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Community College Labor Market Responsiveness in Technician Occupations

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Introduction

Colleges and universities are increasingly under pressure to meet labor market needs, motivated by interest in ensuring that graduates find well-paying jobs and that employers have access to the skilled workers they require to be productive and competitive. Economic development goals are also motivating concern about higher education responsiveness, as a training ecosystem in which workforce programs meet industry needs is a key indicator of a sound economic development infrastructure.[1] [2] To the extent it is effective in meeting labor market demand, a responsive higher education system can generate significant economic and societal returns. But how responsive is higher education to the labor market?

Measuring the degree to which higher education is actually meeting those needs presents challenges. Rather than attempting to measure the responsiveness of higher education writ large, it is preferable to focus on specific segments of the higher education sector. Technicians form a unique and increasingly essential part of the regional labor force as re-shoring efforts seek to bring back a host of manufacturing jobs.[3] This paper focuses on the specific question of whether and to what extent community college technician education programs are responsive to the needs of local industry.

The Case for Labor Market Responsiveness

Universities and colleges can function not only as institutions of educational achievement but also as engines of economic development.[4] [5] To the extent that community colleges are responsive to labor market needs, they can foster technological progress and productivity enhancements by providing more qualified workers, thus supporting long-term economic growth and increases in the standard of living.

More responsive educational systems also enhance economic efficiency. When higher education institutions are adept at meeting the skill needs of employers, they help to ensure that graduates with the right skills are allocated to the fields where they are most needed. In other words, labor market responsiveness can support

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[1] US Economic Development Administration. (2023). *Comprehensive economic development strategy (CEDS) content guidelines: Recommendations for creating an impactful CEDS* (032823). Retrieved from https://www.eda.gov/sites/default/files/2023-03/2023-CEDS-Content-Guidelines-Full-Report.pdf

[2] Cheng, W., Dohrmann, T., Kerlin, M., Law, J., & Ramaswamy, S. (2018). *Creating an effective workforce system for the new economy.* McKinsey & Company. https://www.mckinsey.com/industries/public-sector/our-insights/creating-an-effective-workforce-system-for-the-new-economy.

[3] Moser, H. (2024). Enabling the reshoring surge: Best practices for strengthening the US workforce. *ASSEMBLY Magazine*. Retrieved from https://www.assemblymag.com/articles/98453-enabling-the-reshoring-surge-best-practices-for-strengthening-the-us-workforce

[4] Van Noy, M., & Biswas, R. (2023*). Illuminating economic development in community colleges: Lessons from NSF ATE grants*. Education and Employment Research Center, Rutgers University. Retrieved from https://sites.rutgers.edu/eerc-hii/wp-content/uploads/sites/609/2023/08/Illuminating-Economic-Development-NSF-HII-EERC-6.16.23-FINAL.pdf

[5] Schwartz, R. B., & Lipson, R. (2023). *America's hidden economic engines: How community colleges can drive shared prosperity*. Boston: Harvard Education Press.

labor market alignment by reducing skill shortages and surpluses, resulting in more efficient labor markets for employers.[6]

Responsiveness is also important for students, helping them find work and become less likely to suffer unemployment. By minimizing the mismatch between the skills that workers possess and those that employers require, responsive education systems ensure that graduates have the skills that employers actually need, making it easier for them to find jobs. Responsiveness is critical for ensuring that educational institutions do not train a surplus of students in fields with limited employer demand.

Finally, because community colleges are engines of social mobility, more responsive community colleges support those at the lower end of the socioeconomic ladder in acquiring the skills they need for employment and upward mobility. The result can be improved social mobility and lower economic disparities.[7]

Labor Market Responsiveness versus Labor Market Alignment

The concepts *labor market responsiveness* and *labor market alignment* are highly interrelated, as both describe the extent to which the education system meets the needs of employers and the economy. Community colleges are responsive to the local labor market when they modify their programs to meet the needs of local employers. Colleges are aligned with the labor market when their programs train students in the skills that local employers require. An aligned community college is necessarily a responsive community college. After all, alignment requires colleges to respond to employer needs by modifying their programs to meet those needs. To some extent, labor market alignment can be understood as the outcome of labor market responsiveness. By responding to labor market signals, colleges can modify their curricula, faculty, and program offerings and in so doing align their educational offerings with the needs of the labor market.

Although these concepts are closely related, they are nonetheless analytically distinct. Labor market responsiveness refers more to shorter-term adaptability of institutions to changing market demand. Responsiveness can involve expanding enrollment in current programs, adding new educational programs, or updating current curricula. On the other hand, alignment is more related to the extent to which the skills that colleges teach match the skills that firms require and to whether colleges are producing an appropriate volume of graduates with these skills. Alignment, then, is more of a calibration to see if supply and demand match, whereas responsiveness is to some extent a cruder question, considering only the reaction of educational institutions to demand signals.

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[6] Hanushek, E. A., & Woessmann, L. (2015). *The knowledge capital of nations: Education and the economics of growth*. Cambridge, MA: MIT Press.

[7] Chetty, R., Friedman, J. N., Saez, E., Turner, N., & Yagan, D. (2017). Mobility report cards: The role of colleges in intergenerational mobility (Working Paper 23618). National Bureau of Economic Research. https://doi.org/10.3386/w23618

This difference has important implications in terms of measurement. Alignment is more of a snapshot of whether college and market are aligned at a point in time, whereas responsiveness is necessarily a dynamic concept: Over time, as labor markets change, is the college responding to those changes?

Studies of labor market responsiveness therefore tend to examine change in educational programs or graduates over time. An assessment of alignment might instead study how closely the distribution of educational credentials at a point in time matches the distribution of occupational needs within a specific region or industry.

Studies by Cleary and Van Noy offer another framework for understanding the distinction between labor market responsiveness and alignment presented here.[8] Within the concept of labor market alignment, they differentiate between two separate components: what they label job vacancy alignment and skills alignment. Job vacancy alignment "involves matching the number of graduates from particular programs with the quantitative demand for workers with these credentials," whereas skills alignment "involves aligning the skills, competencies, and credentials offered in higher education with those most in demand in the labor market".[9] Job vacancy alignment maps closely to the concept of labor market responsiveness described here.

When it comes to measuring responsiveness to the labor market, one possible approach is to measure student completions relative to labor market needs. Student completions are, in fact, a joint function of college decisions about which programs to offer or expand on one hand and student enrollment decisions on the other. College responsiveness hinges on institutional capacity to offer and expand programs to meet the needs of the labor market. That is, institutions need to be able to offer enough classes so they can generate graduates in a field. They also need to have the organizational capacity to establish new programs. These institutional shifts can take time—both in terms of launching the programs and in terms of influencing student behavior by encouraging them to enroll. Student responsiveness depends on the interest and choices made by those individuals, which institutions can influence via student outreach and advising.

In short, college responsiveness to a labor market signal requires action on the part of both the college and its students. In this paper, we examine the dynamics at both of these levels—institutional and student—as mechanisms that underlie college responsiveness to the labor market.

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[8] Van Noy, M., & Cleary, J. (2017). *Aligning higher education and the labor market: Guiding principles and open questions*. Education and Employment Research Center, School of Management and Labor Relations, Rutgers University. Retrieved from https://smlr.rutgers.edu/sites/default/files/Documents/Centers/EERC/eerc_lma_issue_brief_final%20%281%29.pdf

[9] Cleary, J., & Van Noy, M. (2014). *A framework for higher education labor market alignment: Lessons and future directions in the development of jobs-driven strategies* (Working Paper). Heldrich Center for Workforce Development, Rutgers University. https://files.eric.ed.gov/fulltext/ED565469.pdf

Prior Research Related to Responsiveness and Alignment

Although there has been extensive research on the linkage between higher education and the labor market, analyses specifically examining community college responsiveness to the labor market are limited.

Studies of Higher Education Labor Market Responsiveness

A handful of studies have explicitly sought to answer the question of how responsive the higher education sector is to labor market demand. Bardhan, Hicks, and Jaffee[10] study the responsiveness in four-year and longer degree attainment to employment and wage signals and find that prior employment growth is positively associated with current degree completions, particularly in computer science fields. They find that wage changes are associated with increases in completions.

Conzelmann et al.[11] investigate the extent to which colleges and universities, particularly bachelor's degree–granting institutions, are responsive to shifts in labor market demand. They measure labor market demand by combining online job postings, alumni locations from LinkedIn, industry-specific job growth data, and data on degrees and course credits from colleges. They find that, on average, increased demand for a specific major and college leads to a small but significant increase in related course-taking and degree production.

Studies of Labor Market Alignment

Strohl, Mabel, and Campbell study the alignment between middle-skills education across the universe of training providers in 565 local labor markets and the corresponding labor market demand. They find "great misalignment between credential supply and labor-market demand" [12](1). Specifically, in 283 out of 565 labor markets studied, at least 50 percent of middle-skills credentials would need to be in different fields to match projected labor demand through 2031.

Leigh and Gill[13] also examine labor market alignment per the aforementioned distinction between the two, though they term it responsiveness. They find that in California, colleges are aligned with the needs of local employers, though the degree of alignment differs depending on whether the institution operates on a single campus or across multiple sites, with multi-site institutions being more aligned than single-site institutions.

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[10] Bardhan, A., Hicks, D., & Jaffee, D. (2013). How responsive is higher education? The linkages between higher education and the labor market. *Applied Economics*, 45(10), 1239–1256. https://doi.org/10.1080/00036846.2011.613801

[11] Conzelmann, J. G., Hemelt, S. W., Hershbein, B. J., Martin, S., Simon, A., & Stange, K. M. (2024). *Skills, majors, and jobs: Does higher education respond?* (Upjohn Institute Working Paper 24-400). Kalamazoo, MI: W.E. Upjohn Institute for Employment Research. https://doi.org/10.17848/wp24-400

[12] Stohl, J., Mabel, Z., Campbell, K. (2024). *The Great Misalignment: Addressing the Mismatch between the Supply of Certificates and Associate's Degrees and the Future Demand for Workers in 565 US Labor Markets*. (Center on Education and the Workforce). Georgetown University, McCourt School of Public Policy. https://cew.georgetown.edu/wp-content/uploads/cew-the_great_misalignment-fr.pdf

[13] Leigh, D., Gill, A., (2007). Do Community College Respond to Local Needs?: Evidence from California. Kalamazoo, MI: W.E. Upjohn Institute for Employment Research. https://doi.org/10.17848/9781429492089

Studies Related to Influences on Student Choice

As explained in the previous section, student completions are a joint decision of the colleges that offer programs and the students who complete them. We now turn to a discussion of literature that examines how education's labor market returns influence student enrollment and program choice. There is, for example, a large empirical literature examining the labor market returns to community college education in general and to certificates in particular as indicators of labor market alignment.[14] [15] [16] [17] [18] [19]

Other literature in this area shows that the decision to attend an institution of higher education is driven in part by the perceived returns to education. Mincer[20] empirically demonstrates that postsecondary enrollments rise with higher labor market returns. Freeman[21] finds that economic rewards significantly influence college enrollment decisions. Similarly, Jacob[22] finds that the attendance gap in higher education between men and women is partly the result of its association with higher labor market returns for women compared to men.

At the level of student program selection, research at the occupation level is somewhat mixed with respect to how students respond to economic returns. In their analysis of engineering fields, Ryoo and Rosen[23] find a relationship between student enrollment decisions and earnings. Freeman and Hirsch[24] match degrees with the knowledge content of related occupations and discover that student major choice responds somewhat

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[14] Jepsen, C., Troske, K., & Coomes, P. (2014). The labor-market returns for community college degrees, diplomas, and certificates. *Journal of Labor Economics*, 32(1), 95–121. http://doi.org/10.1086/671809

[15] Marcotte, D. E. (2010). The earnings effect of education at community colleges. *Contemporary Economic Policy*, 28(1): 36–51. https://doi.org/10.1111/j.1465-7287.2009.00173.x

[16] Bailey, T., Kienzl, G. S., & Marcotte, D. E. (2004). *The returns to a sub-baccalaureate education: The effects of schooling, credentials, and program of study on economic outcomes*. New York, NY: Teachers College, Community College Research Center, Columbia University.

[17] Dadgar, M., & Trimble, M. J. (2015). Labor market returns to sub-baccalaureate credentials: How much does a community college degree or certificate pay? *Educational Evaluation and Policy Analysis*, 37(4), 399–418. https://doi.org/10.3102/0162373714553814

[18] Xu, D., & Trimble, M. (2016). What about certificates? Evidence on the labor market returns to nondegree community college awards in two states. *Educational Evaluation and Policy Analysis*, 38(2), 272–292. https://doi.org/10.3102/0162373715617827

[19] Minaya, V., & Scott-Clayton, J. (2022). Labor market trajectories for community college graduates: How returns to certificates and associate's degrees evolve over time. *Education Finance and Policy*, 17(1): 53–80. https://doi.org/10.1162/edfp_a_00325

[20] Mincer, J. (1994). Investment in US Education and Training (NBER Working Paper 4844). Paper presented at the 1993 International Conference on Human Capital Investments and Performance, Santa Barbara. Retrieved from https://www.nber.org/system/files/working_papers/w4844/w4844.pdf

[21] Freeman, R. (1986). "Chapter 6: Demand for education." In 0. Ashenfelter and A. Layard (Eds.), *Handbook of labor economics: Vol. 1* (pp. 357–386). https://doi.org/10.1016/S1573-4463(86)01009-X

[22] Jacobs, J. (2012). The essential role of community colleges in rebuilding the nation's communities and economies. In J. E. Lane & D. B. Johnstone (Eds.), *Universities and colleges as economic drivers: Measuring higher education's role in economic development* (pp. 191–204). https://doi.org/10.1515/9781438445021-010

[23] Ryoo, J., & Rosen, S. (2004). The engineering labor market. *Journal of Political Economy*, 112(S1), S110–S140. https://doi.org/10.1086/379946

[24] Freeman, J., & Hirsch, B. (2007). College majors and the knowledge content of jobs (IZA Discussion Paper No. 2941). *Economics of Education Review*, 27(5), 517–535. https://doi.org/10.1016/j.econedurev.2007.07.004

weakly to wage differentials. Several studies, however, find that program choice generally is not influenced by earnings. [25] [26] [27]

Institutional Perspective

On the community college decision-making side, there is also a literature seeking to describe how colleges align their program offerings with local labor markets and attempt to facilitate economic development.[28] [29] [30] Similarly, some scholars are seeking to understand how community colleges use labor market information to better align what they do with the labor market.[31] Although there is much research that touches on themes related to the current study, there are comparatively few studies that seek to empirically estimate the extent to which either higher education in general, or community colleges in particular, respond to labor market conditions over time—a potentially more dynamic measure than alignment.

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[25] Ruder, A. I., & Van Noy, M. (2017). *Labor market expectations and major choice for low-income, first-generation college students: Evidence from an information experiment*. Education and Employment Research Center, Rutgers University. Retrieved from https://smlr.rutgers.edu/sites/default/files/Documents/Centers/EERC/Labor%20Market%20Expectations%20and%20Major%20Choice%20for%20Low%20Income%20First%20Generation%20College%20Students%20Evidence%20from%20an%20Information%20Experiment.pdf

[26] Baker, R. R., Bettinger, E., & Marinescu, J. B. (2018). The effect of labor market information on community college students' major choice. *Economics of Education Review*, 65, 8–30. https://doi.org/10.1016/j.econedurev.2018.05.005

[27] Kerr, S. P., Pekkarinen, T., Sarvimäki, M., & Uusitalo, R. (2020). Post-secondary education and information on labor market prospects: A randomized field experiment. *Labour Economics*, 66(C). https://doi.org/10.1016/j.labeco.2020.101888

[28] Atwell, A., Klein, S., Ecton, W., D'Amico, M. M., & Sublett, C. (2022). Community college responses to align career and technical education programs with changing labor markets. *New Directions for Community Colleges*, 197, 45–58. https://doi.org/10.1002/cc.20496

[29] Van Noy, M., & Biswas, R. (2023*). Illuminating economic development in community colleges: Lessons from NSF ATE grants*. Education and Employment Research Center, Rutgers University. Retrieved from https://sites.rutgers.edu/eerc-hii/wp-content/uploads/sites/609/2023/08/Illuminating-Economic-Development-NSF-HII-EERC-6.16.23-FINAL.pdf

[30] Jacob, B. A. (2002). Where the boys aren't: Non-cognitive skills, returns to school and the gender gap in higher education. *Economics of Education Review*, 21(6), 589–598. https://doi.org/10.1016/S0272-7757(01)00051-6

[31] Bjorn, G., & Kerrigan, M. R. (2023, October 25). *Labor market information (LMI) usage in postsecondary institutions: A systematic literature review*. Education and Employment Research Center, School of Management and Labor Relations, Rutgers University. Retrieved from https://smlr.rutgers.edu/sites/default/files/Documents/Centers/EERC/LMI%20Lit%20Review_EERC_March%202024.pdf

Research Questions

The question of interest for this study is: *Whether and to what extent do community colleges offer programs in response to labor market demand?* Our expectations are as follows:

- Greater employer demand for workers in a particular occupation will translate into an increased probability of local community colleges offering training in related programs in the future.
- Greater employer demand for workers in a particular occupation will result in higher student participation in related training programs at local community colleges in the future.

Concepts to be Measured

What does it mean for colleges to be responsive to labor market demand? For the purpose of this study, a college is responsive to the demands of the labor market when it expands enrollment and increases the number of graduates. More specifically, we seek to understand community colleges' responsiveness to labor market demand in specific technician occupational fields. This distinction is relevant because national labor market demand may drive colleges' programmatic and enrollment decisions more than local labor market demand for some technician fields (e.g., software development). In occupations for which the demand for labor is national, the skills required may be more general than employer specific, and the performance of job duties is not tied to a specific place. Further, the skills required may be in more limited supply, and salaries are higher, making it worthwhile for prospective employees to relocate.

In other technician occupations, like the ones examined here, local or regional demand is likely to be a more powerful driver of community college program offerings than national demand. Programs related to these occupations may offer curricula that is more tailored to specific local employers, lead to technician jobs that typically have to be performed on site, and be associated with lower salaries. The key markers of demand responsiveness therefore are a) whether community colleges offer programs and b) how many students colleges enroll in programs that are related to the occupations for which local employers have significant demand. Although student enrollment is, of course, largely driven by student decisions based on how they are interpreting the signals they perceive from the labor market—whether they think they will be able to get a job when they finish the program—it is a joint decision that also requires responsiveness on the part of higher education institutions. When the labor market signals demand for workers in a specific occupation, colleges must make decisions about expanding their capacity to meet local employer needs by hiring additional faculty and by increasing awareness of labor market opportunities among potential students.

Measurement Challenges

Answering the proposed research questions presents four challenges:

- Identifying related programs

- Measuring student participation in technician programs
- Appropriately lagging the labor market signal
- Measuring labor market demand

Identifying Related Programs

How do we know whether a program is related to a particular occupation? If we are to correctly measure the response of community colleges to labor market demand, it is necessary to have an accurate method for determining the occupation(s) for which a technician program prepares students. If programs are not correctly assigned to related occupations, then the signal will be unrelated to the response. We would not, for example, expect veterinary programs to increase the number of astronauts (unless we start launching a bunch of dogs into space!). For the purposes of this study, we use the CIP-SOC Crosswalk to identify related occupations for training programs[32] Details of this crosswalk are described in the Data Sources section below.

Measuring Student Participation in Technician Programs

Ideally, we would have accurate data on first-time student enrollment for each technician program. Unfortunately, there is no such dataset. Although enrollment data from the IPEDS Institutional Characteristics dataset detailed in the next section provide accurate information on key characteristics of enrollees (e.g., demographics, enrollment status, retention rates), they do not include data on the programs in which students are enrolled. This is not entirely surprising, as reliably reporting these data would likely be difficult. Students may not select their programs of study until a year or more after being enrolled in college, and some colleges may code all enrolled students under the same CIP code, such as liberal arts, for simplicity. The most accurate and consistent data on students' programs of study come from the IPEDS Completions dataset,[33] also detailed below. Therefore, to measure student participation in technician programs, we use these completions data.

Appropriately Lagging the Labor Market Signal

In this study, we are measuring student participation as a response to a demand signal from the labor market. Operationalizing this response using completions data presents a bit of a challenge. Although it is accurate to assume that students who completed a program in a specific year also participated in the program during that year, students made their decisions to enroll in the program, and the college made the decision to offer the program, well before that year. In other words, student completion is a very delayed response to the signal of labor market demand. The difficulty is that it is impossible to know the point in time when the college made the programmatic decisions that resulted in the observed number of completions of a specific program in a given year. The answer will certainly vary by college and by program, as each college has its own review process for creating new programs and/or hiring faculty to expand programs.

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32 National Center for Education Statistics. (2022). *Crosswalk.* US Department of Education. Retrieved from https://nces.ed.gov/ipeds/cipcode/crosswalk.aspx?y=56

33 Integrated Postsecondary Education Data System (IPEDS) [Online dataset]. *Compare Institutions: Completions, 2012–2021*. National Center for Education Statistics, US Department of Education. Retrieved from https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx?year=[YYYY]&gotoReportId=7&sid=1622edcd-9c59-430a-a8a5-19c0f398ae76&rtid=7

For the purpose of this study, we make two key assumptions:

- Technician programs take between one and two years to complete. By this assumption, May 2022 completers (for example) would have started their programs sometime between August and September of 2020.
- Colleges respond to labor market signals between one and three years either before the program is in place or before they want to boost enrollment. This means that colleges are processing and acting on the labor market signals between three and five years before students complete related programs. With respect to May 2022 completers, for example, college decisions about whether to offer a program and how many students to train—and hence how many instructors to hire—would need to have been made at some point between 2017 and 2019.

To operationalize these assumptions, we measure the signal—labor market demand—three, four, and five years before students completed their programs. In the case of students completing in 2022, we run one model with the labor market signal from 2019, one with the signal from 2018, and a third with the signal from 2017. We do this in order to assess the robustness of the results. If the statistical models indicate that colleges are responsive to labor market demand in each of the three years, that provides stronger support for the hypothesis than if they are responsive in only one of the three years.

Measuring Labor Market Demand

We used two different metrics to measure labor market demand—employment and wages—because these data are publicly available through the government administrative datasets described below. We did not use data from job postings because those data are not publicly available. Future research could extend this analysis by using job postings data.

Data Sources

Postsecondary completion data come from the Integrated Postsecondary Education Data System, or IPEDS, maintained by the US Department of Education's National Center for Education Statistics (NCES). Occupational data on employment and earnings are published annually by the US Bureau of Labor Statistics (BLS) through its Occupational Employment and Wage Statistics (OEWS) program. Data on program-occupation relationships come from the CIP-SOC Crosswalk, which is jointly published by NCES and BLS.[34]

IPEDS

IPEDS is a system of interrelated surveys conducted annually by NCES that gathers information from every college, university, and technical and vocational institution that participates in federal student financial aid programs.[35] Data used for this research are data the colleges have reported to IPEDS on program completers. Program classifications are based on the NCES Classification of Instructional Program (CIP) codes. CIP codes were most recently updated in 2020 and are the basis for the program information used in this study.

We used two files from the IPEDS data system. First, we used the Directory Information files from the Institutional Characteristics survey to collect the unique identifier and zip code for each institution. Then, from the Completions survey, we collected programs' 6-digit CIP code and award level, as well as the race/ethnicity and gender of completers, for each institution. We created a dataset of technician programs by selecting technician CIP codes using a selection process described below, then aggregated those data by institution, year, and CIP code. We then joined these two files to associate a zip code with each college.[36]

Definition of Technician Programs of Study

For the purpose of this analysis, we focused solely on technician programs listed in the 2020 NCES Classification of Instructional Programs. We identified these programs using the following process.

Technician Programs INCLUDE:

- CIP Family 15 Engineering/Engineering-Related Technologies/Technicians
- CIP Family 41 Science Technologies/Technicians
- CIP Family 47 Mechanic and Repair Technologies/Technicians
- Four-digit CIP 48.05 Precision Metal Working (within CIP Family 48 Precision Production)
- All other programs including the word *technician* EXCEPT healthcare programs and other specified programs detailed below

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[34] National Center for Education Statistics. (2022). *Crosswalk.* US Department of Education. Retrieved from https://nces.ed.gov/ipeds/cipcode/crosswalk.aspx?y=56

[35] The Higher Education Act of 1965, as amended, requires institutions that participate in federal student aid programs to report data on enrollments, program completions, graduation rates, faculty and staff, finances, institutional prices, and student financial aid.

[36] Integrated Postsecondary Education Data System. (2022). National Center for Education Statistics. Retrieved from https://nces.ed.gov/ipeds

Technician Programs EXCLUDE:

- CIP Family 26 Biological and Biomedical Sciences
- CIP Family 31 Parks, Recreation, Leisure, and Fitness Studies
- CIP Family 43 Homeland Security, Law Enforcement, Firefighting and Related Protective Services
- CIP Family 25 Library Science
- CIP Family 46 Construction Trades
- CIP Family 12 Personal and Culinary Services
- CIP Family 44 Public Administration and Social Service Professions
- Six-digit CIP 48.0303 Upholstery/Upholsterer (within CIP Family 48 Precision Production Trades, General)
- Six-digit CIP 48.0304 Shoe, Boot and Leather Repair (within CIP Family 48 Precision Production Trades, General)
- Six-digit CIP 48.0399 Leatherworking and Upholstery, Other (within CIP Family 48 Precision Production Trades, General)
- Six-digit CIP 47.0402 Gunsmithing/Gunsmith (within CIP Family 47 Mechanics and Repairers, General)
- Six-digit CIP 47.0403 Locksmithing and Safe Repair (within CIP Family 47 Mechanics and Repairers, General)

OEWS

OEWS is the BLS program for collecting and publishing data on employment and earnings for various occupations in the United States. It provides valuable information on the labor market, including the number of people employed in specific occupations and their median earnings. Occupational data on employment and earnings are derived from the BLS Standard Occupational Classification (SOC) system, which classifies workers into occupational categories for the purpose of collecting, calculating, or disseminating data. Occupation titles may change from year to year to include more or fewer workers depending on whether the definition of the occupation becomes narrower or broader. BLS last updated SOC codes in 2018, and those codes are the basis for the occupation classifications used in this study.[37]

Program-to-Occupation/CIP-SOC Crosswalk

To identify the occupation to which a training program is related, we used the CIP-SOC Crosswalk, which is a joint effort of BLS and NCES to match 2020 six-digit CIP codes with corresponding 2018 six-digit SOC codes. Per NCES,

> [T]he purpose of the crosswalk is to match postsecondary programs of study that provide graduates with specific skills and knowledge to occupations requiring those skills or knowledge to be successful. The matches are based on the content of the CIP Code and SOC Code descriptions combined with expertise from statisticians at both federal agencies. The CIP-SOC Crosswalk is not based on actual empirical data.[38] (National Center for Education Statistics, 2022)

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[37] Bureau of Labor Statistics. (2022). Occupational employment and wage statistics. US Department of Labor. Retrieved October 23, 2022, from https://www.bls.gov/oes/

[38] National Center for Education Statistics. (2022). *Crosswalk*. Retrieved from https://nces.ed.gov/ipeds/cipcode/post3.aspx?y=56

Analysis Dataset

Time Period

The data analyzed in this study span the period 2012 through 2021 for the IPEDS completers data and 2008 through 2017 for the OEWS data (as the latter are lagged).

Unit of Analysis

To account for the geographic level of the occupational demand data, the unit of analysis is the occupation–Metropolitan Statistical Area (MSA)–year. The lowest geographic level at which occupational demand data are available is the MSA. Since IPEDS data are not available at the MSA level, it was necessary to download data from the HUD-USPS ZIP Code Crosswalk, an annual crosswalk of zip codes to MSAs. We assigned a single MSA to each zip code by selecting the MSA with the highest incidence for that zip code. We then merged the zip code and MSA dataset with the IPEDS data to associate each institution with an MSA. We then "aggregated up" the IPEDS data to the MSA level by combining all of the colleges with zip codes located in the same MSA and summing the number of completers in those zip codes by technician occupation program. We used the zip code from the IPEDS institution data to identify the MSA in which each college is located. We then grouped the dataset by year, MSA, and CIP code and summed the count of graduates in each year, MSA, and CIP to produce a count of the number of graduates per year–MSA–CIP.

Dependent Variable

The dependent variable is the count of completers in all programs related to a specific occupation in an MSA in year t. It is important to describe how this count is created for each observation. Programs are related to specific occupations using the CIP-SOC Crosswalk. Some programs in these data are related to only a single occupation, whereas others are related to as many as four different occupations. To build a dependent (response) variable, we counted the number of completers of all programs related to an individual occupation. This means that if five local colleges each offered two programs related to one occupation, we combined all completers from those ten programs to produce the completer count associated with that occupation–MSA–year combination.

Key Explanatory Variables

We include four explanatory variables:

- Employment Signal. Employment in the related occupation in an MSA in a given year (measured three, four, and five years before the associated count of completers). This variable comes from the OEWS data and is the number of workers employed in the occupation in a given year in a particular MSA.
- Earnings Signal. Median earnings in the related occupation (measured three, four, and five years before the associated count of completers). This data element also comes from the OEWS data.
- Program Size. The number of students who completed programs in the related occupation in the previous year. The number of students who completed in the previous year is expected to be the strongest predictor of the count of graduates in the current year. This data element comes from the IPEDS completions data.

- **MSA Size.** Population of the MSA in a given year, drawn from the US Census American Community Survey. It is expected that higher-population MSAs are served by more community colleges and will have greater enrollment totals relative to MSAs with fewer people. Omitting this variable would raise the question whether it is labor market demand or simply population that is driving levels of student participation in related programs.

Design and Methodological Approach

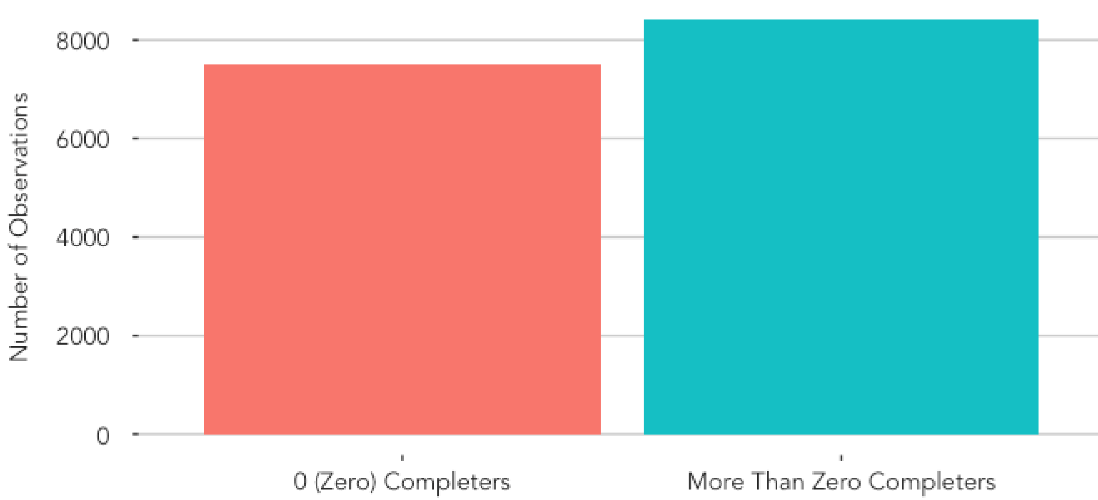
The design of this study is correlational, meaning that although we will be able to establish whether there is a statistical relationship between labor market demand and college enrollments in technician fields, we will not be able to determine whether the labor market signal is causally related to the relationship we observe. To test for the presence of a correlative relationship, we use a zero-inflated negative binomial count model, which is a model for counting the occurrences of certain events. In this case, we use it for modeling counts of program completers.

Distribution of Completers

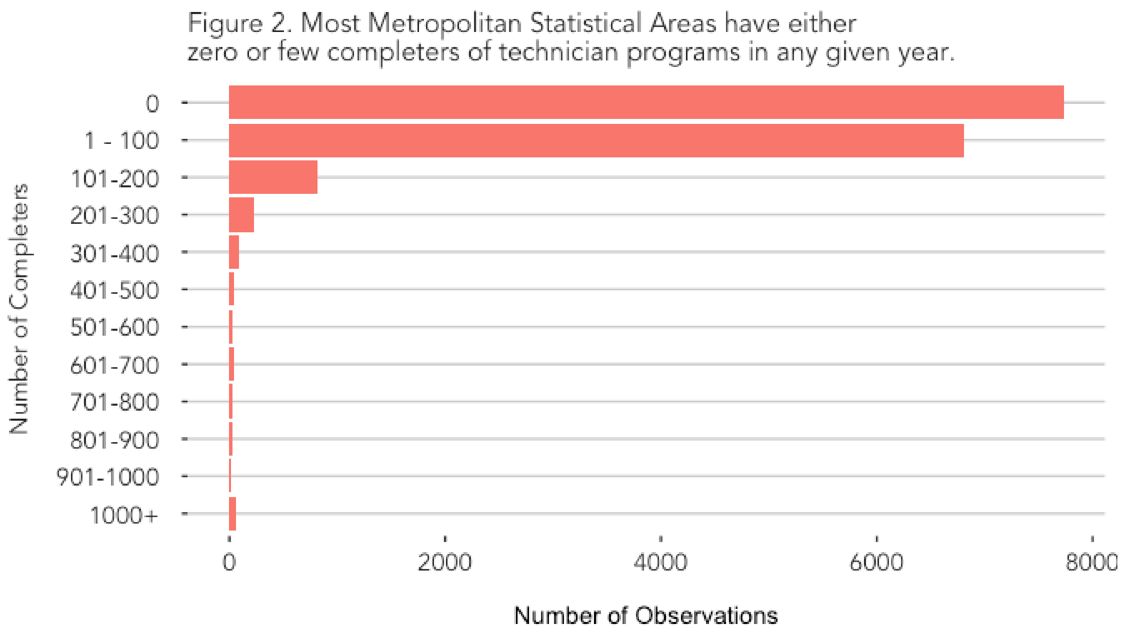
Technician occupations can be somewhat niche occupations in the sense that in some MSAs, the industrial makeup of the local economy may be such that there is little demand for workers in a specific technician occupation. If colleges offer programs based on employer demand, as we hypothesize, then we would expect to find many MSAs in which technician programs related to some occupations are not offered at all simply because there is not enough demand from local industry to make those programs worthwhile. Indeed, Figure 1 indicates that a substantial proportion of the occupation–MSA–year combinations have counts of zero completers.

It is important to note that MSA–occupation combinations only made it into this dataset if there was some level of demand (i.e., employment) reported in every year of the sample in the OEWS data. Our hypothesis is that in MSAs with less demand for trained technicians in a given occupation, fewer colleges will offer—and fewer students will complete—a related program.

Figure 1. Nearly half of Metropolitan Statistical Areas have zero completers of technician programs in any given year.



Even when colleges do offer technician programs, enrollment in them tends to be lower than enrollment in traditional academic fields. So it is not a surprise that the sample skews toward low numbers of students overall, even when colleges do offer technician programs (see Figure 2).



Comparison of MSAs with Low and High Labor Demand

We begin the analytic process by examining the bivariate relationship between the labor market signal (employer demand for labor as measured by the number of workers) and the community college response. Figure 3 shows that MSA–occupation combinations with few workers (left hand side of the figure) are much less likely to have technician programs in related occupations compared to MSA–occupation combinations with higher rates of employment. This is indicated by the greater vertical height of the lower boundary of the red figure compared to that of the teal figure and the greater horizontal width of the teal compared to the red.

Figure 3. MSAs with less labor demand are less likely to have related programs.

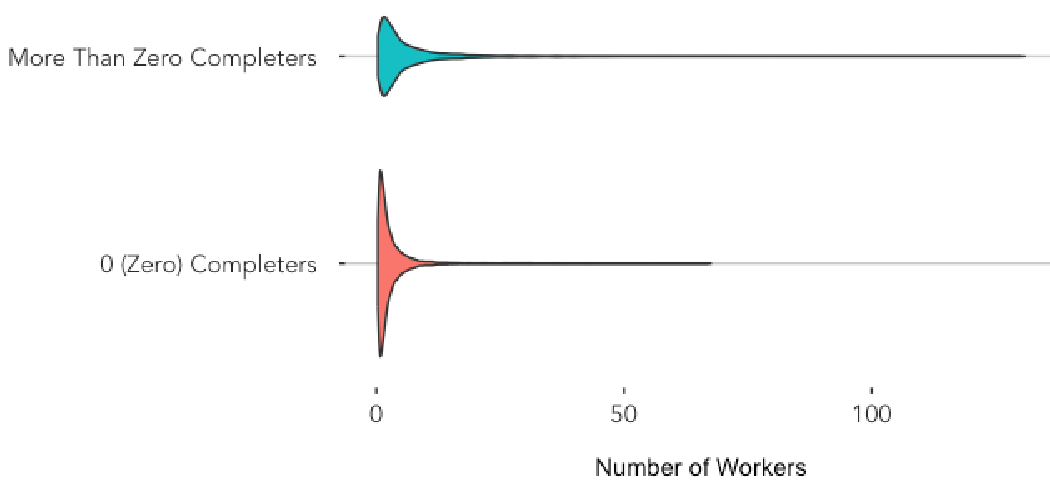
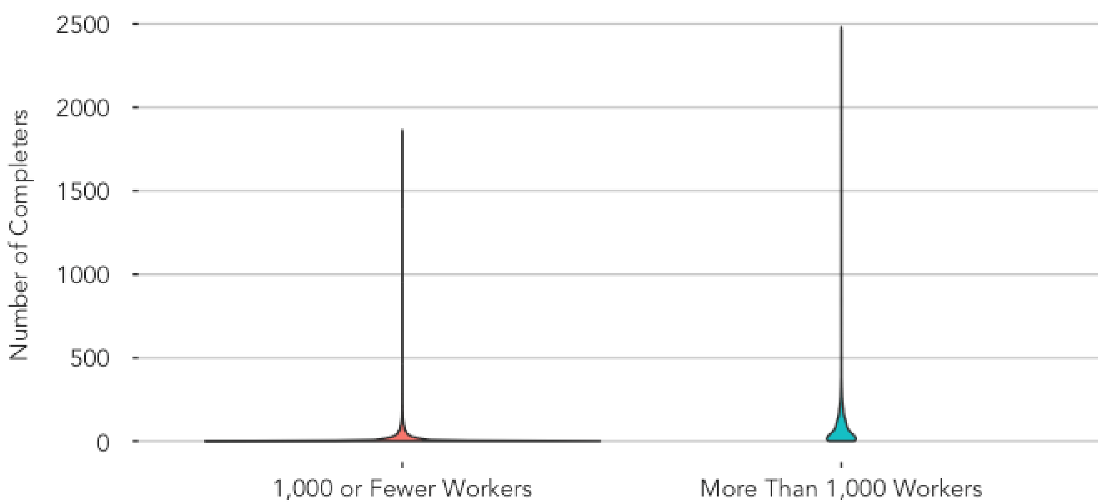


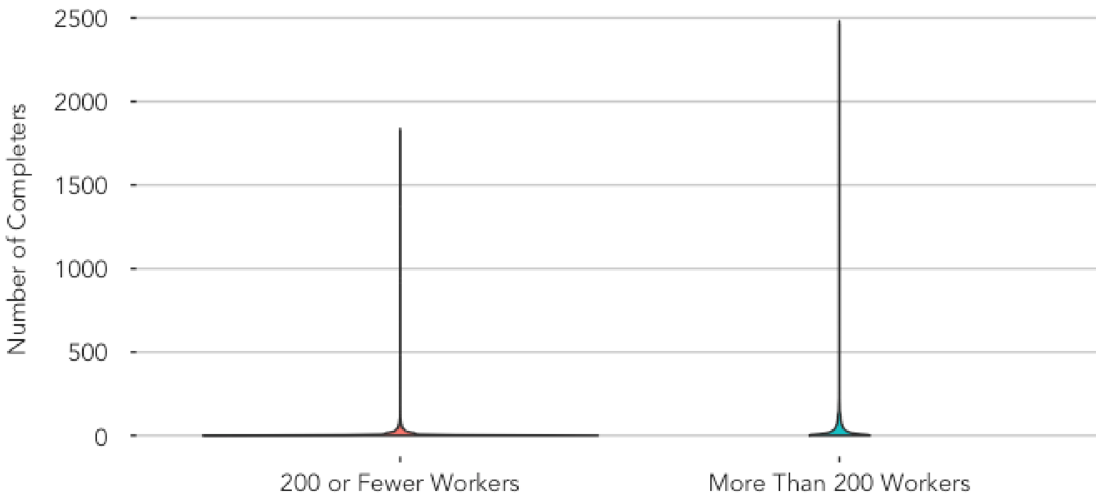
Figure 4 demonstrates that a very small proportion of MSAs with more than 1,000 workers in an occupation has zero students in related technician programs compared with MSAs with fewer than 1,000 workers in those occupations. Likewise, MSA–occupation combinations with fewer than 1,000 workers have a greater proportion of related program areas with zero completers, as indicated by the much wider horizontal line at zero for the red figure compared to the teal figure.

Figure 4. MSAs with fewer than 1,000 workers in an occupation have a greater share of related programs with zero or few students.



Finally, a very small proportion of MSAs with more than 200 workers in an occupation have zero students in related technician programs compared to MSAs with fewer than 200 workers in those occupations.

Figure 5. MSAs with fewer than 200 workers in an occupation have a greater share of related programs with zero or few students.



Results

Results Summary

We ran three separate zero-inflated models, one each for Years 3, 4, and 5 before the students completed programs in related occupations. In all models, the labor market signal—the number of workers employed in the occupation—was statistically significant in the hypothesized relationships for both parts of the zero-inflated model. In other words, more workers were associated with higher counts of completers three, four, and five years later. In addition, more workers were associated with a greater probability of offering a related program—i.e., having more than zero completers—three, four, and five years later. The salary variable was only occasionally significant.

Models Run

We ran three zero-inflated negative binomial models on data pooled across all years. The model included as explanatory variables:

- Number of workers
- Median earnings
- Total completers in the previous year
- Population

Below, we present the results of the model that includes the labor market variables measured four years before the completer count because we thought this was the most reasonable lag to employ. Still, all models, regardless of the time period lag or the inclusion or exclusion of the population variable, generated the same results. Since the data had multiple observations per MSA, the MSA was included as a random effect.
As explained above, in the first model, the number of workers and salary were measured three years before the completer count, four years before in a second model, and five years before in a third model. In addition, we ran year-by-year models. When we ran year-by-year models including the population variable, none of the models converged. When the models did generate results (without converging)—perhaps having found only a local minimum—the number of workers coefficient was always significant. We mention this not as supporting evidence of the proposed hypothesis, but rather to indicate that we did not discover any disconfirming evidence of the hypothesis.

When we ran year-by-year models that excluded the population variable, the coefficient on number of workers was statistically significant in the expected direction for every model.

Coefficients Tables and Visualizations of Results

Count Part of the Model

The number of workers employed in an occupation has a strong positive association with the number of students who completed a related program four years later. Salary, on the other hand, appears to be unrelated, suggesting that colleges may be more responsive to the number of people employed in an occupation than to how much employees in those occupations earn.

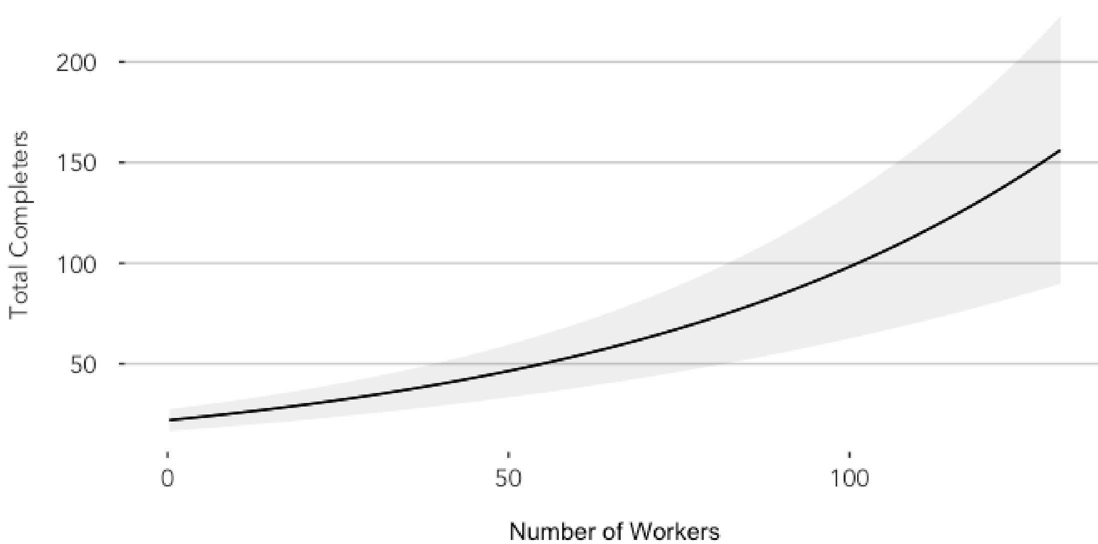
Table 1. Count Model Results

DV = Number of Program Completers	Estimate	Std. Error	z. value
(Intercept)	2.8772	0.0690	41.6956
number_workers_lag4***	0.0150	0.0013	11.2865
total_completers_lag1***	0.0055	0.0002	34.1644
salary_lag4	0.0005	0.0013	0.3977
population***	0.0001	0.0000	3.5665

***p<.001

Table 1 shows that greater numbers of workers employed in technician occupations in an MSA in a given year is associated with higher enrollment in related community college technician programs four years later.

Figure 6. More technician workers in an MSA in a given year is strongly associated with higher enrollment in related technician programs four years later.



Zero-Inflated Part of the Model

The model indicates that more workers in an MSA means that the MSA is less likely to have zero completers in related programs four years later. Table 2 presents the results for the zero-inflated portion of the count model. The negative coefficient on the number_workers_lag4 variable indicates that as the number of workers increases, MSAs are less likely to have zero completers in related programs four years later.

Table 2. Zero-Inflated Model Results

Variable Name	Estimate	Std. Error	z. value
(Intercept)	3.2566	0.2237	14.5595
number_workers_lag4	-0.0528	0.0118	-4.4821
total_completers_lag1	-2.4402	0.1460	-16.7146
salary_lag4	-0.0094	0.0049	-1.9127

Figure 7 charts the predicted probability of observing a non-zero count as the number of workers variable increases. The chart shows that at all values of number of workers, the predicted probability of observing a count greater than zero is quite high—above about 0.85. This is likely because the model is predicting a count between 0 and some maximum. We would expect for the model to predict a count of exactly zero infrequently.

Figure 7. More technician workers in an MSA in a given year is strongly associated with a higher probability of colleges offering related programs four years later.

Conclusion

This study has examined the question of whether community colleges offer programs and expand enrollment in response to labor market demand. All of the evidence from the research is consistent with our expectation that colleges are indeed responsive to labor market demand. Because of the purely correlational design employed in this study, however, we are unable to draw any conclusions as to whether changes in labor market demand cause changes in colleges' programmatic and enrollment decisions. The correlational results are consistent with such a finding, but further research using quasi-experimental designs are required to move this research in the direction of establishing causality.

Appendix

A standard approach to modeling count data is the Poisson family of models.[39] But the negative binomial model is a more flexible model than Poisson for handling count data, as it is better able to handle overdispersion, a situation where there is more variability in the data than what is expected by the Poisson.[40] The negative binomial allows the counts to vary more around the mean than expected. A likelihood ratio test of overdispersion, comparing the Poisson to the negative binomial model,[41] was highly statistically significant, indicating the presence of overdispersion. This signals that the negative binomial model is more appropriate for these data than the Poisson.

The zero-inflated model is appropriate for these data for two reasons:

- *There are many years in which there are zero counts*—the number of graduates from technician programs related to a specific occupation are zero. In addition, there may be more than one data-generating process producing the zeros. One reason for zero counts, of course, is the colleges' perception of labor market demand. They are not offering a program because they think there is insufficient demand for it. There may also be other processes at work, driving what are known as "excess zeros" (e.g., the inability to hire additional instructors or the process of program approval being so involved that it takes an excessively long time to launch a new program). A zero-inflated model is appropriate for such situations.
- *It allows us to decompose the count into two parts:* (1) the probability that the college has more than zero students in a particular occupation-related program (i.e., whether it offers a program) and (2) the number of students enrolled in that occupation-related program at the college. The model has two components: one for modeling the counts, and a second for modeling extra zeros on top of what would normally be expected from the underlying distribution.

The estimating equation for the count portion of the model is:

log(mu) = log(1 - pi) + log(theta) + B1Total Completers Previous Year + B2Number of Workers Four Years Earlier + B3Median Earnings Four Years Earlier + B4Population + MSA indicator (as random effects)

The estimating equation for the zero-inflated portion of the model is:

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39 Cameron, A. C., & Trivedi, P. K. (2013). *Regression analysis of count data*. Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9781139013567

40 Ridout, M., Hinde, J., & Demetrio, C. G. B. (2001). A score test for testing a zero-inflated Poisson regression model against zero-inflated negative binomial alternatives. *Biometrics* 57(1): 219–223. https://doi.org/10.1111/j.0006-341x.2001.00219.x

41 Xiang, L., Lee, A. H., Yau, K. K. W., & McLachlan, G. J. (2006). A score test for overdispersion in zero-inflated Poisson mixed regression model. *Statistics in Medicine* 26(7): 1608–1622. https://doi.org/10.1002/sim.2616

$$\text{logit}(p_i) = a_0 + a_1\text{Total Completers Previous Year} + a_2\text{Number of Workers Four Years Earlier} + a_3\text{Median Earnings Four Years Earlier}$$

Together, these allow for the estimation of zero and non-zero counts.

About

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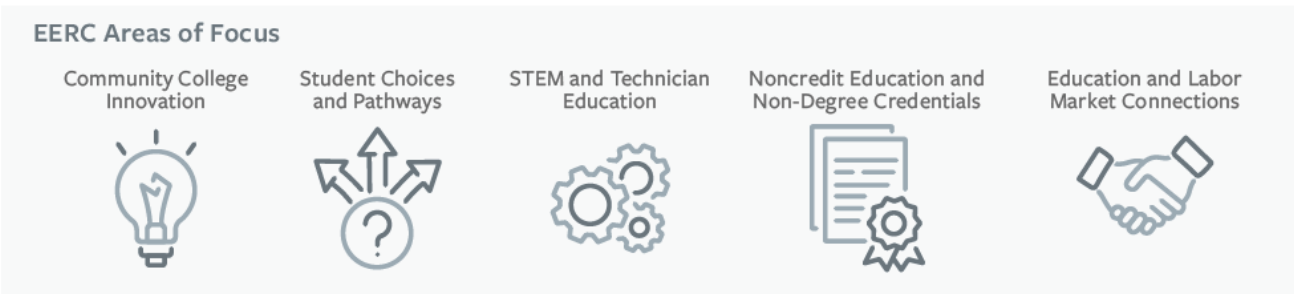

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