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Convergence and Divergence: The Link between Spatial Labor Market Disparities and Educational Attainment

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ABSTRACT: The benefits and burdens of structural changes in U.S. economic activity have not been felt evenly across U.S. labor markets in the last four decades. Workers without college degrees have experienced the largest adverse effects in terms of declines in employment and wages. Declines in job opportunities associated with losses in manufacturing employment and the persistently high relative premium to college-level employment would be expected to increase incentives for educational attainment. But, the realization of educational gains assumes that neither credit constraints nor limits in the supply-side of schooling opportunities impede attainment. Because public schools at the K-12 level rely on both local property taxes and state revenues while colleges and universities receive substantial subsidies from state governments, a basic concern is that declines in regional economic prosperity may place downward pressure on educational resources at the same time that more and more students are seeking to change their prospects through increased educational attainment. Using data on responses in enrollment and degree attainment to local labor market shocks, this analysis shows that while secondary school persistence and college enrollment do rise with declines in local labor market opportunities, there is little evidence of a positive impact on college degree attainment. Concurrent declines in public resources supporting expenditures on schooling at the K-12 level and state appropriations to public colleges and universities provide evidence that the supply side of education markets does not fully accommodate increased student demand.

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Convergence and Divergence:

The Link between Spatial Labor Market Disparities and Educational Attainment

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Section 0. Introduction

Historically high labor market returns to college education combined with significant geographic stratification in economic outcomes are defining features of the U.S. labor market in the 21st century. Can investments in education serve as a lever to increase economic mobility and to narrow gaps in economic outcomes by geography and family circumstances? Alternatively, do place-based differences in labor market outcomes exacerbate differences in educational opportunities and attainment? The purpose of this paper is to explore how place-based disparities in labor market outcomes relate to the educational resources and educational attainment at the local level.

The benefits and burdens of structural changes in U.S. economic activity have not been felt evenly across U.S. labor markets in the last four decades. Those areas in which manufacturing and mining predominated forty years ago have faced the greatest job losses induced by trade and technological change (Autor, Dorn and Hanson, 2013; Austin, Glaeser, and Summers, 2019). Over the same interval, the coastal areas and other cities with concentrations of college-educated workers and industries in financial services and technology have experienced the greatest gains. And, when local labor markets have experienced large declines in economic activity in recent decades, it has been workers without college degrees who have seen the largest adverse effects in terms of declines in employment and wages (Autor, Dorn and Hanson, 2013).

Yet, in an integrated labor market with robust educational institutions, differences in local economic circumstances would be expected to dissipate over time as workers adjust by location choice and educational attainment. As an empirical matter, the channel of migration in which workers move from declining labor markets to those with growing opportunities has been much more modest in the most recent decade relative to the research evidence established decades ago. And, for workers without a college degree, recent evidence would suggest that the returns to mobility are potentially weaker in the 21st century (Autor, 2019).

From a theoretical perspective, declines in job opportunities associated with losses in manufacturing employment and the persistently high relative premium to college-level employment would be expected to put upward pressure on educational attainment, including college degree receipt. Such effects would be expected to be magnified when regional job loss is caused by structural shifts – the permanent loss of jobs -- rather than short-turn cyclical fluctuations. Such changes would be expected to impact the educational trajectories of children, beyond the more immediate choices made by young adults deciding whether to persist in (or return to) college based on immediate job opportunities.

But, the realization of educational gains assumes that neither credit constraints nor limits in the supply-side of schooling opportunities impede attainment. The vast majority of education in the U.S. is provided by public institutions funded by state and local governments. Nearly 90% of students at the K-12 level are enrolled in public schools while 74% of students at degree-granting colleges and universities are at public institutions (*Digest*, Table 105.30). Because public schools at the K-12 level rely on both local property taxes and state revenues while colleges and universities receive substantial subsidies from state governments, a basic concern is that declines in regional economic prosperity may place downward pressure on educational

resources at the same time that an increased share of young people are seeking to change their prospects through increased educational attainment.

Evidence presented in this paper indicates that educational convergence that could facilitate regional economic convergence does not extend to college degree attainment. While there is some evidence of increased persistence in high school and enrollment in college (particularly among women), there is little impact on college degree receipt among recent high school graduates who are at the beginning of labor force participation. The gap between geographic areas in collegiate attainment actually widens, reflecting both low attainment and potential out-migration among college degree recipients. Shrinking public support for education in the least prosperous areas likely contributes to an erosion of quality on the supply-side of the education market. The empirical objectives of this paper are twofold: 1) presenting the basic descriptive evidence of changes over time in high school and college enrollment and attainment by geography (commuting zone and state) and 2) estimating the causal effect of local economic shocks (trade exposure) on the educational attainment of youth at the local level.

The analysis that follows begins with (hopefully brief) "stage setting", outlining the basic overlap between educational institutions and labor markets describing the salient differences across geographies in educational attainment and finances with measures of the extent of convergence (and divergence) over time. The second section sets forth prior research evidence on changes in educational outcomes in response to labor market changes and introduces the estimation framework.[1] The third section presents estimates of adjustments in educational

[1] The innovation of this analysis is not as the first research effort presenting estimates of the effects of labor demand shocks on educational attainment or enrollment. A growing collection of research efforts have covered at least pieces of this territory (Feller and Senses, 2017; Tuhkuri, 2018; Bryan, 2019). Instead, the value added of this effort is in the integration and synthesis of different measures of education attainment outcomes and the explicit consideration of how schools and colleges may be impacted on the "supply side" by changes in local labor market conditions.

attainment and finances in response to local labor shocks generated by import penetration (following the basic strategy of Autor, Dorn and Hanson (2013)). The final section discusses the potential implications for place-based policies and future research.

Section 1. Local Labor Markets and Education Differentials

Defining the Context of Education and Labor Markets

Economics and policy discussions focused on the geography of economic inequality employ a range of spatial constructs ranging from broad regions, states, commuting zones, counties/cities and even units as small as neighborhoods or Census tracts. The analysis that follows presents measures at the level of local labor markets captured by the commuting zones as defined by Tolbert and Sizer (1996) and states.

In the context of education policy, states and school districts represent primary units of funding and institutional organization. Of the $706 billion spent on public elementary and secondary education in 2015-16, nearly $331 billion came from state sources and about $316 billion came from localities (*Digest*, Table 235.10) and, among public colleges and universities, $80 billion came from state sources.

The family unit necessarily generates a coupling – if not 1:1 mapping – between education markets and labor markets. Particularly for students in the pre-K, elementary and secondary years, the labor market of parental employment largely defines schooling options, with degree of district choice within labor markets varying by geography. While higher education has some (though limited) dimensions of a national market in supply, the presence of relatively lower tuition levels for students in their state of residence generates an attachment to

parental state of residence at the post-secondary level. Overall, among recent high school graduates who enroll in college, 80% attend and institution in their home state (*Digest*, 309.20).

Potential Convergence: Labor Market Outcomes

A dominant theme over the long horizon of nearly a century has been one of convergence in earnings and education across states, even as there are evident differences in in industrial structure and the stock of human capital. Until the 1980s, the decennial change in wages and income was decreasing in baseline income (convergence) before increasing in later decades (Berry and Glaeser, 2005).[2] Slowing (or reversing) income convergence in the last two decades relative to the mid-20th century across spatial units is evident at both the state level and at the level of local labor markets (Austin, Glaeser and Summers, 2019).

But, since the 1980s, local labor demand shocks due to de-industrialization and the decline of manufacturing appear to have produced widening not narrowing in employment and labor market outcomes (Bartik, 1991; Bound and Holzer (2000)).[3] Focusing on the impacts of plausibly unanticipated changes in the pattern of trade, Autor, Dorn and Hanson (2013) find substantial reductions in manufacturing employment in areas particularly affected by these trade shocks, with the impacts acute among those with a high school degree or less education. And, in many cases, there is evidence that these shocks have had permanent (or extended) impacts on local labor markets rather than dissipating within a few years (Autor, Dorn, and Hanson, 2019).

[2] When changes in the stock of college-educated workers are taken into consideration in the later decade, evidence of convergence -- low income areas catching up to the more affluent – persists albeit at a lower rate than in the decades before 1980 (Berry and Glaeser, 2015).

[3] Measured at both the state and labor market levels Austin, Glaeser and Summers (2019) show that positive labor demand shocks reduce non-employment with the magnitude magnified by prior period non-employment rates

Migration of labor is the primary mechanisms through which changes in labor demand (or supply) are absorbed in the short run, while adjustments in education – changing the stock of human capital – is a longer run dimension of adjustment. Moreover, migration and education appear to be closely coupled to the extent that higher levels of education may be accompanied by skills that facilitate adaptation to new communities or greater job opportunities. From the early 1990s, the much-cited analysis by Blanchard and Katz (1991) provided empirical evidence to support the economic argument that labor demand shocks are dissipated by regional migration, albeit over a horizon of nearly a decade. Within a decade, cyclical unemployment shocks are absorbed with employment rates returning to pre-shock rates, albeit at changed levels of employment. Related work, including Bound and Holzer (1991), found that that college graduates adjust more rapidly than those with less education to local labor market demand shocks, while low-education workers were more likely to exit the labor force.

The remainder of this section presents a broad overview of, first, elementary and secondary education, and second, colleges and universities in terms of geographic markets and the degree of inequality across spatial areas. Measurement of educational attainment follows from micro-data surveys like the ACS/Census and administrative reporting from school districts and colleges and universities. Following other analyses, we focus on decennial years with the aim of measuring relatively low-frequency changes in enrollment and attainment.

Several data limitations produce challenges in measurement. The ideal data would allow researchers to follow individuals longitudinally, measuring attainment at different ages for multiple birth cohorts along with place of residence. What is observed at each geographic area is repeated cross-sectional measures of enrollment, along with educational attainment of the adult population.

Convergence and Divergence in Enrollment

A striking convergence across geographies in high school attainment over the last two decades contrasts to the persistence of geographic differences in college attainment. These patterns are evident at both the local labor market and state levels, with convergence in high school graduation most apparent in the last decade (see also, Nunn, Parsons and Shambaugh, 2018). At the secondary level, Figures 1, 2 and 3 measure enrollment of youth aged 16-19, dropout rates of those ages 16-19 and high school completion of those ages 19-21. These presentations illustrate convergence at the local and state levels. In each figure, the top panel plots outcomes for commuting zones and the bottom panel plots outcomes at the state level, with the horizontal axis showing the outcome measure in the base period of 1990 and the vertical axis showing the change in the outcome from 1990 to 2014. Rates of convergence across commuting zones and states are broadly congruent in each of these presentations. For example, at both the state and CZ levels, convergence is marked, with a 10 percentage baseline gap in high school graduation narrowing by about 6.8 percentage points over the interval.[4] A point to emphasize is that "convergence" has not occurred at a constant rate, but rather accelerated markedly after 2000.

The transition from high school to college enrollment marks somewhat less absolute convergence over time as shown in Figure 4. Measured as the college enrollment rate for those ages 19-21, Figure 4A shows the period from 1990-2014 and Figure 4B shows the shorter period from 1990-2007. For 1990-2007, there is modest convergence at the CZ level with a 10

[4] There has been robust discussion in the economics research literature on the measurement of high school graduation rates and trends (Heckman and LaFontaine, 2010; Murnane, 2013). A recent analysis by Murnane (2013) summarizes the determinants of the stagnant levels of graduation rates in the 1970-2000 period while also identifying the substantial increase in high school graduation rates in the first decade of the 21st century.

percentage point gap narrowing by about 1.5 percentage points, state-level convergence is essentially zero which suggests modest within state equalization in outcomes. For the long period from 1990-2014, the convergence measure rises markedly as the larger gains in college enrollment were concentrated where there were low levels of initial college participation.

When we move from college enrollment to four-year college degree attainment, we see that statewide differences widen, while there is virtually no convergence at the local labor market level as the convergence estimate is indistinguishable from 0 (Figure 5). The correspondence between enrollment and degree completion in these data is linked by two distinct factors which may vary with geography: first, college completion rates vary with individual characteristics and the colleges attended by students and, secondly, the measure of young adults with a college degree may reflect post-collegiate migration decisions. Our measures are necessarily somewhat imperfect because we do not measure place of high school graduation, place of college enrollment and place of early career residence in a single resource. Using data from the IPEDS survey, we measure BA degrees at the state and CZ levels, relative to the population age 22. These data measure a distinct object as not all students who receive BAs do so in their "home" locality, while not all BA recipients choose to work in either their initial home location.

The unambiguous takeaway from the comparison of educational convergence at different levels is that place-based differences are magnified as one moves from high school to college graduation. At question is whether the persistent gaps at the post-secondary level can be traced to differences across geographies in student achievement and educational institutions or whether they represent responses to differences in local labor market opportunities. A starting point to address this comparison is the direct consideration of differences in resources over time at the K-12 level and among public colleges and universities.

Place-Based Differences in Education Institutions

Elementary and Secondary Schools

Decentralization of elementary and secondary education to the local level has been heralded as a "virtue" of the U.S. economy, at least in the first two-thirds of the 20th century (Goldin and Katz, 2007). While competition among districts produced broad high school access well in advance of European nations, the decentralized nature of school finance produced substantial inequality in spending among districts.

This inequality in school spending (as well as outcomes) is evident between states, as well as within states. Sources of persistent differences in funding for schools are multicausal and include not only differences in demand for education related to both wealth and tastes along with variation in costs of living. Across states, per student inequality in school funding differs by more than a factor of two between the highest and lowest spending and, over the interval from 1970 to 2016, the nationwide average school spending has risen from about $5000 per student to more than $12,000 while between state inequality has also increased.[5]

Over the course of the last 50 years, the balance in sources of educational funding has shifted markedly from majority local revenues to a greater share of resources from state sources. In 1970, 52% of funding for elementary and secondary schools came from local sources (primarily property tax) and 40% can from states; by 2015, the balance had shifted with 47% of funding from states and 45% from local sources. The share of resources from the federal government has not changed markedly even as federal regulation has increased markedly.

[5] In academic year 1969-1970, the lowest spending state was Mississippi ($3000 per student) and the highest spending state New York ($7845); by 2015-16, New York remained the highest spending state ($23,150 per student) while Utah claimed the position of the lowest spending ($7,296). Source: *Digest of Education Statistics*, Table 236.65.

School finance litigation and aggressive state reforms in recent decades have done much to narrow gaps in funding across districts tied to variation in local income and wealth. LaFortune, Rothstein and Schanzenbach (2018) show that between 1990 and 2012, real per pupil revenues rose by roughly 30 percent in the highest income districts, and by over 50 percent in the lowest income districts, producing near parity in average spending between the top and bottom quintiles in terms of district-level income.

Changes in place-based educational resources are naturally tied to both state and local economic conditions, as both states and localities face balanced budget requirements. To the extent that local labor market shocks are weakly correlated with the overall level of state prosperity, state finance may serve as a compensatory role – essentially "filling in" for lost local tax revenues. However, when state and local economic circumstances are highly correlated, district resources can be expected to decline. What we present in Figure 6, paralleling the figures on educational attainment, are measures of resources per student and their changes over time (measured in log differences) in expenditures per student for local labor markets and states.

Higher education

The higher education market is distinguished from elementary and secondary education in the *potential* decoupling of the parental labor market and the college market chosen by students. Moreover, colleges and universities are differentiated in mission and resources to a greater degree than elementary and secondary schools. Two dimensions of the higher education market distinguish "access" to post-secondary education by local labor markets. First, for broadly historical reasons, localities differ in the number and composition of colleges and universities. Secondly, there are broad – and widening – differences among states in the level and distribution of public support for higher education.

Since the middle of the 20th century public colleges universities have been a dominant supplier of higher education.[6] The role of public universities expanded markedly with the advent of "mass" higher education, commencing in the immediate post-war era. During the quarter century after World War II, state support for higher education increased: public universities expanded and new public colleges and universities were opened, with the rising demand for postsecondary schooling lead to the establishment of community college systems. By the 1960s, state systems of higher education had evolved to reflect distinctive hierarchies, with one selective and high-resource school at the top followed by a large set of less- or non-selective colleges with open-access missions and fewer resources (Goldin and Katz, 2008).[7]

There is some historical accident in where colleges and universities are located within states and the number of "local" institutions available to a student will vary markedly with place of residence.[8] In turn, college proximity has a strong connection to where students apply to and choose to attend college. Card (1995) shows that even after conditioning on a full battery of covariates including test scores, college proximity has a strong effect on collegiate attainment.

[6] The predominance of public universities varies markedly by state and is tied – at least in part – to the structure of economic activity nearly a century ago. States with the strongest public university sectors were those with a broad potential middle class and industries dependent on agriculture and mining likely to benefit from scientific innovation, such as states in the Midwest and Western U.S. (Goldin and Katz, 1999). While college enrollment had started its upward trajectory in the pre-World War II years, the subsequent expansion was extraordinary: rising to 2,44,900 students in 1949-1950 to 8,004,660 by 1969-1970 (Digest, Table 301.20). Veterans returning from World War II (and later Korean War) were given tuition and college enrollment subsidies through the GI Bills, dramatically increasing both enrollment and college degree attainment. Federal policy at mid-century also promoted the expansion of post-secondary education and Truman's Commission on Higher Education (1946) underscored the importance of opportunities in higher education for low- and moderate-income youth.

[7] Stratification in higher education expanded at the national level too, as the geographic integration of the market for students, faculty and research increased. Prior to World War II, the system of higher education was highly localized, described as a "collection of local autarkies" (Hoxby 2009). The increased stratification and geographic integration among the elite colleges and universities should not obscure the fact that most college participation is local. To wit, 74% of first time freshmen in 2016 enrolled in a college or university in-state while 65% of first-time students and 78% of all undergraduate students enrolled at a public college or university.

[8] The founding of colleges and universities over a century ago might be thought of as plausibly exogenous to contemporary conditions; for example, Moretti (2004) makes the case that the federal nature of the 19th century Morrill Acts established land grant public universities that are effectively random and uncorrelated with the nature of local labor markets or the natural resources that could impact economic prosperity.

What is more Card (1995) finds that proximity matters more for low-income students and the children of parents without a college degree – those who are likely to be potentially on the margin of continuing their education.[9] Examining the variation in the supply of colleges and universities by commuting zone, Hillman (2016) identifies "education deserts" where college opportunities – particularly at the four-year level – are constrained by socio-economic status.

Beyond geographic proximity, another source of variation in the supply of public universities is generated by variation in state support for higher education. Over the last three decades, there has been a substantial decline in appropriations per student from about $12,000 per FTE in the mid-1980s to less than $7,000 per FTE in the most recent year (Bound, Braga, Khanna, Turner, 2019). The decline in constant dollar state appropriations led to a marked increase in the share of public universities' total educational revenues covered by net tuition revenue, a share that rose from 29.2% in 2001 to 47.8% in 2012.

Not only have some states spent more per student than others at the collegiate level, but there have been marked differences in the degree to which public universities have experienced declining state appropriations. Figure 7 shows the divergence in stratification in state spending on a per capita basis – there is considerable variation in the magnitude of erosion of higher education spending, while appropriations per student have actually increased in some states. Put indelicately, there is no single variable that is the "smoking gun" to explain changing appropriations over time. One common explanation identifies higher education as one of the few

[9] Hoxby and Avery (2013) show that the presence of a college within 10 miles of a student's residence has a very strong impact on college application decisions for low-income students (but little impact on high income students). Thus, one might hypothesize that the presence of local colleges (and their quality) may impact the extent to which young people engage with college opportunities when local labor market conditions change. While absent from the current draft, this discussion ties to expected future analysis examining how enrollment changes differ with the density of colleges in a local market.

"discretionary" items in state budgets and the latitude of states to broadly absorb fiscal shocks has contracted as entitlements like Medicaid have increased as a share of state budgets (Kane, Orszag, and Apostolov, 2005). However, using data from 1980 to 2014, Bound, Braga, Khanna and Turner (2019) find that changes in expenditures on Medicaid can account for only a modest fraction of the total decline in state appropriations, suggesting there must be other important forces at work. One hypothesis is that states that "exported" college graduates in the 1970s, 1980s and 1990s such as Michigan, Wisconsin, Indiana, Minnesota, and Iowa are among the historically high spending states experiencing funding declines and these localities find it increasingly difficult to find the political will to support higher education (Bound, Braga, Khanna and Turner, 2019).

Section 2. Research Context: Linking Placed Based Labor Market Shocks and Education

Local Labor Market Shocks and Educational Investments

Basic economic theory suggests that local labor market conditions impact investments in education and skills through both the opportunity cost of schooling and the prospective returns to investments in different types of skills. Most obviously when local labor market conditions are weak, foregone earnings are relatively modest and enrollment rates are expected to rise as young people have greater incentives to persist in schooling or to return to school. The magnitude of the response in educational attainment depends on individual characteristics such baseline skills and age, as older workers will have fewer years over which to accrue the returns to any investment. The nature of shock also affects the response: relatively high-frequency cyclical labor demand shocks yield different predicted impacts than structural changes in local labor markets which represent permanent industrial dislocation. When local labor markets experience structural changes in job opportunities, those who have been displaced may face the tradeoff

among investing in new skills, moving to a different labor market or accepting reduced economic prospects in the existing labor market. While those who have lost jobs are most visibly affected by structural change in local labor markets, young people who are still in enrolled at the elementary and secondary levels may also adjust their educational trajectories to the extent that the local jobs anticipated disappear.

Educational adjustments of current labor force participants are distinguished from those of youth in a number of salient dimensions, theoretically and empirically. With a shorter number of years over which to realize returns to new investments and a greater degree or irreversible investments (eg, effort exerted in high school or initial college choice cannot be undone), the education response of labor force participants to demand shocks is likely to involve relatively short-term post-secondary investments. For school age youth, there is more latitude to shift the duration, intensity and focus of K-12 and post-secondary investments in response to permanent shocks in labor demand, while transitory shocks are unlikely to impact long-term investments.

While the primary focus of this analysis is on youth educational attainment and the adjustment to sustained changes in local labor market conditions, a very brief discussion of the research evidence on the educational response of labor force participants provides useful context. Focusing on dislocated workers receiving UI, Jacobson, LaLonde, and Sullivan (2005a) find 23.5% of women under 35 and 16.8% of men in this age range completed as least one community college course. More broadly, changes in post-secondary participation following larges increases in unemployment have been unambiguously substantial in recent decades and. much of the increase in post-secondary enrollment in the wake increases in unemployment comes from workers outside the pool of recent high school graduates (Barr and Turner, 2013;

Betts and McFarland, 1995).[10] These workers are making relatively short-term investments in schooling and they tend to be focused in programs that have an explicitly vocational component.

The evidence on the return to post-secondary education for displaced workers is limited, but suggests that the gains may be some gains. Jacobson, LaLonde, and Sullivan (2005a, 2005b) present two of the only studies on the return to post-secondary enrollment among displaced workers. They find that an additional year of community college education generates increases in long-term earnings of 7 to 10 percent among displaced workers, which result from both higher wages and additional hours worked.[11] And, policy programs targeting displaced workers such as Trade Adjustment Assistance (TAA) not only provide extended UI benefits but also supplemental access to financial aid. A notable observation is that TAA provides educational benefits only to worker who can certify that job losses were caused by foreign competition, but it does not provide compensatory educational resources in the communities in which job loss occurs.

Prior Research: Local Demand Shocks and Youth Educational Investments

How mass layoffs, trade shocks and the more general place-based decline in employment opportunities impact youth educational investments has received some attention in the education and public finance literature, with a more sustained focus on elementary and secondary education than the transition to college or collegiate attainment. The questions present some challenges for

[10] Writing nearly 25 years ago, Betts and McFarland (1995) find large cyclical responses in public community college enrollments to changes in local unemployment rates. More recently, Barr and Turner (2013) measure the type of institutions impacted by cyclical enrollment and find that there is substantial variation across institutional types in responses to cyclical employment changes. Research universities and liberal arts colleges are most likely to be supply-inelastic – responding only modestly to changes in enrollment demand. At the other end of the spectrum, community colleges and open access four-year institutions may be particularly well-positioned to adjust enrollment to the extent that they offer vocational and technical courses.

[11] However, the returns to training were not homogeneous; the effects for technical coursework were generally greater than 10 percent whereas non-technical credit receipt resulted in a small or null increase in earnings.

empirical research because it is quite likely that the largest impacts are from the relatively low-frequency sustained labor market changes rather than relatively transitory job loss.

The focus of this analysis is not on the direct effect of parental job loss, but rather the more broadly defined place-based impact of changes in local economic opportunities on educational outcomes.[12] Others have examined this question from various angles (see Appendix Table 1 for a summary), looking at particular educational outcomes in relation to local economic shocks. Perhaps the earliest paper to explicitly examine the link between local labor market conditions and youth enrollment is the work of Black, McKinnish and Sanders (2005) who examine how the rise and fall of coal prices in communities in which coal mining is the primary industry affect the high school persistence of youth; more recently, Cascio and Narayan (2015) examine the impact of fracking on youth enrollment and find a somewhat smaller negative effect of the fracking boom on youth dropout rates.

More recently, authors have built on the variation in studies examining the wage and employment impacts of trade shocks (Autor, Dorn and Hanson, 2013) and mass layoffs (Foote, Grosz and Stevens, 2017) to examine educational outcomes like high school attainment, college enrollment and college degree attainment. Two studies examine variation in high school attainment in response to the effect of import penetration on manufacturing; Greenland and Lopresti (2016) find quite large (approximately 4 percentage points per $1000 increase in import penetration in local markets) effects on high school diploma receipt while Tuhkuri finds somewhat smaller effects on dropout rates among those ages 16-19. Feler and Senses (2017)

[12] Parental job loss has been shown to have unambiguously negative effects on children's education attainment in a number of dimensions including grade repetition (Kalil and DeLeire, 2002), lower GPA (Rege, Telle et al 2011), and lower collegiate attainment (Oreopolous Page and Stevens, 2008). In addition, adverse effects on affective dimensions of skill development and psychological health (McKee Ryan, Song et al 2005).

examine K-12 school finance changes in the broader public finance context of changes in tax revenue. Overall, there is a growing body of research that identifies lasting educational impacts of local labor market reductions. The evident "positive" effects of greater persistence in high school would seem to lack carryover to increased college completion, while there is evidence of erosion of resources for educational institutions in the most affected areas.

Estimation Framework: Repurposing the Autor-Dorn-Hanson Framework

Evidence of the persistence of local labor market impacts of trade shocks, mass layoffs and more broadly defined labor demand shifts is among the most persuasive motivations for research focused on place-based differences in outcomes (Autor, Dorn and Hansen, 2013; Foote, Grosz, and Stevens, 2018; Bound and Holzer, 2000). This analysis is not the first to consider the education market impacts of these changes as others (notably, Feler and Senses 2017; Greenland and Lopresti 2016; Stuart, 2019 and Foote and Grosz, 2019) have examined specific educational outcomes with similar identification strategies. The innovation of this presentation is to present a synthesis and to integrate the impact of these labor market shocks on high school and college attainment in the context of the associated public funding of educational institutions.

The basic identification follows closely from Autor, Dorn and Hanson (2013, 2019), with these papers presenting a thoughtful motivation of the econometric setup; thus, only a summary follows below. The aim is to use plausibly exogenous changes that impact local labor markets to measure the response in education attainment. And, as such, the primary outcomes of interest are approximately decennial changes in educational outcomes (ΔE_{it}) as a function of the expected change in employment induced by unanticipated increased imports from China (ΔIPW_{uit}). The Chinese import penetration measure is constructed to reflect the change in U.S.

imports of Chinese goods per worker in a local area, using the commuting zone share in national industry employment as weights:

$$\Delta IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}}$$

where *L* represents start of period employment and *ΔM* is the overall change in the value of U.S. imports from China, with *i* indicating commuting zone, *j* indicating industry, and *t* indicating time period. The primary specification form is as follows:

$$\Delta E_{it}^{m} = \gamma_t + \beta_1 \Delta IPW_{uit} + X'_{it}\beta_2 + e_{it}$$

Following Autor, Dorn and Hanson (2013), we instrument the imports measure with a measure based on lagged employment shares to mitigate the possibility of contemporaneous adjustment and the change in the value of imports to other high-income countries. Following these specifications, changes are measured over the stacked intervals 2007-2000 and 2000-1990 at the level of the commuting zone. [Note that an update using 2014 data is "coming soon."]

The challenge of estimating the impact of sustained market demand shocks on educational attainment is ultimately somewhat more complicated than the case for labor market outcomes such as wages or employment because "education markets" are not coincident with labor markets and likely vary in geography with level of education. At the elementary and secondary level, there are often many school districts within commuting zones though generally school districts aggregate to commuting zones. More problematic is the post-secondary level where students may leave their parents homes to attend college (thought the majority do stay within state) and, for public institutions, it is state not local governments that provide public support of higher education. A further – and related – measurement complication that is evident

with the ACS/Census is that after terminating secondary schooling individual mobility increases making it more difficult to align attainment and place of parental residence.

One approach to addressing these challenges is to consider alternative geographical approaches to estimation. The first approach is to change the level of analysis from the commuting zone to the state level, effectively "aggregating up" the import exposure to the state level. Following Feler and Senses (2017), we also consider a configuration where the import penetration measure is computed at the state level and the combination that captures the commuting zone and the state measure minus the local effect in order to capture the effects of intergovernmental transfers.

Section 3. Persistent Labor Market Shocks and Education Outcomes

The question(s) of this paper are ultimately empirical. On the one hand, adverse shocks – particularly those that disproportionately affect manufacturing employment and the non-collegiate workforce – would be expected to exert a positive impact on educational attainment for those still of school age, while also generating incentives for return schooling among current labor force participants. The countervailing force is that the same economic forces that increase the demand for education may also lead to contractions in the "supply side" of educational markets, while also adding to constraints and pressures at the family level that adversely impact attainment. Adverse local labor market shocks are often accompanied by fiscal contractions which likely erode the capacity of state and local governments to pay for existing educational services, much less expanding services to accommodate additional demand at the K-12 and collegiate levels.

Secondary Enrollment and Attainment

One metric of educational attainment is secondary school enrollment: Are those ages 16-19 enrolled in school if they have not completed high school? And, does this share increase in the wake of a plausible adverse labor demand shock? As seen in Table 1, the answer is unambiguously yes. With measures of enrollment shares from the Census/ACS as outcomes, we see that increasing import exposure by $1000 leads to an increase of about 0.78 of a percentage point increase in enrollment, when we control for a full set of covariates like region and start of period manufacturing share (Col. 5). The last two columns of the table (6 and 7) build on the specification suggested in Feler and Senses (2016) which considers the overall state import shock (col. 6) and the combination of the state and local shocks (col. 7). These latter measures indicate that school persistence is magnified by trade shocks in the surrounding parts of the state.

In turn, measures of dropping out of high school yield consistent results – naturally of opposite sign. An increase of import exposure by $1000 leads to a decrease in dropout of about 0.31 percentage points. Notably, these estimate are broadly consistent with those presented by Tuhkuri (2018) who predates this presentation with a similar analysis. These results are smaller than those presented by Black, McKinnish and Sanders (2005) in the study of adjustments to changes in opportunities in coal mining and larger than those presented by Cascio and Narayan (2015) in the context of adjustments to the fracking boom.

While there are unambiguous increases in high school persistence, the impacts on high school completion are less clear cut (Table 3). Using the ACS, this analysis finds that import shocks have a modest negative impact on the share of the young adults (ages 19-21) receiving high school degrees and remaining in the community, with a weakly significant impact of 0.3 percentage points per $1000 increase in imports though zero is in the confidence interval in

many of the specifications.[13] Null (or negative) effects may flow from at least two channels: first, the "hurdle" of carrying forward enrollment status is likely much less than the requirements of degree completion and, secondly, if students induced to receive degrees are also more geographically mobile immediately after graduation than in the control case, the measured graduation effect would likely be attenuated. When we use measures of diploma receipt relative to population (a strategy that parallels Greenland and Lopresti (2016)), results are generally positive in sign but indistinguishable from zero (Table 4).[14]

That "leaving home" may be particularly common after high school in response to weak labor markets is supported by evidence from both the Census/ACS samples and the Census Bureau's Population Estimates Program.[15] Estimates show a fairly modest – yet significant – outmigration effect for those of immediate high school graduation age. Examining the difference in the log change in relative size of 19-20 cohort relative to 16-17 cohort, we find that a $1000 increase in import exposure reduces this difference by about -0.0143 (see Table 5). What these young people do – and where they go – is of some importance for understanding the dynamics of educational attainment and labor market outcomes. One hypothesis is that high school graduates from markets where manufacturing and blue collar jobs have disappeared may be more likely to join the military. A preliminary test of this hypothesis is afforded by data from Armed forces

[13] Similar results follow with high school completion measured at different ages levels (18, 19, 19-21, etc). Note that 18 is the modal age of high school degree receipt, though over 30% of degree recipients complete at age 19.
[14] These estimates are not aligned with Greenland and Lopresti (2016) who use similar data but differ in specification by including commuting zone level fixed effects. Greenland and Lopresti (2016) produce estimates which imply that a $1000 increase in import exposure would lead to a 3.7 percentage point increase in the graduation rate, which is an order of magnitude larger than what we estimate for either persistence or dropout behavior. It would seem that the inclusion of locality fixed effects dramatically reduces the identifying covariance between the instrument and the endogenous variable while also exacerbating finite sample bias, along with the basic problems of a weaker instrument.
[15] Census/ACS data presents challenges for the study of migration because, first, the 1990 and 2000 enumerations examine five-year immigration and the later ACS looks at one-year migration and, secondly, it is not possible to examine both the origin and destination of migrants by CZ.

enlistments for the relatively recent period of 2006 to 2019 in relation to local area mass layoffs, following the strategy of Foote, Grosz and Stevens (2019). In preliminary work, Murphy and Turner (in progress) show that when mass layoffs relative to workforce rise by 1 percentage point, enlistments rise by more than 2.8% (see Appendix Table 2).

Post-Secondary Educational Outcomes

Whether collegiate attainment serves as an effective lever to moderate the effects of local job loss depends on the potential gains to students at the margin of enrollment or persistence, the capacity to pay for college (the absence of binding credit constraints) and the supply of collegiate opportunities. To begin, we measure college enrollment by age at the level of the commuting zone using the ACS in response to import shocks.[16] The commuting zone is an appropriate measure to the extent that students attend college close to home or they report enrollment in relation to parental residence. Indeed, among college students enrolled in public institutions the average distance between home and school is 52 miles while the median is 11 miles (Hillman, 2016).[17] We also report post-secondary measures at the state level to account for the broader state-based geographical markets at the post-secondary level.

There is unambiguous evidence that enrollment rates of young adults who are likely to be recent high school graduates increase in response to local import exposure. While the overall

[16] Measures of college enrollment or attainment in relation to "home" geographies require assumptions about the process of enumeration: essentially, are students "counted" with their parents' place of residence? While there are some cases of ambiguity, the enumeration process identifies residence as the place where individuals live or stay most of the time ("usual address") or stay at the residence more time than any other place (Cohn, 2010). The interpretation is that college students should be counted at their college address, either on campus or off campus, or at their parents' home only if they live there most of the year. If college students attend college close to home and within the same commuting zone (as many – but not all do) or live at home while attending college, there is no measurement problem. Moreover, while levels of college enrollment by home CZ are undercounted (overcounted) if students migrate out of (into) a zone for college attendance, the dependent variables used in this analysis are measures of decennial change which means bias in coefficient estimates are generated if the rate of out (in) zone attendance is differentially impacted by the trade shock.

[17] Students who attend private institutions tend to be wealthier and, in turn, more geographically mobile.

level of college enrollment for ages 19-21 was about constant between 1990 and 2000 at about 43%, it rose markedly by 2007 to about 53%. Relative to these national baselines, the overall enrollment response to a $1000 increase in import exposure is about 0.55 percentage points for those ages 19-21 and about 0.9 percentage points for those ages 22-23 (see Tables 6).[18] Of note, these effects differ markedly by gender with the near entirety of the effect seen for women and essentially no effect for men as shown in Table 7.

When we examine BA attainment at different age levels of observation we find no discernable impact of import exposure on BA degree college completion in the ACS data (Table 8). [In other results, there are no impacts for attainment of the AA degree either.] In the main, effects measured in columns (1)-(5) are weakly positive for ages 23-24 and weakly negative for the older group of ages 25-26, but zero is in the confidence in all cases. Columns (7) and (8) use respectively the alternative of the state-level measure of the import exposure and the division between the commuting zone and state measure (less own CZ). These effects distinguish the extent to which local shocks are compounded by state effects. Here we see consistently negative effects of import exposure at the state level on BA degree attainment, though these effects are only significant for the broader age 25-29 age group (shown in the Appendix Table 3).[19]

The nature of the ACS data construction does leave open the question of whether the null effects represent non-completion of degrees among students who were induced to attend college in zone or whether what we capture is differential outmigration to the extent that the number of

[18] One critique of these results, which will be addressed with additional tabulations in a future version, is that "selection" into the 19-21 and 21-23 population groups has changed with outmigration of those likely to be "high school, no college" in response to market shocks. Not only are the population shocks "too small" to full compensate but there is also evidence of corresponding increases in enrollment observed in institutional data from IPEDS.
[19] The larger negative effects for older age groups likely reflect both somewhat greater "outmigration" of degree recipients in treated districts along with the potential for age-specific effects as cohorts impacted at older ages may have somewhat different educational responses than those impacted at younger ages.

BA degrees awarded increases in trade impacted areas only to be rapidly dissipated with outmigration. The commuting zone may be "confining" in that students at the margin for degree completion will attend institutions like state flagships which may require a move out of a local CZ, even as the student is still likely to remain in-state. To address this concern, state-aggregate estimates are presented in Table 9. These results indicate broadly null (and negative in sign) effects on BA attainment using measures from both the Census/ACS and institutional degree counts from IPEDS. The overall absence of positive degree effects is broadly consistent with other research efforts. Foote and Grosz (2019) do not find effects on degrees when examining educational responses to mass layoffs. Also, in a research effort which employs access to the confidential linked Census files, Stuart (2019) uses childhood variation in the local severity of the 1980-82 recession and shows that relative areas experiences relatively severe loss of per capita earnings also experienced declines in adult college degree attainment.

Several empirical findings and unanswered questions emerge from the analysis of enrollment and educational attainment:

- *Secondary school participation increases in trade-impacted areas, young people stay in school longer and effectively "drop out" at older ages;*
- *Changes in high school degree receipt are far less definitive, with likely small effects accompanied by evidence of out-migration among high school graduates (including military enlistment);*
- *College enrollment shows increases in trade-impacted areas, with these effects largest for women;*
- *College degree attainment (either at the BA or AA levels) does not show discernable gains in trade-impacted areas at either state or local levels.*

The absence of large gains in college degree completion, which is where labor market rewards are likely to be concentrated, leads to the consideration of the mechanisms on the supply-side of education markets that contribute to what might be described as anemic educational adjustment.

Schools and Colleges: Financing Supply-Side Adjustments

The capacity of educational institutions to serve as economic stabilizers depends on resources and, because these institutions are supported by state and local funds, there is ample concern that school resources contract as demand increases. Feler and Senses (2017) present a comprehensive analysis of how trade shocks impact local public finance including spending on education, as well as other public services afforded with local tax revenue. They find substantial negative effects on tax revenues per capita, with spending on local services (including education) declining as demands increase. In turn, not only do public revenue flows from state and federal sources provide incomplete insurance against loss of local revenues, but these effects are compounded when there are substantial trade shocks impacting other parts of a state. The analysis that follows replicates the basic work of Feler and Senses (2017) and extends their approach to the higher education sector.

There are three key findings from Feler and Senses (2017) which they derive using data from the Census Bureau's historical data on State and Local Government Finances; below we produce parallel results on expenditures per student using data from school district sources. First, Feler and Senses (2017) find that local expenditure on education declined by nearly 1 percent for every $1,000 increase in Chinese imports. Secondly, these financial impacts have clear educational resource implications as increased trade exposure also increases student-teacher ratios. Moreover, when both the commuting zone and the remaining areas of a state experience

negative economic shocks, the decline in educational expenditures and resources is magnified. Following the same estimation framework using resources per student (as distinct from resources per capita), estimates in Table 10 show that an increase in trade exposure of $1000 decreased constant dollar expenditures per student by about $300 per student. These effects are magnified by measures at the state level (effects of about $630 in association with a statewide increase in trade exposure of $1000). An open question that we are unable to address empirically is whether declines in school resources adversely impact student learning and academic achievement as measured by changes in test scores. It is plausible that these resource effects contribute to the attenuation of the high school degree effects relative to the secondary enrollment variables.

Turning to the post-secondary domain, Table 11 shows increased trade exposure places downward pressure on appropriations and upward pressure on tuition levels at public four-year universities when institutional indicators are aggregated to the commuting zone level. Because state – more than local – boundaries define higher education markets, the bottom panel of Table 9 shows state level regressions of appropriations measure on the trade exposure measure. Overall, a $1000 increase in statewide trade exposure produces a decline of 15% in total state appropriations and a decline of about 13% in appropriations per FTE. Measured at the state level, the adverse effects of area level shocks are more robust and of increased magnitude.

The broad takeaway from the examination of changes in public support for K-12 and higher education is that changes in funding from states have not been compensatory for local demand shocks but likely magnify the challenge of supporting educational investments in response to adverse shocks.

Section 4. Education Institutions and the Constraints on Adjustment

Educational attainment – both the completion of high school and college – is often advertised as a lever of economic mobility and an avenue allowing those in places most impacted by economic shocks to find new job opportunities. However, the effectiveness of this tool is blunted when the same forces that create local job loss also reduce or constrain educational resources. While there have been gains in secondary school persistence in response to adverse changes in local labor markets, gains in college degree receipt are not detectable, resulting in widening of place-based differences in the college degree receipt and the concentration of college-educated workers.

It has widely recognized that the substantial aggregate net gains from trade liberalizations produce benefits and costs that are not equally distributed across localities. To date, policies in the education sphere that aim to address the adverse consequences of trade shocks have focused quite narrowly on those who can demonstrate job loss as a direct result of policy induced changes in the patterns of trade and more generally on those who qualify for federal education assistance. Left unaddressed are the place-based deficits in school funding and appropriations for colleges and universities that follow from declining state and local tax revenues.

While funding for educational institutions is a necessary condition to provide pathways to high return secondary and post-secondary credentials, it is likely insufficient to address long-standing structural challenges which limit the success of students from families and communities for which college completion is not the norm. It is well-established that students from non-urban areas where manufacturing and agriculture have been historically dominant industries are less likely to enroll in four-year colleges and – when they do – are disproportionately likely to enroll in colleges with low resources or weak outcomes.

The precise mechanism(s) impacting the nexus between student outcomes and public funding changes merit further research inquiry. Specifically, it would be ideal to pursue additional metrics which allow for the measurement of student achievement (test scores), beyond the relatively broad indicators of grade progression. In addition, it is quite plausible that impacts are felt differentially among sectors of higher education, with community colleges, broad-access public institutions and flagship universities responding on different margins. Finally, an important avenue for future work is to consider impacts of changes on different demographic groups. Preliminary indicators point to very different transitions from high school to college for men and women, which may be mediated by other outcomes including military enlistment (Murphy and Turner, in progress). Measuring the extent to which young people from low-income families and racial minorities experience particularly adverse educational impacts of local labor demand is a significant question which speaks to broader connection between place-based outcomes and inequality in America.

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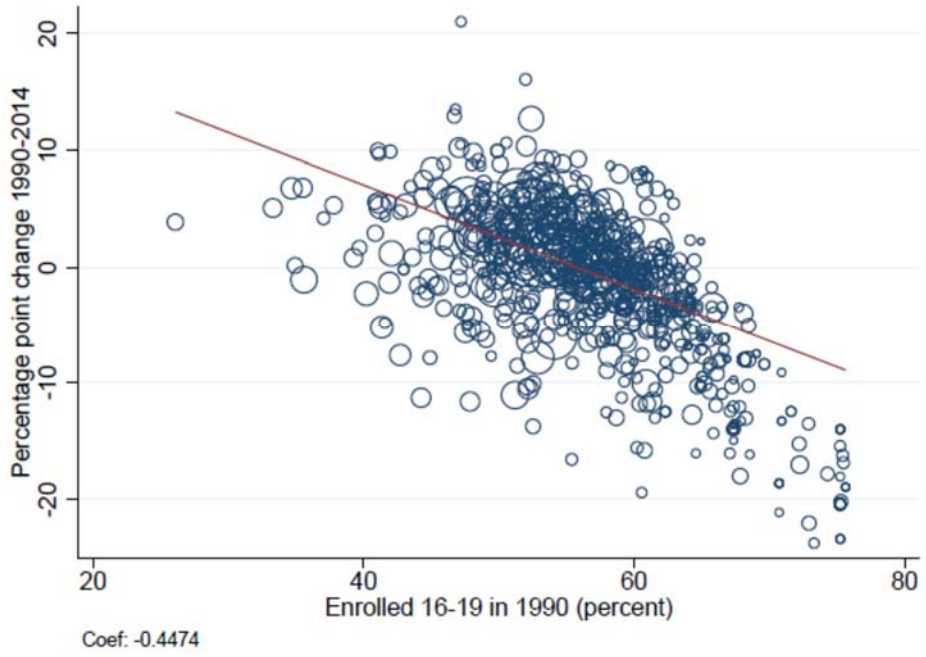
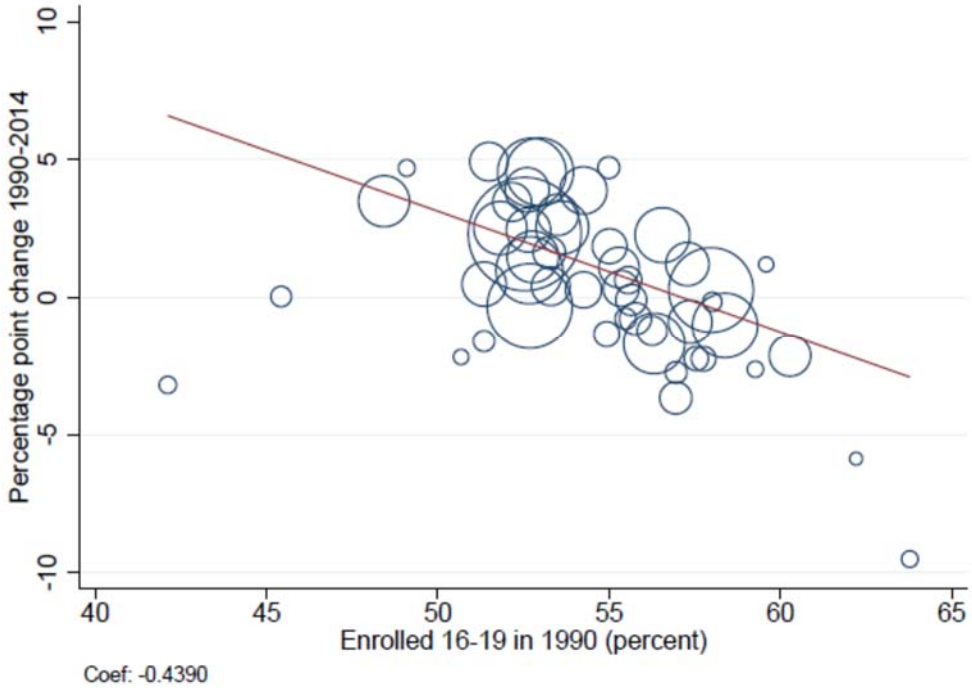
Figure 1. School Enrollment 16-19 Year Olds, 1990-2014

A. Commuting Zone



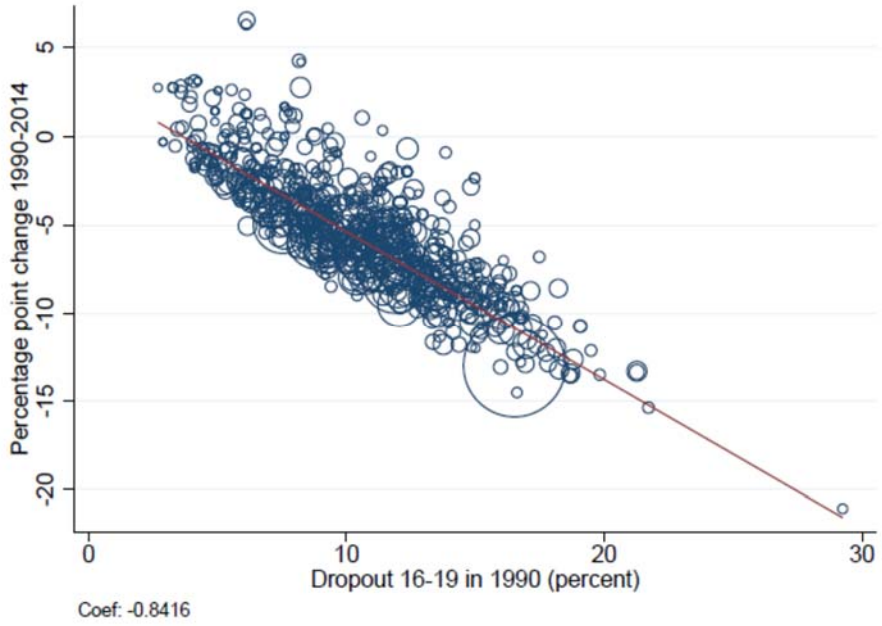
B. State



Notes: Data are from the ACS / Census enumerations and measured as a percent of the indicated population. Regression line indicated in red and initial CZ (state) population represented by size of market.

Figure 2. Dropout Rate (non-Enrollment) ages 16-19, 1990-2014

A. Commuting Zone



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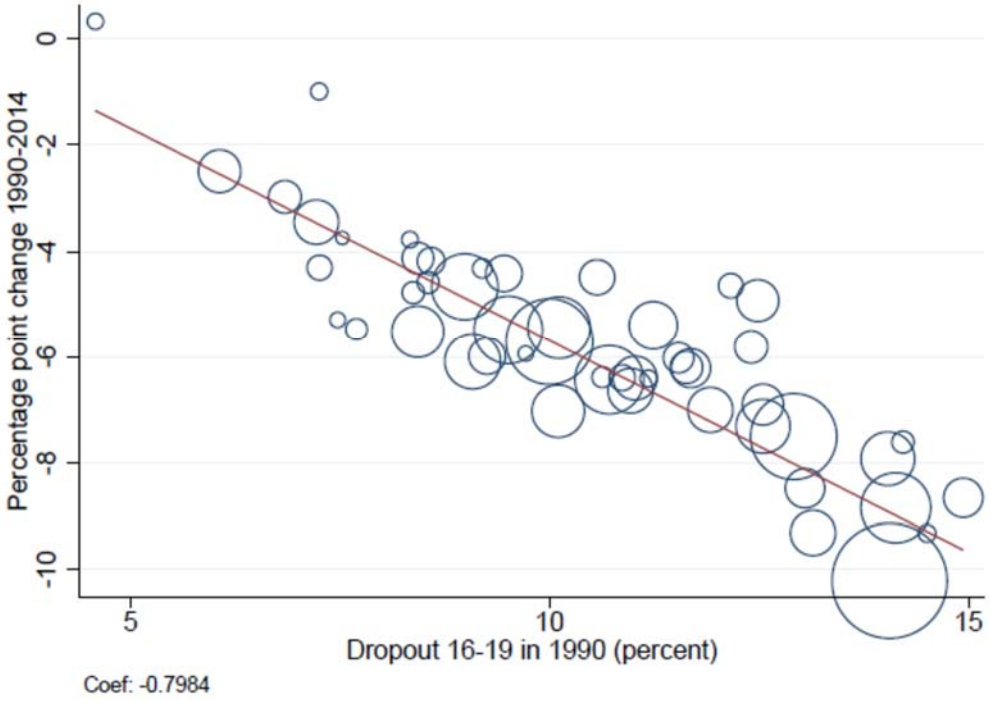
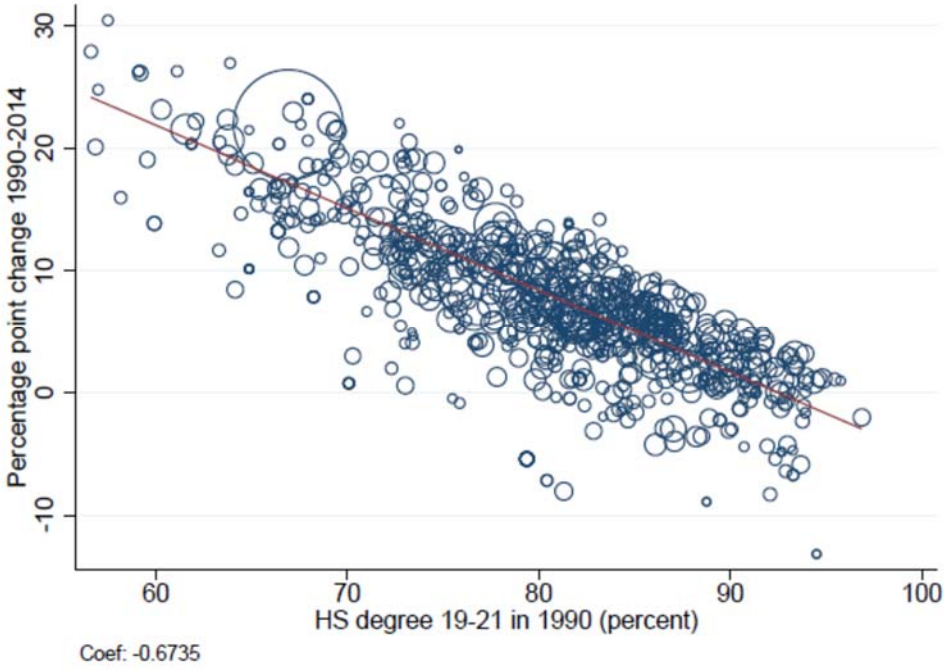


Figure 3. High School Degree Receipt, 1990-2014

A. Commuting Zone



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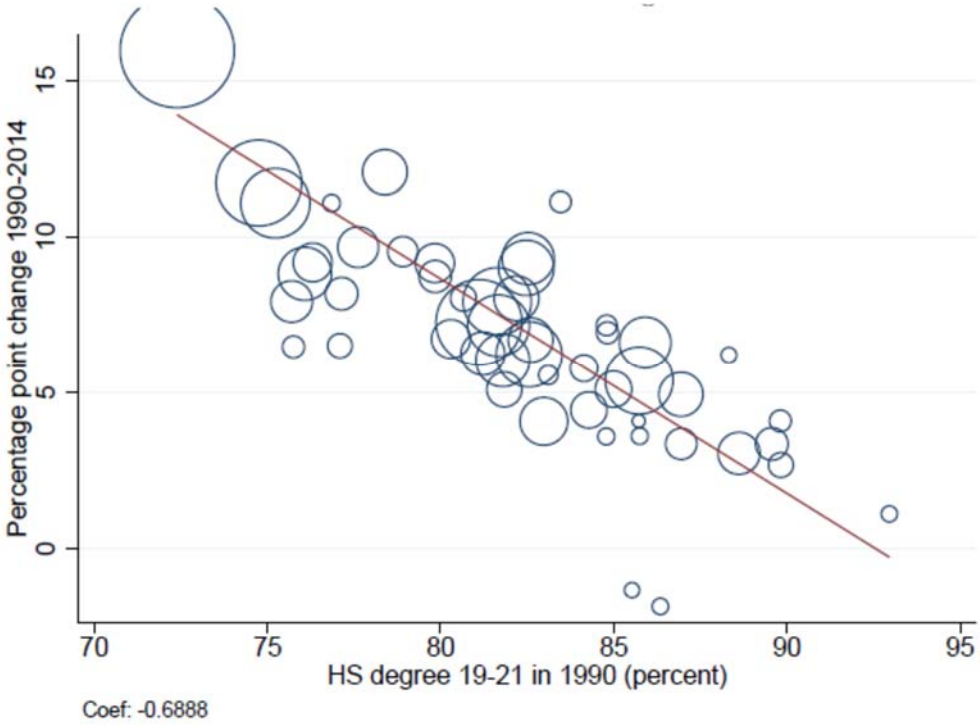
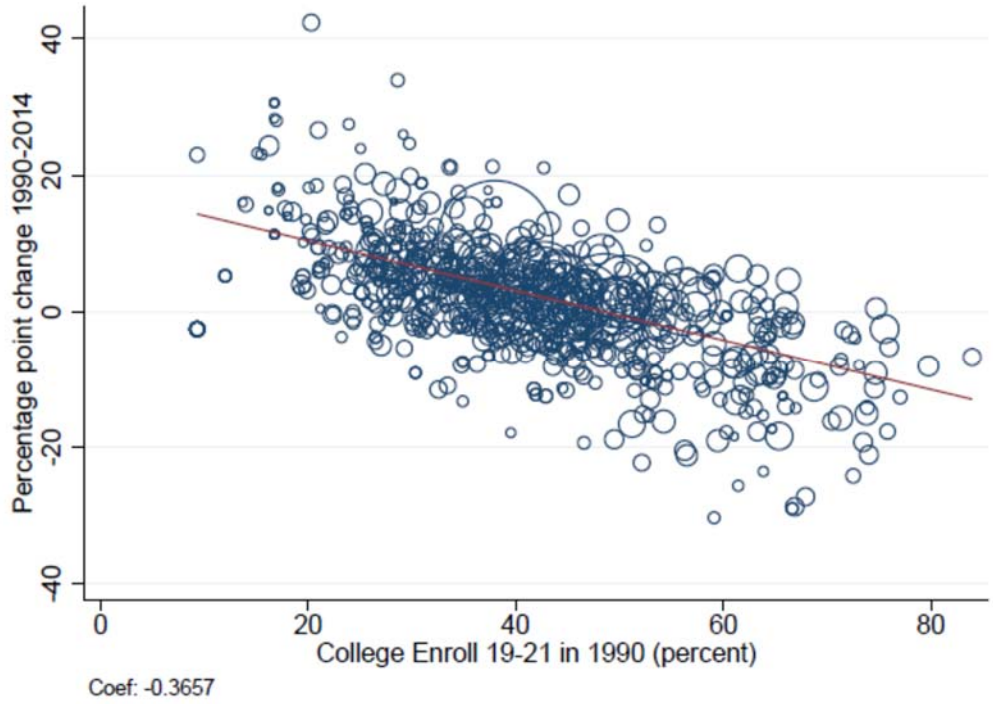


Figure 4A. College Enrollment, Ages 19-21, 1990-2014

A. Commuting Zone



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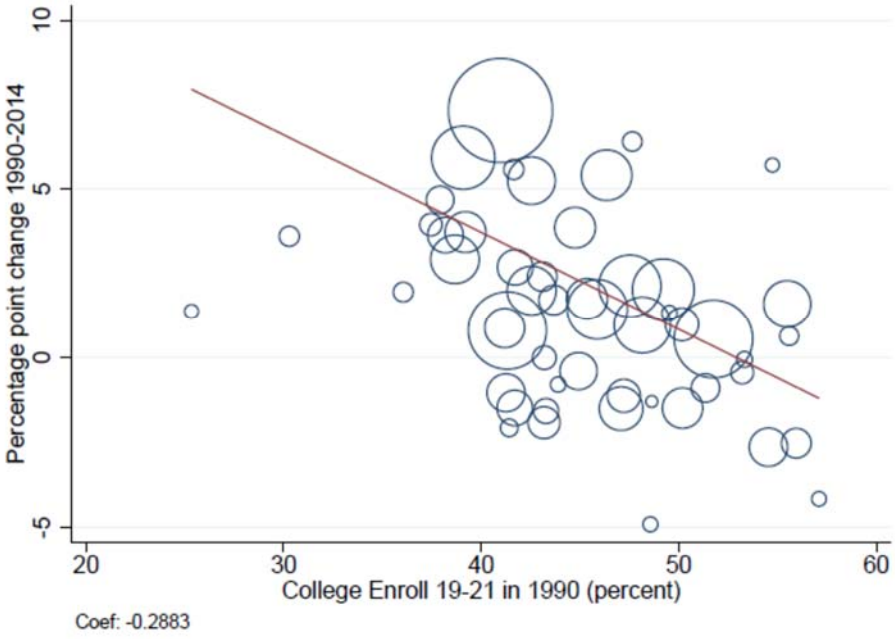
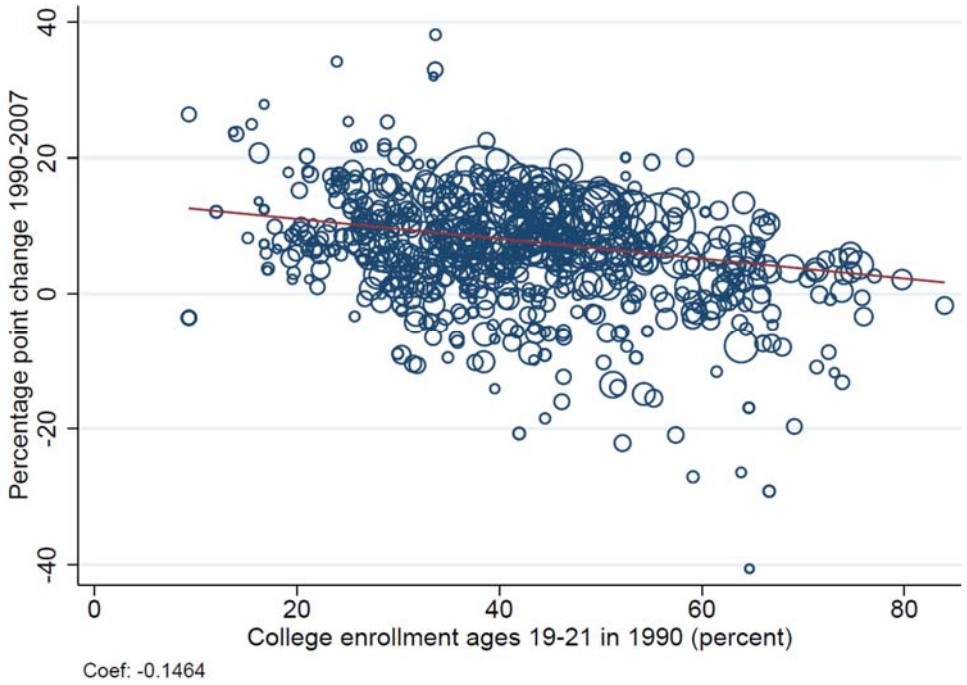


Figure 4B. College Enrollment, Ages 19-21, 1990-2007

A. Commuting Zone



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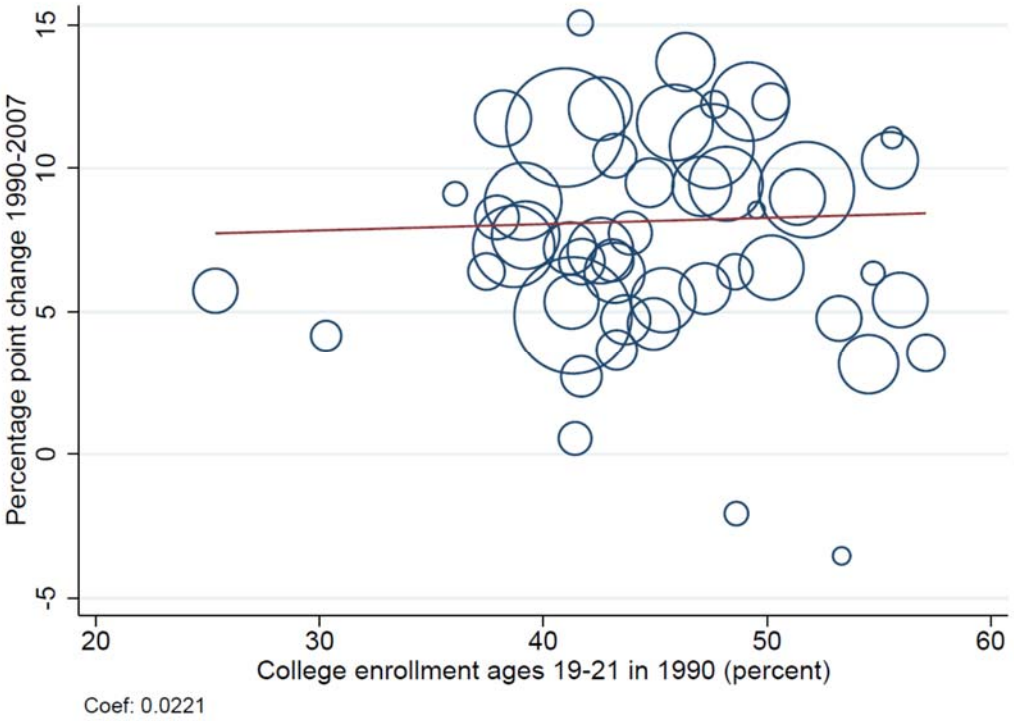
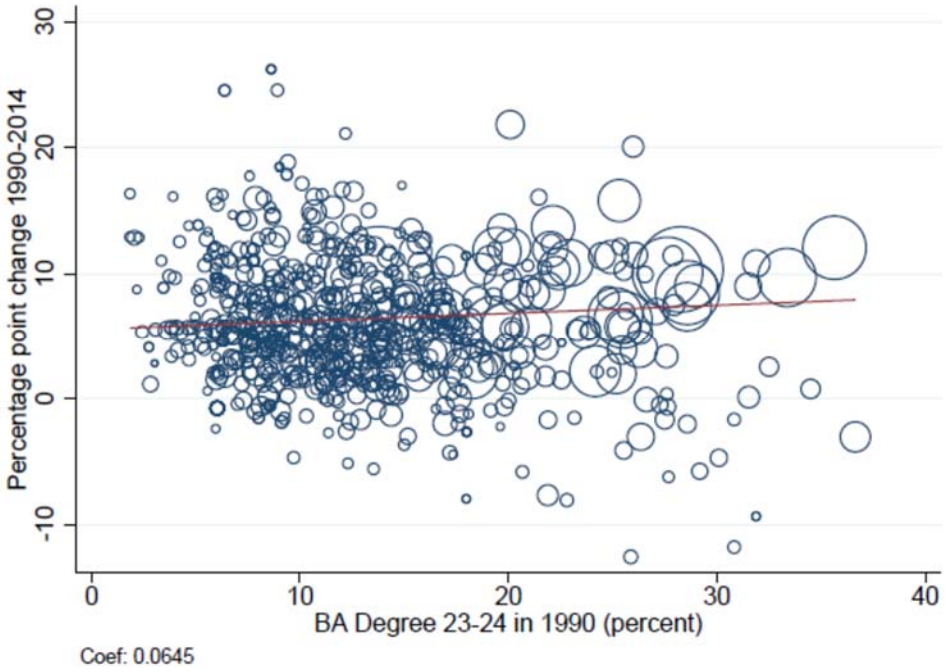


Figure 5A. BA Degree Attainment, Ages 23-24, 1990-2014

A. Commuting Zone



B. State

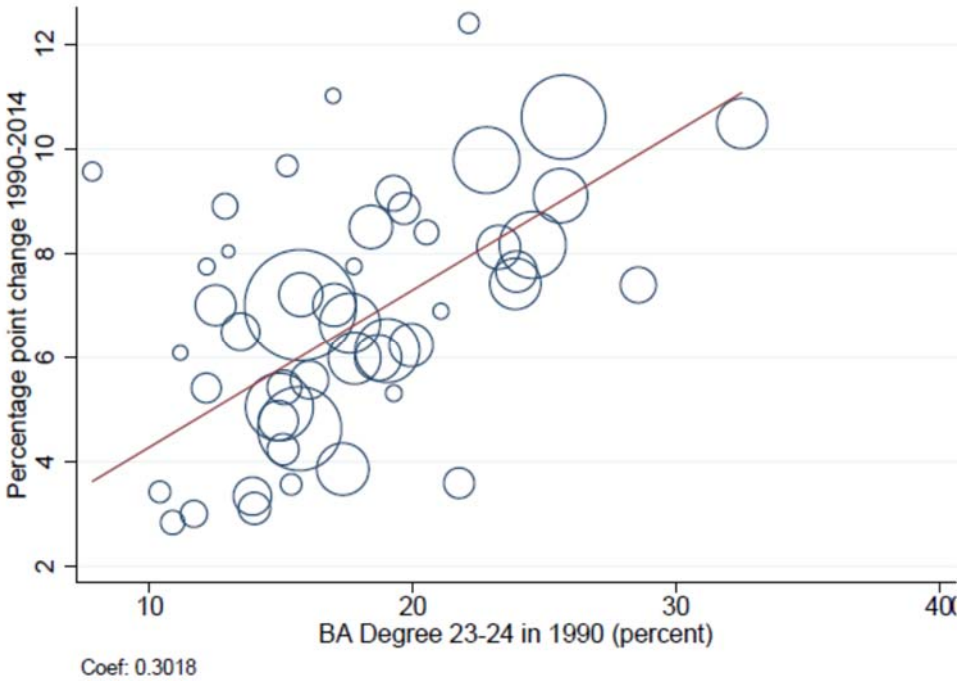
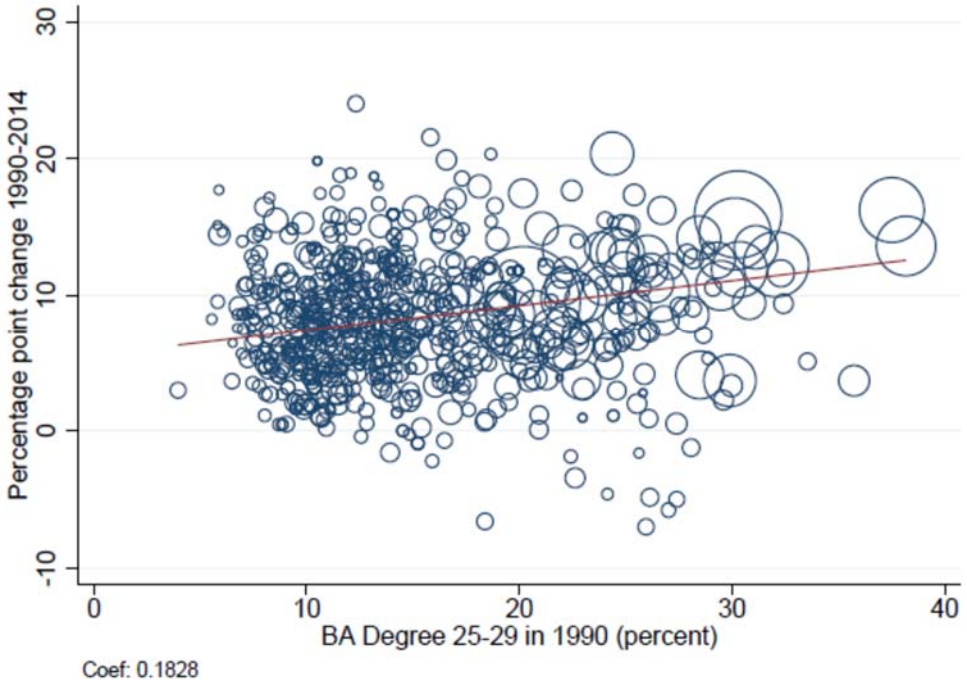


Figure 5B. BA Degree Attainment, Ages 25-29, 1990-2014

A. Commuting Zone



B. State

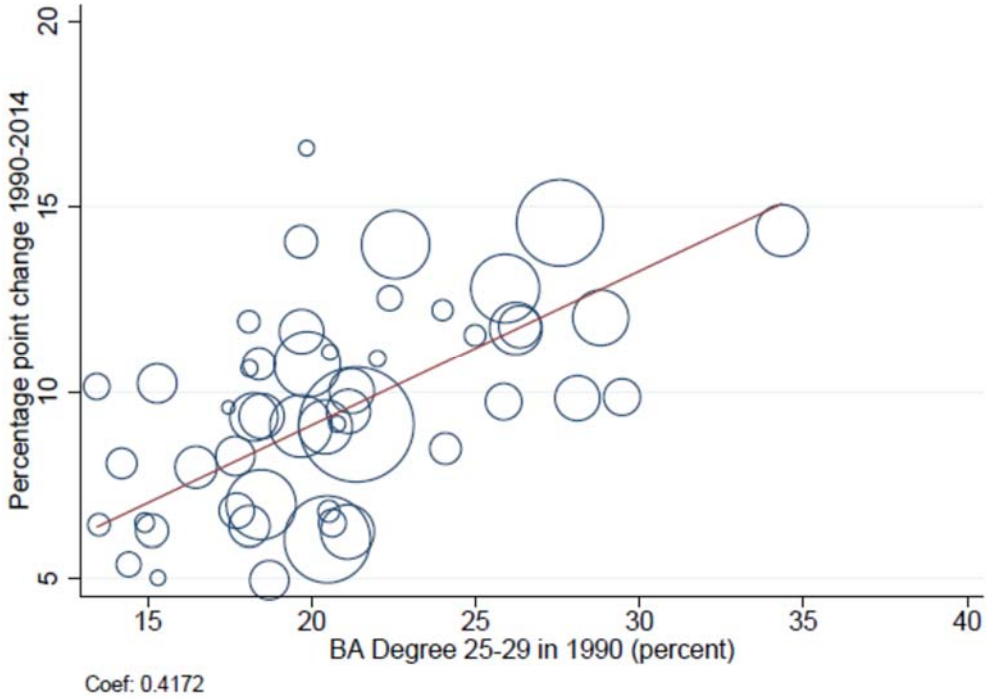
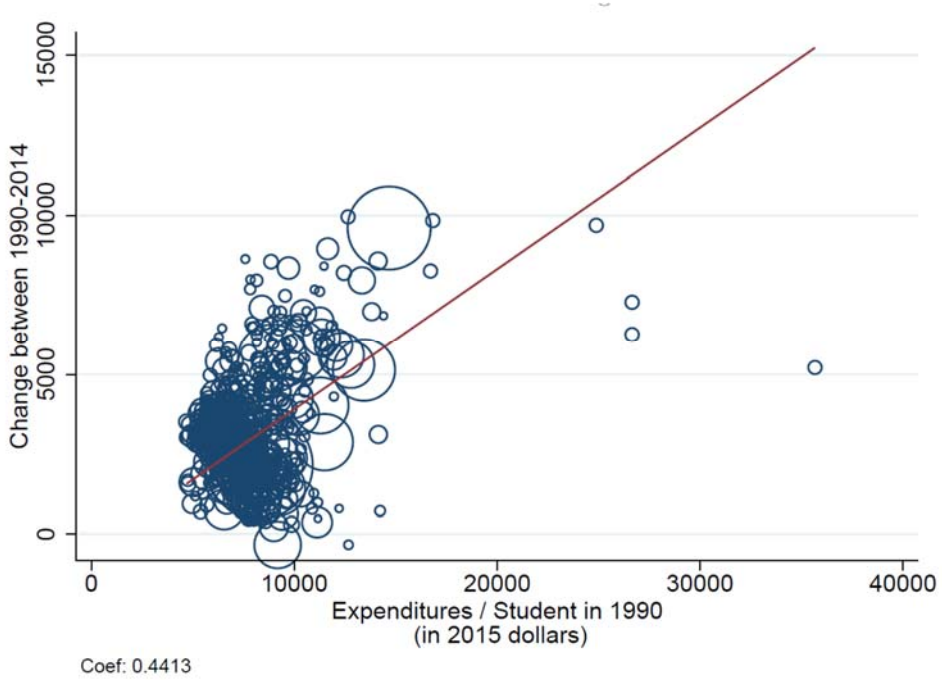


Figure 6. Expenditures per student K-12

A. Commuting Zone



B. State

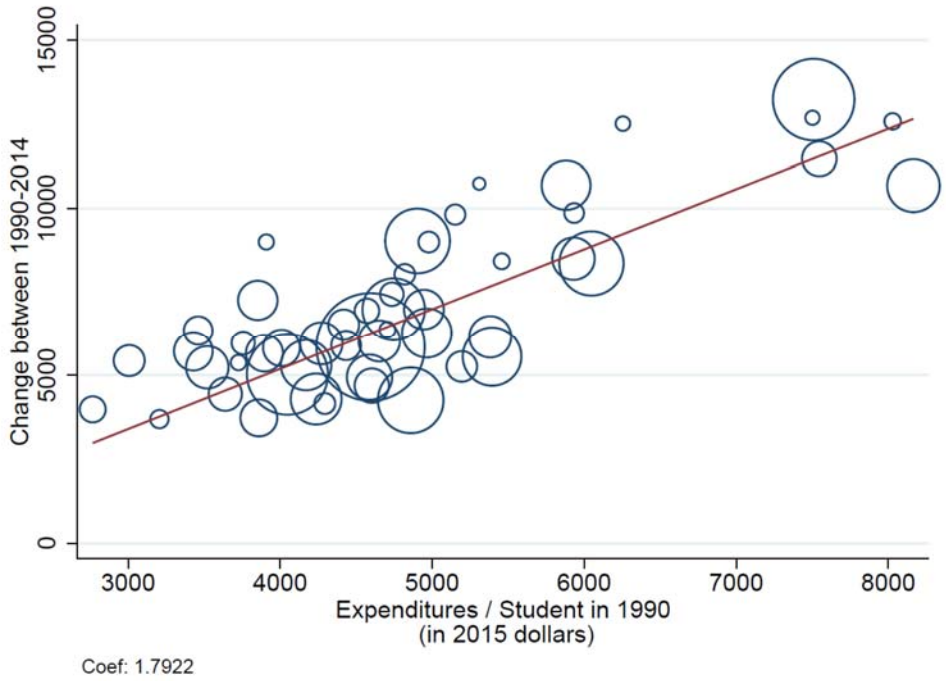
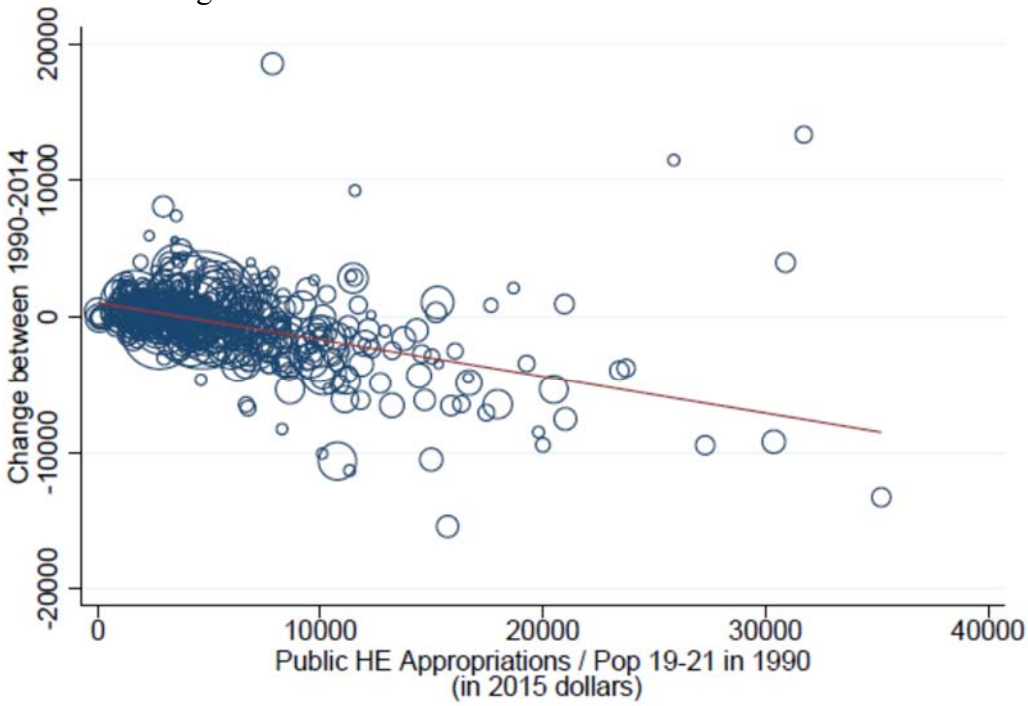


Figure 7. Public Higher Education Appropriations per Capita

A. Commuting Zone



B. State

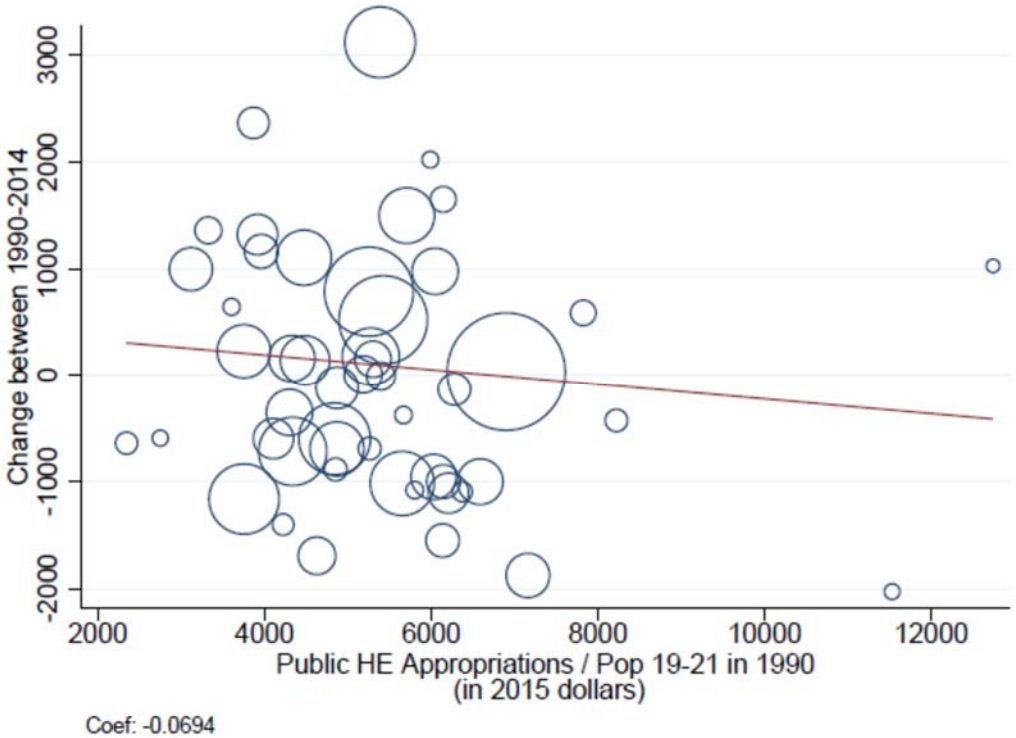


Table 1. Effect of Local Change in Imports from China on School Enrollment Ages 16-19

Dependent Variable: Enrolled in School 16-19 (x 100)							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	0.3874	0.6550	0.6160	0.7725	0.7868		0.7482
	(0.101)***	(0.174)***	(0.219)***	(0.225)***	(0.237)***		(0.243)***
State (Δ imports fr Ch to US)/worker						1.1004	
						(0.445)**	
State-j (Δ imports fr Ch to US)/worker							0.2882
							(0.436)
Pctg. of employ. in manufacturing		-0.0700	-0.0649	-0.0848	-0.1030	-0.0432	-0.1045
		(0.026)***	(0.036)*	(0.027)***	(0.037)***	(0.027)	(0.038)***
Pctg. of college-educated pop.			-0.0186		-0.0513	-0.0345	-0.0529
			(0.034)		(0.034)	(0.036)	(0.034)
Pctg. of foreign-born population			0.0509		-0.0119	0.0094	-0.0100
			(0.020)***		(0.022)	(0.019)	(0.023)
Pctg. of employ. among women			0.0420		-0.0396	-0.0356	-0.0399
			(0.043)		(0.041)	(0.041)	(0.043)
Pctg. of employ. routine occupations				0.4713	0.4752	0.3623	0.4582
				(0.090)***	(0.086)***	(0.083)***	(0.094)***
Avg. offshorability index of occup.				-0.9709	-0.2328	0.1662	-0.1677
				(0.529)*	(0.612)	(0.539)	(0.592)
Constant	3.7857	4.9297	2.6660	-9.8994	-4.2667	-3.8902	-3.9128
	(0.435)***	(0.654)***	(2.594)	(2.920)***	(3.953)	(3.748)	(3.877)
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.577	0.573	0.584	0.591	0.593	0.604	0.588
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 2. Effect of Local Change in Imports from China on Dropout Rate Ages 16-19

Dependent Variable: High School Dropout Rate 16-19 (x100)							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	-0.1994	-0.3468	-0.2606	-0.3428	-0.3115		-0.3478
	(0.068)***	(0.110)***	(0.146)*	(0.148)**	(0.153)**		(0.166)**
State (Δ imports fr Ch to US)/worker						-0.2394	
						(0.175)	
State-j (Δ imports fr Ch to US)/worker							0.0889
							(0.233)
Pctg. of employ. in manufacturing		0.0386	0.0236	0.0237	0.0410	0.0117	0.0444
		(0.017)**	(0.019)	(0.021)	(0.020)**	(0.012)	(0.020)**
Pctg. of college-educated pop.			0.0678		0.0969	0.0909	0.0984
			(0.018)***		(0.015)***	(0.015)***	(0.015)***
Pctg. of foreign-born population			-0.0800		-0.0392	-0.0471	-0.0377
			(0.015)***		(0.015)***	(0.013)***	(0.017)**
Pctg. of employ. among women			-0.0393		0.0115	0.0086	0.0116
			(0.029)		(0.030)	(0.029)	(0.031)
Pctg. of employ. routine occupations				-0.1667	-0.1370	-0.0992	-0.1423
				(0.068)**	(0.050)***	(0.050)**	(0.056)**
Avg. offshorability index of occup.				-0.0864	-0.7219	-0.8630	-0.7086
				(0.403)	(0.413)*	(0.389)**	(0.423)*
Constant	-1.2301	-1.8601	-1.1297	4.6047	-2.2222	-2.3386	-2.2027
	(0.314)***	(0.416)***	(1.555)	(2.004)**	(2.226)	(2.114)	(2.238)
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.301	0.297	0.402	0.353	0.414	0.424	0.412
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 3. Effect of Local Change in Imports from China on High School Completion Rate, Ages 19-21

Dependent Variables: High School Graduation Rate, 19-21 (x 100)							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	-0.2306	-0.0873	-0.2940	-0.1955	-0.3076		-0.2627
	(0.149)	(0.195)	(0.148)**	(0.150)	(0.151)**		(0.164)
State (Δ imports fr Ch to US)/worker						-0.1608	
						(0.271)	
State-j (Δ imports fr Ch to US)/worker							-0.1776
							(0.354)
Pctg. of employ. in manufacturing		-0.0375	0.0012	-0.0032	-0.0126	-0.0437	-0.0153
		(0.026)	(0.021)	(0.029)	(0.022)	(0.020)**	(0.022)
Pctg. of college-educated pop.			-0.1318		-0.1832	-0.1888	-0.1840
			(0.028)***		(0.027)***	(0.028)***	(0.027)***
Pctg. of foreign-born population			0.1728		0.1160	0.1084	0.1131
			(0.025)***		(0.018)***	(0.017)***	(0.021)***
Pctg. of employ. among women			-0.0448		-0.1122	-0.1156	-0.1138
			(0.037)		(0.038)***	(0.040)***	(0.039)***
Pctg. of employ. routine occupations				0.0225	-0.0507	-0.0160	-0.0374
				(0.131)	(0.083)	(0.088)	(0.087)
Avg. offshorability index of occup.				0.8642	2.2228	2.0900	2.2037
				(0.608)	(0.489)***	(0.488)***	(0.490)***
Constant	-0.6737	-0.0613	6.8037	-2.7484	16.1549	16.0525	16.2528
	(0.379)*	(0.682)	(1.908)***	(4.135)	(3.008)***	(3.132)***	(3.065)***
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.630	0.632	0.737	0.676	0.743	0.743	0.741
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 4. Effect of Local Change in Imports from China on High School Diploma Receipt

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(△ imports from China to US)/worker	0.0057	0.0016	0.0025	0.0071	0.0015	0.0072	0.0314
	(0.005)	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)	(0.015)**
Pctg. of employment in manufacturing (lag)		0.0011	-0.0002	0.0002	-0.0001	-0.0002	0.0020
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Pctg. of college-educated population (lag)				0.0063		0.0052	0.0210
				(0.001)***		(0.001)***	(0.011)*
Pctg. of foreign-born population (lag)				-0.0053		-0.0065	0.0132
				(0.003)*		(0.004)*	(0.010)
Pctg. of employment among women (lag)				-0.0044		-0.0058	0.0300
				(0.003)*		(0.003)*	(0.014)**
Pctg. of employment in routine occupations (lag)					-0.0045	-0.0002	-0.0473
					(0.007)	(0.005)	(0.021)**
Avg. offshorability index of occupations (lag)					0.0122	0.0411	-0.2681
					(0.033)	(0.055)	(0.077)***
Constant	-0.0159	-0.0336	0.0086	0.0131	0.1520	0.1765	
	(0.014)	(0.032)	(0.031)	(0.143)	(0.220)	(0.283)	
Observations	1,439	1,439	1,439	1,439	1,439	1,439	1,434
R-squared	0.000	0.007	0.080	0.188	0.083	0.193	0.223
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes
Number of czone							717

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measure of high school diploma count is from the NCES Common Core Data, an administrative survey of school districts, divided by population age 17. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population. Column (7) includes CZ level fixed effects following Greenland and Lopresti (2017); see text for discussion.

Table 5. Effect of Local Change in Imports from China on Log change in size of 19-20 cohort relative to 16-17 cohort

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(△ imports from China to US)/worker	-0.0083	-0.0178	-0.0102	-0.0153	-0.0143		-0.0138
	(0.004)**	(0.005)***	(0.006)	(0.005)***	(0.005)***		(0.005)***
(△ imports from China to US)/worker (state)						-0.0263	
						(0.008)***	
(△ imports from China to US)/worker (rest of state)							-0.0131
							(0.009)
Pctg. of employment in manufacturing (lag)		0.0025	0.0003	0.0019	0.0014	0.0005	0.0016
		(0.001)***	(0.001)	(0.001)***	(0.001)*	(0.001)	(0.001)*
Pctg. of college-educated population (lag)			-0.0018		-0.0006	-0.0010	-0.0005
			(0.001)*		(0.001)	(0.001)	(0.001)
Pctg. of foreign-born population (lag)			-0.0029		-0.0009	-0.0013	-0.0010
			(0.000)***		(0.000)*	(0.000)***	(0.000)**
Pctg. of employment among women (lag)			-0.0024		0.0001	0.0001	0.0000
			(0.001)**		(0.001)	(0.001)	(0.001)
Pctg. of employment in routine occupations (lag)				-0.0118	-0.0114	-0.0091	-0.0104
				(0.002)***	(0.002)***	(0.003)***	(0.003)***
Avg. offshorability index of occupations (lag)				-0.0225	-0.0112	-0.0189	-0.0126
				(0.014)*	(0.019)	(0.019)	(0.019)
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.127	0.137	0.288	0.317	0.323	0.339	0.326
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 6. Effect of Local Change in Imports from China on College Enrollment

Panel A. Ages 19-21

Dependent Variable: Enrolled in College 19-21 (x100)							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	0.2851	0.5245	0.4781	0.5501	0.5414		0.5607
	(0.166)*	(0.235)**	(0.242)**	(0.254)**	(0.249)**		(0.254)**
State (Δ imports fr Ch to US)/worker						0.5458	
						(0.401)	
State-j (Δ imports fr Ch to US)/worker							0.1759
							(0.428)
Pctg. of employ. in manufacturing		-0.0626	-0.1322	-0.0884	-0.1534	-0.1061	-0.1598
		(0.032)**	(0.031)***	(0.024)***	(0.031)***	(0.033)***	(0.033)***
Pctg. of college-educated pop.			-0.1715		-0.2062	-0.1954	-0.2061
			(0.039)***		(0.044)***	(0.045)***	(0.044)***
Pctg. of foreign-born population			0.0905		0.0414	0.0555	0.0431
			(0.017)***		(0.029)	(0.031)*	(0.030)
Pctg. of employ. among women			0.1788		0.1176	0.1218	0.1206
			(0.059)***		(0.072)	(0.075)	(0.073)*
Pctg. of employ. routine occupations				0.2200	0.1710	0.1007	0.1522
				(0.100)**	(0.102)*	(0.101)	(0.111)
Avg. offshorability index of occup.				-0.1001	0.8338	1.0902	0.8326
				(0.548)	(0.851)	(0.782)	(0.877)
Constant	0.7274	1.7508	0.0977	-4.0041	1.1987	1.4226	0.7243
	(0.502)	(0.819)**	(3.618)	(3.213)	(6.173)	(6.074)	(6.266)
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.502	0.498	0.554	0.540	0.556	0.563	0.552
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Panel B. Ages 22-23

Dependent Variable: College Enrollment Rate Ages 22-23 (x 100)							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	0.5580	0.8673	0.8649	0.8831	0.8949		0.9463
	(0.231)**	(0.310)***	(0.348)**	(0.352)**	(0.353)**		(0.372)**
State (Δ imports fr Ch to US)/worker						0.5192	
						(0.354)	
State-j (Δ imports fr Ch to US)/worker							-0.2832
							(0.425)
Pctg. of employ. in manufacturing		-0.0809	-0.1306	-0.1077	-0.1491	-0.0599	-0.1521
		(0.033)**	(0.035)***	(0.033)***	(0.035)***	(0.026)**	(0.034)***
Pctg. of college-educated pop.			-0.0879		-0.1314	-0.1149	-0.1300
			(0.035)**		(0.030)***	(0.028)***	(0.029)***
Pctg. of foreign-born population			0.0537		-0.0005	0.0218	-0.0052
			(0.023)**		(0.028)	(0.032)	(0.030)
Pctg. of employ. among women			0.0305		-0.0356	-0.0261	-0.0388
			(0.057)		(0.068)	(0.070)	(0.066)
Pctg. of employ. routine occupations				0.0848	0.0747	-0.0282	0.0743
				(0.104)	(0.108)	(0.091)	(0.120)
Avg. offshorability index of occup.				0.1549	1.4993	1.8901	1.5361
				(0.489)	(0.607)**	(0.488)***	(0.618)**
Constant	1.8889	3.2109	7.3543	1.9742	12.2825	12.5889	12.1265
	(0.465)***	(0.667)***	(3.000)**	(3.210)	(4.497)***	(4.327)***	(4.387)***
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.132	0.117	0.189	0.176	0.194	0.220	0.186
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 7. Effect of Local Change in Imports from China on College Enrollment by Gender, Ages 19-21

	(1)	(2)	(3)	(4)	(5)	(6)
Women						
Δ imports from China to US)/worker	0.5430	0.8846	0.9106	0.8786	0.9189	0.9375
	(0.218)**	(0.281)***	(0.330)***	(0.326)***	(0.321)***	(0.322)***
Men						
Δ imports from China to US)/worker	0.0379	0.1887	0.1837	0.1019	0.1884	0.1619
	(0.173)	(0.258)	(0.248)	(0.251)	(0.264)	(0.261)
Pctg. of employment in manufacturing (lag)		Yes	Yes	Yes	Yes	Yes
Pctg. of college-educated population (lag)				Yes		Yes
Pctg. of foreign-born population (lag)				Yes		Yes
Pctg. of employment among women (lag)				Yes	Yes	Yes
Pctg. of employment in routine occupations (lag)					Yes	Yes
Avg. offshorability index of occupations (lag)					Yes	Yes
Census division dummies	No	No	Yes	Yes	Yes	Yes

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 8. Effect of Local Change in Imports from China on College Degree Receipt

A. Ages 23-24

Dependent Variable: BA Share Ages 23-24							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	0.0390	0.2333	0.1744	0.2119	0.2225		0.2995
	(0.109)	(0.164)	(0.158)	(0.163)	(0.171)		(0.186)
State (Δ imports fr Ch to US)/worker						-0.1456	
						(0.258)	
State-j (Δ imports fr Ch to US)/worker							-0.4579
							(0.298)
Pctg. of employ. in manufacturing		-0.0525	-0.0665	-0.0444	-0.0745	-0.0452	-0.0764
		(0.023)**	(0.029)**	(0.020)**	(0.030)**	(0.022)**	(0.031)**
Pctg. of college-educated pop.			-0.0624		-0.0658	-0.0630	-0.0683
			(0.021)***		(0.021)***	(0.020)***	(0.020)***
Pctg. of foreign-born population			0.0152		0.0042	0.0091	-0.0011
			(0.015)		(0.021)	(0.019)	(0.020)
Pctg. of employ. among women			0.1186		0.1023	0.1079	0.1017
			(0.031)***		(0.035)***	(0.036)***	(0.034)***
Pctg. of employ. routine occupations				0.1494	0.1313	0.1120	0.1663
				(0.087)*	(0.090)	(0.083)	(0.098)*
Avg. offshorability index of occup.				-0.3207	-0.2742	-0.1977	-0.3427
				(0.562)	(0.575)	(0.536)	(0.559)
Constant							
Observations							
R-squared							
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

B. Ages 25-26

Dependent Variable:BA Share Ages 25-26							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	-0.2303	-0.2309	-0.1868	-0.0315	-0.0588		-0.0284
	(0.192)	(0.304)	(0.313)	(0.219)	(0.224)		(0.250)
State (Δ imports fr Ch to US)/worker						-0.2573	
						(0.280)	
State-j (Δ imports fr Ch to US)/worker							-0.3484
							(0.374)
Pctg. of employ. in manufacturing		0.0002	-0.0377	-0.0382	-0.0404	-0.0400	-0.0379
		(0.038)	(0.047)	(0.033)	(0.042)	(0.027)	(0.042)
Pctg. of college-educated pop.			-0.0710		-0.0168	-0.0188	-0.0179
			(0.026)***		(0.029)	(0.027)	(0.029)
Pctg. of foreign-born population			-0.0085		0.0347	0.0327	0.0302
			(0.019)		(0.019)*	(0.018)*	(0.020)
Pctg. of employ. among women			0.0548		0.0996	0.1009	0.0962
			(0.042)		(0.045)**	(0.047)**	(0.046)**
Pctg. of employ. routine occupations				0.3991	0.3693	0.3828	0.3990
				(0.109)***	(0.106)***	(0.107)***	(0.109)***
Avg. offshorability index of occup.				-2.7600	-3.3508	-3.3948	-3.3712
				(0.669)***	(0.813)***	(0.814)***	(0.799)***
Constant							
	1,444	1,444	1,444	1,444	1,444	1,444	1,440
	0.146	0.146	0.196	0.223	0.226	0.226	0.226
Observations							
R-squared							
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measured from the ACS / Census enumerations and measured as a percent of the indicated population, with observations presented in difference form. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 9. State Level Measures of the Effects of Import Exposure on Higher Education Outcomes

	College Enr, 19-21	College Enr, 22-23	Share BA, 23-24 (ACS)	Share BA, 25-29 (ACS)	BA Degrees Awarded (IPEDS)	BA / Pop 22
(Δ imports from China to US)/worker	-0.0089	0.0275	-0.0499	-0.0186	-0.0258	-0.0305
	(0.018)	(0.023)	(0.035)	(0.019)	(0.015)*	(0.024)
Pctg. of employ. in manufacturing	-0.0002	-0.0044	0.0032	-0.0026	0.0032	0.0035
	(0.002)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)
Pctg. of college-educated pop.	-0.0036	-0.0049	-0.0083	-0.0074	-0.0053	-0.0097
	(0.002)**	(0.003)*	(0.002)***	(0.002)***	(0.004)	(0.004)**
Pctg. of foreign-born population	0.0029	0.0010	0.0034	-0.0003	0.0029	0.0025
	(0.001)**	(0.002)	(0.002)	(0.001)	(0.003)	(0.002)
Pctg. of employ. among women	0.0074	0.0058	0.0068	0.0034	0.0045	0.0137
	(0.003)**	(0.005)	(0.004)*	(0.003)	(0.005)	(0.006)**
Pctg. of employ. routine occupations	0.0048	-0.0029	-0.0167	-0.0055	-0.0053	0.0155
	(0.009)	(0.013)	(0.013)	(0.008)	(0.012)	(0.013)
Avg. offshorability index of occup.	-0.0546	0.0018	0.0190	-0.0141	0.0028	-0.0284
	(0.053)	(0.070)	(0.065)	(0.039)	(0.088)	(0.076)
Constant	-0.4426	0.1356	0.6318	0.6609	0.1281	-0.8681
	(0.398)	(0.595)	(0.543)	(0.292)**	(0.436)	(0.603)
Observations						
R-squared						
Census division dummies	Ln (Approp.)		ln (App / FTE Enr)	ln (App / pop 19-21)		
(Δ imports from China to US)/worker	-0.1527		-0.1260	-0.1588		
	(0.060)**		(0.056)**	(0.049)***		
Pctg. of employ. in manufacturing	0.0124		0.0058	0.0146		
	(0.009)		(0.008)	(0.006)**		
Pctg. of college-educated pop.	-0.0065		-0.0128	-0.0093		
	(0.006)		(0.005)**	(0.005)*		
Pctg. of foreign-born population	0.0090		0.0049	0.0068		
	(0.004)**		(0.004)	(0.003)**		
Pctg. of employ. among women	-0.0133		-0.0162	-0.0062		
	(0.008)*		(0.010)	(0.006)		
Pctg. of employ. routine occupations	-0.0136		-0.0065	0.0206		
	(0.024)		(0.033)	(0.023)		
Avg. offshorability index of occup.	0.0571		0.2304	-0.0120		
	(0.117)		(0.204)	(0.124)		
Constant	1.6722		2.0282	0.2787		
	(0.971)*		(1.590)	(0.880)		

Notes: In the first four columns, the dependent variables are measured as shares from the Census / ACS, with each observation a difference over a ten-year period. In the remainder of the columns, dependent variable measures are from IPEDS survey of colleges and universities. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 10. Effect of Local Change in Imports from China on Expenditures per Student in Elementary and Secondary

A. In Logs

Dependent Variable: Ln Expenditure Per Student (K-12)							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	-0.0062	-0.0088	-0.0187	-0.0196	-0.0214		-0.0213
	(0.005)	(0.007)	(0.008)**	(0.009)**	(0.008)**		(0.008)***
State (Δ imports fr Ch to US)/worker						-0.0513	
						(0.017)***	
State-j (Δ imports fr Ch to US)/worker							-0.0215
							(0.013)*
Pctg. of employ. in manufacturing		0.0007	0.0026	0.0016	0.0030	0.0020	0.0035
		(0.001)	(0.001)*	(0.001)	(0.001)**	(0.001)**	(0.001)***
Pctg. of college-educated pop.			0.0016		0.0014	0.0008	0.0014
			(0.001)		(0.001)	(0.001)	(0.001)
Pctg. of foreign-born population			0.0008		0.0009	0.0003	0.0007
			(0.001)		(0.001)	(0.001)	(0.001)
Pctg. of employ. among women			-0.0069		-0.0067	-0.0066	-0.0070
			(0.001)***		(0.002)***	(0.002)***	(0.002)***
Pctg. of employ. routine occupations				-0.0077	-0.0077	-0.0039	-0.0056
				(0.003)**	(0.004)**	(0.003)	(0.003)*
Avg. offshorability index of occup.				0.0201	0.0351	0.0224	0.0332
				(0.018)	(0.027)	(0.028)	(0.027)
Constant							
	1,444	1,444	1,444	1,444	1,444	1,444	1,440
	0.043	0.043	0.194	0.138	0.196	0.263	0.243
Observations	No	No	Yes	Yes	Yes	Yes	Yes
R-squared							
Census division dummies							

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

B. In Levels (Constant Dollar)

Dependent Variable: Expenditures Per Student							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	-137.8398	-67.7218	-269.1755	-251.1734	-299.6259		-316.0822
	(92.250)	(79.607)	(111.844)**	(112.234)**	(115.583)***		(125.658)**
State (Δ imports fr Ch to US)/worker						-653.1794	
						(251.224)***	
State-j (Δ imports fr Ch to US)/worker							-78.2226
							(225.684)
Pctg. of employ. in manufacturing		-18.3460	32.2955	5.1843	37.4463	21.4085	42.0305
		(18.816)	(17.220)*	(13.470)	(17.763)**	(11.830)*	(17.268)**
Pctg. of college-educated pop.			36.3916		36.9538	29.7114	38.3263
			(18.174)**		(19.640)*	(17.715)*	(19.707)*
Pctg. of foreign-born population			29.6837		34.8118	26.1297	34.5852
			(16.884)*		(26.009)	(26.269)	(27.867)
Pctg. of employ. among women			-86.5899		-79.2720	-79.2432	-80.2623
			(26.046)***		(26.286)***	(28.888)***	(25.956)***
Pctg. of employ. routine occupations				-75.5059	-85.9919	-34.8484	-74.3588
				(41.464)*	(43.024)**	(39.801)	(42.105)*
Avg. offshorability index of occup.				432.0760	257.4153	85.3133	235.7426
				(227.388)*	(440.493)	(470.393)	(439.079)
Constant							
	1,444	1,444	1,444	1,444	1,444	1,444	1,440
	0.111	0.117	0.358	0.292	0.358	0.409	0.367
Observations	No	No	Yes	Yes	Yes	Yes	Yes
R-squared							
Census division dummies							

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measures are from NCES Common Core Data on local school districts. Some CZ without public colleges are omitted. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Table 11. Effects of Import Exposure on Selected Higher Education Revenue and Expenditure Measures, Commuting Zone Level

A. State Appropriations per student (Ln)

Dependent Variable: Ln State Appropriations							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/worker	0.0019	0.0087	-0.0120	-0.0030	-0.0100		0.0067
	(0.016)	(0.027)	(0.024)	(0.021)	(0.022)		(0.018)
State (Δ imports fr Ch to US)/worker						-0.0972	
						(0.082)	
State-j (Δ imports fr Ch to US)/worker							-0.1270
							(0.109)
Pctg. of employ. in manufacturing		-0.0018	0.0014	-0.0017	0.0016	0.0035	0.0020
		(0.005)	(0.004)	(0.002)	(0.004)	(0.003)	(0.004)
Pctg. of college-educated pop.			-0.0005		0.0015	0.0010	0.0010
			(0.004)		(0.005)	(0.005)	(0.005)
Pctg. of foreign-born population			0.0026		0.0045	0.0040	0.0027
			(0.002)*		(0.003)*	(0.003)	(0.003)
Pctg. of employ. among women			-0.0145		-0.0122	-0.0117	-0.0138
			(0.008)*		(0.008)	(0.008)	(0.009)
Pctg. of employ. routine occupations				0.0086	0.0061	0.0102	0.0159
				(0.015)	(0.015)	(0.017)	(0.021)
Avg. offshorability index of occup.				-0.1156	-0.0969	-0.1078	-0.1013
				(0.105)	(0.105)	(0.117)	(0.115)
Constant							
	1,012	1,012	1,012	1,012	1,012	1,012	1,008
Observations	0.035	0.037	0.109	0.097	0.111	0.094	0.084
R-squared	No	No	Yes	Yes	Yes	Yes	Yes
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

B. Four Year Public Tuition and Fees (Ln)

Dependent Variable: Ln Public Tuition and Fees							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/work	0.0258	0.0432	0.0300	0.0325	0.0319		0.0298
	(0.013)*	(0.022)*	(0.017)*	(0.016)**	(0.017)*		(0.019)
State (Δ imports fr Ch to US)/worke						0.1104	
						(0.041)***	
State-j (Δ imports fr Ch to US)/wor							0.0303
							(0.046)
Pctg. of employ. in manufacturing		-0.0047	-0.0012	-0.0011	-0.0021	-0.0018	-0.0025
		(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
Pctg. of college-educated pop.			-0.0026		-0.0046	-0.0037	-0.0048
			(0.002)		(0.003)*	(0.003)	(0.003)*
Pctg. of foreign-born population			0.0035		0.0008	0.0018	0.0013
			(0.002)*		(0.002)	(0.002)	(0.002)
Pctg. of employ. among women			0.0015		-0.0019	-0.0021	-0.0014
			(0.005)		(0.006)	(0.006)	(0.006)
Pctg. of employ. routine occupatio				0.0055	0.0043	-0.0027	0.0015
				(0.006)	(0.005)	(0.005)	(0.007)
Avg. offshorability index of occup.				0.0254	0.0710	0.0930	0.0731
				(0.026)	(0.057)	(0.058)	(0.055)
Constant	0.3265	0.4033	0.2426	0.0484	0.4687	0.5026	0.4299
	(0.033)***	(0.062)***	(0.283)	(0.178)	(0.523)	(0.476)	(0.497)
Observations	1,037	1,037	1,037	1,037	1,037	1,037	1,033
R-squared	0.074	0.076	0.289	0.283	0.293	0.315	0.308
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variable measures are from IPEDS survey of colleges and universities. Some CZ without public colleges are omitted. Covariates follow Autor, Dorn and Hanson (2013) and Feler and Senses (2017). 2SLS estimates; standard errors clustered at the level of state and data are weighted by start of period share of national population

Appendix Table 1. Prior Research on the Effects of Local Labor Market Shocks on Youth Educational Attainment

Citation	Outcome variables	Data and Identification	Results
Cascio, Elizabeth U., and Ayushi Narayan. 2015. "Who Needs a Fracking Education? The Educational Response to Low-Skill Biased Technological Change." NBER Working Paper 21359	High school degree attainment	Census/American Community Survey (ACS) and the Common Core of Data (CCD)	Estimates imply that, absent fracking, the teen male dropout rate would have been 1 percentage point lower over 2011-15 in the average labor market with shale reserves, implying an elasticity of school enrollment with respect to earnings below historical estimates.
Foote, Andrew and Michael Grosz. (2019). The Effect of Local Labor Market Downturns on Postsecondary enrollment and Program Choice. Forthcoming *Education Finance and Policy*.	College enrollment at the CZ level	WARN Act mass layoff data combined with IPEDS data on enrollment and degree receipt by institution; data are at the level of the CZ and year; 1996-2013	Find that, on average, two year college enrollment increases by 3 students for every 100 workers laid off. Completions of career-technical programs also increase but there is no evidence of increased degree attainment
Greenland, Andrew & Lopresti, John, 2016. "Import exposure and human capital adjustment: Evidence from the U.S," *Journal of International Economics*, Elsevier, vol. 100(C), pages 50-60.	High school graduates / population 17 Census / ACS high school graduation rate	ADH strategy with high school data from the common core, as well as ACS.	Find that a movement from the 25th to the 75th percentile in Chinese import exposure led to an average increase in the graduation rate of 3.64 percentage points.
Feler, Leo, and Mine Z. Senses. 2017. "Trade Shocks and the Provision of Local Public Goods." *American Economic*	State and local expenditures School funding and school resources	ADH strategy with data from the Census / ACS and various public finance sources.	Find a decline in quality / funding of public services as a result of trade exposure. A $1000 increase in imports per worker corresponds to 7.7 percent decline in welfare expenditures, 2.4 percent decline in public transportation, 6.8 percent decline in public housing

Journal: Economic Policy, 9 (4): 101-43.			and 0.9 percent decline in public education. These effects are magnified when state effects are relatively large. The authors also document and increase in the student teacher ratio, which appear to be largely due to a relative increase in the number of teachers.
Black, Dan A., Terra G. McKinnish, and Seth G. Sanders. 2005. "Tight Labor Markets and the Demand for Education: Evidence from the Coal Boom and Bust." *Industrial and Labor Relations Review* 59(1): 3-16.	High school enrollment High school degree receipt	Heterogeneity in exposure to labor market exposure to coal; impact of changes in coal prices in Kentucky & Pennsylvania using Census data	The authors find that high school enrollment rates in Kentucky and Pennsylvania declined considerably in the 1970s and eased in the 1980s in coal-producing counties relative to counties without coal. The estimates indicate that a long term 10% increase in the earnings of low-skilled workers could decrease high school enrollment rates by as much as 5-7%
Tuhkuri, Joonas. 2018. "Children of Crisis: The Intergenerational Effects of Manufacturing Decline."	High school graduation College access among bottom quartile	Modified ADH strategy Using ACS / Census	A 1 percentage point decline in high school drop-out rates follows from each 3 percentage point decline in manufacturing as a share of total employment
Hubbard, Daniel. 2017. "The Impact of Local Labor Market Shocks on College Choice: Evidence from Plant Closings in Michigan"	College enrollment among high school graduates	Business closings and mass layoffs in MI using data from the WARN Act and unit record data from Michigan	A 1 standard deviation increase in per capita job losses is associated with a small but significant 0.2 pp (0.3%) increase in the likelihood of college attendance driven entirely by the the two-year margin
Stuart, Bryan. 2019. "The Long-Run Effects of Recessions on Education and Income." Working Paper. George Washington University.		Confidential linked Census files.	Difference-in-differences regressions that exploit variation across counties in recession severity and across cohorts in age at the time of the recession. For individuals age 0-10 in 1979, a 10 percent decrease in earnings per capita in their county of birth reduces four-year college degree attainment by 10 percent and income in adulthood by 3 percent

Appendix Table 2. Effect of Mass Layoffs on Enlistments

VARIABLES	(1) Log Enlistment	(2) Log Enlistment	(3) Log Enlistment
Mass Layoff shareLF	2.826**	2.360*	3.206**
	(1.220)	(1.379)	(1.621)
Mass Layoff shareLF (t-1)		-0.504	-1.439
		(1.115)	(1.157)
Mass Layoff shareLF (t-2)			1.315
			(1.357)
2007	-0.0866***		
	(0.0162)		
2008	-0.0272	0.0613***	
	(0.0195)	(0.0176)	
2009	-0.0812***	0.0122	-0.0505**
	(0.0224)	(0.0223)	(0.0207)
2010	-0.0719***	0.0175	-0.0401*
	(0.0205)	(0.0217)	(0.0227)
2011	-0.230***	-0.143***	-0.215***
	(0.0203)	(0.0196)	(0.0224)
Constant	3.372***	3.294***	3.347***
	(0.0130)	(0.0141)	(0.0213)
Observations	4,122	3,431	2,745
R-squared	0.057	0.059	0.084
Number of cz	718	717	717
CZ FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Mass layoff data are from Foote, Grosz, Stevens (2019). Enlistment data from institutional data provided by U.S. Army.

Appendix Table 3 Effect of Local Change in Imports from China on College Degree Receipt, Ages 25-29

Dependent Variable: Share BA recipients 25-29

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(Δ imports from China to US)/work	-0.1968	-0.2325	-0.2183	-0.1026	-0.0922		-0.0546
	(0.179)	(0.263)	(0.270)	(0.175)	(0.180)		(0.212)
State (Δ imports fr Ch to US)/worke						-0.5009	
						(0.249)**	
State-j (Δ imports fr Ch to US)/wor							-0.6306
							(0.334)*
Pctg. of employ. in manufacturing		0.0093	-0.0379	-0.0380	-0.0470	-0.0433	-0.0401
		(0.030)	(0.037)	(0.022)*	(0.031)	(0.020)**	(0.032)
Pctg. of college-educated pop.			-0.0433		-0.0064	-0.0097	-0.0060
			(0.024)*		(0.027)	(0.025)	(0.027)
Pctg. of foreign-born population			-0.0271		-0.0034	-0.0068	-0.0123
			(0.017)		(0.018)	(0.017)	(0.018)
Pctg. of employ. among women			0.0390		0.0625	0.0645	0.0529
			(0.032)		(0.035)*	(0.038)*	(0.036)
Pctg. of employ. routine occupatio				0.3681	0.3655	0.3917	0.4132
				(0.075)***	(0.076)***	(0.079)***	(0.077)***
Avg. offshorability index of occup.				-2.4367	-2.6716	-2.7503	-2.6639
				(0.428)***	(0.552)***	(0.542)***	(0.521)***
Constant	5.5224	5.3698	7.3314	-4.1215	-7.7672	-7.8732	-6.8099
	(0.373)***	(0.689)***	(1.746)***	(2.514)	(3.035)**	(2.849)***	(2.680)**
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,440
R-squared	0.287	0.286	0.366	0.393	0.398	0.395	0.394
Census division dummies	No	No	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1