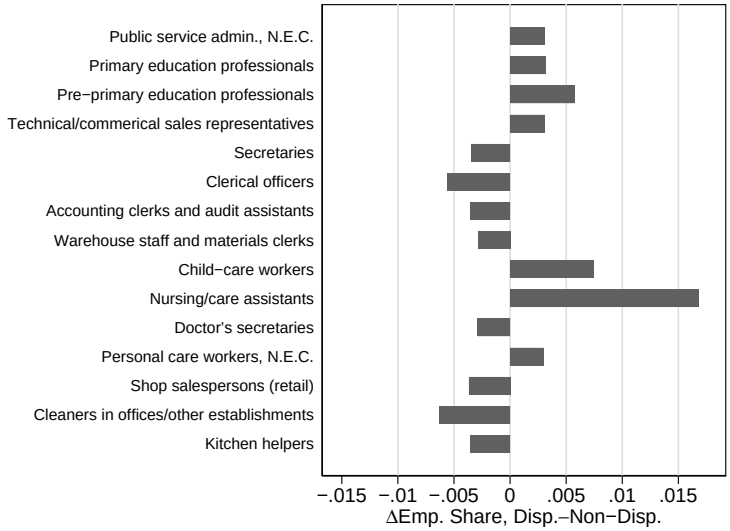
As a starting point, Figures 6a and 6b compare the differences in occupational choices between young displaced and non-displaced workers. Occupations are measured in 2017, when the sample of young workers range from age 39–54. Among both displaced women (panel a) and men (panel b), employment becomes increasingly skilled and service orientated later in life.

Relative to non-displaced workers, young displaced women have a substantially higher share of employment in service care occupations—nursing assistants and child-care workers—and professional occupations—public service administration, education professionals, and technical sales representatives. Interestingly, service care occupations are the fields which are incorporated into the PCS in 1997, suggesting that later displaced women drive occupational changes. Increases in service and higher-skilled occupations among displaced workers arise from declines in clerical work and elementary occupations. In particular, displaced workers have lower shares of employment as clerical officers, clerks, secretaries, and cleaners. Young displaced men have substantially higher shares of employment as construction managers, engineering technicians, carpenters, plumbers, electricians, and telephone installers. Similar to displaced women, increases in high-skilled and vocational occupations overwhelmingly come at the expense of declines in employment in warehouse clerical occupations.

While non-displaced young workers are employed in clerical work at higher rates later in life, displaced young workers are employed in higher-skilled, service, and vocational occupations. An extensive literature documents the role of computerization in the decline of clerical work and routine tasks as a whole (Autor, Levy, and Murnane, 2003; Autor

Figure 6: Long-run Differences in Occupational Choices Between Young Displaced and Non-Displaced Workers

(a) Female



(b) Male

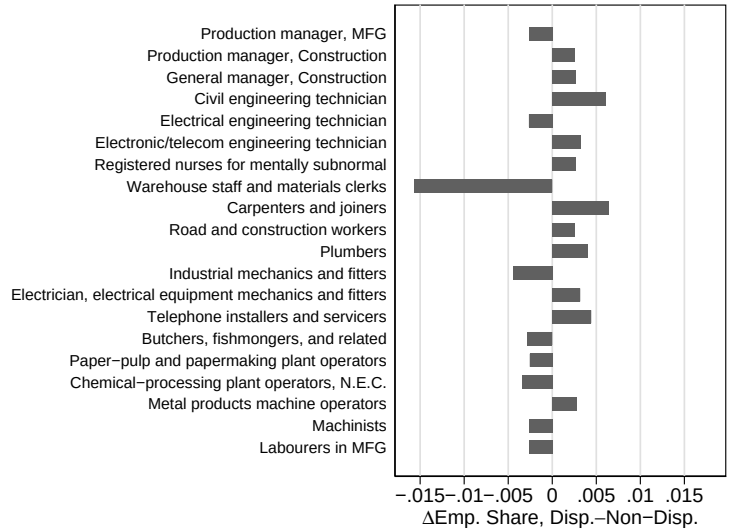


Figure plots the difference in occupational shares between displaced and non-displaced workers for women (panel a) and men (panel b). Occupations are measured in 2017, when sample of young workers are aged 39–54. Occupations are classified according to the Norwegian standard classification of occupations as discussed in Appendix J. Occupations with absolute difference in employment share of larger than 0.0025 reported. Sample of high-tenured workers defined as in Section 3.1.

and Dorn, 2013; Goos, Manning, and Salomons, 2014), and young displaced workers shift away from occupations where labor demand is declining. Table 3 asks whether the observed differences in occupational choices translate into meaningful shifts in the nature of work performed among young displaced workers, matching occupations to measures of math, routine, social, and service tasks using O*NET data as in Deming (2017).[18]

Table 3: Task Usage in 2017 Among Young Displaced Workers 1990–1999

	Female			
	(1) Math Tasks	(2) Routine Tasks	(3) Social Tasks	(4) Service Tasks
Displaced	-0.0074	-0.1556***	0.1249***	0.2394***
	(0.0405)	(0.0472)	(0.0419)	(0.0570)
Individuals	39054	39054	39054	39054
Avg. Non-Displaced	3.21	3.43	4.25	5.23
	Male			
Displaced	0.0209	-0.2319***	0.1002**	0.0666*
	(0.0358)	(0.0391)	(0.0480)	(0.0400)
Individuals	54826	54826	54826	54826
Avg. Non-Displaced	3.75	4.89	3.55	2.89

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression of one of four task measures (math, routine, social, and service) on displacement dummy. Tasks defined as in Deming (2017). Occupations are measured in 2017, when sample of young workers are aged 39–54. Sample of workers who are employed in 2017 and whose occupation is mapped to task intensity measures, see Appendix J for a discussion of the linkage between occupations and tasks. Estimating equation: $task_{o(i)} = \alpha + \beta \cdot D_{ib} + \pi_b + \varepsilon_{ib}$, where $D_{ib} = 1$ if a worker was displaced from 21–27.

Young displaced women, reported in the top panel, perform significantly less routine tasks relative to young non-displaced women. At the same time, young displaced women perform significantly more social and service tasks. Declines in routine tasks and increases in service tasks are driven by women displaced after the expansion of the PCS, suggesting that certification among women plays an important role in long run occupational choices

[18]Appendix J details the linkage of occupations in the Norwegian register data to tasks in the U.S. O*NET data. Importantly, Appendix J.4 reveals that the observed differences in tasks in Table 3 are not driven by the matching process between occupations in the Norwegian classification system to occupations in the US classification system, as focusing on direct one to one matches reveals similar results.

(see Table K.8). Young displaced men also perform significantly less routine tasks in their occupations later in life and significantly more social tasks. The increase in service tasks among displaced men is considerably less than the increase in service tasks among women, though non-displaced men also perform considerably less service tasks than women.

5.3.2 Income, Income Stability, and Benefit Receipt Late in Life

Given the declining demand for routine tasks—which are increasingly able to be performed by new technology and overseas—job displacement—and the corresponding increase in education—enables young workers to shift out of deteriorating occupations. Table 4 suggests that changes in occupations and the corresponding tasks performed benefit the level of income of young displaced men, but not for women. Compared to their non-displaced counterparts, men displaced at young ages are ranked 1.6 percentiles higher in the income distribution and significantly more likely to be in the top half and the top 25% of the income distribution. For both women and men, the standard deviation of income also increases, that is, early career displaced workers have more volatile income later in life.

At the same time, young displaced men are also less reliant on public benefits later in their working lives. Table M.10 reveals that displaced men receive significantly less disability benefits, 15% lower relative to non-displaced workers, a decrease which is partially offset by a significant increase in the amount of unemployment benefits received. In contrast, young displaced women receive higher amounts of disability benefits, though such differences are not significant, and slightly less basic assistance allowances for necessary expenses due for medical reasons. Previous papers have emphasized that those receiving disability benefits in Norway have considerable work capacity (Kostøl and Mogstad, 2014), suggesting that displacement at young ages, and the corresponding increase in skills, increases men's economic standing while also decreasing their reliance on welfare transfers later in life.

Though displaced women see meaningful changes in their tasks performed, this does not translate into any significant changes in income levels later in life. However, while the rise of service employment for women may not necessarily lead to increases in labor

Table 4: Position in the Income Distribution from 2014–2018 Among Young Displaced Workers 1990–1999

	Female				
	(1) Percentile in Distribution	(2) S.D. Income (1000s)	(3) Pr. in Top 50%	(4) Pr. in Top 25%	(5) Pr. in Top 90%
Displaced	0.0176	2.8824***	0.0072	0.0066	0.0026
	(0.4157)	(0.9713)	(0.0095)	(0.0068)	(0.0036)
Individuals	56256	56189	56256	56256	56256
Avg. Non-Displaced	48.326	52.489	0.447	0.141	0.036
	Male				
Displaced	1.4882***	8.0770***	0.0350***	0.0286***	0.0067
	(0.3551)	(1.8456)	(0.0085)	(0.0074)	(0.0042)
Individuals	75796	75649	75796	75796	75796
Avg. Non-Displaced	55.663	72.427	0.583	0.209	0.051

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression of one of four percentile measures (percentile in earnings distribution and 3 variables indicating if a worker is in the top 50%, top 75% or top 10% of the income distribution) and the standard deviation of income on displacement dummy. National income distribution calculated using data on income from 2014–2018, separately by gender and for each birth cohort. Estimating equation: $percentile_i = \alpha + \beta \cdot D_{ib} + \pi_b + \varepsilon_{ib}$, where $D_{ib} = 1$ if a worker was displaced from 21–27.

market earnings, the occupations that displaced women flow into are less susceptible to labor market shocks. Indeed, Stevens (1997) emphasizes the importance of multiple job losses among displaced workers. Table L.9 confirms that plants whose workers perform more routine tasks are significantly more likely to have a mass-layoff or closing event in the next year, while plants which perform more service and social tasks are significantly less likely to have a layoff or closing event.

Table 5: Position in the Income Distribution from 2014–2018 Among Young Displaced Workers 1990–1999

	Female				
	(1) Percentile in Distribution	(2) S.D. Income (1000s)	(3) Pr. in Top 50%	(4) Pr. in Top 25%	(5) Pr. in Top 90%
Displaced	-0.0755	4.5107***	0.0053	0.0037	0.0051
	(0.5154)	(1.2598)	(0.0115)	(0.0083)	(0.0046)
Displaced × Expansion	0.2953	-5.1561***	0.0059	0.0092	-0.0082
	(0.8575)	(1.8792)	(0.0201)	(0.0141)	(0.0071)
Individuals	56256	56189	56256	56256	56256
Avg. Non-Displaced	48.326	52.489	0.447	0.141	0.036
	Male				
Displaced	1.7157***	7.5815***	0.0364***	0.0310***	0.0082*
	(0.4208)	(1.9548)	(0.0099)	(0.0086)	(0.0048)
Displaced × Expansion	-0.8312	1.8083	-0.0052	-0.0088	-0.0058
	(0.7506)	(4.5388)	(0.0185)	(0.0162)	(0.0088)
Individuals	75796	75649	75796	75796	75796
Avg. Non-Displaced	55.663	72.427	0.583	0.209	0.051

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression of one of four percentile measures (percentile in earnings distribution and 3 variables indicating if a worker is in the top 50%, top 75% or top 10% of the income distribution) and the standard deviation of income on displacement dummy interacted with $expansion_b$. National income distribution calculated using data on income from 2014–2018, separately by gender and for each birth cohort. Estimating equation: $percentile_i = \alpha + \beta_1 \cdot D_{ib} + \beta_2 \cdot D_{ib} \times expansion_b + \pi_b + \varepsilon_{ib}$, where $D_{ib} = 1$ if a worker was displaced from 21–27.

Prior work also emphasizes that education not only increases the level of earnings but also reduces the volatility of earnings (Delaney and Devereux, 2019). Table 5 asks whether women displaced after the expansion, who certify at significantly higher rates,

have more stable income later in life. Following their certification, young women displaced post-expansion have significantly less volatile income, while those displaced pre-expansion have significantly higher income volatility. Such changes are large in magnitude, as the income of women displaced post-expansion is 10% less volatile relative to the average among non-displaced workers.

While certification for women does not translate into higher income for post-expansion cohorts, for the same income level, women displaced post-expansion have a more stable income. Men, on the other hand, see no significant differences after the expansion of the PCS, confirming that differences in certification among women are the cause behind the increased stability of income. Job stability is an important factor which increases among women who certify, as they transition into occupations in adulthood which are more in demand and, as a result, are less susceptible to future displacement events.

6 Conclusion

How can high school dropouts upgrade their skills? What makes them re-evaluate the importance of a high school degree and return to education? This paper reveals that job loss during a mass-layoff event leads young high school dropouts to certify their practical skills by completing vocational high school through a certification scheme. Displaced workers also continue with education beyond the high school level to complete higher education. The availability of opportunities to formally certify skills matters: an unanticipated expansion of the certification scheme to include additional fields causes women displaced after the expansion to certify at significantly higher rates. Displaced workers with higher levels of cognitive ability certify at even higher rates, though workers with average levels of cognitive ability also certify post-displacement.

By leading young workers to certify their practical skills, job displacement has long-lasting consequences for young high school dropouts. However, in contrast to the displacement literature, which identifies persistent earnings losses following job loss, early career displacement may be beneficial to workers through increases in education. Indeed,

certification aids in the recovery of income after job loss. The increase in certification among women displaced post-expansion leads to strong income recovery relative to women displaced pre-expansion, whose recovery is significantly weaker.

In addition, the occupational choices of young displaced workers far later in life, from the ages of 39–54, are substantially different compared to non-displaced workers. Young displaced workers shift away from occupations specializing in routine tasks, favoring occupations which specialize in service and social tasks. Given the declining demand for routine tasks established in the literature (Autor, Levy, and Murnane, 2003), such changes reduce the probability that workers displaced at young ages are afflicted by additional mass-layoff events. Indeed, plants which downsize are significantly more likely to specialize in routine tasks and significantly less likely to specialize in service and social tasks. Consistent with this, the income of women displaced post-expansion is significantly less volatile relative to the income of women displaced pre-expansion.

The education literature debates the importance of the relative merits of academic education—with its more general focus and transferable skills—compared vocational education—with its more narrow focus on specific occupational skills at the expense of broader skills. Though vocational education can play an important role in developing relevant labor market skills, it is traditionally marginalized in policy debates in favor of academic education (OECD, 2010). While the school-to-work transition period is of clear importance (Ryan, 2001), this paper reveals that the work-to-school transition in vocational education is equally important for young workers who joined the labor market after dropping out of high school.

Results are relevant to policymakers wishing to improve the prospects of high school dropouts, as they reveal that flexibility in the provision of second chance opportunities for formally documenting relevant skills within in the education system fosters recovery from negative shocks. Among the 20–30% of a cohort who drop out of high school, a route for skill upgrading through certification of practical vocational skills offers a labor market return. In addition, the impacts of skill upgrading at young ages persist well into adulthood, consistent with the literature on active labor market programs which

emphasizes the importance of human capital accumulation in the labor market benefits of ALMPs (Card, Kluve, and Weber, 2017).

Similar to the returns to specific community college programs such as nursing in the US (Grosz, 2020), the paper reveals that skill upgrading in vocational education at young ages is an important opportunity for subsequent labor market outcomes among the low educated. While labor market shocks lead displaced workers to re-evaluate their labor market prospects as a high school dropout, understanding the precise forces which change among displaced workers, who decide to certify after previously dropping out, is of crucial importance. The paper suggests that shifts in perceived expectations matter, as certification increases considerably more among those who faced favorable employment opportunities at young ages. However, further research is needed to isolate the potential importance of shifting preferences over the life cycle from the importance of shifts in expectations.

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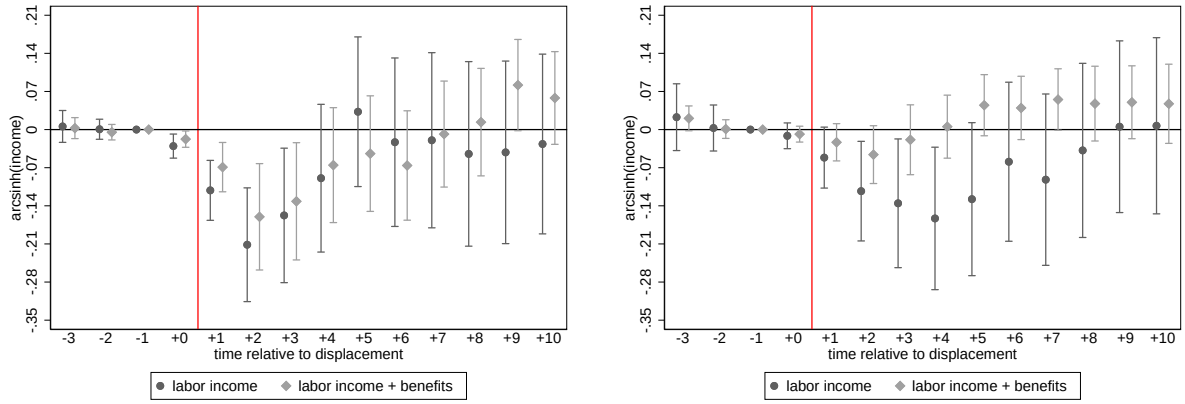
A Estimated Impact of Job Displacement on Income Varying Income Measurement

For displacement cohorts 1996 and onward, a measure of labor income excluding benefits is available for the entire period from -3 to $+10$. Figure presents how the impact of job displacement on income varies across a measure of income including and excluding benefits. As expected, benefits reduce the earnings losses post-displacement.

Figure A.1: The Estimated Impact of Displacement on Labor Market Outcomes

(a) Female

(b) Male—Income



Outcome variable inverse hyperbolic sine (arcsinh) of income in panels (a) and (b). Income defined as labor income and labor income including benefits, the measure of income used throughout this paper. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

B Full Results Interacting Post-Expansion Indicator with Displacement Indicators

Tables present the full results of equation (1) shown in Section 4.2, both the estimated δ_k coefficients as well as the γ_k coefficients.

B.1 Certification

Table B.1: Estimated Impact of Displacement on Certification Interacting with Post-Expansion Indicator, Women

	completed vocational HS	
	(1)	(2)
	Displacement Base Term	× post-expansion
−3	-0.0009	0.0014
	(0.0028)	(0.0050)
−2	-0.0005	0.0033
	(0.0020)	(0.0036)
−1	0.0000	0.0000
	(.)	(.)
+0	0.0003	-0.0011
	(0.0018)	(0.0043)
+1	0.0005	0.0077
	(0.0025)	(0.0070)
+2	0.0001	0.0136
	(0.0029)	(0.0086)
+3	-0.0004	0.0235**
	(0.0034)	(0.0099)
+4	-0.0053	0.0312***
	(0.0037)	(0.0107)
+5	-0.0041	0.0366***
	(0.0043)	(0.0115)
+6	-0.0063	0.0400***
	(0.0047)	(0.0123)
+7	-0.0077	0.0435***
	(0.0053)	(0.0129)
+8	-0.0073	0.0402***
	(0.0057)	(0.0135)
+9	-0.0101*	0.0361***
	(0.0061)	(0.0139)
+10	-0.0144**	0.0421***
	(0.0063)	(0.0143)
N	793301	793301
avg. outcome, −1	0.029	0.029
avg. outcome, non-displaced +10		0.136

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between $Expansion_b$ and $(D_{ib} \times time_t$ from equation 1 (δ_k coefficients) as well as base coefficients from $(D_{ib} \times time_t$ (γ_k coefficients) for women. Outcome variable equal to 1 if an individual has completed vocational high school. Post-expansion cohorts are those from 1996 onward. Column (1) corresponds to impact of displacement on certification among pre-expansion cohorts while column (2) corresponds to the additional impact of displacement on certification among post-expansion cohorts relative to pre-expansion cohorts (both relative to their respective non-displaced counterparts). Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1.

Table B.2: Estimated Impact of Displacement on Certification Interacting with Post-Expansion Indicator, Men

	completed vocational HS	
	(1)	(2)
	Displacement Base Term	× post-expansion
−3	-0.0003	-0.0094
	(0.0047)	(0.0086)
−2	0.0020	-0.0067
	(0.0031)	(0.0063)
−1	0.0000	0.0000
	(.)	(.)
+0	0.0026	-0.0057
	(0.0032)	(0.0066)
+1	0.0269***	-0.0274***
	(0.0051)	(0.0099)
+2	0.0308***	-0.0388***
	(0.0057)	(0.0116)
+3	0.0259***	-0.0361***
	(0.0061)	(0.0125)
+4	0.0219***	-0.0286**
	(0.0065)	(0.0134)
+5	0.0212***	-0.0245*
	(0.0070)	(0.0140)
+6	0.0192***	-0.0216
	(0.0074)	(0.0144)
+7	0.0162**	-0.0243
	(0.0077)	(0.0148)
+8	0.0148*	-0.0247
	(0.0080)	(0.0152)
+9	0.0169**	-0.0279*
	(0.0081)	(0.0154)
+10	0.0149*	-0.0252
	(0.0082)	(0.0156)
N	1075041	1075041
avg. outcome, −1	0.115	0.115
avg. outcome, non-displaced +10		0.312

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between $Expansion_b$ and ($D_{ib} \times time_t$ from equation 1 (δ_k coefficients) as well as base coefficients from ($D_{ib} \times time_t$ (γ_k coefficients) for men. Outcome variable equal to 1 if an individual has completed vocational high school. Post-expansion cohorts are those from 1996 onward. Column (1) corresponds to impact of displacement on certification among pre-expansion cohorts while column (2) corresponds to the additional impact of displacement on certification among post-expansion cohorts relative to pre-expansion cohorts (both relative to their respective non-displaced counterparts). Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1.

B.2 Higher Education

Table B.3: Estimated Impact of Displacement on Higher Education Interacting with Post-Expansion Indicator, Women

	completed higher education	
	(1)	(2)
	Displacement Base Term	× post-expansion
−3	-0.0013	0.0014
	(0.0016)	(0.0024)
−2	-0.0001	-0.0016
	(0.0009)	(0.0020)
−1	0.0000	0.0000
	(.)	(.)
+0	0.0007	0.0010
	(0.0011)	(0.0021)
+1	0.0015	-0.0012
	(0.0016)	(0.0027)
+2	0.0009	-0.0010
	(0.0019)	(0.0032)
+3	0.0013	-0.0013
	(0.0024)	(0.0040)
+4	0.0022	-0.0043
	(0.0030)	(0.0046)
+5	0.0043	-0.0054
	(0.0034)	(0.0055)
+6	0.0083**	-0.0046
	(0.0040)	(0.0068)
+7	0.0081*	-0.0062
	(0.0043)	(0.0074)
+8	0.0095**	-0.0046
	(0.0046)	(0.0083)
+9	0.0098**	-0.0060
	(0.0048)	(0.0087)
+10	0.0093*	0.0031
	(0.0050)	(0.0097)
N	793301	793301
avg. outcome, −1	0.004	0.004
avg. outcome, non-displaced +10		0.045

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between $Expansion_b$ and ($D_{ib} \times time_t$ from equation 1 (δ_k coefficients) as well as base coefficients from ($D_{ib} \times time_t$ (γ_k coefficients) for men. Outcome variable equal to 1 if an individual has completed higher education. Post-expansion cohorts are those from 1996 onward. Column (1) corresponds to impact of displacement on certification among pre-expansion cohorts while column (2) corresponds to the additional impact of displacement on certification among post-expansion cohorts relative to pre-expansion cohorts (both relative to their respective non-displaced counterparts). Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1.

Table B.4: Estimated Impact of Displacement on Higher Education Interacting with Post-Expansion Indicator, Men

	completed higher education	
	(1)	(2)
	Displacement Base Term	× post-expansion
−3	0.0001	-0.0007
	(0.0012)	(0.0022)
−2	-0.0002	0.0000
	(0.0010)	(0.0018)
−1	0.0000	0.0000
	(.)	(.)
+0	0.0001	0.0006
	(0.0009)	(0.0017)
+1	0.0020	-0.0028
	(0.0016)	(0.0021)
+2	0.0075***	-0.0071**
	(0.0025)	(0.0033)
+3	0.0107***	-0.0121***
	(0.0030)	(0.0039)
+4	0.0128***	-0.0083
	(0.0034)	(0.0052)
+5	0.0125***	-0.0073
	(0.0035)	(0.0058)
+6	0.0126***	-0.0061
	(0.0037)	(0.0062)
+7	0.0128***	-0.0080
	(0.0038)	(0.0064)
+8	0.0130***	-0.0060
	(0.0041)	(0.0069)
+9	0.0148***	-0.0053
	(0.0043)	(0.0073)
+10	0.0147***	-0.0043
	(0.0044)	(0.0075)
N	1075041	1075041
avg. outcome, −1	0.005	0.005
avg. outcome, non-displaced +10		0.039

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between $Expansion_b$ and $(D_{ib} \times time_t$ from equation 1 (δ_k coefficients) as well as base coefficients from $(D_{ib} \times time_t$ (γ_k coefficients) for women. Outcome variable equal to 1 if an individual has completed higher education. Post-expansion cohorts are those from 1996 onward. Column (1) corresponds to impact of displacement on certification among pre-expansion cohorts while column (2) corresponds to the additional impact of displacement on certification among post-expansion cohorts relative to pre-expansion cohorts (both relative to their respective non-displaced counterparts). Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1.

B.3 Income

Table B.5: Estimated Impact of Displacement on Income Interacting with Post-Expansion Indicator, Women

	arcsinh(income)	
	(1)	(2)
	Displacement Base Term	× post-expansion
−3	-0.0116	0.0107
	(0.0073)	(0.0123)
−2	-0.0030	-0.0040
	(0.0052)	(0.0089)
−1	0.0000	0.0000
	(.)	(.)
+0	-0.0047	-0.0141
	(0.0052)	(0.0092)
+1	-0.0731***	0.0014
	(0.0197)	(0.0298)
+2	-0.0895***	-0.0739
	(0.0314)	(0.0577)
+3	-0.0757**	-0.0688
	(0.0355)	(0.0648)
+4	-0.0826**	0.0116
	(0.0406)	(0.0666)
+5	-0.0912**	0.0321
	(0.0453)	(0.0698)
+6	-0.1089**	0.0319
	(0.0486)	(0.0703)
+7	-0.1563***	0.1378*
	(0.0519)	(0.0709)
+8	-0.1376***	0.1380*
	(0.0527)	(0.0716)
+9	-0.1350**	0.2026***
	(0.0534)	(0.0675)
+10	-0.1003*	0.1494**
	(0.0514)	(0.0667)
N	793291	793291
avg. outcome, −1	8.392	8.392
avg. outcome, non-displaced +10		8.000

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between $Expansion_b$ and $(D_{ib} \times time_t$ from equation 1 (δ_k coefficients) as well as base coefficients from $(D_{ib} \times time_t$ (γ_k coefficients) for women. Outcome variable log of income. Post-expansion cohorts are those from 1996 onward. Column (1) corresponds to impact of displacement on certification among pre-expansion cohorts while column (2) corresponds to the additional impact of displacement on certification among post-expansion cohorts relative to pre-expansion cohorts (both relative to their respective non-displaced counterparts). Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1.

Table B.6: Estimated Impact of Displacement on Income Interacting with Post-Expansion Indicator, Men

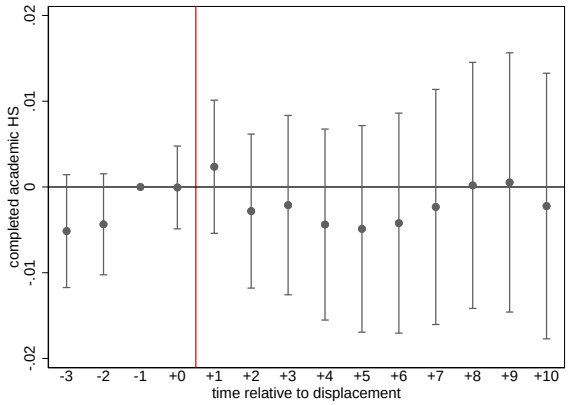
	arcsinh(income)	
	(1)	(2)
	Displacement Base Term	× post-expansion
−3	-0.0082	0.0140
	(0.0085)	(0.0145)
−2	0.0058	-0.0124
	(0.0071)	(0.0113)
−1	0.0000	0.0000
	(.)	(.)
+0	-0.0100	0.0068
	(0.0063)	(0.0098)
+1	-0.0697***	0.0553**
	(0.0124)	(0.0218)
+2	-0.1019***	0.0662**
	(0.0202)	(0.0338)
+3	-0.0772***	0.0613
	(0.0221)	(0.0401)
+4	-0.0576***	0.0620
	(0.0222)	(0.0380)
+5	-0.0347	0.0862**
	(0.0233)	(0.0377)
+6	-0.0170	0.0655*
	(0.0245)	(0.0387)
+7	-0.0145	0.0801**
	(0.0267)	(0.0397)
+8	0.0227	0.0357
	(0.0261)	(0.0436)
+9	0.0185	0.0386
	(0.0266)	(0.0436)
+10	0.0284	0.0229
	(0.0263)	(0.0461)
N	1075015	1075015
avg. outcome, −1	8.711	8.711
avg. outcome, non-displaced +10		8.797

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports the interaction between $Expansion_b$ and ($D_{ib} \times time_t$ from equation 1 (δ_k coefficients) as well as base coefficients from ($D_{ib} \times time_t$ (γ_k coefficients) for men. Outcome variable log of income. Post-expansion cohorts are those from 1996 onward. Column (1) corresponds to impact of displacement on certification among pre-expansion cohorts while column (2) corresponds to the additional impact of displacement on certification among post-expansion cohorts relative to pre-expansion cohorts (both relative to their respective non-displaced counterparts). Displacement event occurs between +0 and +1. Sample of high-tenured workers defined as in Section 3.1.

C Do Displaced Workers Post-Expansion Substitute Vocational Education for Academic Education?

Figure C.2: Post-displacement Academic High School Pre- and Post-Expansion of the PCS

(a) Female



(b) Male

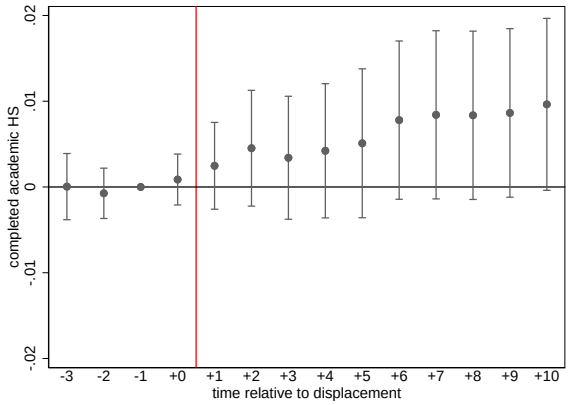


Figure plots the interaction between $Expansion_b$ and $D_{it}^{k \text{ years after displacement}}$ from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed academic high school. Post-expansion cohorts are those from 1996 onward. Coefficients interpreted at the difference between displaced workers post-expansion and displaced workers pre-expansion (both relative to their respective non-displaced counterparts). γ_{-1} omitted by convention. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1.

D Robustness of Baseline Results

D.1 The Impact of Displacement on Certification, Pooling Pre-/Post-Expansion Cohorts

Figures D.3a and D.3b present estimates of the pre- and post-displacement γ_k coefficients from equation (1) for women and men respectively, excluding the interaction with the expansion of the PCS. While both displaced and non-displaced workers certify in the time prior to displacement, the estimated coefficients for γ_k when $k \leq 0$ are small in magnitude and not significantly different from zero. The lack of significant differences prior to displacement reveals that while future displaced and non-displaced workers do certify prior to displacement, they have similar trends in certification prior to displacement.

Immediately following displacement in +1, displaced workers certify their skills with a vocational degree at significantly higher rates. This is particularly true among men, who are slightly more than 2 percentage points more likely to certify soon after job loss (19% from base year average in Table 1). Certification among women continues to increase over time, such that 5 years after displacement, displaced women are 1.5 percentage points more likely to certify (51%).

For both women and men, the estimated impact of displacement on certification fades out over time. Ten years after displacement, the impact of certification among displaced workers is smaller, and not significantly different from zero. Such decline over time is driven by increases in certification among non-displaced workers in the longer run. Irrespective of displacement status, young workers on the whole return to certify at high rates. Thus, displacement leads young workers to certify at younger ages, as though those displaced ultimately certify at similar rates compared to their non-displaced counterparts, they do so earlier in life.

Figure D.5 shows that there is no impact on enrollment in high school education. Indeed, displaced workers complete vocational high school without returning to the classroom, pointing to the importance of certification rather than returning to the classroom.

In addition, there is no impact of displacement on the completion of academic high school (Figure D.6), suggesting young displaced workers certify rather than return to full-time education.

Figures D.4a and D.4b plot the estimated impact of displacement on the completion of higher education. Certification may lead to the completion of additional higher education and the opportunity to invest in even further skills. Higher education increases among both women and men and certification matters not only for immediate employment opportunities but also for further opportunities in the education system. In contrast to the estimated impact of displacement on certification, the impact of displacement on higher education does not fade out over time. As such, the age of certification matters considerably for the probability of continuing into higher education: while non-displaced workers eventually do certify over time, they do not continue into higher education. Similar patterns are seen in Bennett, Blundell, and Salvanes (2020), where women who return to high school at younger ages also complete higher education at significantly higher rates than those who return at older ages.

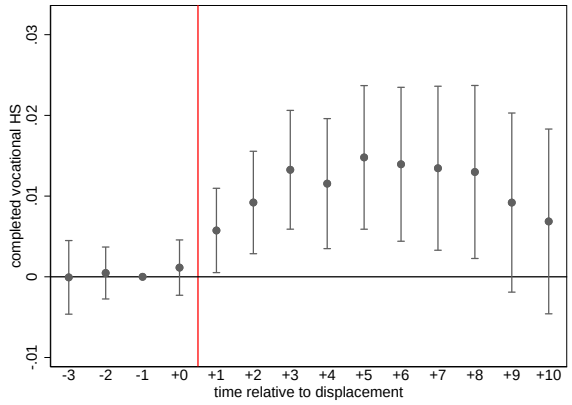
As longer time is needed to invest in the completion of higher education, the impact of displacement on higher education increases a few years after job loss. This is particularly true for women. In the long-run, women and men are roughly 1.5 percentage points more likely to have finished higher education. The impact of displacement on higher education is sizable in magnitude, as less than 1% of the sample completes higher education prior to displacement. While they complete higher education at similar rates, displaced women and men complete higher education in very different fields. While women complete degrees in science subjects (a half-year course), nursing, and teacher training, men complete higher education in mechanical engineering, social education, and electrical engineering.

D.2 The Impact of Displacement on Other Measures of Education

D.2.1 Enrollment in Vocational High School

Figure D.3: The Estimated Impact of Job Displacement on Certification

(a) Female



(b) Male

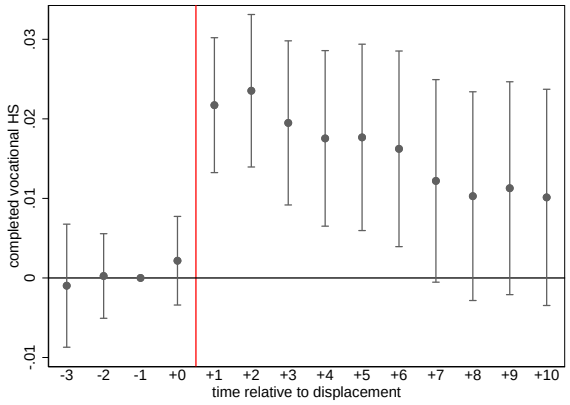
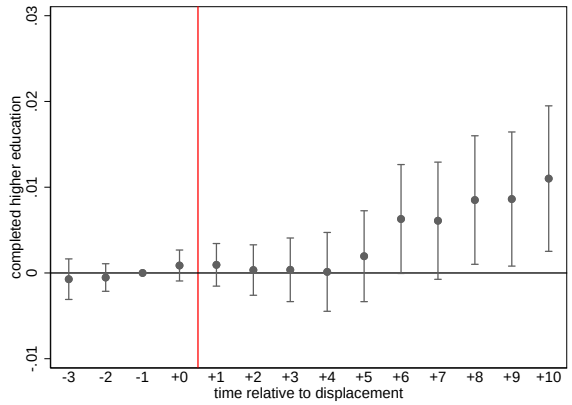


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Displacement event occurs between +0 and +1. 95% confidence interval reported. Average completion of vocational high school among sample in base year (both displaced and non-displaced): 2.9% for women and 11.5% for men. Long-run average completion of vocational high school among non-displaced workers in +10: 13.6% for women and 31.2% for men. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $HS_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

Figure D.4: The Estimated Impact of Displacement on Higher Education

(a) Female



(b) Male

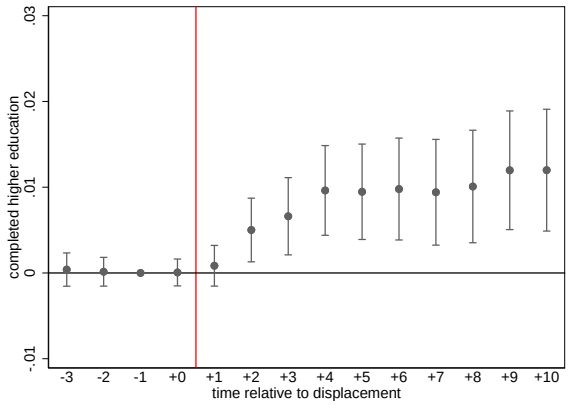


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed higher education. Displacement event occurs between +0 and +1. 95% confidence interval reported. Average completion of higher education among sample in base year (both displaced and non-displaced): 0.6% for women and 0.6% for men. Long-run average completion of vocational high school among non-displaced workers in +10: 5.2% for women and 4.3% for men. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Higher_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

Figure D.5: The estimated impact of job displacement on enrollment in vocational high school

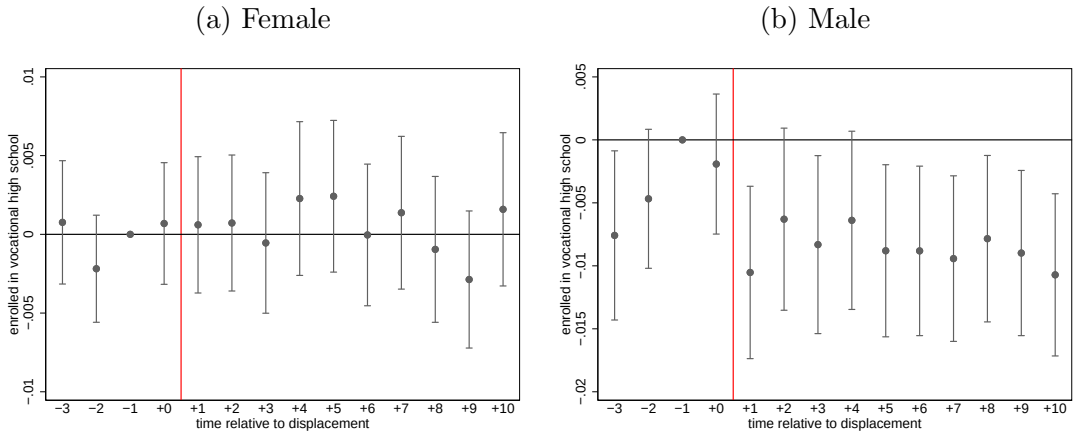


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual is enrolled in vocational high school. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $enrolled_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

D.2.2 Completion of Academic High School

Figure D.6: The estimated impact of job displacement on completion of academic high school

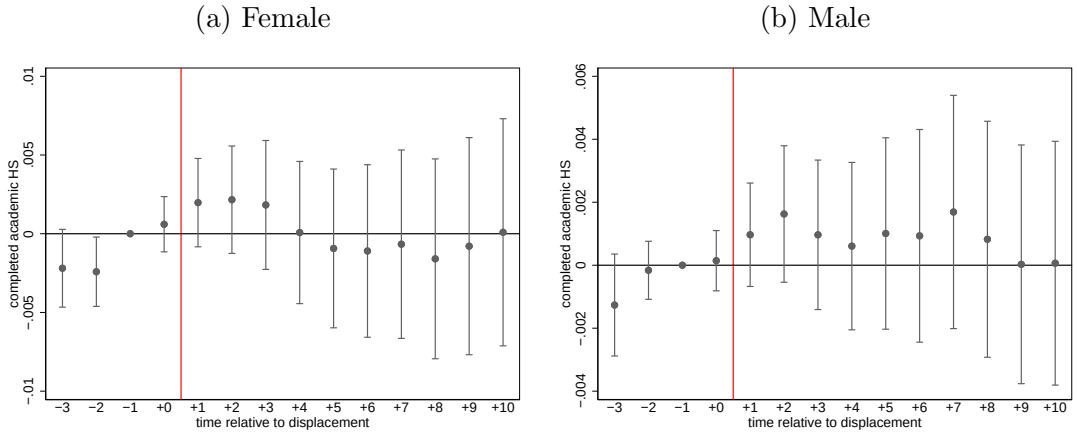


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has ever completed academic high school. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $AcademicHS_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

D.3 Selection into worker retention

First, there may be selection into whom plants layoff. In particular, plants may layoff their least capable workers while retaining their more productive workers. To address whether selection into layoff is of concern among the young displaced worker sample, Figure D.7a compares the ability of workers who are displaced during a mass-layoff event to those displaced during a plant closing event. While there may be considerable choice in who to retain during a mass-layoff event, this is clearly not the case during plant closings as all workers are impacted. As such, if selection into whom to layoff were very problematic for the results, those displaced during mass-layoff events should be negatively selected on ability relative to those displaced during a plant closing. Note that selection of this nature would likely *overstate* earnings losses attributed to displacement.

Figure D.7a plots the distribution of cognitive ability for displaced men separately for whether they were displaced during a plant closing or mass-layoff event. Workers displaced during a plant closing are slightly more likely to have a median IQ of 5, and

slightly less likely to have an IQ of 4, just below the median. While those displaced in a plant closing do have a slightly higher IQ, such differences are small: 36.5% of those displaced in a plant closing have a median IQ or higher, 35.7% of the mass-layoff displaced have a median IQ or above. As such differences are not statistically significant ($p = 0.64$), the relative similarity of cognitive ability between displaced men across different types of displacement suggests that selection into who is laid off is not of concern.

Figure D.7: Distribution of IQ by Displaced in Mass-layoff/Plant Closing

(a)

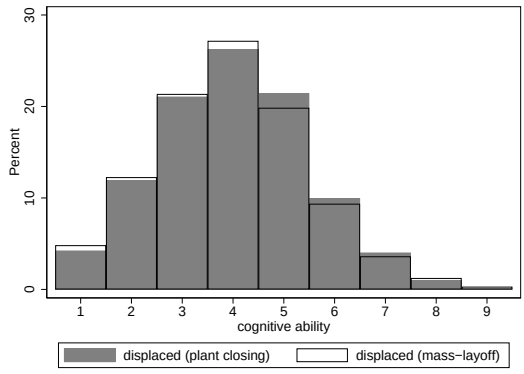


Figure compares the cognitive ability of men, measured by IQ scores at age 18, of displaced workers comparing those displaced in a plant closing event to those displaced in a mass-layoff event. Plant closings are defined as plants whose employment declines by 95% or more from b to $b+1$, excluding false closings where 80% of the workers move to the same plant in $b+1$.

D.4 Selection of young workers into plants

Second, as discussed in Von Wachter and Bender (2006), there may be selection of young workers into different plants. Indeed, some of the workers employed in the sample will still be employed in their first job after entering the labor market. If lower ability workers self-select into plants (or industries) with higher levels of turnover, and plants with higher turnover are more prone to mass-layoff events, then displaced workers will be negatively selected on ability relative to non-displaced workers. To examine the potential importance of selection into the composition of displaced workers relative to non-displaced workers, Figure D.8a plots the distribution of cognitive ability comparing displaced men (of any reason) to non-displaced men.

While lower ability men may select into plants with higher turnover, Figure D.8a reveals that, if anything, displaced workers have slightly *higher* levels of cognitive ability relative to their non-displaced counterparts. Differences are more pronounced in the bottom of the IQ distribution, where a lower fraction of displaced workers have IQ scores of 3 or below. Indeed, while 36% of displaced workers have a median or higher IQ, only 33.1% of non-displaced workers do, and differences are significant at the 1% level ($p = 0.0005$). Relative to their non-displaced counterparts, displaced workers have slightly higher levels of IQ and are not negatively selected in terms of ability. Results in Figure D.9 confirm that the main results are robust to accounting for the small differences in the composition of cognitive ability between displaced and non-displaced workers. As such, the displacement methodology isolates displaced and non-displaced workers with similar observable characteristics and ability levels.

Figure D.8: Distribution of IQ by Displaced/Non-Displaced

(a)

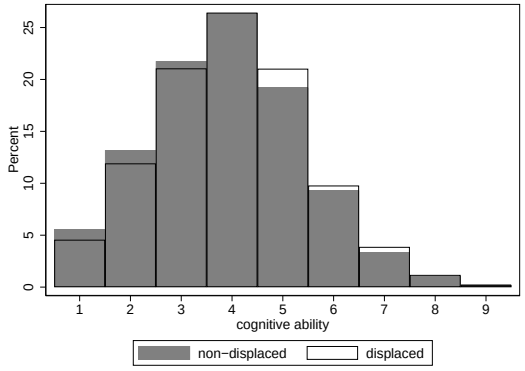


Figure compares the cognitive ability of men, measured by IQ scores at age 18, of displaced and non-displaced workers as defined in Section 3.2.

D.4.1 Weighting Baseline Results by IQ

However, given the slightly higher levels of cognitive ability among displaced workers, increase in education and rapid recovery of earnings may be due to slightly higher cognitive ability among displaced workers. Figure D.9 designs a robustness check to examine how the results are impacted by such IQ differences. Results replicate the main results accounting for differences in cognitive ability between displaced and non-displaced workers. Using data on IQ to estimate the probability of being displaced in the future, the results weight the regression by the inverse propensity score measured prior to displacement. Such a procedure accounts for pre-treatment differences in observable factors (Abadie, 2005; Blundell and Dias, 2009). The average cognitive ability of non-displaced workers is lower than that of displaced workers. Intuitively, weighting by the inverse propensity score weights up non-displaced workers with higher IQ, those with more similar IQ levels to future displaced workers, and weights down non-displaced workers with lower levels of IQ, those with less similarity to future displaced workers. Results display the same patterns and the estimated post-displacement coefficients have similar magnitude, suggesting that pre-displacement differences in cognitive ability do not impact the post-displacement dynamics of outcome variables.

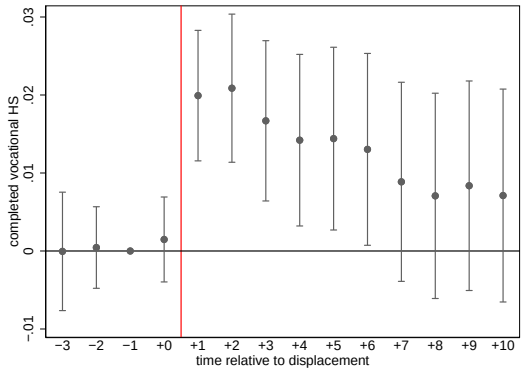
Figure D.9 estimated the regression equation (1), weighting by the inverse propensity score as in Mastrobuoni and Pinotti (2015):

$$displaced\frac{p}{P\left(X_i\right)}+\left(1-displaced\right)\frac{1-p}{1-P\left(X_i\right)}. \tag{2}$$

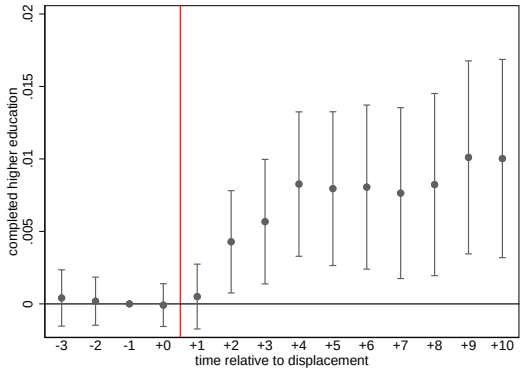
p corresponds to the unconditional probability of displacement and $P\left(X_i\right)$ corresponds to the estimated propensity score (probability of displacement conditioning on IQ scores).

Figure D.9: The Estimated Impacts of Job Displacement, re-weighting on IQ

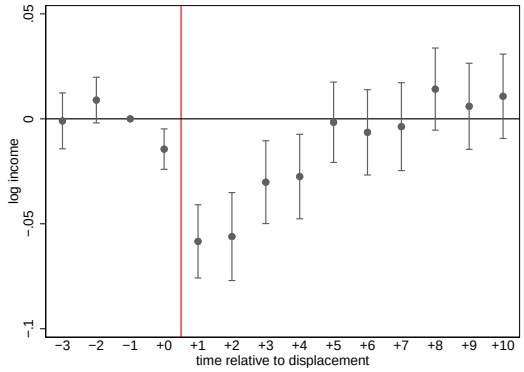
(a) Male—Certification



(b) Male—Higher Education



(c) Male—Income



(d) Male—Full-time Employment

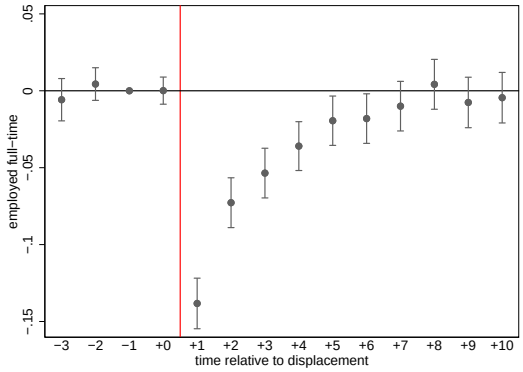


Figure plots δ_k coefficients from equation 1, weighting by the inverse propensity score of equation (2), for one of four outcome variables for men. Outcome variable is certification in panel (a), the completion of higher education in panel(b), log income in panel (c), and full-time employment (30+ hours/week) in panel (d). Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

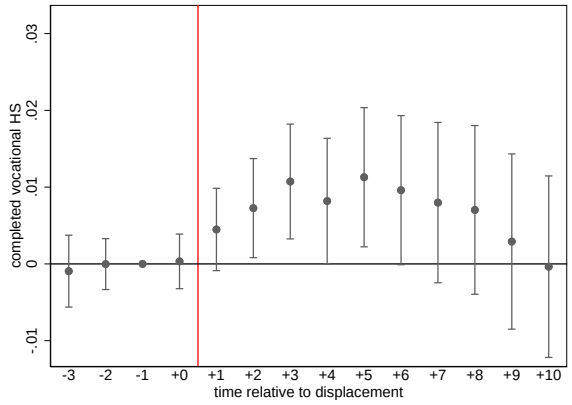
D.5 Different Counterfactual Groups of Non-Displaced Workers

D.5.1 The Estimated Impacts of Job Displacement, mass-layoff/plant closing counterfactual

Counterfactual group is those workers who are non-displaced between +0 and +1, but whose plant has a mass-layoff or closing event in the future, between +1 and +2 or in any future time periods.

Figure D.10: The Estimated Impact of Job Displacement on Certification

(a) Female



(b) Male

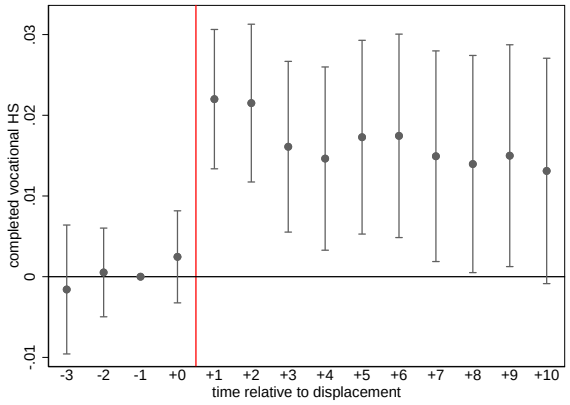
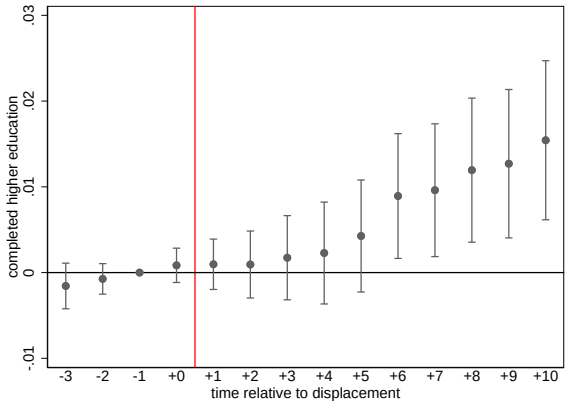


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1, where non-displaced workers are those whose employing plant will experience a mass-layoff or plant closing event from +1 to +10. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

Figure D.11: The Estimated Impact of Displacement on Higher Education

(a) Female



(b) Male

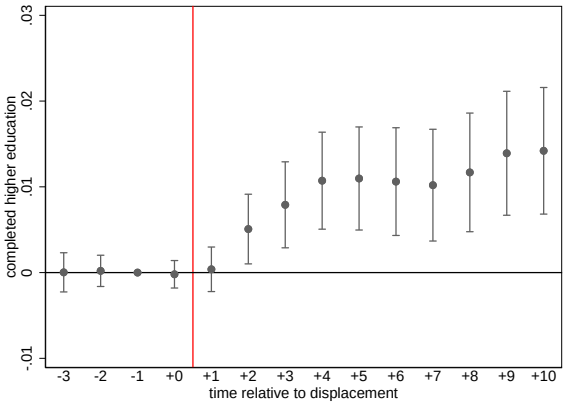


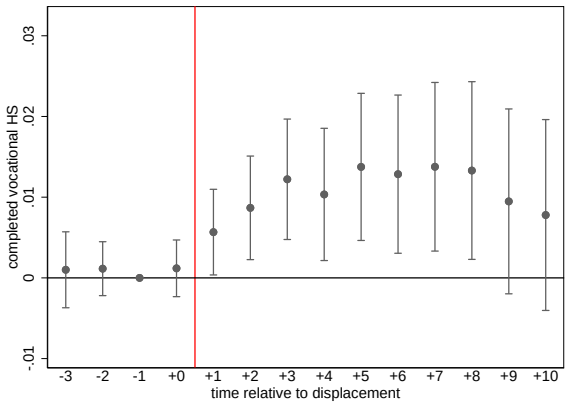
Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed higher education. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1, where non-displaced workers are those whose employing plant will experience a mass-layoff or plant closing event from +1 to +10. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

D.5.2 The Estimated Impacts of Job Displacement, declining plants between b and $b+1$ counterfactual

Counterfactual group is those workers who are non-displaced, but in plants which decline in employment between b and $b+1$. Those whose plants are increasing in employment size are thus excluded.

Figure D.12: The Estimated Impact of Job Displacement on Certification

(a) Female



(b) Male

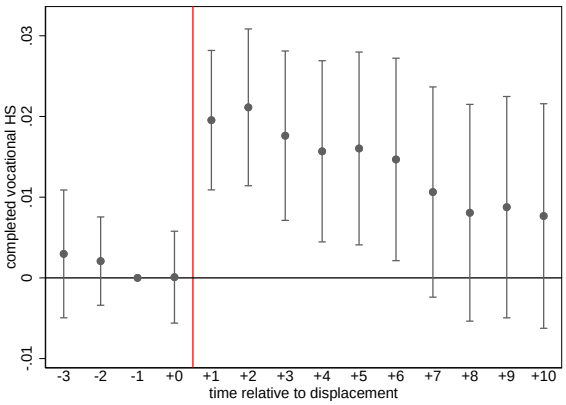
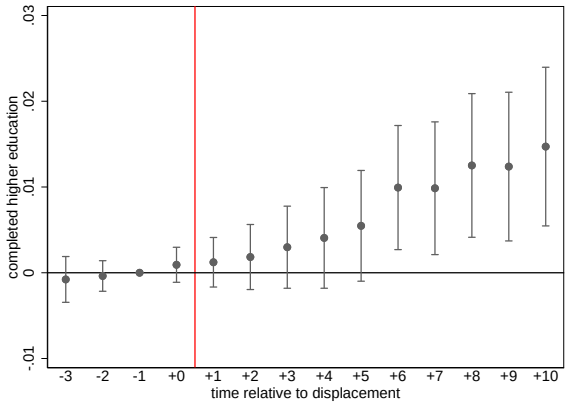


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1, where non-displaced workers are those whose plant in the base year declines between +0 to +1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

Figure D.13: The Estimated Impact of Displacement on Higher Education

(a) Female



(b) Male

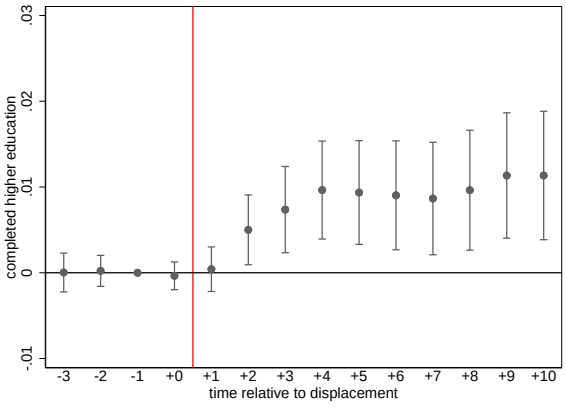


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed higher education. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1, where non-displaced workers are those whose plant in the base year declines between +0 to +1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

D.6 The Estimated Impacts of Job Displacement, 50+ employees in year b

Restricts sample to 50+ employees. While a restriction of 10+ employees in year b corresponds to the 70$^{\text{th}}$ percentile of plant size distribution in 1990 (excluding those self-employed), a restriction of 50+ employees corresponds to 94$^{\text{th}}$ percentile of employer size distribution, as plants in Norway are, on average, smaller than in the US. 133,457 high-tenured workers are in sample of 10+ employees (both men and women), while only 77,791 high-tenured workers are in the sample of 50+ employees.

Figure D.14: The Estimated Impact of Job Displacement on Certification

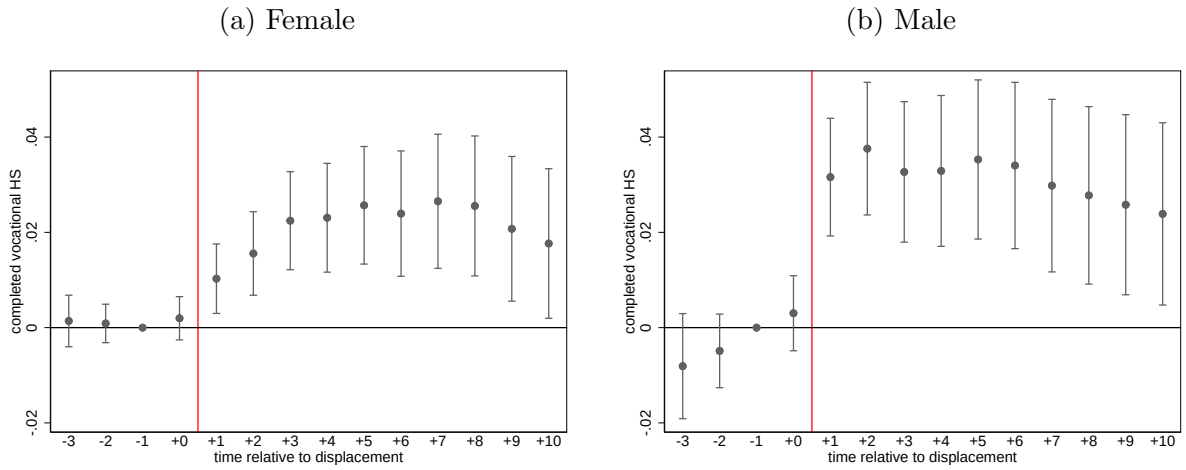
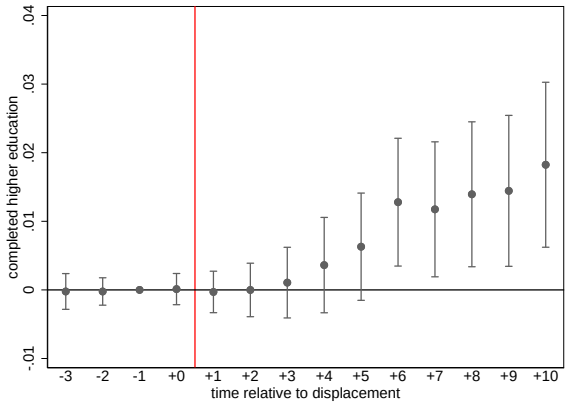


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1, restricting to 50+ employees in +0. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

Figure D.15: The Estimated Impact of Displacement on Higher Education

(a) Female



(b) Male

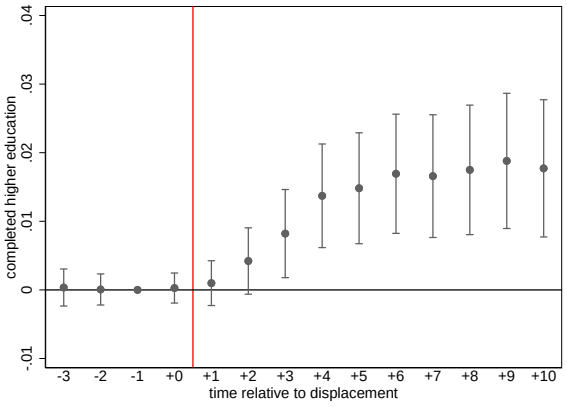
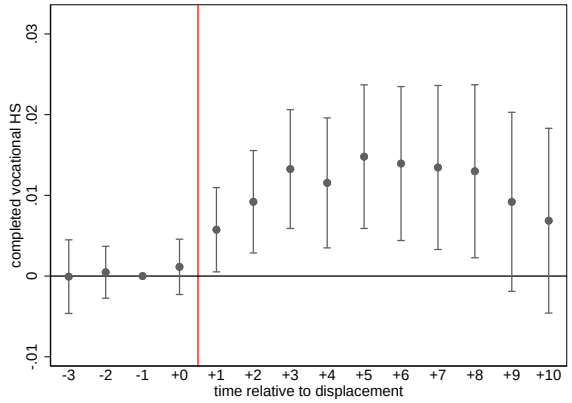


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed higher education. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1, restricting to 50+ employees in +0. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

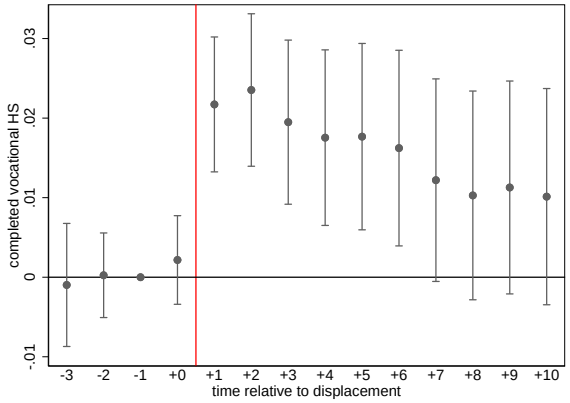
D.7 The Impact of Job Displacement on Certification, Comparing Older and Younger Workers

Figure D.16: The Estimated Impact of Job Displacement on Certification

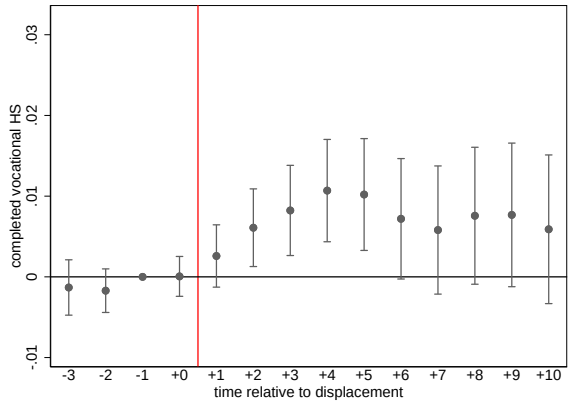
(a) Female, baseline ages 21–27



(b) Male, baseline ages 21–27



(c) Female, ages 28–30



(d) Male, ages 28–30

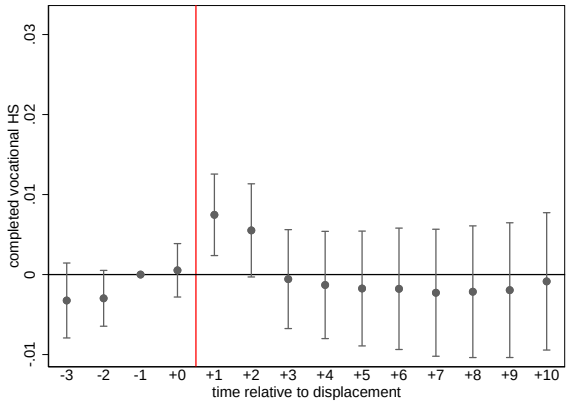


Figure plots δ_k coefficients from equation 1, separately for women (panels a and c) and men (panels b and d), with the outcome variable equal to 1 if an individual has completed vocational high school. Sample of workers aged 21–27 in panels (a) and (b), while panels (c) and (d) consider workers 28–30. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

E The Importance of IQ for Education—Comparing high/low IQ

Figure E.17a plots the impact of displacement on certification among higher ability workers (those with an IQ at or above the median score) and lower ability workers (those with IQ below the median). Only 39% of workers in the sample are classified as higher ability workers, as the sample of high school dropouts is (on average) negatively selected in terms of IQ. Figure E.17a reveals that increases in certification after displacement are driven by higher ability workers, as the estimated impact of displacement on certification is considerably larger in magnitude and much more persistent over time. In addition, Figure E.17b suggests that higher ability workers are those who, in addition to certifying, continue past high school to complete higher education.

Figure E.17: The Importance of Cognitive Ability for Post-displacement Certification and Higher Education

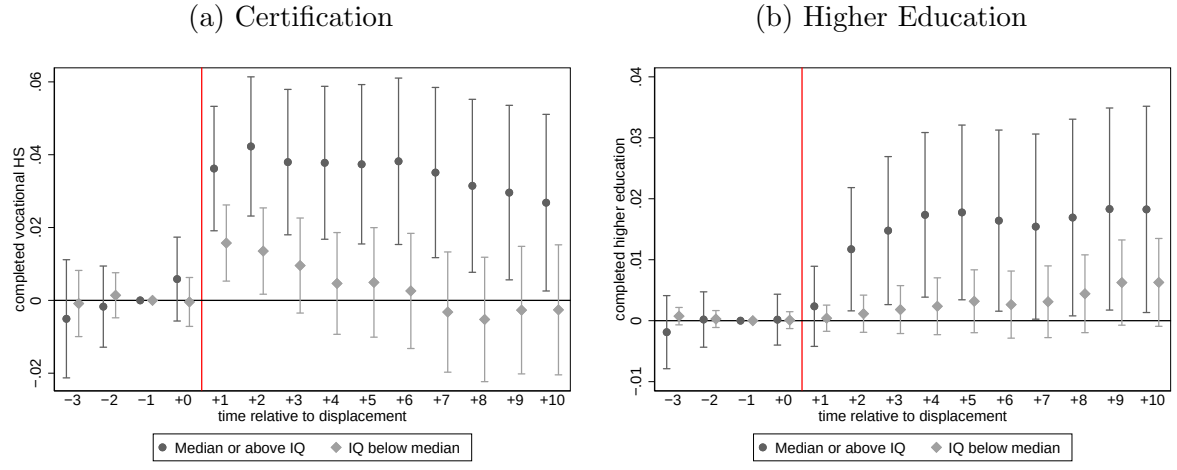


Figure plots δ_k coefficients from equation 1 for men, with the outcome variable equal to 1 if an individual has completed vocational high school (panel a) or completed higher education (panel b). Panels (a) and (b) estimate separate regressions by whether or not a worker has an IQ at or above the median. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

F Why Might Displaced Workers Return to Education?

A student deciding between stopping education at a lower level and entering the labor market or completing additional education at a higher level will weigh the present value of earnings with the lower level of education and the present value of earnings with the higher level of education. However, this decision is complicated by many factors. The school stopping decision is an inherently complex decision, and individuals who found it optimal to stop education in favor of joining the labor force might find it optimal to re-enroll in education later in life for many reasons.

First, a student enrolled in high school might lack information about the true returns to education when deciding to continue with further education. That is, the true returns to education may differ from the perceived returns to education. Over time, individuals may update their expectations about the labor market returns to a given level of education. Manski (1993) emphasizes the joint importance of preferences, expectations, and opportunities for students making the optimal schooling decision. Given the high degree of uncertainty surrounding such a decision, the potential for mis-specified decisions is high. Consistent with this, Bridgeland, DiIulio, and Morison (2006) report that among young disadvantaged high school drop outs in the United States, 74% of students who dropped out of high school reported they would have stayed in school if they could make the decision again.

Existing evidence suggests that student beliefs are important in explaining decisions. Stinebrickner and Stinebrickner (2014) document that beliefs explain a substantial amount of education decisions in university. Wiswall and Zafar (2014) find that such beliefs about the returns to specific fields of study in university education are biased. In particular, students both over- and under-state the true labor market returns to specific fields of study. Boneva and Rauh (2017) conclude that socio-economic status is an important factor in the gap between perceived and actual benefits to university education. Jensen (2010) show that middle school students in the Dominican Republic substantially

understate the returns from additional schooling and that randomly providing information on the returns to education not only increase perceived returns months later but also lead to an increase in schooling.

Second, students place less weight on the future due to less-developed cognitive brain functions during adolescence. As such, individual preferences may change over time. Lavecchia, Liu, and Oreopoulos (2016) emphasize that preferences change with age due to the development of brain functions and that lifetime investments such as education occur in a time period when the brain of students overemphasize the present. As such, what is optimal for young individuals in their teenage years might not be optimal if the same person were to make the same decision later in life. In line with this, Oreopoulos (2007) suggests that the presence of substantial drop out rates from high school despite the large lifetime benefits is consistent with overweighing the immediate costs of schooling. Carrillo (forthcoming) find evidence consistent with students' overemphasizing the present and that temporary booms in coffee prices in Colombia lead students to leave school at the expense of future earnings gains had they remained in education.

Lastly, students may return to education due to a change in opportunities or personal situations. For instance, students may drop out of high school due to becoming a parent, caring for a family member, or needing to provide for their family. Incomplete access to resources to fund further education might also lead to students dropping out of education even if they would have liked to continue in the education system.

Following Becker (1975), equation (3) formulates the a standard school restarting decision in a formal way as someone at age a_0 maximizing lifetime earnings:

$$\underbrace{\sum_{a=a^0+1}^{A} \frac{Y(a)_{s \text{ years}} - Y(a)_{s-1 \text{ years}}}{(1+r)^a}}_{\text{return to high school}} = \underbrace{Y(a^0)_{s-1 \text{ years}}}_{\text{opportunity cost}} + \underbrace{C(a^0)}_{\text{psychic cost}}, \tag{3}$$

where A represents retirement age, s years of schooling, Y earnings, and C the psychic cost of schooling. For simplicity, focus on the decision to re-enroll in high school for someone who dropped out of high school one year away from completing high school. At each age a_0 after dropping out of high school, an individual faces a choice of whether

to restart their education. Their restarting decision weighs the return to completing high school—the earnings potential of graduating from high school compared to their earnings remaining a high school dropout over their remaining working years—with the costs of returning to high school—foregone earnings through a reduction in time spent in employment and any psychic cost of returning to schooling.

Immediately following job displacement, displaced workers have a substantially lower opportunity cost of returning to school, as they find themselves laid off and searching for a new job. Thus, job displacement would lead those at the margin of returning to education to do so, even if the return to high school and psychic costs of returning to schooling were unchanged. However, the shock of job displacement may also lead workers to change their expectations of the lifetime return to being a high school dropout. Such a negative shock is likely to lead some workers to believe the difference in lifetime income between being a dropout and graduating high school is larger than they previously thought. Such a change will also lead those at the margin to return to education. At the same time, displacement might directly impact individual preferences, for instance how much an individual discounts the future. There exists little evidence on how displacement directly impacts worker preferences.

G The Importance of Other Factors for Certification

G.1 The importance of having a parent co-worker

Networking is an important channel for finding a job, and is particularly important after the completion of education when entering the labor market for the first time (Kramarz and Skans, 2014). Parental connections matter: Corak and Piraino (2011) show that 40% of men are employed at an employer which their father has worked for at some point in their working lives. Kramarz and Skans (2014) conclude that parental ties matter if the parent is employed within the same plant as a child and such parental connections matter more among the lowest educated. Indeed, 14% of compulsory school graduates are employed in their first job at a plant which employs their parent. Similar patterns exists among sample of high-tenured high school dropouts, where 11% (8%) of men (women) are employed in the same employer as their father (mother) prior to displacement. Such workers are negatively selected on cognitive ability: 26% of men who are employed in the same employer as their father have a median or above IQ compared to 31% of non-same employers.

Having a parental connection may matter for the dropout decision of a child, either by the direct influence of a parent to follow in their footsteps or by reducing the search costs of finding employment. The availability of networking via parental connections makes employment marginally more attractive than investing in an additional year of education, pushing students at the margin of dropping out to enter the labor market. Figure G.18a assesses the importance of having a mother employed in the same plant in the base year for women and Figure G.18b assesses the importance of having a father co-worker for men. While certification remains significantly higher among displaced workers who do not have a parent co-worker, the estimated impacts of displacement on certification are remarkably higher among displaced workers with a parent co-worker. While the standard errors among a relatively small sub-sample of the total estimation sample are large, displacement increases certification among women with a co-working mother by

5 p.p. and among men with a co-working father by 7.5 p.p., an impact which remains statistically significant by +10.

Figure G.18: The Importance of Parental Co-workers for Certification Post-displacement

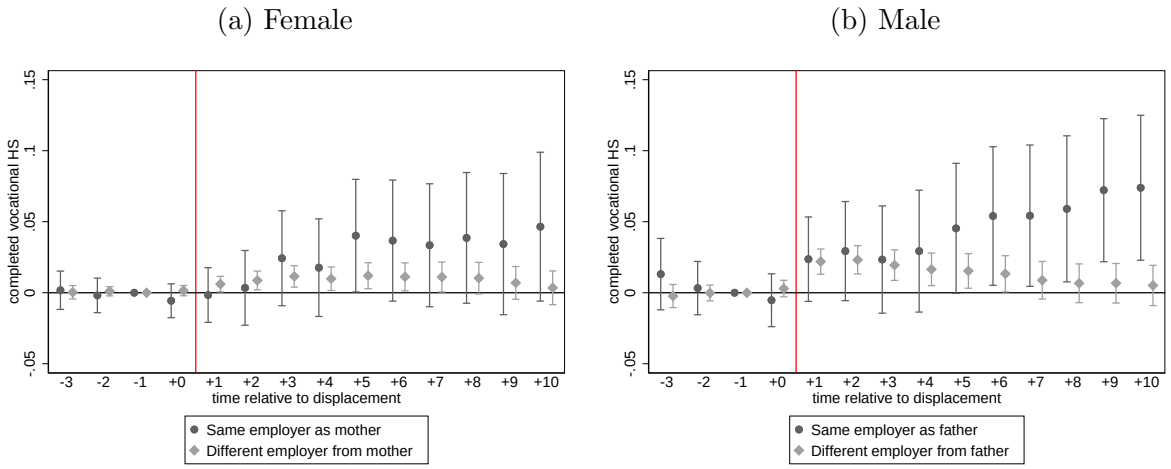


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Separate regressions estimated by whether or not a worker is employed in the same plant as their mother (panel a) or father (panel b) in time +0. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

The presence of a co-working parent clearly matters for certification. Such workers experience a more salient shock—indeed their parent may also be displaced in the same mass-layoff event—and their network is severely impacted, limiting the potential to quickly transition to a new job. Bearing these points in mind, the importance of parental connections for certification reveals that such connections among local employers lead students to drop out of education too early, and the shock of job displacement unequivocally leads them to re-evaluate the importance of certified skills. As the long-run impacts on certification among the parental connection sample do not fade out in the same fashion as seen previously, non-displaced workers in well connected jobs have no need for certification of skills. These stark differences by parental connections suggest that revised expectations on future employment prospects as a high school dropout play an important role in returning to certify skills.

G.2 The importance of local economic conditions at the time of dropout

A diverse literature exploits area-cohort variation in economic conditions to examine the importance of graduating into a recession (Kahn, 2010; Oreopoulos, von Wachter, and Heisz, 2012; Liu, Salvanes, and Sørensen, 2016; Bell, Bindler, and Machin, 2018; Schwandt and von Wachter, 2019). By isolating variation in economic conditions within an area across graduating cohorts, the literature assumes that the remaining variation at the local level is attributed to shifts in aggregate demand which are uncorrelated with characteristics which vary across graduation cohorts. In a similar fashion, results below exploit variation in the local employment rate across different cohorts, measured at the age of 15 just prior to when a student is deciding whether to enroll in high school.

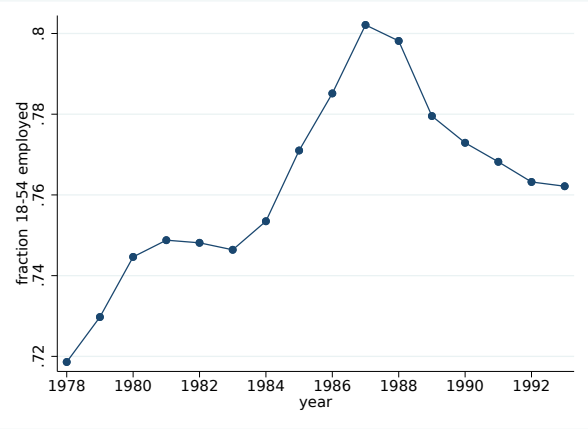
Figure G.19a plots the variation in the national employment rate ($\frac{\sum_{m=1}^{M} employed_m}{\sum_{m=1}^{M} population_m}$) from 1978 (when those aged 27 in base year 1990 are 15) to 1993 (when those aged 21 in base year 1999 are 15). At the national level, there is considerable variation in the employment. Employment ranges from 72% in 1978, to over 80% at its peak in 1987, and then declining to 76% by 1993. Such fluctuations impact the opportunities available in different areas at different points in time, such that two students aged 15 living in the same municipality face very different available employment opportunities.

Figures G.19b and G.19c assess the importance of employment conditions at age 15 for post-displacement certification for women and men respectively. Results plot regressions of equation (1) from separate samples of workers who faced more favorable economic conditions at age 15, those with local employment above the median, and those who faced less favorable conditions at age 15, those below the median. While the estimated coefficients are not statistically different across the two sub-samples, displaced workers who faced favorable conditions at age 15 certify at much higher rates and those displaced who faced less favorable conditions tend to see no significant increases in certification.

Such differences suggest that booming local economic conditions at the time of deciding to continue in high school may have pushed some students who were at the margin of

Figure G.19: The Importance of Variation in Local Economic Opportunities at age 15 for Certification Post-displacement

(a) National Employment Rate, 1978–1993



(b) Female

(c) Male

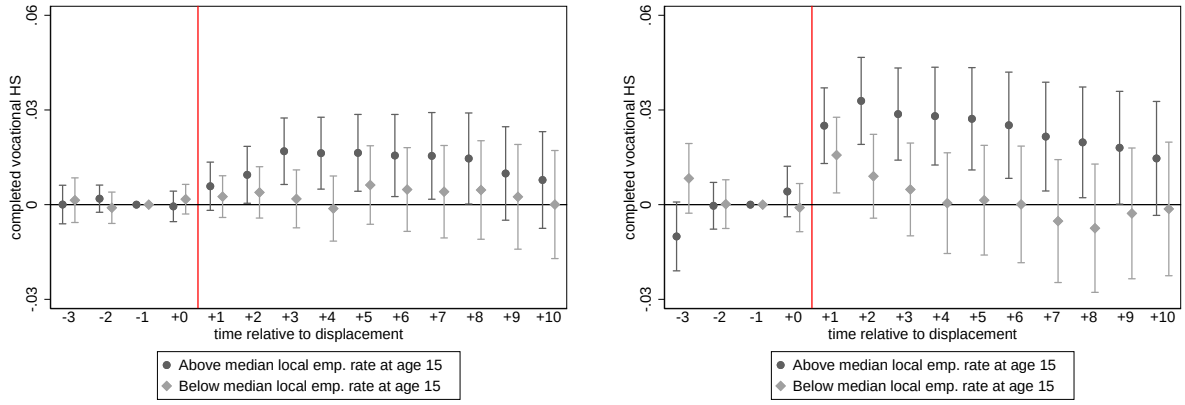


Figure plots the national employment rate from 1978–1993 (panel a) and δ_k coefficients from equation 1, separately for women (panel b) and men (panel c), with the outcome variable equal to 1 if an individual has completed vocational high school. National employment rate defined as total employment over the national population for all individuals aged 18–54. Panels (b) and (c) estimate separate regressions by whether or not a worker lived in an area at age 15 with equal to or higher employment. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

continuing in high school to enter the labor market instead. Following the labor market shock of displacement, such workers re-evaluate the returns to dropping out of high school and certify their vocational skills. Updated expectations relative to what the same person had at the time of drop out appears to be a key determinant of future certification: indeed preferences would need to be very different across high school dropouts of areas with different employment prospects at age 15 to reconcile the differences of Figures G.19b and G.19c.

G.3 The importance of children

The availability of workers' time may also impact the decision to certify post-displacement. Figures G.20a and G.20b examine whether the impacts of displacement on certification differ by the presence of children. Those with children prior to displacement, 33% of men and 47% of women, may find it more difficult to take time away from their children to invest in certification and additional higher education. While certification rates are similar between women displaced with and without children, men without children tend to certify at higher rates post-displacement. In addition, results in Figure G.21 reveal that those without children continue in the education system to complete higher education at much higher rates for both women and men, suggesting that available time impacts the ability to invest in higher education which requires a longer time invested compared to certification.

Figure G.20: The Importance of Children for Post-displacement Certification

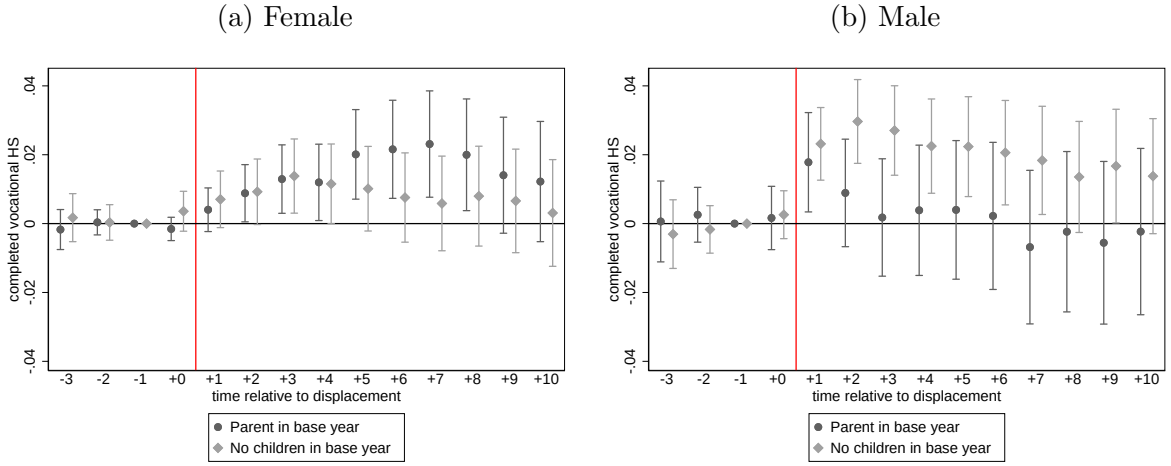


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Panels (a) and (b) estimate separate regressions by whether or not a worker had a child in +0. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

Figure G.21: The Importance of Children for Post-displacement Higher Education

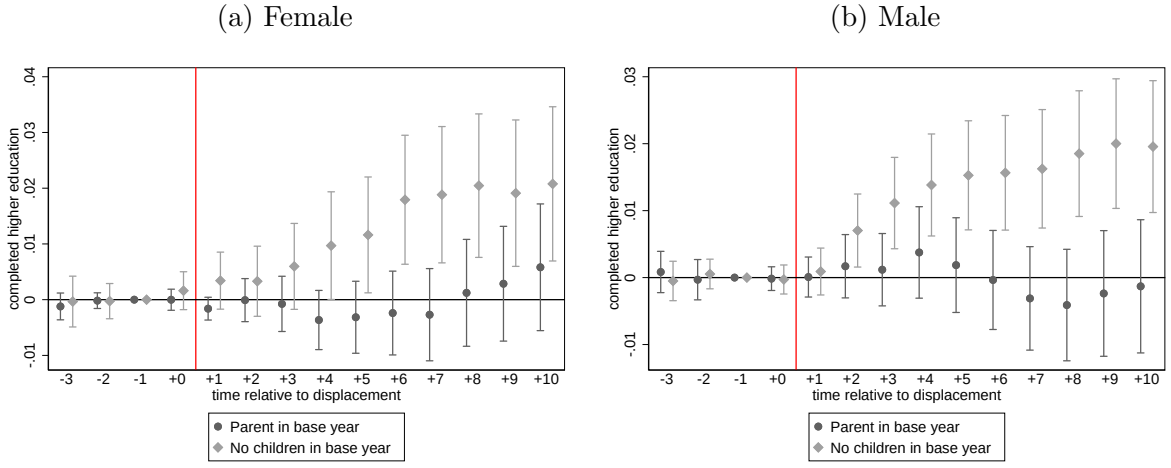


Figure plots δ_k coefficients from equation 1, separately for women (panel a) and men (panel b), with the outcome variable equal to 1 if an individual has completed vocational high school. Panels (a) and (b) estimate separate regressions by whether or not a worker had a child in +0. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1. δ_{-1} set to zero by convention. Estimating equation: $Y_{ibjmt} = \alpha + \sum_{k=-3}^{+10} \gamma_k \cdot (D_{ib} \times time_t)^k + \theta \cdot D_{ib} + municipality^{t=0} \times time_{m,t} + tenure^{t=0} \times time_{i,t} + \pi_b + \varepsilon_{ibjmt}$.

H Probability of Zero Income Post-Displacement

Figure H.22: The probability of zero income post-displacement

(a) Female

(b) Male

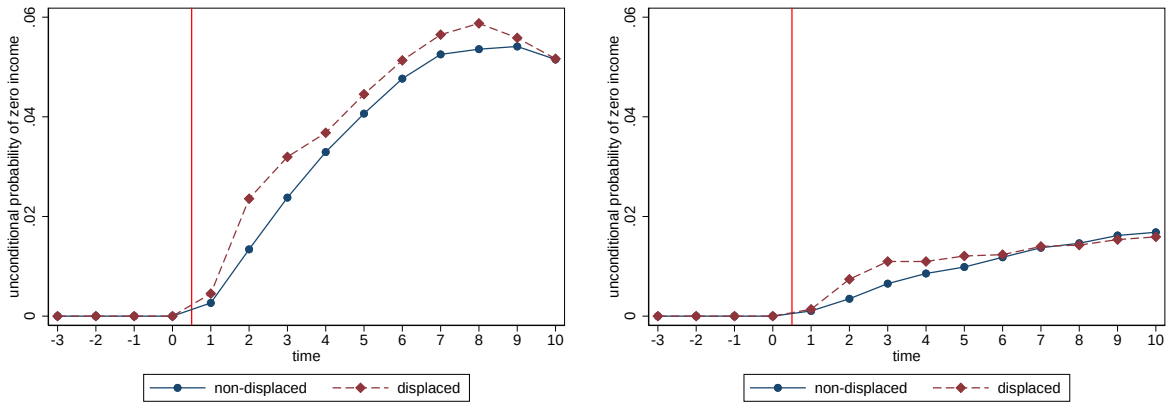
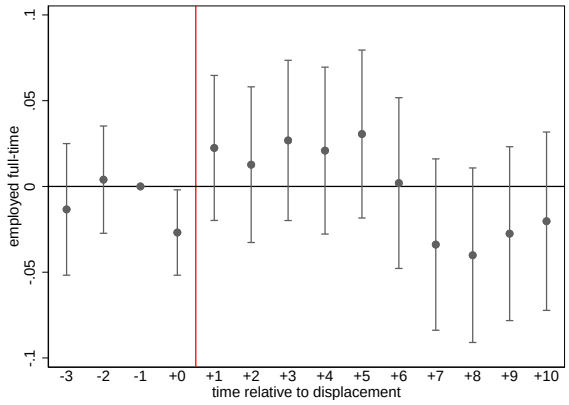


Figure plots the unconditional probability of having zero income for displaced and non-displaced workers separately for women (panel a) and men (panel b).

I Does Employment Differ Between Displaced Pre-/Post-Expansion?

Figure I.23: Post-displacement Employment Pre- and Post-Expansion of the PCS

(a) Female



(b) Male

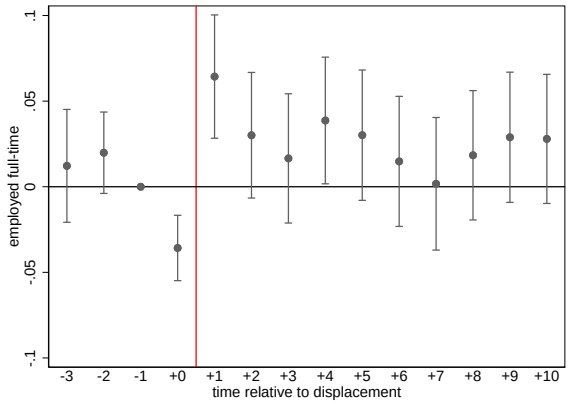


Figure plots the interaction between $Expansion_b$ and $D_{it}^{k \text{ years after displacement}}$ from equation 1, separately for women (panel a) and men (panel b), with the outcome variable full-time employment. Post-expansion cohorts are those from 1996 onward. Coefficients interpreted at the difference between displaced workers post-expansion and displaced workers pre-expansion (both relative to their respective non-displaced counterparts). γ_{-1} set to zero by convention. Displacement event occurs between +0 and +1. 95% confidence interval reported. Sample of high-tenured workers defined as in Section 3.1.

J Linking Occupations to Tasks

J.1 Norwegian Occupation Data

Occupations are classified in the Norwegian Register data according to the Norwegian Standard Classification of Occupations, developed in 1998 (STYRK-1998). The basis of the classification system is the European International Standard Classification of Occupations 1988 (ISCO-88) system. At the 3 digit level, the Norwegian standard is virtually identical to the ISCO-88, and only differs in minor aspects at the most detailed (4 digit) level to accommodate differences in the Norwegian structure of work. An occupation is defined as a group of jobs which are bound by very similar tasks and responsibilities. There exist 356 unique occupations at the 4 digit level. In 2017, 100% of workers who are employed at least 1 hour have an occupation reported in the data.

J.2 Linking Norwegian Occupation Data to US Standard Occupational Classification

To match Norwegian occupations to tasks using O*NET data on the task intensity of occupations in the US, I develop a linkage between the Norwegian occupation standard and the US Standard Occupational Classification (SOC), 2000 version. The mapping proceeds as follows. First, 4 digit occupations in the Norwegian standard are matched manually to the closest 6 digit occupation in the SOC.[19] Direct matches where 1 Norwegian occupation matches to 1 US occupation represent 60.3%. This is due to the fact that the US system is much more detailed than the Norwegian system: while there are 356 unique occupations in the Norwegian standard, there exist 821 unique occupations in the US standard.

Second, all occupations which do not have one-to-one matches are matched to multiple occupations in the US standard. For instance, while "Historians, archaeologists and philosophers" are grouped into one occupation in the Norwegian standard, "Historians"

[19] Matches are created based on the description of tasks in both standards, as well as relevant occupation titles.

and "Anthropologists and Archeologists" are two separate occupations in the US standard. One-to-two matches represent 24.7% of occupations in the Norwegian standard. One-to-three matches represent another 6.6%. For instance, while "Butchers, fishmongers and related food preparers" is one Norwegian occupation, "Butchers and Meat Cutters", "Meat, Poultry, and Fish Cutters and Trimmers", and "Slaughterers and Meat Packers" are 3 separate occupations. One-to-four matches represent another 3.7% and occupations which match to more than 4 occupations in the US standard are the remaining 4.6% of occupations.

In practice, when one Norwegian occupation maps to multiple occupations in the US SOC, these occupations often fall within the same group in the SOC standard. 37.2% of one-to-two matches are within the same 5 digit level (broad occupation) and 60.4% are within the same 3 digit level (minor group). 52.2% of one-to-three are within same broad occupation and 65.2% fall within the same occupation minor group.

J.3 Linking Norwegian Occupation Data to O*NET Task Measures

O*NET data used is version 3.0 from year 2000. Tasks are extracted at the 6 digit US SOC level following Deming (2017), whose four main task measures are math, routine, social, and service tasks.[20] Deming (2017) shows these measures closely resemble other measures used in the literature. For occupations in the Norwegian standard which map to multiple occupations in the US standard, the average of the US occupations is taken and assigned to the unique Norwegian occupation.

Tasks are standardized to run from 0–10, where 10 is the occupation with the highest task intensity and 0 is the occupation with the lowest task intensity. The three occupations in the Norwegian system with the highest routine intensity are Sewing-machine operators, Stenographers and typists, and Shoemaking- and related machine operators. For math intensity, the three highest ranked occupations are Mathematicians and related

[20]See Online Appendix in Deming (2017) for details of the survey measures in the O*NET data which represent the data used to create the tasks

professionals, Physicists and astronomers, and Chemical engineers. For service intensity, the three highest ranked occupations are Religious professionals, Registered Nurses for the Mentally Subnormal, and Nursing and midwifery professionals. For social intensity, the highest ranked occupations are Senior government officials, Directors and chief executives, and Lawyers.

J.4 Task Usage Results Focusing Exclusively on 1 to 1 Matches

Table J.7: Task Usage in 2017 Among Young Displaced Workers 1990–1999, 1 to 1 Matches Between Norwegian and US

	Female			
	(1) Math	(2) Routine	(3) Social	(4) Service
Displaced	-0.0001	-0.1887***	0.1522***	0.2711***
	(0.0569)	(0.0625)	(0.0530)	(0.0745)
Individuals	23968	23968	23968	23968
Avg. Non-Displaced	3.01	3.05	4.25	6.06
	Male			
Displaced	0.0070	-0.3968***	0.1427*	0.1643**
	(0.0611)	(0.0562)	(0.0811)	(0.0702)
Individuals	23961	23961	23961	23961
Avg. Non-Displaced	4.09	4.54	3.98	3.23

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression of one of four task measures (math, routine, social, and service) on displacement dummy. Tasks defined as in Deming (2017). Occupations are measured in 2017, when sample of young workers are aged 39–54. Sample of workers who are employed in 2017 and whose occupation is mapped to task intensity measures, see Appendix J for a discussion of the linkage between occupations and tasks. Sample restricted to 1 to 1 matches between the Norwegian and US occupation classification systems, 61% of the sample of women and 44% of men in Table 3. Estimating equation: $task_{o(i)} = constant + \beta \cdot D_i + \pi_b + \varepsilon_i$, where $D_i = 1$ if a worker was displaced from 21–27.

K How do Tasks Differ Between Displaced Workers Pre- and Post-expansion?

Table K.8: Task Usage in 2017 Among Young Displaced Workers Post-expansion and Pre-expansion

	Female			
	(1) Math	(2) Routine	(3) Social	(4) Service
Displaced	0.0629	-0.0694	0.1350***	0.1228*
	(0.0501)	(0.0585)	(0.0519)	(0.0702)
Displaced × post-expansion	-0.2114**	-0.2593***	-0.0304	0.3507***
	(0.0842)	(0.0981)	(0.0866)	(0.1182)
Observations	39054	39054	39054	39054
	Male			
Displaced	0.0180	-0.2114***	0.0857	-0.0091
	(0.0422)	(0.0456)	(0.0567)	(0.0463)
Displaced × post-expansion	0.0104	-0.0728	0.0515	0.2686***
	(0.0770)	(0.0844)	(0.1029)	(0.0879)
Observations	54826	54826	54826	54826

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression of one of four task measures (math, routine, social, and service) on displacement dummy. Tasks defined as in Deming (2017). Occupations are measured in 2017, when sample of young workers are aged 39–54. Sample of workers who are employed in 2017 and whose occupation is mapped to task intensity measures, see Appendix J for a discussion of the linkage between occupations and tasks. Estimating equation: $task_{o(i)} = constant + \beta_1 \cdot D_i + \beta_2 \cdot D_i \times Expansion_b + \pi_b + \varepsilon_i$, where $D_i = 1$ if a worker was displaced from 21–27.

L Does task composition predict future mass-layoff/ closing event?

Table L.9: Do Tasks Measured in 2016 Predict Future Mass-Layoff or Closing Event in 2017?

	(1) Mass-layoff or plant closure
Average routine tasks	0.0040***
	(0.0006)
Average social tasks	-0.0016**
	(0.0007)
Average service tasks	-0.0038***
	(0.0005)
Average math tasks	-0.0127***
	(0.0008)
Number of plants	181170
average outcome, -1	0.121

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression, at the plant-level, of a variable equal to 1 if a plant has a mass-layoff or plant closing event in 2017 on average task composition of workforce in 2016. Data on all workers are linked to tasks and collapsed to the plant-level. Mass-layoff and plant closing event defined as in Section 3.2. Estimating equation: $layoff_{p,2017} = constant + \beta_1 \cdot routine_{p,2016} + \beta_2 \cdot social_{p,2016} + \beta_3 \cdot service_{p,2016} + \beta_4 \cdot math_{p,2016} + \varepsilon_p$.

M Impact of Displacement on Benefit Receipt Later in Life

Table M.10: Benefit Receipt from 2014–2018 Among Young Displaced Workers 1990–1999

	Female				
	(1) Disability Benefits	(2) Unemployment Benefits	(3) Sickness Absence Benefits	(4) Basic Assistance Allowance	(5) Social Assistance
Displaced	10577.7	-1584.3	2097.5	-402.6*	100.5
	(7440.7)	(1291.0)	(2993.9)	(219.1)	(474.3)
Individuals	56024	56024	56024	56024	56024
Avg. Non-Displaced	162335	14257	96678	2070	2780
	Male				
Displaced	-15588.0***	3001.8**	3039.0	43.3	403.7
	(5637.1)	(1522.8)	(2665.3)	(208.1)	(578.3)
Individuals	75306	75306	75306	75306	75306
Avg. Non-Displaced	106795	18540	75488	1427	3657

Standard errors clustered at the individual level. ***, **, and * correspond to significance at the 1%, 5%, and 10% levels respectively. Table reports results from cross-sectional regression of one of five benefit measures: disability benefits, unemployment benefits, sickness absence benefits, basic allowance assistance (a benefit covering necessary expenses due illness, disability, or injury), and social assistance. Benefits are measured as the sum of the amount received in Norwegian kroner from 2014–2018 (including zeros). Estimating equation: $benefit_i = \alpha + \beta \cdot D_{ib} + \pi_b + \varepsilon_{ib}$, where $D_{ib} = 1$ if a worker was displaced from 21–27. Average value reported among non-displaced workers corresponds to sum of benefits received over 5 year span.