Portability: A New Measure for Comparing the Value of Career Certifications

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Abstract

Career certifications represent a cost-effective avenue for post-secondary education, offering immediate employment prospects and facilitating entry into the middle-class. The National Science Board estimated that the US economy will have 3.4 million unfilled skilled technical workforce (STW) jobs by 2022 that were essential to maintain a competitive economy. STW jobs are those that demand specialized technical competencies without a four-year college degree. This research describes a novel measure for the certification portability, to gauge the potential opportunities of a certification in the transition to occupations affording higher remuneration than their initial certified employment. Researchers can use this measure to estimate the value of certifications, to advise policies and practices for equitable technical education. Portability also sheds light on the geographic variability in certification value, providing crucial insights for regional planning. Career development advisors can use this methodology to suggest better training options, particularly important for individuals who do not seek a typical four-year college degree. The portability metric not only enhances the precision of certification valuation but also contributes to incentivizing preferences for technical careers.

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INTRODUCTION

Comparing the value of education and training helps inform policies that ensure a solid labor market and establish adequate career advice. Research has focused on formal education, and there is still a niche to be explored regarding non-degree credentials. Certifications are valuable as a post-secondary education option because individuals seek immediate employment opportunities, certifications are relatively more affordable, and they provide individuals seeking social mobility through technical jobs that the U.S. market desperately needs to fill. The absence of a standardized methodology for accurately comparing the value of certifications calls for further scholarly research.

Addressing this gap is especially important for workers seeking social mobility without a traditional degree. By comparing choices between individual certifications, workers can go beyond simply choosing a job and rather plan careers. There must exist an adequate mechanism to match motivation, credentials, and careers so that workers find opportunities to generate income and, in the long term, specialize in a technical activity that allows the workers to gain experience. The portability of certifications is a measure that helps connect these elements to advise on a successful career technical pathway.

This article describes a measure for determining the portability of certifications. Researchers can use this measure to estimate the value of certifications, and to advise policies and practices for equitable technical education. The methods employed in this analysis does not establish causality between specific certification gains and career progression. However, the metrics proposed in this methodology study provide information on the relative importance of various credentials. We hope this serves as a foundation for further research aimed at quantifying the benefits of

obtaining certifications. In this article, we provide some background on the need for valuing certifications and the gap in current methodologies for doing so. Next, we describe how we created a measure for portability using two datasets and network analysis, and then we show how to use this measure by describing a case study. Finally, we conclude with recommendations for researchers in labor economics as well as considerations for policy makers and career advisers.

The measure of portability portrayed in this study stresses the importance for more flexibility on the job market solutions for individuals. With the rapid changes in technology, an occupation may become obsolete, and certifications proved to be advantageous to obtain a job in a different occupation with relatively similar requirements or a different career pathway. For instance, Gallup reported that 48% of U.S. employees were actively job searching or watching for job opportunities in 2021 (Pendell, 2022). Also, a 2019 Indeed survey revealed that 49% of U.S. workers had made a dramatic career shift at some point in their lives, seeking higher salaries, career development, additional time with family, or more learning (Indeed, 2019).

BACKGROUND

A determinant of the economic competitiveness of the United States resides in its highly skilled workforce. Labor market strength and skills is one of the World Economic Forum's main four pillars for sustaining the United States' high global ranking in competitiveness (Schwab et al. 2020). However, as of 2019, the United States has slipped in skills strength component from third to eighth position globally, a decrease that had been predicted over previous years.

In particular, the United States has a seen a steady decrease in skills strengths necessary for the Skilled Technical Workforce (STW). A job in the STW is one that requires a high level of knowledge in a technical domain such as computers, mathematics, healthcare, architecture,

engineering, construction, or extraction, but does not necessarily demand a four-year college degree (Rothwell 2015). In a 2017 report, the National Science Board predicted the U.S. economy would face a deficit of 3.4 million STW workers by 2022 (NASEM 2017).

Because STW jobs typically do not require a four-year college degree, the labor market has an opportunity to fill the gap in STW jobs by encouraging potential STW workers to attain certifications. A certification is an occupational credential awarded by a recognized entity, such as an industry or professional association, to demonstrate that an individual gained a specific knowledge, skills, and abilities in a particular occupation. Numerous certifications come with defined durations and are subject to renewal (Credential Engine, 2022). Because these certifications are often more affordable and completed more quickly than four-year college degrees, STW jobs provide an opportunity for individuals to enter the middle-class. But the extent of this opportunity varies by the value of different certifications. Therefore, comparing the value of certifications becomes important for two reasons: 1) to ensure the U.S. economy has the necessary skilled technical workforce (STW) to remain globally competitive and 2) to advise potential STW workers on career pathways that enhance their social mobility.

Some STEM occupations that do not require a four-year degree are classified as STW and vice versa. However, most post-secondary education funding, job ad classifications, and immigration policies allocating visas are based on STEM degrees, potentially creating a bias against technical careers in the STW (Kim, 2019). We raise the overlapping importance of STW within STEM fields by differentiating these categories to increase awareness of these issues that may limit education-to-employment pathways for STW careers, a policy aspect that calls for relevant further research.

By social mobility, we refer to the change in the socioeconomic condition of an individual. Social mobility can happen in relation to an individual's parents, also known as inter-generational mobility, or during the individual's lifetime, or intra-generational mobility (Chetty et al., 2014; Narayan et al. 2018). For many potential STW workers, inter-generational mobility is not an option, so attaining social mobility requires them to make the change themselves, for example, by planning a career they can access and grow in.

Previous research has provided methodologies for comparing the value of education and training, including certifications. Becker (1962) pioneered the study of human capital investments by estimating the returns to schooling. Later, Mincer's equation (Mincer 1975) became the standard model to study returns to years of schooling and experience. Based on human capital accumulation from Becker (1962), and signaling model effects (Spence 1978), Acemoglu and Autor (2011) estimated an earnings premium between college and high school graduates: premium from college education increased from 49.2 % in the 1970s to 97.4 % by 2008. Belfield et al. (2017) concluded that sub-baccalaureate degrees have important salary returns in the United States: associate degrees yield approximately from $4,640 to $7,160 in additional earnings per year, compared to non-complete college in 2014. Also, certifications showed a positive but modest earnings returns with an average annual increase of $2,120 and $2,960 (2014 dollars) for men and women, respectively.

However, more recent literature suggests that college premiums have stagnated (Autor et al., 2023; Bengali et al. 2023; Valetta, 2018; Weber, 2022). This raises the question – if the costs of going to college outweigh the benefits, will certifications become more important? Or perhaps the value of certifications has an impact on college premiums. The relative value of certifications remains to be fully clarified. Minaya et al. (2017) examined returns of associate degrees and

certifications of community college students for 11 years in Ohio and found that the expected return linked to an associate degree grew substantially after graduation whereas the value of a certification remained flat in the long term. In California, Bahr (2016) observed that the returns of associate degrees last the longest over time and short and long-term certifications maintain or decline over time, typically after seven years. Also, Bahr found that engineering and industrial technologies, biological sciences, health, law, and protective services yielded the most consistent positively returns across both degrees and certifications.

The stagnant college premium and the need for rapid entry into the workforce underscores the increasing importance of job certificates over time. This trend is driven by rapidly changing labor market demands, with certifications often providing specialized training and practical skills that align more closely with job requirements. Additionally, certifications are typically less time-consuming compared to a four-year degree, enabling individuals to enter the workforce more rapidly or transition to new careers. Moreover, certifications also become a financially appealing option, allowing individuals to avoid the significant debt often associated with obtaining a college degree.

If we value certifications by their ability to create multiple career pathways rather than by impact on earnings, their value appears to increase. Adult learners often use certifications to switch to new industries, rather than just seeking an earnings boost, at least in the short term (Xu et al. 2016). Also, certification holders earn more than high school graduates without further education (Carnevale 2013; Belfield 2011; Bailey et al. 2004). Xu et al. (2016) also found that long-term certifications in technical areas, such as mechanics, repair, welding, and nursing, yield high returns in Virginia. Regarding field of study, the highest earnings were found in transportation, business, mathematics, nursing, and allied health certifications. Certifications may

be more valuable than previously estimated, but some certifications are likely to be more valuable than others once we include the portability of certifications in our estimate.

Portability is the extent to which a certification (or other credential) enables the holder to transition to one or more jobs that offer higher pay than the job initially obtained through the certification. The measure of portability proposed in this study aims to enhance workers' understanding of the extent of potential benefits of certifications, thereby motivating them to enter the skilled technical workforce. As a measure, we define the portability of a certification with two factors: 1) the number of occupations which list this credential and 2) of these occupations, the number of occupations that offer a higher salary for certified employees than employees without certification. Figure 1 shows an example of how we define the portability of a certification based on not only number of occupations but also whether those occupations permit higher salaries. Occupations are categorized under skilled technical workforce (STW); Science, Technology, Engineering and Mathematics (STEM), and others using the 2019 O*NET SOC classification (Lancaster et al., 2021) and definitions of the National Science Board (2019).

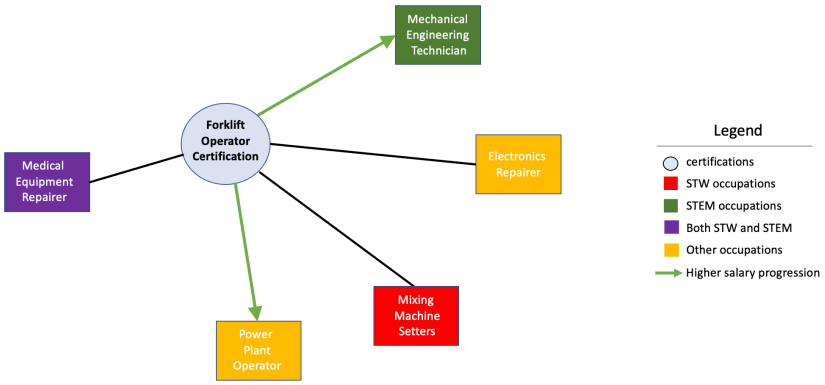


Figure 1: Graphical explanation of portability of certifications using networks. Colors differentiate STW, STEM and other occupations.

By measuring portability, we can more accurately compare the value of certifications for enabling multiple career pathways, thereby making social mobility more accessible. In the following sections, we describe a new methodology to measure the portability of certifications. We then describe the results of measuring portability in one case study: the Manufacturing industry in Virginia. We then discuss how the results from this case study can inform advice for career planning, while also providing recommendations to researchers considering using this methodology.

DATA AND METHODS

Data

The analysis described in this paper relies on two main sources of information: salaries and occupation-credential connections. We prepared data for the network analysis through two primary methods. The first method utilized publicly available data accessed via the Department of Labor and the Bureau of Labor Statistics. The second dataset was constructed from a proprietary database of web-scraped job advertisements provided by Burning Glass Technologies (now Lightcast), which we acquired through grant funding. Our analysis assesses the connections between occupations and certifications within the nine Virginia Growth and Opportunity Regions (VA GO), as delineated by the Virginia Growth and Opportunity Initiative.

Our main data source for occupation-certification connections is 2021 O*NET program data sponsored by the Department of Labor. The O*NET database includes more than 1000 occupations classified by Standard Occupation Classification (SOC) codes, a federal U.S. standard to classify

workers across 23 major occupational groups. O*NET aggregates occupations of similar skillsets into 16 Career Clusters. This article uses these codes to focus on the Manufacturing Career Cluster containing 150 occupations, and the bulk of our analysis focuses on O*NET's official list of occupation and certification connections for our network analysis. O*NET does not include information on salaries associated with occupations, so we supplement this data with the Survey of Occupational Employment and Wage Statistics from the Bureau of Labor Statistics (BLS) which includes annual wage estimates for over 800 occupations. (BLS, 2022).

The alternative occupation-certification dataset is created using 2019 Burning Glass Technologies (BGT) data. BGT uses artificial intelligence technology to scrape hundreds of millions of job postings worldwide to provide job market analytics for employers to make data-driven decisions. This is a rich dataset including SOC codes, skills, certifications, and salaries. Using the same Career Clusters from O*NET, we also select only the Manufacturing Career Cluster from BGT. A previous report reviews the usability of Burning Glass job ads data (Lancaster et al., 2019).

We have a dataset containing occupations, certifications, and their respective salaries for the 150 occupations Manufacturing Career Cluster. This allows for the creation of an Occupation Certification Network, which represents shared certifications between manufacturing occupations, while retaining information about each occupation's average salary. While we leverage salary gains to assess certification portability, this research does not analyze the correlation between certifications and higher salaries. Instead, we describe a method to identify potential opportunities associated with specific certifications within the skilled technical workforce.

Network Analysis

We study labor market information for certifications and occupations using network analysis to facilitate the understanding of career pathways. The fundamental elements of networks are nodes and edges. Nodes are the origin or destination points which are connected by relationships (edges). These concepts lend easily to occupation networks, where occupations are connected by their shared credentials. The output of this network analysis is a sequence that starts on a node (initial occupation), continues through an edge (the certification) and leads to a new node (new occupation). This sequence is considered as a career pathway.

We use network analysis because it allows the measurement of structures that would be practically impossible to represent without relational concepts. Additionally, network analysis permits the explicit graphical representation of units that influence one another, using foundations of graph, statistical, and probability theory.

One of the most important measures in network analysis is degree centrality, which indicates the number of connections derived from a particular node. The measure of centrality identifies the relevance of relationships within a network (Kolaczyk et al., 2014). Degree centrality represents the extent of opportunity given by a certification. For example, as in the study described further below, where occupations are nodes connected to other occupations through certifications (the edges), one individual who works in occupation *i*, can obtain a certification *v* that allows them to advance to another occupation *j*. This may be the case of a maintenance worker who may become a First Line Supervisor of repairers after obtaining a Managerial Plant Maintenance certification.

Mathematical Expressions for Analyzing Portability

We developed two mathematical expressions to enable a measure of portability. First, we developed a mathematical expression to create the Occupation Certification Network, using the two previously described datasets. Consider an adjacency matrix *M* that represents the network relational structure, with *i* row and *j* column elements, that is, M_{ij}. We represent a connection between nodes (occupations) *i* and *j* using $M_{ij} = 1$, and $M_{ij} = 0$, otherwise. For example, matrix *M* below suggests that occupation *i=1* has a connection with 2 occupations (*j=2* and *j=4*) through a certification:

$$M = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 \end{bmatrix}$$

The degree of centrality of node I is given by the sum of the elements of the corresponding row I of the adjacency matrix M, which can be represented by the following expression, where J is the total number of nodes in the network:

$$C_i = \sum_{j=1}^{J} M_{ij} \tag{1}$$

Next, we add a constraint to the degree of centrality to characterize wage progression. Consider adjacency matrix M, with pairs of existing occupations connected by a certification, as described above. Consider salaries for initial occupations (w_i) and progression occupations (w_j), where salaries are determined independently of the network. Then, a portability matrix P is formed by the relational matrix M, subject to salary constraint indicating wage increase, that is, as long as, $w_j > w_i$, which is given by the matrix identifying wage progression, W_p. The portability matrix

can be constructed by the multiplication of matrix M times the wage-progression matrix, where $P = M \times W_p$. Matrix P shows the progression path that is graphically depicted above in Figure 1, where only two resulting occupations provide higher salaries than the starting occupation, indicating the portability extent of the Forklift Operator certification.

EMPIRICAL FINDINGS AND ANALYSIS (RESULTS)

Demonstrating the Measure of Portability

To demonstrate how this method enables a measure of portability, we now describe a case study on the portability of certifications for STW jobs in Virginia using a subset of the O*NET data for the conceptualization and the BGT information for the practical case study for 2019. We focused on STW occupations because of their importance for the competitiveness for the U.S. economy (ref NCES). Note that while we focused on certifications for STW jobs, some of these certifications lead to jobs in other skills areas. We captured this information in the network using four categories: STW, STEM, both STEM and STW, and Other occupations (Lancaster et al., 2021). In addition to understanding the portability of a certification, this categorization helps show where training towards an STW career may enable workers not just to transition into higher-paying jobs but transition into new industries as well.

The Manufacturing Occupation and Certification Network from O*NET indicates that some occupations provide more opportunities for career advancement than others. Within the manufacturing occupations, 13 occupations connect to a total of 59 certifications that appear disconnected from the overall network of career advancement, as "isolated" occupations (see

figure 2). These 59 certifications have a portability of 1. For example, Figure 2 shows how the Vending Machine Repair certification leads to just one occupation (Coin Vending Servicers), indicating that this certification has low portability of 1.

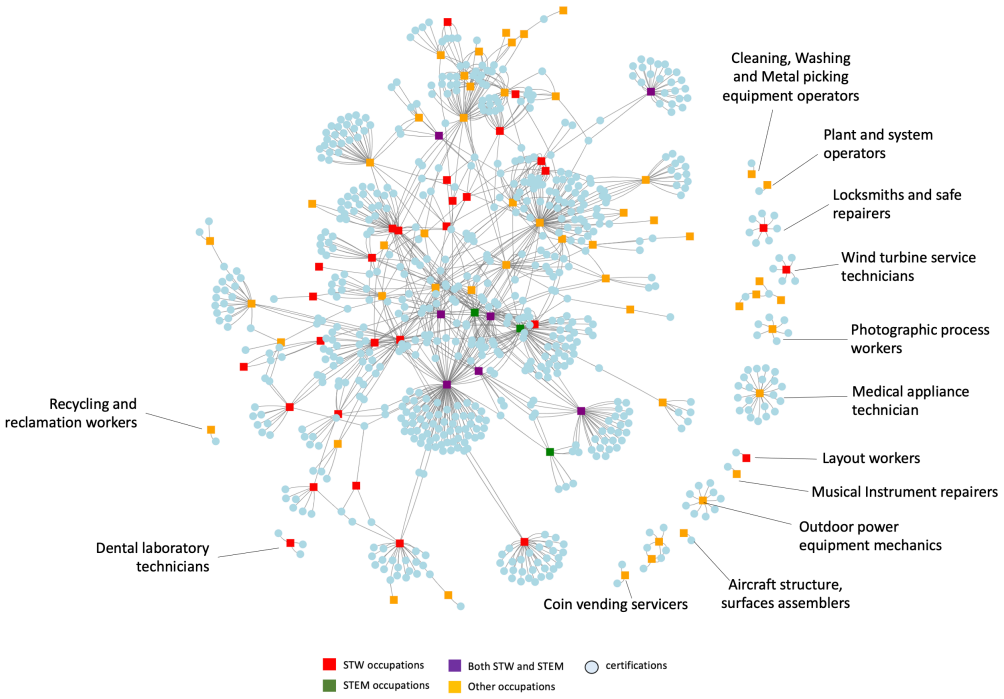


Figure 2: The Portability Network of occupations and certifications in the O*NET Manufacturing cluster shows that some certifications have high portability (center nodes) and some certifications have low portability (disconnected nodes on the edges).

Where an isolated occupation has multiple certifications, such as Medical appliance technicians with 21, the lack of portability of the certifications may in fact be a lack of portability within the Manufacturing cluster only. For example, the certifications connected to Medical Appliance Technicians also connect to occupations in another cluster. Therefore, determining the portability of a certification requires examining more than one cluster at a time. Furthermore, these apparent

disconnects indicate a potential need to reclassify some of these occupations, both in this analysis and more importantly when promoting certifications and training.

By measuring the portability of the certifications, we can then more accurately compare the value of different certifications—by not only average salary increase but also by the potential to advance to more than one occupation with higher salaries. Figure 3 compares the potential salary increase enabled by a certification with the potential job opportunity increase (portability) enabled by a certification. For example, although the Back-Flow Certification appears to offer the highest value in dollars ($8,253), this certification is one of the least portable, with only two career opportunity ahead (Engineering Technicians and Industrial Machinery Mechanics). Meanwhile, the Welding certification provides opportunity to advance to six new jobs with higher wages, including Engineering Technicians, Inspectors, Testers, Sorters, Samplers, and Weighers; Non-Destructive Testing Specialists; Production, Planning, and Expediting Clerks; First-Line Supervisors of Mechanics, Installers, and Repairers; and Photographic Process Workers and Processing Machine Operators. Figure 3 shows the portability measure, and the average salary increases to graphically identify the champion certification that combines the most possibilities for a career (portability) along with the best dollar gain. The commercial driver's license class A (CDL class A) and the cardiopulmonary resuscitation and automated external defibrillator (First Aid Cpr Aed) certifications possess the highest portability measures with salary increases of $4,904 and $3,744; respectively. These two certifications may rather seem generic across several industries. The welding certification also presents the next highest level of portability, by enabling advancement to 6 occupations with higher salaries and enabling an average salary increase of more than $4,000 per year (2019 dollars).

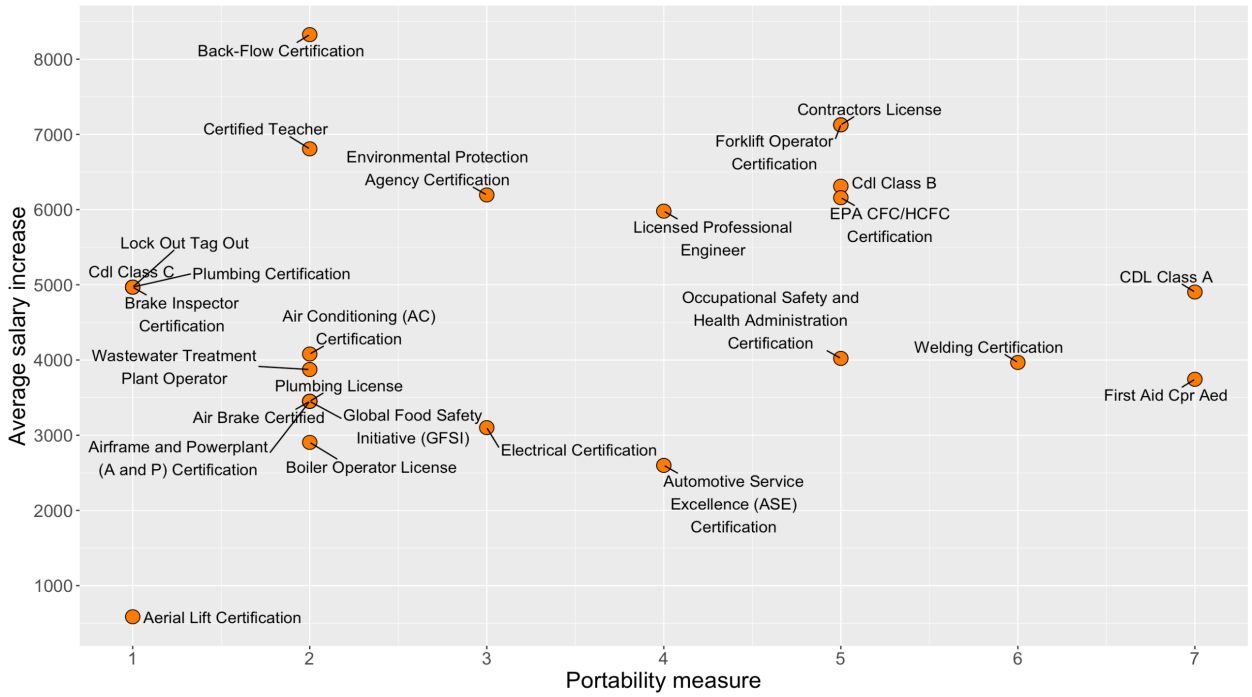


Figure 3: Portability and salary increase of certifications. Every observation corresponds to a certification and indicates the number of potential job opportunities (x-axis) and the potential dollar increase in salary (y-axis)

In addition to comparing the value of certifications—by salary increase *and* portability—within occupation clusters, we can also compare the value of certifications across geographic regions. Our dataset uses nine regions identified by the Virginia Initiative for Growth and Opportunity (VA-GO 2023). VA GO is an economic development initiative to strengthen the economy, education, and business in the state of Virginia. This initiative created nine geographical clusters according to their most common industries and provides context for the occupations: VA GO Region 1, Southwest Virginia, is characterized by Energy and Minerals, Advanced Manufacturing Agriculture, and Food and Beverage Manufacturing. Region 5, Hampton Roads, specializes in Advanced Manufacturing, Shipbuilding and Repair, Logistics, Port Operations, and Warehousing. Finally, Region 7's Northern Virginia economy is primarily based on Computer Services,

Cybersecurity, Consulting, Financial and Engineering Services, and Research Organizations. See Figure 4 for the VA GO map.

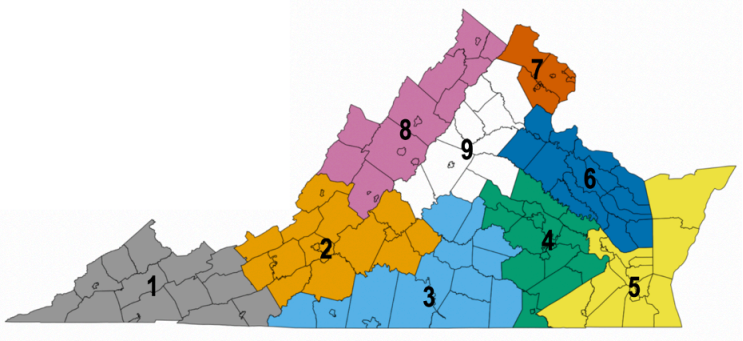
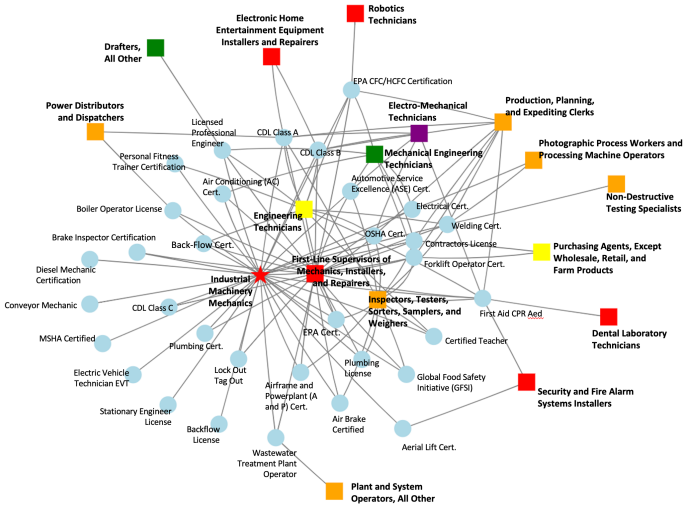


Figure 4: Map of the nine Virginia (VA) Growth and Opportunity (GO) Regions, taken from Virginia Growth and Opportunity Initiative (image courtesy of VA-GO 2023).

Our analysis by region shows that the portability of some occupations is region-specific. For example, Figure 5 shows the portability network for one of the occupations in the Manufacturing cluster: Industrial Machinery Mechanics. Of the 33 certifications linked to this occupation, 27 certifications lead to another occupation with higher salary, indicating relatively high portability for certifications connected to this occupation in Virginia.



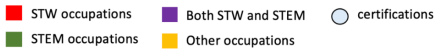
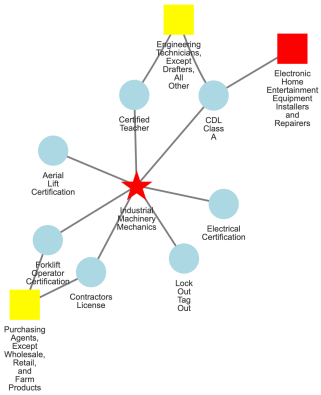


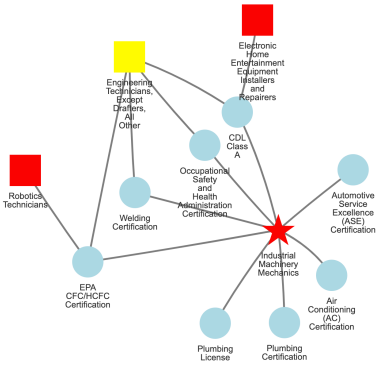
Figure 5: Virginia's portability network for industrial machinery mechanics (the occupation indicated by a red star in the center of the network) indicates that most certifications connected to this occupation are relatively portable: lead to occupations with higher salary.

However, when we look at the network by region, we see that the portability of the certifications connected to Industrial machinery mechanics is higher in some regions than others (figure 6). Specifically, a person with a certification connected to Industrial machinery mechanics has the most opportunity to advance to a higher paying job in Region 5. Compared to the 3 or 4 occupations that connect to this certification in Regions 2, 4, 6, and 7, Region 5 connects to 19 occupations. Therefore, the certification has high portability—enables the most possibilities for career advancement for these mechanics—specifically in the region that has the largest industrial complex in the state.

Region 2

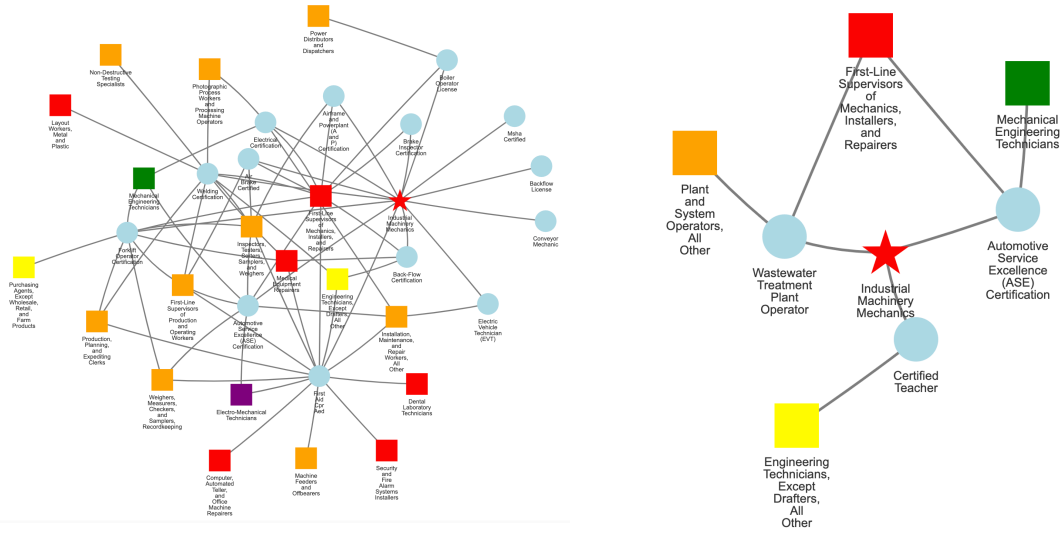


Region 4



Region 5

Region 6



Region 7

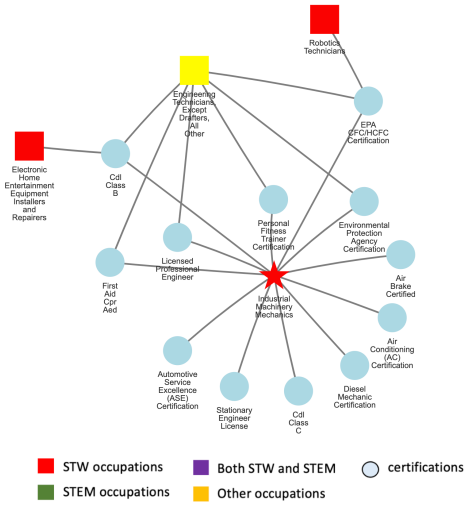


Figure 6. Example of the certification-occupations network for different VA GO regions with available information. Region 5 offers the most portability for certifications connected to Industrial Machinery Mechanics.

Other occupations face a more complex landscape of certifications and career connections. For example, Figure 7 summarizes the results of this study with the certifications with the largest dollar increase in salary and the highest portability for the occupations that comprise the Manufacturing career cluster in Virginia. We provide a summary of findings to try to answer the

research questions of this study, regarding the most valuable certifications, which are the certifications that have the highest portability, and the largest salary increases. Job ads for Industrial Machinery Mechanics were found in 5 VA Regions and that is why Figure 7 includes subfigures within 5 regions only.

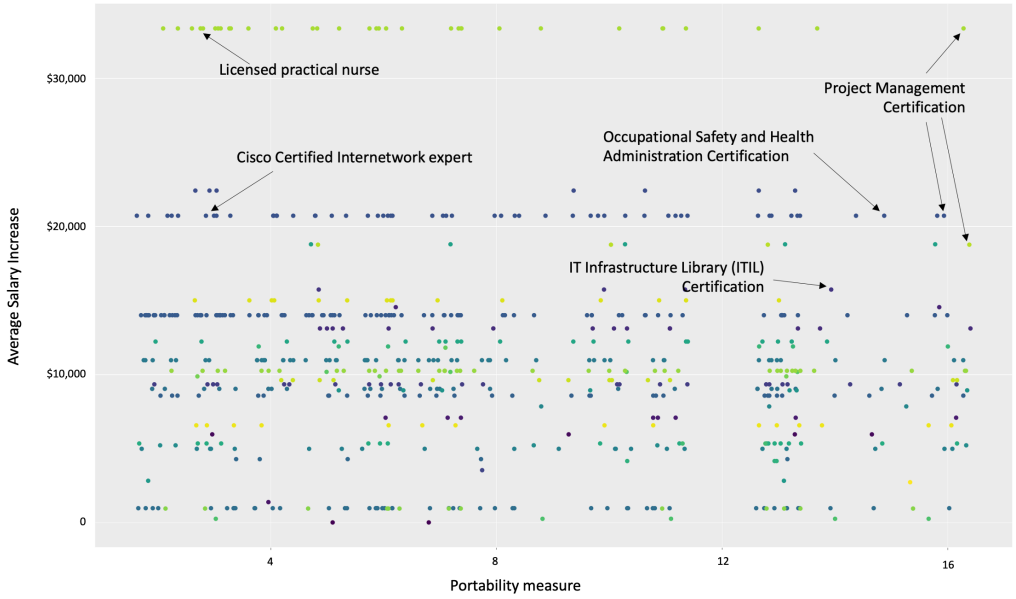


Figure 7: Portability indicating the number of potential next occupations (x-axis) and average dollar increase in salary per year of certifications for Maintenance and Repair Workers in Virginia. Colors indicate different occupations. Source: BGT, 2019.

DISCUSSION

By measuring portability, we identify certifications that are more likely to facilitate technical workers' career progression and economic mobility. For example, we observe how the Back-Flow Certification appears to offer the best chance of economic mobility—until you measure portability. Once we determine the portability of the certifications in that geography, we learn

that rather the Welding certification offers the best chance of both career advancement and economic mobility. Measuring portability unfolds information about certifications that otherwise goes unseen, thereby enabling a more accurate estimation of a certificate's value.

One of the strengths of this methodology is the identification by geography and industry of the portability metric, which, combined with a salary increase, could help advise the most beneficial choice of certification for an individual based on their career goals. For example, while Project Management is the champion certification in the Maintenance and Repair industry overall, an individual who plans to live in VA Region 9 might have a better chance of economic mobility with a CompTIA Security+ certification, which has more portability in Region 9 than Project Management. The portability measure responds to the economic composition of the region. This suggests that future work could use multilevel modelling techniques to estimate regional variation in certification portability, or alternatively, adjust for regional differences to rank certifications by their portability in a linear model.

In addition, an individual who wants to break into a new industry might best fit an Occupational Safety and Health Administration Certification, which enables portability not only within Manufacturing but also connects to higher paying careers such as Dental Technician in the Healthcare industry.

We want to highlight that this method for determining portability has several limitations. For instance, a worker's career advancement and salary returns are determined by multiple factors, such as years of experience, formal education, industry, non-technical skills, or required combinations of certifications (i.e., teamwork or enduring stressful environments). The marginal effects of these variables must be evaluated using causal methods that go beyond the scope of

this research, yet we hope will be motivated by this work. Another limitation is the need for specific datasets using data from job ads, which are currently not publicly available. The information detail, geographic granularity, and time adequacy of this data are fundamental. This study was completed using proprietary data, whose cost may be prohibitive for some researchers. Finally, the study uses the demand-side information of the labor market, that is, the information posted by employers in job ads, with minimum and maximum ranges of salary. This information does not contain the final salary after an employer-employee negotiation, reallocation benefits, and additional compensations.

Our portability certification method is a novel methodology to understand the vast and complex network of certifications in the labor market in the United States. There are more than 500,000 non-degree credentials according to Credential Engine, and this study is the first attempt, to the best of our knowledge, to provide a detailed connection of jobs with specific certifications along with their salary returns. The network analysis clarifies the value of a certification using a combination of two elements: salary gains and pipelines to more occupations.

Certifications vary in cost, time requirements, and validity. These constraints should be considered when advising job seekers on selecting an occupation that matches skills and credentials. An analysis of costs warrants its own specific study. However, there is no source of information that centralizes data on the costs of such a large number of diverse and non-standardized non-degree credentials, to the best of our knowledge. A new research effort is needed to address the information needs about the costs associated with certifications to provide adequate data-driven recommendations.

In future studies, researchers might want to obtain publicly available data to compute portability measures. However, there might be potential alternatives that can be substitutes for private data. For example, the National Labor Exchange (NLx) collects information from the Direct Employers (DE) and the National Association of State Workforce Agencies (NASWA) for the entire United States. Then NLx condenses this information in a unique and centralized friendly platform all the possible information regarding job ads, industries, salaries, certifications, and skills. A next step would be to strengthen the capabilities of NLx and similar open-source data venues to include the metric for certification portability.

CONCLUSIONS

Assessing portability helps researchers determine the value of certifications more accurately. For example, portability shows whether a worker can switch to other jobs with the potential for higher salaries. The worker benefits from a more transparent picture of the training requirements for a career upgrade. With a transparent pathway for a technical career, first-time workers can more easily plan their careers over the long term, and incumbent workers may find a helpful guide for easier career transitions with improved economic returns.

Additionally, portability shows how the value of a certification can vary by specific geographies. Knowing where a certification leads to more jobs with higher salaries also helps workers plan their careers in the long term: workers can plan which careers are available to them based on where they live now and may live in the future.

With this methodology, people who advise on career development can suggest better training options for individuals. Using portability to advise on certifications is particularly important for advising workers who do not seek a typical four-year college degree. In addition, measuring

portability may help Offices of Employment and career placement enhance training pipelines towards industries with high demand for specific skills, like in the case of Manufacturing.

For researchers and policy makers in labor economics, the portability measure can provide additional insights to incentivize technical career preferences. The United States has a large demand for Skilled Technical Workers. The insights gained from measuring portability may inform policies to develop a workforce with the necessary skills for these technical industries. For example, given the high portability of a Welding certificate, and the high demand for welders in the United States, policies might promote the addition of Welding certificates to community college offerings and promote the high return on investment of this certificate to encourage enrollment in these certificate programs.

The portability measure helps solve the career selection dichotomy between higher salary searching and career advancement. First-time workers may face limitations regarding years of experience that may translate into salary caps. Having the information enabled by the measure of portability, these workers can plan for training options not just to apply for a job, but to plan a career that aligns with their skills and motivation. And when workers pursue training and employment that aligns with their skills and motivation, retention rates and job performance improve.

DECLARATIONS:

Availability of data and materials: The data used is proprietary. If any researcher wants to access this dataset, please contact the corresponding author.

Competing interests: We declare that the authors do not have any competing interest in the manuscript.

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