

Math Curriculum and Labor Markets: Long-Run Evidence from New Math

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Working Paper[†]

Abstract

I study how mathematics curriculum shapes occupational outcomes, exploiting the New Math movement of the 1960s. New Math replaced arithmetic-focused K-12 instruction with abstract concepts such as set theory and formal logic, prompted by the Soviet launch of *Sputnik 1* in 1957. I exploit variation in New Math adoption across Ohio to estimate the effect of abstract mathematics instruction on the occupational task composition. Using O*NET task measures standard in the literature, I find New Math exposure shifted workers away from calculation-intensive jobs such as bookkeepers and cashiers, with no detectable effect on wages or education. The results provide broader evidence that curriculum shapes labor market outcomes independent of educational attainment, a dimension of human capital obscured by standard attainment proxies. Together, these findings constitute the first empirical study of the New Math movement.

JEL: I21, I28, J24, N32

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“The Soviets have put a satellite into space. It does not raise the specter of immediate danger. But it does raise deep concern—about our scientific and technical progress, our educational system, and our ability to remain the world’s leading nation.”

— Dwight D. Eisenhower, *Statement Upon Signing the National Defense Education Act*, 1958

I Introduction

There exists a vast literature on the effects of inputs into the education production function. Inputs such as teachers (Rivkin, Hanushek, and Kain 2005; Hanushek and Rivkin 2010; Chetty, Friedman, and Rockoff 2014), facilities (Hanushek 2003; Baron 2022), and class size (Angrist and Lavy 1999; Hoxby 2000; Rivkin, Hanushek, and Kain 2005) have all been found to affect student outcomes. Effects of the education production function itself, through curricula and pedagogy, remain unclear. Haeck, Lefebvre, and Merrigan (2014) find that replacing traditional instruction with student-led, problem-based learning worsened math scores and Hahm (2026) finds adoption of the Common Core to increase annual wages and increase communication.

A separate literature connects education to labor market outcomes through occupational tasks. Autor, Levy, and Murnane (2003) defined jobs as a bundle of tasks that can be measured. Work by David Autor, David Dorn, David Deming, and others have shown technological change to substitute for routine work and complement social and abstract work (e.g., Autor and Dorn 2013; Autor and Handel 2013; Deming 2017). Goldin and Katz (2008) trace the origins and evolution of the American high school curriculum, emphasizing how its content was shaped by the changing skill demands of the economy. While their work focuses on attainment and broad curriculum expansion, it leaves open whether specific curricular content affects later occupational outcomes, as Murnane and Levy (1996) suggest in connecting K-12 curriculum directly to labor market skill demands.

I exploit plausibly exogenous variation in curriculum content to estimate whether the curriculum itself can affect task composition. I exploit the largest and best funded reform to mathematics education in the U.S., the New Math movement of the 1960s (Raimi 1996). New Math represented a temporary change in mathematics curriculum in America following the Soviet Union’s launch of *Sputnik 1* in 1957. The launch of *Sputnik* intensified fears that the United States was falling behind the Soviet Union, prompting the federal government to pass the National Defense Education Act and expand funding for education, particularly in math and science. At the center of mathematics reform was New Math whose rapid implementation provides an ideal setting for curriculum evaluation.

New Math was a change in curriculum from rote calculation and memorization to abstract concepts such

as set theory, different number systems, and proofs for students as young as kindergarten. The curriculum shifted to teach third and fourth year college math classes by the time students graduated high school in hopes of shifting the set of skills available in the U.S. labor market towards more mathematicians and scientists. While New Math programs received generous funding following *Sputnik*, backlash from mathematicians, teachers, and parents led to it being almost non-existent by the mid 1970s.

This paper investigates the shift in tasks completed by individuals exposed to New Math in elementary and secondary school. I exploit the exogenous timing of New Math’s implementation, spurred by *Sputnik*’s launch, and use historical documents from prominent New Math groups and state education departments in Ohio to measure individuals’ exposure to abstract mathematics instruction. Following the task literature, I estimate New Math’s effects on the composition of tasks individuals later perform in their occupations. I find that New Math exposure reduces sorting into calculation-heavy occupations (e.g., bookkeepers and cashiers) with no effect on abstract math-oriented occupations (e.g., mathematicians, physicists, and economists). These results, consistent with critics who argued New Math damaged computational skills without delivering gains in abstract reasoning, provide new evidence that curriculum and pedagogy shape occupational sorting and constitute the first empirical work on the effects of the New Math movement.

II New Math Curriculum

The introduction of New Math shifted the way mathematics was taught in K-12 education from using math as a way of calculation to math as a logical system, more similar to how math is taught in universities. New Math curricula differed from traditional instruction in three fundamental ways. First, New Math prioritized abstract mathematical structures such as set theory, non-Euclidean geometry, symbolic logic, and alternative number bases over computation, algebraic manipulation, and Euclidean geometry (Kline 1973). New Math treated abstraction as a foundation for learning calculation rather than as an advanced topic reserved for college courses.

Second, while traditional curricula aimed for computational proficiency through memorization and drills, New Math emphasized deductive reasoning to teach students why mathematical procedures work rather than how to execute them (Miller 1990). The third difference was in mathematical language and formalism. New Math introduced formal mathematical notation and terminology, often centered in set theory, in elementary and secondary school. Rather than teaching addition through counting, New Math taught addition through the union of disjoint sets as shown for fourth graders in Figure 1. Additional examples of New Math content and principles are contained in the Curriculum Appendix.

Figure 1: New Math Addition

A binary operation is *commutative* if changing the order of the numbers operated on does not affect the result. Since the sum of two numbers is the cardinal number of the union of two disjoint sets, we can show that addition of whole numbers is a commutative operation. First we note that $A \cup B$ is the same set as $B \cup A$, for any two sets A and B , because however we join A and B , we still have the same elements in the union. Second, suppose that a and b are two whole numbers, and that A and B are two disjoint sets whose cardinal numbers are a and b , respectively. Then by definition of addition:

$a + b$ is the cardinal number of $A \cup B$.
 $b + a$ is the cardinal number of $B \cup A$.

These two cardinal numbers are the same, since $A \cup B = B \cup A$. Thus $a + b$ is equal to $b + a$, no matter what whole numbers a and b are. This is what is meant by the statement, "Addition of whole numbers is commutative." This observation is important because, as we will see later, not all operations are commutative.

Note: Source: Greater Cleveland Mathematics Program 1962.

III New Math History

III.A Beginnings

Beginning in the 1940s, mathematicians affiliated with the American Mathematical Society (AMS) and the Mathematical Association of America (MAA) began expressing dissatisfaction with K–12 mathematics education in the United States. They believed school curricula focused excessively on rote arithmetic and calculation, neglecting newer mathematical developments such as set theory and abstract algebra.¹ In response, Max Beberman founded the University of Illinois Committee on School Mathematics (UICSM) in 1951. UICSM sought to develop a new pedagogy for high school mathematics and produced a wide array of instructional materials (UICSM Mathematics Project 1970).² Beberman and UICSM designed the first curriculum of what would later become the New Math movement emphasizing logic and number systems over computation (Phillips 2014).³ Despite UICSM's influence, it remained limited in scope, operating primarily

¹This dissatisfaction is documented in both peer-reviewed journals and historical accounts (e.g., Stanic and Kilpatrick 1992, Graham 2006, and Phillips 2014).

²For contemporary discussion of early reform efforts led by Max Beberman's UICSM, see Time (1958).

³New Math was often referred to as the modern mathematics movement.

as a pilot program in a few dozen schools (Loman 1961).

The Soviet Union launched *Sputnik 1*, the world’s first artificial satellite, on October 4, 1957. The launch sparked widespread fear in the United States, marking the beginning of the Space Race and leading to the creation of the National Aeronautics and Space Administration (NASA) the following year. This science-oriented arms race affected all levels of American society including the education system. *Sputnik* was cited as a “powerful impetus” for change as the federal government dramatically increased investment in science and mathematics education through the National Defense Education Act in 1958 and increased funding to the National Science Foundation (NSF) (Sharp 1964). Investment from the federal government led to widespread changes among K-12 education. For example, the rate of mathematics instructional innovation in New York public schools nearly tripled in the fifteen months following *Sputnik*’s launch (Brickell 1961). Additionally, the College Entrance Examination Board published a report of their recommendations supporting New Math in 1959 (Sharp 1964).

III.B Sputnik, the NSF, and the School Mathematics Study Group

The NDEA aimed to help America catch up to the Soviet Union in science and technology. The NDEA raised the NSF’s appropriation from \$40 million in 1958 to \$134 million the following year (Hunt 2025). Among the major recipients of NSF funding was Edward Begle’s School Mathematics Study Group (SMSG), which launched at Yale University in 1958 (Begle 1963).⁴ Inspired by Beberman’s earlier efforts, Begle’s SMSG collaborated with mathematicians and educators to produce K–12 textbooks that emphasized set theory, alternative number bases, and formal logic, which states began incorporating into their official curricula (Phillips 2014). While initial efforts focused on high school, the approach eventually spread across all K–12 grades.

III.C Greater Cleveland Mathematics Program and Other New Math Groups

While SMSG was the largest New Math group, many others were created following *Sputnik* to revamp math education across the US. The most influential in Ohio was the Greater Cleveland Mathematics Program (GCMP), created by the Educational Research Council of Greater Cleveland (ERC), an independent nonprofit organization founded in 1959 by Dr. George Baird. GCMP was ERC’s first and largest program and sought to improve the quality of elementary and secondary math education in and around Cleveland, Ohio (ERC 1963).⁵

⁴ *Time* magazine labeled Edward Begle, and other leaders of the New Math movement, as “*Sputnik*-stirred mathematicians” (Time 1961).

⁵ The Educational Research Council of Greater Cleveland was later renamed to the Educational Research Council of America in 1967. For this reason, I refer to the group as the Education Research Council or ERC from this point on.

Similar to SMSG and GCMP, two other groups' New Math curricula were taught in Ohio, although at far fewer schools. These other groups are the Teachers of Elementary Mathematics Advisory Committee (TEMAC) and the Minnesota Mathematics and Science Teaching Project (Minnemast). Each of these groups were similar to GCMP being based off of SMSG and UICSM's programs, but focused on the elementary-school curriculum. However, both TEMAC and Minnemast consisted mostly of experienced elementary math teachers, unlike other New Math groups whose writers were predominantly mathematicians.

III.D Back to Basics Movement

Criticism of New Math emerged quickly.⁶ Detractors argued that New Math was too abstract, introduced advanced concepts before students had mastered basic arithmetic, and was often incomprehensible to both students and their parents. The largest critic was Morris Kline, chairman of NYU's mathematics department, whose book *Why Johnny Can't Add* argued that New Math was hopelessly abstract and impractical. He had many other showings against New Math, but none were bigger than his 1962 *American Mathematical Monthly* letter signed by sixty-four other mathematicians proclaiming their disdain for New Math (Kline et al. 1962). Nobel physicist Richard Feynman similarly contended that New Math was written by and for mathematicians, not children (Feynman 1965). Critics also pointed out that most teachers lacked sufficient training to effectively teach the new curriculum, compounding confusion in classrooms (Stanic and Kilpatrick 1992).

These concerns resulted in the "Back-to-Basics" movement of the early 1970s, which advocated for a return to traditional arithmetic and skills-based instruction (Offner 1982; Cuban 1993; Ravitch 2000).⁷ This backlash accelerated the withdrawal of New Math from public schools, a process already underway in the late 1960s. New Math groups continually had their funding cut with SMSG ending in 1977. Although the ERC continued until 1984 with other programs, no GCMP documents were published after 1968.

IV Data

IV.A New Math Implementation

I measure New Math exposure using two sources of historical documents. The first is the 1966 *Catalog of Educational Changes in Ohio Public Schools*, led by Daniel Stufflebeam and commissioned by a collective

⁶Tom Lehrer, a famous satirical signer-songwriter and mathematician, released his song "New Math" in 1965 poking fun at the New Math Curriculum. In it he claims, "(New Math)'s so simple, so very simple. That only a child can do it!" Around the same time as "New Math", Peanuts, came out with seven daily comic strips emphasizing how New Math was written for mathematicians, not school children. These comic strips are included in the Media Appendix.

⁷Mueller (1966) claimed New Math's honeymoon to be over.

of Ohio education groups. This catalog documents all innovative changes to Ohio public schools from 1958 to 1964, based on the Ohio Educational Innovations Survey administered to all public school districts in 1964. The report categorizes changes as (1) instructional; (2) administrative; (3) pupil personnel services; (4) physical plant; (5) staff; (6) school-community relations; and (7) research (Stufflebeam et al. 1966).

Of Ohio’s 623 school districts at the time, 452 districts (69%) responded to the survey. Stufflebeam’s team rated all reported programs on innovativeness and included only those deemed innovative (rated at least three out of six) in the final catalog. This resulted in 241 districts appearing in the report. I classify all 382 other districts not appearing in the report as non-adopters of New Math.

From the catalog’s instructional program changes, I identify districts that adopted New Math curricula. New Math had several versions developed by different curriculum groups—UICSM, SMSG, GCMP, TEMAC, and Minnemast—each explicitly mentioned in Stufflebeam’s report. I classify any district that explicitly mentions these programs or uses broader terms such as New Math or modern math as a New Math adopter. The specific grades receiving the New Math curriculum are reported for all districts in the catalog. When available, I extract implementation years; otherwise I assume implementation in 1961, which attenuates my results.⁸ Beyond measuring New Math exposure, Stufflebeam’s catalog enables me to control and check for potential confounders by providing comprehensive data on all other educational innovations Ohio districts adopted during this period across the seven program categories.

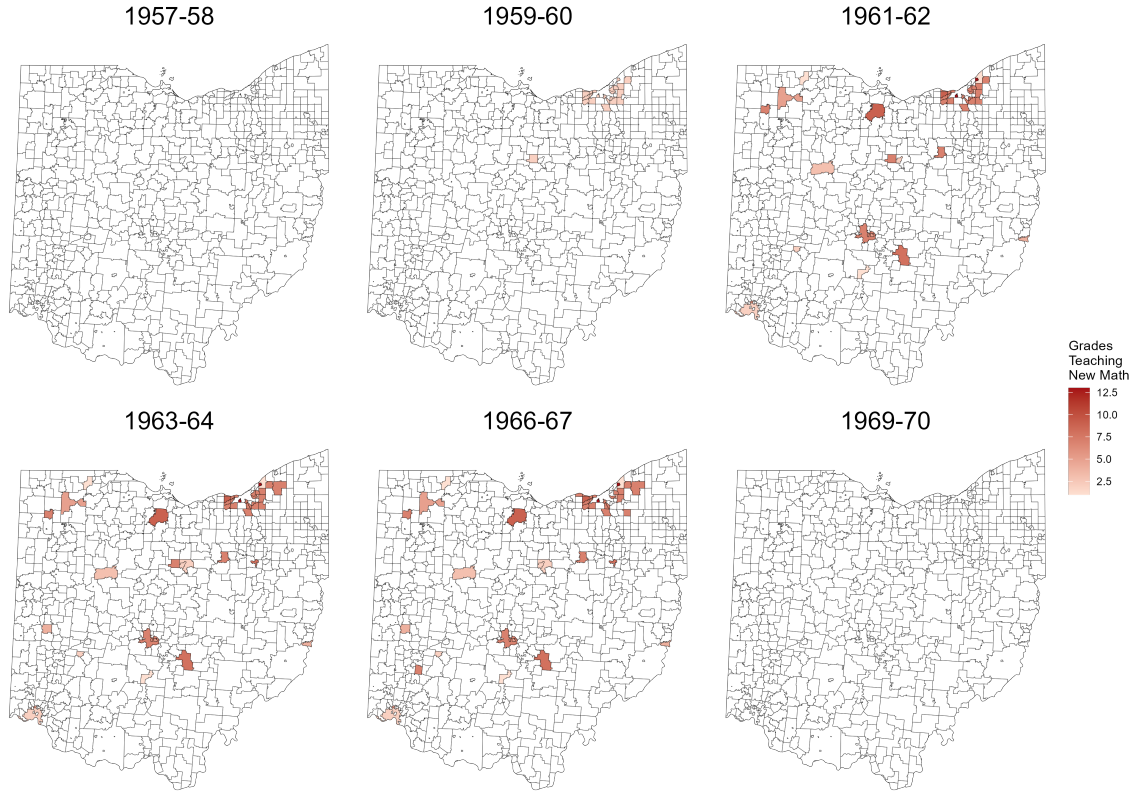
My second source consists of documents from the Greater Cleveland Mathematics Program (GCMP), the most popular New Math curriculum in Ohio. These documents provide cross-sections of all districts using GCMP materials from 1959 to 1968.⁹ I infer program withdrawal when a district appears in an earlier GCMP document but not in a subsequent one, indicating discontinuation prior to the later publication date. I find no documentation of New Math instruction in Ohio after 1968 and therefore assume it was not taught after that date. Figure 2 shows the adoption of New Math over time and Table 1 displays the characteristics of the districts.

Additionally, I digitize maps of all Ohio public school district boundaries as of March 15, 1968 from Ohio Municipal Advisory Council (1968). School-level enrollment from 1956-1974 is obtained from Ohio Department of Education (1956-1974) which I digitize. These allow me to aggregate New Math exposure up to the 2000 Public Use Microdata Area (PUMA) level, this being the most granular residence variable in the Census. I go into more detail about how this is done in Section V.A. Maps of school districts, PUMAs, and counties are included in Figure 3.

⁸1961 is the midpoint of the possible implementation period (1958 to 1964), leading to attenuation.

⁹These documents are Educational Research Council of Greater Cleveland (1961); Educational Research Council of Greater Cleveland (1962); Educational Research Council of Greater Cleveland (1963); Educational Research Council of Greater Cleveland (1966); Educational Research Council of America (1968)

Figure 2: New Math Adoption in Ohio



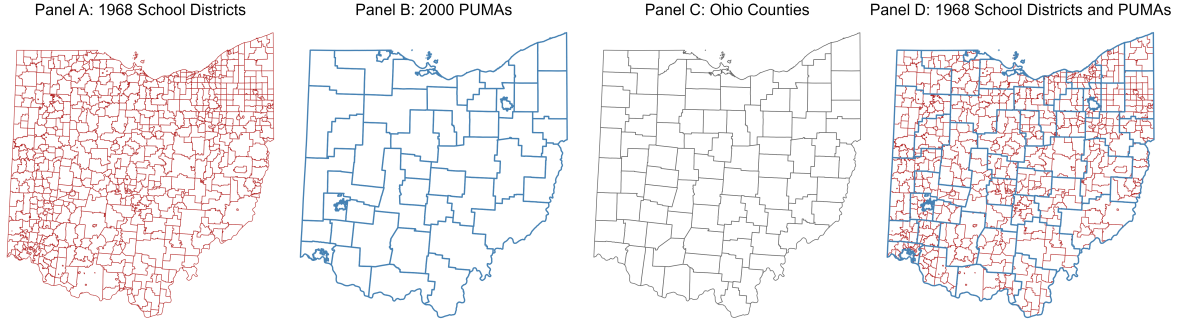
Note: Each panel depicts Ohio school districts teaching New Math in a given school year, shaded by the number of grades receiving New Math instruction.

IV.B Census and American Community Survey

I use the 1990 and 2000 decennial Censuses and 2005-2009 American Community Surveys (ACS) to obtain information on individuals' occupations, education, wages, and other demographics.¹⁰ I restrict the sample to Ohio-born individuals between 24 and 54 years old at the time of survey, following Deming (2017), to prevent selection among those remaining employed near retirement and conflation with documented convergence in task compositions near retirement age (Autor and Dorn 2009; Nunley and Seals 2021). I further restrict to birth cohorts from 1940-1963 to exploit variation only in New Math's implementation, as its withdrawal was less publicized, and assume no New Math was taught after 1968 since this is the last year of documentation I have of New Math being taught in Ohio. Summary statistics are included in Table 2.

¹⁰Wages are adjusted to be in constant 2026 dollar terms and regressions only use the log of hourly wages to account for differences in work hours.

Figure 3: Ohio School Districts in 1968, Counties, and PUMAs



Note: Figure displays Ohio school district boundaries as of 1968, 2000 Census PUMAs, Ohio counties, and the overlay of 1968 school districts and 2000 PUMAs.

Table 1: District Summary Statistics

Variable	All Districts	New Math Districts	Remaining Districts
1957 Enrollment (Median)	1,375	2,414	1,324
Square Miles (Median)	47.100	20.900	49.800
N	623	47	576

Note: District enrollment comes from the Ohio Educational Directories and size in square miles from the 1968 school district maps by county.

Table 2: Individual Summary Statistics

Variable	All PUMAs	New Math PUMAs	Non-New Math PUMAs
Mean NM Exposure	0.339	0.559	0.000
Male	0.496	0.493	0.501
White	0.895	0.875	0.926
Black	0.096	0.115	0.067
Hispanic	0.006	0.007	0.005
Asian	0.001	0.001	0.001
Employed	0.778	0.790	0.760
Years of Education	12.892	13.030	12.678
Completed High School	0.414	0.446	0.365
Completed College	0.192	0.215	0.155
N	10,913,750	6,627,039	4,286,711

Note: Sample draws from the pooled 1990 and 2000 decennial Censuses and 2005-2009 ACS, restricted to Ohio-born individuals aged 24-54 at the time of survey, birth cohorts 1940-1963.

IV.C Occupation Tasks and Abilities

My primary measure of occupational tasks comes from the 1998 US Department of Labor’s Occupational Information Network (O*NET). The O*NET uses a random sample of US workers in each occupation to answer survey questions about their use of different abilities, skills, and knowledge in their jobs. Questions are rated on an ordinal scale. Following Deming (2017), the O*NET allows for the construction of ten task measures, of which I focus on four: analytic tasks, number facility, routine tasks, and social skills.¹¹

Each task measure begins as the average of ordinal scales ranging from 1 to 7.¹² Measures are then converted into percentiles corresponding to their rank in the 1980 employment distribution, using the 1980 Census, to avoid using ordinal averages, as is common in the literature (e.g., Autor, Levy, and Murnane 2003; Autor and Dorn 2013; Deming 2017). Occupation codes, which are reported differently across biennial Censuses and ACSs, are linked using the crosswalk specified in Autor and Dorn (2013).

Other task measures come from the 1977 Dictionary of Occupational Titles (DOT). The DOT evaluates over 12,000 occupations along 44 objective and subjective dimensions by having analysts employed by the US Employment Service conduct on-site job studies and interviews. I follow Autor, Levy, and Murnane (2003) and create five different task measures (1) non-routine cognitive analytical (2) non-routine cognitive interactive (3) routine cognitive (4) routine manual and (5) non-routine manual.¹³ DOT measurements are similarly converted to percentiles using the 1980 employment distribution.

I focus on task measures from the 1998 O*NET for two reasons. The first being is that it is more contemporaneous with the occupations I observe in the Census and ACS data. Secondly, O*NET task measurements more properly align with the New Math curriculum change which went from computation to abstraction. The analytical and number facility tasks, calculated using the 1998 O*NET, correspond to jobs with more abstract math and calculation, respectively. Examples of jobs with high analytical and low number facility are mathematicians, physicists, economists, and lawyers, roughly aligning with jobs New Math hoped to promote. Those with low analytical and high number facility values are bookkeepers, cashiers, and pharmacists. Summary statistics of task measures are available in Table 9 of the Data Appendix.

¹¹The questions corresponding to analytical tasks are (i) mathematical reasoning ability (ii) mathematics knowledge and (iii) mathematics skill. Routine tasks include (i) degree of automation (ii) importance of repeating the same tasks and number facility measures (i) “the ability to add, subtract, multiply, or divide quickly and correctly.” Social skill intensity measured by (i) social perceptiveness (ii) coordination (iii) persuasion and (iv) negotiation.

¹²Importance of repeating tasks is on a 1 to 5 scale while all others are on a 1 to 7 scale. Because of this all task measures are converted to be the average between 0 and 10.

¹³Items on the 1977 DOT corresponding to each task measure are (1) general educational development - mathematical development being the level of mathematical reasoning needed to perform the job (2) direction control and planning capturing managerial and supervision (3) sets limits, tolerances, or standards requiring rule-based cognitive processing (4) finger dexterity capturing repetitive, standardized manual activity and (5) eye-hand-foot coordination capturing situational adaptability.

V Methodology

V.A New Math Exposure

I measure New Math exposure, NM Exposure_{pc} , at the PUMA-cohort (pc) level, where PUMA boundaries correspond to 2000 Census definitions.¹⁴ NM Exposure_{pc} , as shown in Equation 1, captures the expected number of grade-years a child spent under a New Math curriculum.

$$\text{NM Exposure}_{pc} = \sum_{g=0}^{12} \sum_d w_{dpg} \times \mathbb{1} \{ \text{cohort } c \text{ taught New Math in grade } g \text{ in district } d \} \quad (1)$$

NM Exposure_{pc} is the average New Math exposure within the PUMA, aggregated across all grade years (0–12). Exposure at the district level is determined from the historical records, and cohorts are assumed to have begun kindergarten (grade 0) at age five, corresponding to school year $c + 5 + g$, where c is birth year and g is grade.¹⁵ I assume individuals attended school in the PUMA where they currently reside, which attenuates my estimates.¹⁶

The vast majority of school districts fall completely within a single PUMA, but those which don't are aggregated to the PUMA level using the population weights defined in Equation 2. w_{dpg} is the fraction of the students in PUMA p in grade g that came from district d where $\text{Enrollment}_{dg}^{1957}$ is district d 's total enrollment in grade g in 1957, the year *Sputnik* was launched.¹⁷ Figure 4 and 5 display PUMA-level exposure to New Math across cohorts.

$$w_{dpg} = \frac{\text{Enrollment}_{dg}^{1957} \times \frac{\text{Area}(d \cap p)}{\text{Area}(d)}}{\sum_{d'} \left(\text{Enrollment}_{d'g}^{1957} \times \frac{\text{Area}(d' \cap p)}{\text{Area}(d')} \right)} \quad (2)$$

V.B Identification

I exploit the rapid rollout of New Math following *Sputnik* and the resulting variation in individuals' age at exposure to obtain quasi-random variation in New Math exposure. Figure 6 shows that adoption was concentrated in the years immediately following *Sputnik*'s launch. The combination of plausibly exogenous timing driven by supply-side events and variation in individuals' age and exposure intensity supports the use

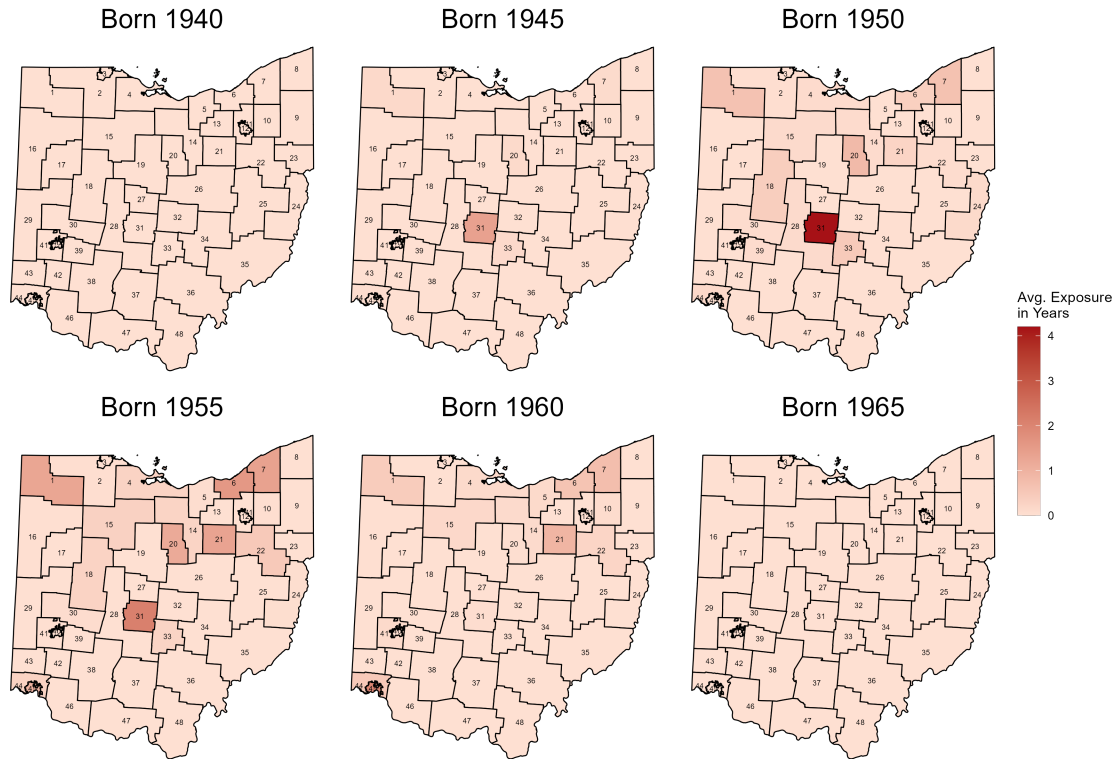
¹⁴I link observations from the 1990 Census, which has its own PUMA boundaries, to its most similar 2000 PUMA. 2005–2009 ACS data uses PUMAs from the 2000 Census.

¹⁵The GCMP's initial K-3 rollout, though categorized as the 1959–60 school year, did not begin until January 1960 (Baird 1961). I therefore count cohorts exposed to GCMP in 1959 as receiving half a year of New Math exposure for that grade year.

¹⁶Table 10 in the Results Appendix shows that individuals do not sort across PUMAs in ways related to New Math exposure.

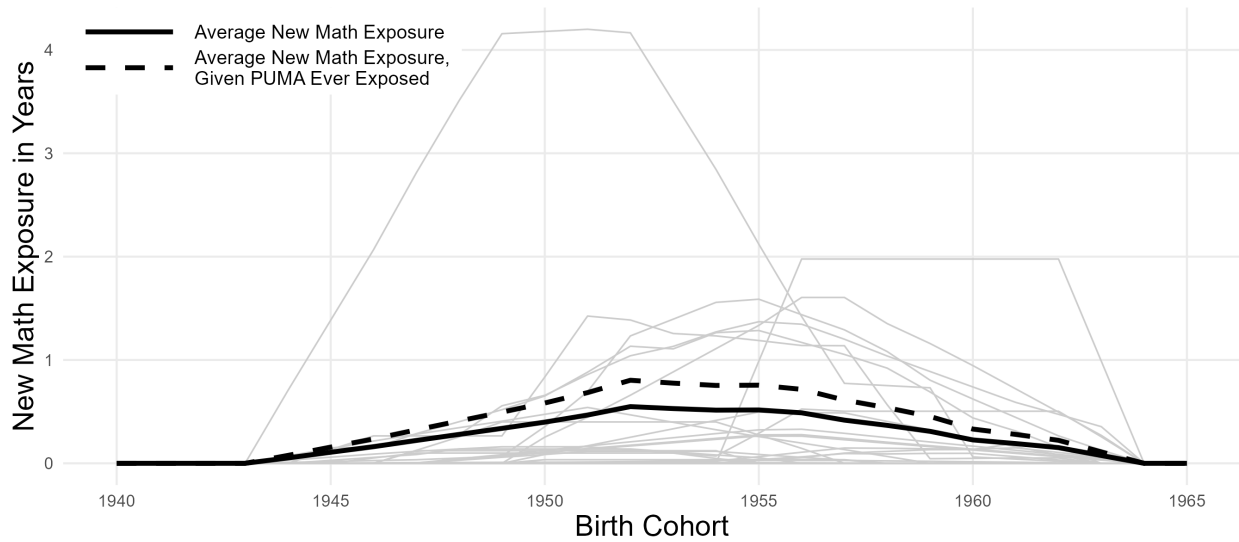
¹⁷Enrollment is assumed to be uniform across grades in a given school.

Figure 4: Ohio New Math Exposure by PUMA



Note: Figure displays New Math exposure by PUMA for selected birth cohorts, constructed as in Equation 1.

Figure 5: Ohio New Math Exposure by PUMA-Cohort



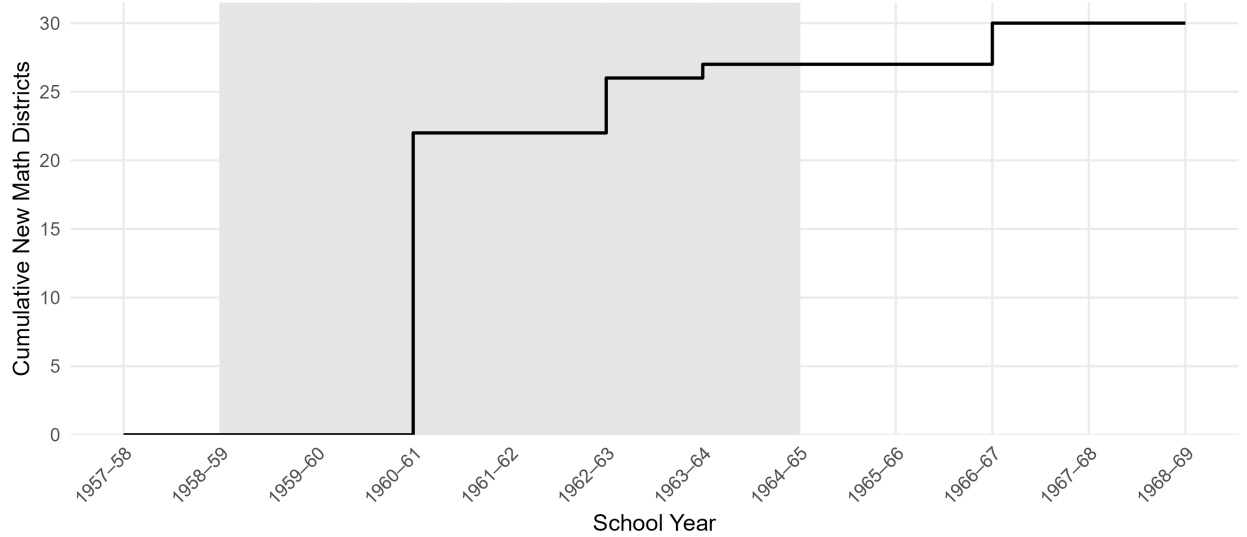
Note: Figure displays New Math exposure by birth cohort across all PUMAs, constructed as in Equation 1. Gray lines represent individual PUMAs. The black and grey lines depict average New Math Exposure among all PUMAs and that conditional on having any New Math exposure, respectively.

of ordinary least squares to estimate Equation 3, yielding the effect of an additional grade-year of exposure on occupational task composition, β_1 .¹⁸

$$Y_{ipct} = \beta_0 + \beta_1 \text{NM Exposure}_{pc} + X_i' \theta + \mu_{p \times t} + \mu_c + \varepsilon_{ipct} \quad (3)$$

Where Y_{ipct} is either a 1998 O*NET or 1977 DOT task measure, log real hourly wages, or an indicator equal for other labor market or education outcomes. NM Exposure_{pc} is a continuous measure of expected New Math exposure based on the individual's PUMA of residence and birth cohort which takes a value between 0 and 12. X_i is a vector of individual gender and race indicators. $\mu_{p \times t}$ and μ_c are PUMA-survey year and cohort fixed effects, respectively. Standard errors are clustered at the PUMA level.

Figure 6: Cumulative New Math Districts



Note: Figure depicts the cumulative number of districts ever adopting any form of New Math in Ohio. There are an additional 19 districts which reported to have implemented New Math between 1958 and 1964 as represented by the shaded portion (Stufflebeam et al. 1966).

VI Results

VI.A Overall

Table 3 displays results from estimating Equation 3 on task measures. Overall, I find that exposure to an abstract math curriculum leads individuals to sort into occupations with less calculations, as measured by the number facility measure. One additional school year of New Math exposure decreases an individual's

¹⁸Figure 9 in the Results Appendix provides supporting evidence of this assumption, showing parallel trends in O*NET task measures in cohorts who graduated high school before New Math.

number facility percentile rank by approximately one-third of a percentile. This corresponds to over a half of a percent decrease relative to the mean.

I find little evidence of effects on other O*NET and DOT task measures. My results are consistent with the long-held belief that New Math worsened computational skills without producing offsetting gains in abstract mathematical reasoning. These results suggest the curriculum’s effect persists into adulthood and affects occupational decisions. Given the numerous data constraints discussed above, my estimates should be interpreted as lower bounds on the true effect of an abstract math curriculum.

I find no effect on other labor market outcomes such as wages, employment, incarceration, and education. The lack of an effect on education outcomes suggests the usual human capital measure, educational attainment, hides significant heterogeneity in abilities. These results are robust to using county of residence, in place of PUMA, although these results only include counties with more than 100,000 residents at the time of survey. County results are included in Table 11 of the Results Appendix.

VI.B Heterogeneity

I estimate heterogeneity in New Math exposure by demographic group, exposure timing, and intensity of exposure. Heterogeneity results of New Math’s effect on the number facility O*NET task measure are displayed in Table 5. I find the results to be concentrated among White females, although the effects are consistent across females, Whites, and Blacks.

Exposure heterogeneity reveals New Math’s effect to be concentrated in those exposed during secondary school and with an above-median, 0.343 grade-years, exposure. The concentration on secondary school is unusual in the education literature, which generally finds early education returns to outweigh those of later education (e.g. Heckman 2006; Cunha et al. 2006; Elango et al. 2016). Heterogeneous effects by tercile, conditional on exposure, reveals New Math to have a stronger intensive effect rather than that at the extensive margin.

Table 3: New Math Task Results

Outcome	(1)	(2)
<i>Panel A: 1998 O*NET Measures</i>		
Analytical	-0.105 (0.165) {52.561}	-0.083 (0.158) {52.578}
Number Facility	-0.380*** (0.099) {52.165}	-0.335*** (0.095) {52.155}
Routine	0.215 (0.171) {48.778}	0.161 (0.168) {48.801}
Social Skills	-0.172 (0.132) {53.787}	-0.080 (0.133) {53.748}
<i>Panel B: 1977 DOT Measures</i>		
Non-routine Cognitive Analytical	-0.030 (0.143) {53.684}	0.039 (0.144) {53.634}
Non-routine Cognitive Interactive	-0.193* (0.108) {52.336}	-0.102 (0.113) {52.305}
Routine Cognitive	0.503*** (0.102) {50.265}	0.442*** (0.101) {50.248}
Routine Manual	0.783*** (0.108) {48.153}	0.710*** (0.107) {48.160}
Non-routine Manual	0.143 (0.103) {49.984}	0.122 (0.094) {49.962}
Included Cohorts	1945-1963	1940-1963
Gender, Race Controls	X	X
PUMA-Survey Year, Cohort FEs	X	X
<i>N</i>	8,317,116	8,593,311

Note: New Math exposure is measured as the population-weighted share of districts, within a PUMA, teaching New Math across the grades a cohort attended, yielding a continuous variable from 0 to 12. 1998 O*NET and 1977 DOT task measures are each individuals' occupation-level, employment-weighted percentile rank in the 1980 Census, following Autor, Levy, and Murnane (2003) and Autor and Dorn (2013). *N* is the number of employed individuals for the included cohorts, who were born in Ohio and only results on employment rate include unemployed individuals. The estimated coefficient is reported along with its standard error, clustered at the PUMA level, (in parentheses) and outcome average {in braces}. * significant at 10%, ** at 5%, *** at 1%.

Table 4: New Math Labor Outcomes and Education Results

Outcome	(1)	(2)
<i>Panel A: Labor Market Outcomes</i>		
<i>Log</i> (Hourly Wage)	0.001 (0.003)	0.001 (0.003)
1 {Employed}	-0.001 (0.003)	-0.001 (0.003)
1 {Incarcerated}	0.000 (0.000)	0.000 (0.000)
<i>Panel B: Education Results</i>		
Years of Education	-0.001 (0.013)	0.002 (0.013)
1 {Some High School}	-0.001** (0.001)	-0.001** (0.001)
1 {High School}	-0.002 (0.004)	-0.001 (0.004)
1 {Some College}	-0.001 (0.002)	0.000 (0.002)
1 {College}	-0.002 (0.002)	-0.001 (0.002)
1 {Graduate School}	0.001 (0.002)	0.001 (0.002)
Included Cohorts	1945-1963	1940-1963
Gender, Race Controls	X	X
PUMA-Survey Year, Cohort FEs	X	X
<i>N</i>	8,317,116	8,593,311

Note: New Math exposure is measured as the population-weighted share of districts, within a PUMA, teaching New Math across the grades a cohort attended, yielding a continuous variable from 0 to 12. The sample is restricted to individuals born in and currently residing in Ohio. The estimated coefficient is reported along with its standard error, clustered at the PUMA level, (in parentheses). * significant at 10%, ** at 5%, *** at 1%.

Table 5: Number Facility Result Heterogeneity

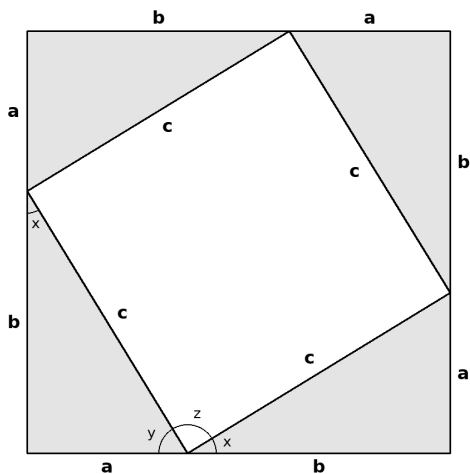
Outcome = Number Facility	(1)	(2)
<i>Panel A: Demographic Heterogeneity</i>		
Male	-0.059 (0.210)	-0.034 (0.190)
Female	-0.720*** (0.243)	-0.652**** (0.241)
White	-0.310** (0.149)	-0.264* (0.140)
Black	-0.841** (0.399)	-0.804* (0.409)
White Male	0.255 (0.369)	0.284 (0.344)
White Female	-0.922*** (0.327)	-0.857** (0.329)
Black Male	-1.250 (0.756)	-1.291 (0.779)
Black Female	-0.510 (0.403)	-0.412 (0.394)
<i>Panel B: Exposure Heterogeneity</i>		
Elementary (K-6)	-0.367 (0.327)	-0.366 (0.317)
Secondary (7-12)	-0.386*** (0.078)	-0.321*** (0.076)
Bottom Tercile Exposure Exposed	2.587 (33.377)	6.764 (34.976)
Middle Tercile Exposure Exposed	-0.489 (1.984)	-1.014 (1.876)
Top Tercile Exposure Exposed	-0.378*** (0.107)	-0.333*** (0.108)
Included Cohorts	1945-1963	1940-1963
Gender, Race FEs	X	X
PUMA-Survey Year, Cohort FEs	X	X

Note: Estimates are from Equation 3 generalized to measure heterogeneous effects on the Number Facility task measure. Sample is restricted to employed, Ohio-born individuals. Standard errors clustered at the PUMA level in parentheses. * significant at 10

VII Appendix

VII.A New Math Curriculum

Figure 7: New Math's Pythagorean Theorem Figure



$$(a+b)^2 = a^2 + 2ab + b^2 = c^2 + 4\left(\frac{1}{2}\right)ab \quad (4)$$

$$\Rightarrow a^2 + b^2 = c^2$$

Note: This figure depicts how the Pythagorean Theorem was taught according to New Math. Here, a rhombus is depicted inside of a square where angles y and x form a right angle. The area of the large square equals that of the the small square plus the four triangles in gray resulting in equation 4 which is the Pythagorean Theorem when simplified. Source: Phillips 2014.

Table 6: Basic Guidelines of the Greater Cleveland Mathematics Program

Guideline	Description
1	The basic program be suitable for use by all students.
2	The program have a continuous and systematic flow of mathematical concept formation from grades kindergarten through twelve.
3	The program originate at the lowest level of instruction in kindergarten or first grade and be continued through to grade twelve.
4	The teaching approach make the greatest possible use of the discovery method of teaching and provide continuous challenge and stimulation to the student.
5	The program be mathematically correct and pedagogically sound.

Note: Source: ERC 1963, pp. 9.

Table 7: Principles of the Greater Cleveland Mathematics Program

In writing the student and teacher materials, the authors have endeavored to create a program:

Principle	Description
1	That stresses reasoning and understanding.
2	That develops the basic properties of the number system.
3	That leads the child to discover patterns and relations for himself.
4	That uses precise definitions in order to develop the mathematical language.
5	That leads the pupil from the concrete to the abstract.
6	That gives the child an opportunity to discover mathematical principles for himself.
7	That makes use of the child's basic intuitive notions.
8	That takes advantage of the child's natural curiosity and creative imagination.
9	That is self-motivating.
10	That is structured on a continuous flow of ideas.
11	That is suitable for all students.
12	That is comprehensive.

Note: Source: ERC 1963, pp. 10–11.

Table 8: GCMP Sequence, Kindergarten–Grade 3

Concepts	K	1	2	3
Sets				
One-to-one correspondence	✓	✓	✓	✓
Equivalent and non-equivalent sets	✓	✓	✓	✓
Union of sets (addition)	✓	✓	✓	✓
Subsets	✓	✓	✓	✓
Set separation (subtraction)	✓	✓	✓	✓
Sets defining multiplication			✓	✓
Set partitioning (division)			✓	✓
Numbers and Numerals				
Cardinal numbers; numeral distinction	✓	✓	✓	✓
Numbers 1–10	✓	✓	✓	✓
Numbers 0–100		✓	✓	✓
Numbers 0–999			✓	✓
Numbers to millions				✓
Reading/writing numerals	✓	✓	✓	✓
Counting (by 1s; then skip counting)	✓	✓	✓	✓
Place Value				
Base-ten system		✓	✓	✓
Expanded notation		✓	✓	✓
Place value beyond 1,000				✓
Order and Relations				
Ordering and comparing numbers	✓	✓	✓	✓
One-more / one-less	✓	✓	✓	✓
Equations and inequalities		✓	✓	✓
Ordinal numbers	✓	✓	✓	✓
Addition of Whole Numbers				
Meaning of addition; basic facts	✓	✓	✓	✓
Properties of addition	✓	✓	✓	✓
Multi-digit addition (no carrying)		✓	✓	✓
Multi-digit addition (with carrying)			✓	✓
Subtraction of Whole Numbers				
Meaning of subtraction	✓	✓	✓	✓
Inverse relation with addition		✓	✓	✓
Multi-digit subtraction (borrowing)			✓	✓
Multiplication of Whole Numbers				
Repeated addition; set interpretation			✓	✓
Facts through 9×9			✓	✓
Multi-digit multiplication				✓
Division of Whole Numbers				
Partitioning; missing factors			✓	✓
Division facts			✓	✓
Multi-digit division				✓
Fractions				
Parts of a whole; equivalence	✓	✓	✓	✓
Common fractions		✓	✓	✓
Ordering and informal operations				✓
Measurement				
Time and money		✓	✓	✓
Advanced money concepts				✓

Note: From ERC (1963).

VII.B Data

Table 9: Task Measure Summary Statistics

Variable	All PUMAs	New Math PUMAs	Non-New Math PUMAs
<i>Panel A: O*NET Task Measures</i>			
Analytical	52.561	52.659	52.404
Number Facility	52.165	52.988	50.842
Routine	48.779	48.322	49.511
Social Skills	53.787	54.823	52.242
<i>Panel B: DOT Task Measures</i>			
Non-routine Cognitive Analytical	53.684	54.792	51.905
Non-routine Cognitive Interactive	52.336	53.355	50.700
Routine Cognitive	50.265	49.866	50.906
Routine Manual	48.153	47.889	48.576
Non-routine Manual	49.984	48.940	51.658
N	8,317,116	5,124,856	3,192,260

Note: Task measures are occupation-level, employment-weighted percentile ranks in the 1980 Census, following Autor, Levy, and Murnane (2003), Autor and Dorn (2013), and Deming (2017). Sample is restricted to employed, Ohio-born individuals aged 24-54, birth cohorts 1945-1963.

VII.C Media

Figure 8: Peanuts Comic Strips Referencing New Math (1964–1965)



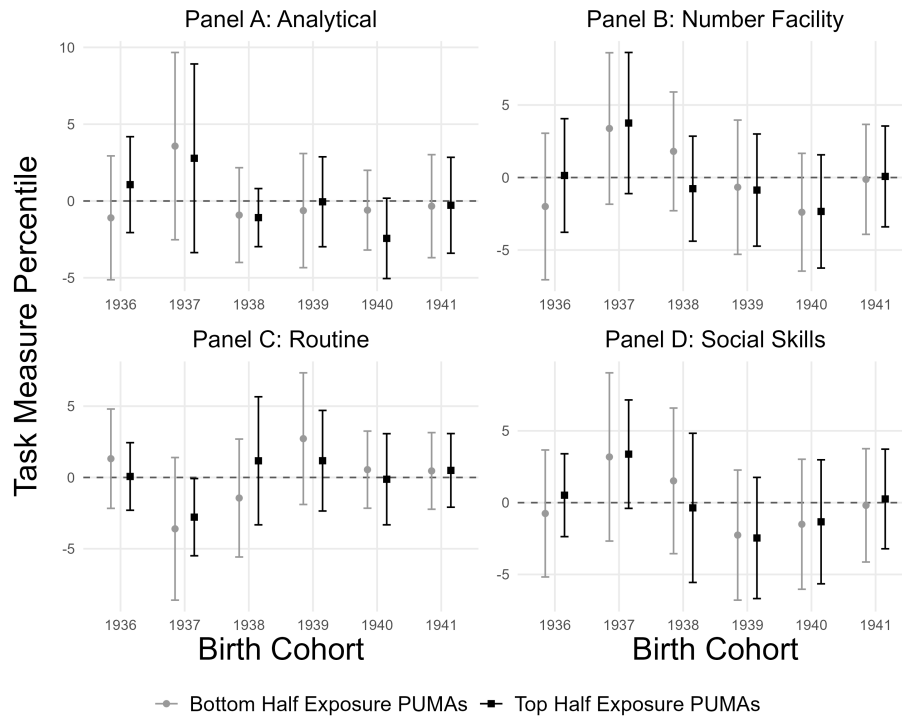
VII.D Results

Table 10: Moving Results

Outcome = Moving MIGPUMA	ACS	Census
All	0.001 (0.001)	-0.003 (0.003)
Male	0.001 (0.002)	0.002 (0.002)
Female	0.001 (0.003)	-0.007 (0.006)
White	0.002 (0.002)	-0.005* (0.003)
Black	-0.005 (0.004)	-0.006* (0.003)
White Male	0.002 (0.002)	-0.001 (0.003)
White Female	0.002 (0.002)	-0.009** (0.004)
Black Male	-0.006 (0.006)	0.020*** (0.005)
Black Female	-0.002 (0.003)	-0.005 (0.008)
Moving Window	1 Year	5 Years
Cohorts	1951–1963	1940–1963
N	6,703,448	2,054,254

Note: Moving is defined as an individual residing in a different MIGPUMA (a small cluster of PUMAs) than in the prior period. The ACS records residence changes within the past year while the Census records changes within the past 5 years. ACS estimates use the 2005–2009 surveys and Census estimates use the 1990 and 2000 decennial Censuses. The sample is restricted to individuals aged 24–54 at the time of survey, which limits the ACS cohort range to 1951–1963. * significant at 10%, ** at 5%, *** at 1%.

Figure 9: Pre-Period Trends by Task Measure



Note: Figure displays coefficients from a regression of each O*NET task measure on an indicator for Top Half Exposure PUMAs, estimated separately for each birth cohort from 1936 to 1941. Top Half Exposure PUMAs are those with above-median New Math exposure among PUMAs with any exposure. All cohorts shown were born prior to New Math's implementation following *Sputnik*'s launch in 1957. 95% confidence intervals shown. Standard errors clustered at the PUMA level.

Table 11: New Math Task Results (County)

Outcome	(1)	(2)
<i>Panel A: 1998 O*NET Measures</i>		
Analytical	-0.091 (0.138)	-0.070 (0.131)
Number Facility	-0.331*** (0.104)	-0.291*** (0.093)
Routine	0.198 (0.168)	0.154 (0.169)
Social Skills	-0.103 (0.108)	-0.027 (0.108)
<i>Panel B: 1977 DOT Measures</i>		
Non-routine Cognitive Analytical	0.097 (0.114)	0.146 (0.114)
Non-routine Cognitive Interactive	-0.084 (0.103)	-0.011 (0.110)
Routine Cognitive	0.497*** (0.127)	0.440*** (0.126)
Routine Manual	0.684*** (0.166)	0.620*** (0.162)
Non-routine Manual	0.099 (0.116)	0.076 (0.109)
Included Cohorts	1945-1963	1940-1963
Gender, Race Controls	X	X
PUMA-Survey Year, Cohort FEs	X	X
<i>N</i>	4,865,362	5,057,130

Note: New Math exposure is measured as the population-weighted share of districts, within a county, teaching New Math across the grades a cohort attended, yielding a continuous variable from 0 to 12. 1998 O*NET and 1977 DOT task measures are each individuals' occupation-level, employment-weighted percentile rank in the 1980 Census, following Autor, Levy, and Murnane (2003) and Autor and Dorn (2013). *N* is the number of employed individuals for the included cohorts, who were born in Ohio, resided in a county with more than 100,000 residents at the time of survey, and only results on employment rate include unemployed individuals. The estimated coefficient is reported along with its standard error, clustered at the county level, (in parentheses). * significant at 10%, ** at 5%, *** at 1%.

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