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Transitioning to the New Economy: Individual, Regional and Intermediation Influences on Workforce Retraining Outcomes

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GOLDSTEIN H. A., LOWE N. and DONEGAN M. Transitioning to the new economy: individual, regional and intermediation influences on workforce retraining outcomes, *Regional Studies*. The problem of helping workers employed in older manufacturing sectors shift to jobs in growing, high-technology sectors continues to frustrate workforce and economic development officials. An innovative retraining programme in North Carolina has been instituted to train former workers for jobs in pharmaceuticals and biomanufacturing. This study examines what factors best explain whether trainees are successful in receiving job offers after completing their programmes, with a special focus on whether training providers that serve workforce intermediary roles, in addition to their educational role, lead to more successful outcomes for their trainees.

New economy Workforce Workforce intermediary BioWork Job training

GOLDSTEIN H. A., LOWE N. and DONEGAN M. 转向新经济：个体、区域以及中介对劳动力再培训的影响，区域研究。对于劳动及经济发展部门的官员而言，如何帮助在旧生产部门就业的工人转向持续增长的高新技术部门中就业是一个尚未解决的难题。在北卡罗来纳，一项极具创新力的再培训项目开始对之前的职工进行培训，使之能在制药业以及生物制造业谋求职位。本研究重点考察哪些要素有助于解释培训者是否在接受培训后成功地获得相关工作职位，特别关注那些除了承担教育职责之外还担负着劳动力中介作用的培训机构是否为其培训对象带来理想的结果。

新经济 劳动力 劳动力中介 生物业 就业培训

GOLDSTEIN H. A., LOWE N. et DONEGAN M. La nouvelle économie en voie de transition: les influences individuelles, régionales et intermédiaires sur les résultats du recyclage de la main-d'oeuvre, *Regional Studies*. Le problème de comment aider les travailleurs des secteurs industriels plus anciens à trouver de l'emploi dans les secteurs en pleine croissance, de pointe ne cesse d'agacer les agents du travail et du développement économique. Un programme innovateur de recyclage en Caroline du Nord a été lancé dans le but de former les anciens travailleurs pour des emplois dans la pharmaceutique et les industries biologiques. Cette étude cherche à examiner les facteurs qui expliquent le mieux si, oui ou non, les stagiaires réussissent à trouver de l'emploi en fin de stage, portant principalement sur la capacité des centres de formation, qui constituent des intermédiaires quant à la main-d'oeuvre, de faciliter des résultats plus réussis pour les stagiaires, en sus de leur rôle éducatif.

Nouvelle économie Main-d'oeuvre Intermédiaire du travail BioWork Formation

GOLDSTEIN H. A., LOWE N. und DONEGAN M. Übergang in die neue Wirtschaft: individuelle, regionale und vermittelnde Einflüsse auf die Ergebnisse bei der Umschulung von Arbeitnehmern, *Regional Studies*. Die Probleme bei der Unterstützung von Arbeitnehmern in älteren produzierenden Betrieben beim Wechsel in wachsende Hochtechnologiesektoren sorgen unter der Belegschaft und unter den Beauftragten für Wirtschaftsentwicklung weiterhin für Frustration. In North Carolina wurde ein innovatives Umschulungsprogramm ins Leben gerufen, bei dem ehemalige Arbeitnehmer für Tätigkeiten im Bereich der Pharmazie und Bio-Produktion ausgebildet werden. In dieser Studie wird untersucht, welche Faktoren nach Abschluss des Programms für den Erfolg der Arbeitnehmer hinsichtlich des Erhalts von Stellenangeboten die größte Rolle spielen, wobei besonders auf die Frage eingegangen wird, ob Schulungsanbieter, die nicht nur eine Ausbildungs-, sondern auch eine Arbeitsvermittlungswahrnehmung, mit für die umgeschulten Arbeitnehmer erfolgreicherem Ergebnissen verbunden sind.

Neue Wirtschaft Arbeitnehmer Arbeitsvermittlung BioWork Berufsausbildung

GOLDSTEIN H. A., LOWE N. y DONEGAN M. La transición a la nueva economía: influencias individuales, regionales e intermedias en los resultados de la formación de los trabajadores, *Regional Studies*. El problema de ayudar a los trabajadores empleados en sectores antiguos de manufactura a cambiar a trabajos en sectores de crecimiento y alta tecnología continúa frustrando al personal y a los funcionarios del desarrollo económico. Se ha creado un programa innovador de formación en Carolina del Norte para capacitar a antiguos trabajadores para empleos en laboratorios farmacéuticos y empresas de biomanufactura. En este estudio examinamos qué factores son más importantes para determinar si los trabajadores reciben ofertas de trabajo al finalizar los cursos, y especialmente si los proveedores de los cursos, que además de tener un papel educativo desempeñan un rol de intermediarios con los trabajadores, ayudan a que los trabajadores obtengan mejores resultados.

Nueva economía Mano de obra Intermediarios de la mano de obra BioWork Formación laboral

JEL classifications: J24, J68, O15, R23

INTRODUCTION

Many regions in the United States whose economic bases have been based on traditional manufacturing industries have struggled to identify and implement successful strategies for transitioning to the 'New Economy'. Although there are many factors that impede successful transitions, one that stands out in the literature is the shortage of skilled labour demanded by firms in technology-based manufacturing sectors (APPELBAUM *et al.*, 2003). Without a deep pool of requisite labour skills, many firms will shun locating in these regions. Relying on in-migration is seen as risky, especially in regions that have been facing competitive disadvantages, declining levels of public services, and above-average unemployment.

An obvious strategy for areas facing this dilemma is the design of customized training and retraining programmes. While Federal government-sponsored job-training programmes have had a somewhat checkered history (WEIR, 1993; LEIGH, 2000; O'LEARY, 2004; OSTERMAN, 2007), a number of states have been experimenting with a variety of new approaches to job retraining (OSTERMAN and BATT, 1993; FITZGERALD, 2006). One emergent strategy involves workforce intermediation. Workforce intermediaries take a dual-customer approach in that they broker the relationship between employers and their prospective employees. With this goal in mind, they provide structured job-placement support to job seekers that goes well beyond basic delivery of a training curriculum. They also establish alternative institutional arrangements between training institutions and employers in order to overcome many of the problems that have plagued traditional job-training programmes in the past (GILOTH, 2004; FITZGERALD, 2004; OSTERMAN, 2007).

This paper, by utilizing data collected on the experiences of participants in one such innovative programme in biomanufacturing implemented in multiple community colleges among different regions of North Carolina, addresses the following question. What factors explain which participants in job-retraining programmes are successful in receiving job offers in the 'new economy'? The paper posits and tests four types of explanatory factors:

- Individual demographic and human capital characteristics.
- Participants' geographic proximity to job vacancies.
- Institutional characteristics of the community college attended, defined here as the degree to which the college functions as a strong workforce intermediary.
- Regional and sub-regional economic and labour market conditions.

The contribution being made to existing studies of worker retraining is an examination of a single training curriculum that is implemented across multiple training facilities that perform differently with respect to workforce intermediation. This enables one to examine the added influence of intermediation on employment outcomes. Across all models, a consistent and positive relationship is found between employment outcomes and the completion of training at a college that functions as a strong workforce intermediary. Additionally, consistent and positive effects of previous work experience in microelectronics are found, reflecting worker exposure to similar production processes and industry standards (that is, clean-room production and good manufacturing practices) found in biomanufacturing. Several of the models also suggest that job seekers who have recently experienced a layoff due to a plant closing or downsizing, who have limited college-level science or mathematics exposure, or who live in an urban county may be at a relative disadvantage during their job search.

The paper is structured as follows. The next section contains a brief review of the pertinent literature. The third section provides contextual background on the North Carolina economy and the BioWork programme. The fourth section describes the methods, data, and variables, and provides the expected relationships between each of the explanatory variables and the dependent variable. The fifth section reports the models' results; while the last section contains a discussion of the results and the principal conclusions.

A REVIEW OF THE LITERATURE

The adjustment of workers to changing regional labour market conditions has been examined through several

theoretical lenses, four of which are outlined in this section and provide the basis for the authors' choice of specific grouped variables included in the models. Several of these theories represent a dramatic departure from neoclassical economics, which emphasizes the supply of other job seekers in a transitioning regional economy and the impact this can have on the ability of displaced or vulnerable workers to secure alternative, equally valued jobs. The assumption under the neoliberal model is that high unemployment – a reflection of excess local labour supply – puts downward pressure on regional wages and also limits the number of successful job searches in the regional labour market. Still, under this model, the economic shocks that initially led to an overabundance of job seekers should correct themselves with time. This is because job seekers, in response to soft labour market conditions, are expected to widen their search outside of the regional labour market in response to better job offers and higher earnings potential (FISCHER and NIJKAMP, 1987). Out-migration, in turn, will improve local labour market conditions by reducing excessive competition for job openings, thus helping to stabilize local wages.

This market-driven adjustment process, while seemingly logical, has been challenged by theories of regional labour geography that recognize the potential 'stickiness' or rootedness of local labour. While at first glance inter-regional labour migration might seem the optimal choice for the unemployed or underemployed worker, it is often constrained by additional economic and non-economic considerations that can add to the pecuniary and psychic costs of relocation (GREENWOOD, 1969; ISSERMAN *et al.*, 1986; FISCHER and NIJKAMP, 1987). Additionally, broad changes in US labour markets, including evidence of lower average job-tenure rates and cross-industry reductions in compensation levels and employment benefits, only complicate the labour migration decision (OSTERMAN, 1999; FLIGSTEIN and SHIN, 2004). In light of changing economic conditions, it may be preferable to cope with the challenges of a job search in a more familiar labour market setting, rather than facing additional costs and uncertainties in an unknown locality.

The stickiness of labour, however, does not imply that less mobile workers automatically face greater local job-search challenges. Rather, it forces theoretical discussion away from cross-regional labour flows towards an examination of intra-regional variations in the job-search experience and employment outcomes. At the local or regional level, geography and spatial distance to a job can still matter. Regional job seekers with longer commute times, for example, may be at a relative disadvantage compared with those in the region living in closer proximity to the job (KALLEBERG, 2007). Greater spatial distance, in this case, adds to an individual worker's costs and, thus, can confine their search to job openings with higher compensation levels. Equally, employers might consider commute times in their

review of a job applicant, as shorter driving distances are associated with lower rates of worker absenteeism and tardiness (HANSON and PRATT, 1995; FERNANDEZ and SU, 2004).¹

Geography, however, is not the only differentiating factor in the local or regional job search. Individual characteristics and capabilities can also influence labour market outcomes. Traditional neoclassical labour market models struggle to account for such differences, in part because they assume labour is relatively homogenous – that is, of equal quality and value to an employer (ISSERMAN *et al.*, 1986). Human capital theorists have helped to address this shortcoming by recognizing measurable differences in human knowledge and the impact of worker skill on employer demand (BECKER, 1964). Rather than modelling a single regional labour market, human capital models account for differences in the job-search experience for skilled and unskilled workers (MATHUR, 1999). Educational qualifications and skill requirements act as barriers to entry, thus limiting the supply of skilled workers in a regional economy. This, in turn, increases their wage premium and essentially the return on their educational investment. In contrast, the wages of less-skilled workers are expected to remain low due to a constantly replenished labour pool of young or foreign-born labour market entrants.

Human capital theory has played a central role in policy choice in recent decades, at both the national and the regional levels. One example is the case of rising income inequality, which labour economists, drawing heavily on human capital theory, attribute to the inability of large segments of the US labour force to keep up with the ever-growing skills and technology demands of US employers (BOUND and JOHNSON, 1992; BERMAN *et al.*, 1994; KATZ and AUTOR, 1999). In response, regional workforce development agencies, including community college systems, greatly expanded vocational training options starting in the 1980s. The goal was to address educational gaps among less-educated job seekers, as well as help modernize the existing skills of the US workforce (BRINT and KARABEL, 1989; OSTERMAN and BATT, 1993; ROSENFELD, 1995).

Still, the effects of vocational training on job access and career advancement have been mixed and are not always the result of differences in educational attainment or prior skill level. This has resulted in an emergent set of labour market theories that consider the conditions under which a programme can influence the hiring practices and decisions of regional employers. This moves the discussion beyond the supply-side function of vocational training and instead stresses the role that labour market interventions can play in shaping local demand for those skills (BENNER, 2003). This expanded institutional role, referred to as workforce intermediation, is expected to occur when programme administrators establish close working partnerships with local

employers, often within related industrial sectors (GILOTH, 2004; FITZGERALD, 2006). Through these partnerships, workforce intermediaries can identify and respond to credentializing mismatches in which employers may actually 'overestimate the skills needed for many entry-level jobs, thus eliminating many qualified applicants' (FITZGERALD, 2004, p. 4).

The concept of workforce intermediation has resonated with scholars studying low-income communities and workers. In this context, the workforce intermediary model is expected to generate career advancement opportunities for less-educated workers by breaking down and sequencing training provisions and drawing out initially hidden, yet potentially transferable skills and talents (FITZGERALD, 2004; OSTERMAN, 2004). While few evaluations of existing intermediary programmes have been conducted, those that exist do identify positive effects on job access and increased earnings potential (LAUTSCH and OSTERMAN, 1998; FITZGERALD, 2004).

Whereas standard training programmes reinforce human capital theory by assuming poor labour market outcomes are primarily the result of individual skills deficiencies, workforce intermediaries recognize a broader set of informational and institutional barriers to regional labour market adjustment (GILOTH, 2004; LAUTSCH and OSTERMAN, 1998; FITZGERALD, 2004; LOWE, 2007a). Regional scientists and labour geographers studying the job-search process have also recognized related barriers to securing a job offer (CLARK, 1987; MAIER, 1987, 1991). In today's fluid and fast-changing regional labour markets, such challenges are only expected to intensify (BENNER, 2003). Workforce intermediation provides one possible solution. One would expect, therefore, that job seekers in a rapidly adjusting regional economy would perform better in the job search if receiving assistance from a workforce intermediary rather than from a more traditional training provider.

The following analysis tests this hypothesis by examining the relationship between the employment outcomes of the job search and the intermediary functions of individual community colleges that provide vocational training assistance for entry-level jobs in biomanufacturing. By looking at a single training curriculum, BioWork, that has been implemented across multiple community colleges which provide varying levels of workforce intermediation support, one can capture the additive effects of intermediation on employment outcomes. This enables one to add analytical strength to existing research on workforce intermediary initiatives which have studied and compared only uniform and cohesive intermediary systems (LAUTSCH and OSTERMAN, 1998; BENNER *et al.*, 2007). Precisely because both strong and weak intermediaries can be included in the models and their effects linked to the experience of individual job seekers, their varied effects were considered within the studied

population. While it is acknowledged that the inclusion of an outside control group of non-participants might add additional value to the analysis, the authors believe that internal variation within a single curriculum still ensures the results are valid and meaningful. Furthermore, this allows one to avoid many of the design challenges associated with trying to identify and track a suitable or appropriate outside control group (LAUTSCH and OSTERMAN, 1998; HECKMAN *et al.*, 1999).

The analysis also considers as controls other potentially influential factors on the job-search process. Drawing on the theoretical overview presented above, the analysis considers the anticipated relationship between employment outcomes and:

- a job seeker's educational qualifications and previous employment experience, in the tradition of human capital theory;
- the economic characteristics of the regional and sub-regional labour market in which a job seeker resides, as discussed by neo-classical growth theories in reference to potential intra-regional competition among job seekers; and
- the spatial and commuting distance between a potential employment opportunity and a job seeker's home residence, as analysed by regional scientists and geographers.

In addition, basic demographic variables, namely the age, race and gender of the job seeker, are also included as these are common variables in employment policy research.

THE ECONOMIC AND INSTITUTIONAL CONTEXT OF NORTH CAROLINA'S BIOWORK PROGRAMME

North Carolina is one of several states with a highly dualistic economy. It is world renowned for its concentration of research and development – especially in biotechnology and the biomedical fields – but it also has a disproportionate concentration of employment in chronically declining manufacturing sectors, most notably in textiles, furniture, and food processing. These industries alone have shed over 200 000 jobs in North Carolina between 1996 and 2006. Yet, despite the magnitude of the job loss, these and other traditional manufacturing industries continue to provide employment for a sizeable portion of the state's workforce without a college education.² That such a large percentage of the state's labour force is still so dependent on declining manufacturing sectors for jobs speaks even more to the need for workforce-development programmes that would be effective in helping the North Carolina economy to make the transition.

The areas in which there continue to be growth in the concentration of research and development and

other new economy activities, and the areas in which traditional manufacturing has historically been located, are distinctly different. The former is centred in the Research Triangle region of the state, but also is growing in other metro areas such as Greensboro and Charlotte along the I-85 corridor that runs through the Piedmont. The latter has been disproportionately concentrated in non-metropolitan areas – small cities or towns or rural areas.

The biotechnology boom that North Carolina has experienced is not just in research and development. North Carolina ranks third nationally in the number of biotechnology and bioprocessing-related establishments. Pharmaceutical giant Glaxo-Smith-Kline has been manufacturing drugs in Wake County since 1983, shortly after first locating its research and development facilities in Research Triangle Park. More recently, major biotechnology corporations such as Biogen Idec, Talecris (formerly Bayer), and Diosynth have located major biomanufacturing operations in North Carolina as well. The significant and growing presence of *biopharma manufacturing* and its well above-average wage/salary levels made it easy for state economic development and workforce development policy officials to focus on this sector for transitioning less-educated workers from traditional but declining manufacturing industries to relatively high-paying jobs in the 'new economy'.

There are a number of programmes in place in North Carolina to prepare students and members of the labour force for jobs in the life sciences and biotechnology field, including short courses in manufacturing standards, two-year associate degree programmes in bioprocessing and biotechnology, and four-year bachelor degrees in applied science and technology areas at many of the University of North Carolina's sixteen campuses. In 2005 alone, close to 6000 students, trainees, and incumbent workers completed community college courses and continuing education programmes in the life sciences. One of the most innovative institutional forms created to help make this transition is the BioWork programme. BioWork is a 128-hour introductory course that combines the basics of manufacturing technology and the fundamentals of biological science for entry-level technician jobs in biotechnology, pharmaceutical, and chemical products manufacturing. The programme was developed by the North Carolina Biotechnology Center's Education and Training Program along with assistance from biomanufacturing firms and the North Carolina Community College system. The course is administered through the community college system; there are currently twelve community colleges that offer BioWork. The programme was initially conceived to serve primarily high-school graduates, traditional manufacturing workers who have lost jobs, or those with a low-wage service job wanting higher pay and chances of access to a career ladder, though anyone could apply and would be

eligible. The key item about BioWork, compared with other programmes, is that neither education beyond high school nor prior work experience is a requirement. To obtain a technical job in the bioprocessing sector, almost all employers in North Carolina are required to have either one year of prior industry experience or successful completion of the BioWork programme.³ To this extent, BioWork has become an institutionalized gateway to jobs in the bioprocessing sector.

To be accepted in the BioWork programme, applicants had to pass a test of reading comprehension and mathematics at 10th-grade level and have a high-school diploma or equivalent. If the test was not passed, applicants could still enrol in BioWork if they attended a pre-BioWork intensive programme – a 'boot camp' – that focused on basic mathematics and reading skills. There were no restrictions at any of the community colleges offering BioWorks which the prospective applicant could attend, but in practice enrollees chose to attend the programme at the community college located closest to their residence. There were no capacity constraints at any of the BioWork sites for the cohort studied, so everyone who was eligible was accepted at the community college of their choice.

The spatial distribution of the twelve community colleges offering BioWork shows a concentration in the middle of the state. Only one is located in the mountainous area of western North Carolina in Asheville; one is located in the eastern portion of the state in Pitt County; and a third was recently added in the south-east in Brunswick County. This uneven distribution mostly reflects the fact that the large majority of firms that engage in bioprocessing are located in the Piedmont part of the state, and many of those are in or close to the Research Triangle region (Fig. 1).

The spatial clustering of both the locations of the BioWork programmes and the bulk of the employers means there is reduced heterogeneity in labour market conditions relative to North Carolina as a whole. However, because each community college perceives its mission of primarily serving the employers (and students) located within its own county,⁴ the focus on sub-regional labour market areas by the community colleges, in effect, amplifies regional differences in labour market conditions faced by both employers and trainees. There are also significant differences in accessibility to jobs – in terms of commuting times and distance – even within the Piedmont area of the state – as will be shown below.

As mentioned above in the section about the emergence of intermediary functions for successful workforce development initiatives, there evolved variation in the roles and services the various community colleges provided in the BioWork programme beyond the formal curriculum. State workforce development officials believed that for programmes like BioWork to be successful, there is a need for an institution to

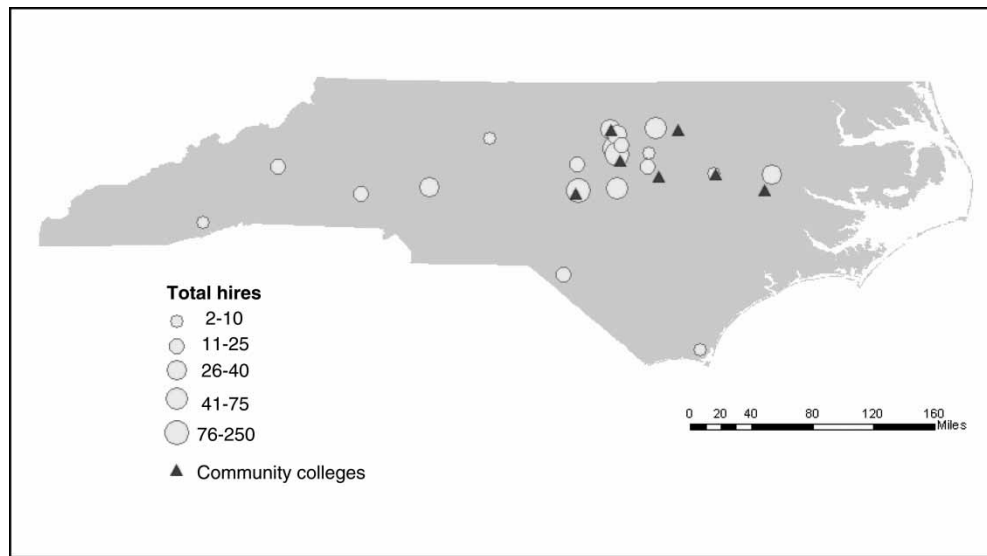


Fig. 1. Community jobs and job locations in North Carolina

Note: Total hires are the number of jobs during 2007 at each biomanufacturing and pharmaceutical manufacturing facility

Source: North Carolina Biotechnology Center

'connect' trainees and employers, though there is no one model for how that intermediary function should be provided. Accordingly, individual community colleges made some changes to the 'standard' BioWork curriculum to take into account the needs of particular employers within the immediate county. This, in turn, has given them an opportunity to secure commitments from certain employers intended to improve the post-training employment prospects of their BioWork participants.

Perhaps even more important, though, were differences in the demand for placement in BioWork programmes among the community colleges in terms of demographics, prior educational attainment, and employment experience. Although the BioWork programme had been initially targeted to 'disadvantaged' groups, the downturn in the macro-economy, which also led to job losses in some high-technology sectors, attracted many individuals with college degrees and recent employment in technology-intensive industries such as microelectronics and telecommunications (LOWE, 2007b). The extent to which this more educated and skilled group sought enrolment in BioWork and posed a potential threat to crowd out the programme's intended target group had a distinct spatial pattern. Many of the newest biopharmaceutical manufacturing plants have been locating in high-growth metropolitan areas, and the community colleges offering BioWork programmes located there or in close proximity were those in which demand for new jobs among former knowledge-based workers was highest. As a response to this unintended demand, some community colleges, particularly those in high-growth areas, adopted new strategies and activities aimed to

give those students with less education and less (or no) technology-related employment experience more equal footing for jobs after completion of the BioWork programme. These strategies include working with the human resource managers of local firms to enhance job creation, to shift their hiring practices and preferences (for example, 'first source' hiring and referral), and to identify and offer services to local employers in need of customized training and employee recruitment support.⁵

To some extent, variation in support for the job-search process across individual colleges are recognized and understood by students enrolled in the programme. This is captured in the present authors' post-programme survey, which indicates that participants at colleges that provided few of these supports were more likely to state that they have relied on their own, self-initiated search strategies for securing a job. In contrast, those that were enrolled in BioWork at colleges that functioned as strong intermediaries were more likely to acknowledge support from the college or their BioWork instructors. Still, from the survey it is also clear that many students who are enrolled at strong intermediary colleges are not always fully aware of the supports they receive. This is due to the fact that many of the actual steps taken to enhance their intermediary role, especially communicating frequently with executives or managers at local biomanufacturing employers, establishing first-source hiring or referral agreements with local employers or receiving donations or other company support for the programme, are not explicitly discussed with students during the class and may, therefore, be hard to recognize without a deep knowledge of their existence and function.

Table 1. Selected local labour market indicators, by community college area

College	Total employment (<i>n</i>)	Employment growth rate (%) ^a	Per cent manufacturing	Per cent professional services	Per cent with a BA or higher ^b	Unemployment rate (%) ^c	Accessibility index ^d
A	29 600	0.88	37.2	3.0	17.2	5.4	8.6
B	189 100	2.42	17.6	11.8	40.1	3.9	31.0
C	45 600	4.41	15.8	5.9	15.9	3.9	15.4
D	75 500	5.30	9.4	4.0	26.4	5.3	3.3
E	37 500	4.54	26.8 ^e 11.8 ^f	2.4 ^e 2.4 ^f	13.0 ^e 10.7 ^f	4.1	12.0
F	461 700	3.08	5.0	11.4	43.9	3.6	19.6
G	42 400	0.76	20.8	6.1	15.1	7.2	7.4
North Carolina		1.89	13.4	6.4	22.5	4.7	
United States		1.63	10.3	8.2	24.4	4.6	

Notes: ^aAverage annual wage and salary employment growth rate, 1992–2006.

^bPercentage of population greater than or equal to twenty-five years with a bachelor's degree.

^cAverage annual unemployment rate, 2006.

^dIndex of accessibility to job openings in bioprocessing.

^eFigures for one of the two counties the college serves.

^fFigures for second of the two counties the college serves.

Table 2. Intermediary roles

College	First source	Job placement	Human resources in the curriculum	Employer linkages	Equipment or US\$	Instructors	Internship
A	No	No	No	No	No	No	No
B	No	No	Yes	Yes	No	Yes	No
C	No	Yes	Yes	Yes	Yes	No	No
D	No	No	No	No	No	No	No
E	Yes	No	Yes	Yes	Yes	Yes	No
F	No	Yes	Yes	Yes	Yes	Yes	No
G	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: First source = college has a first-source referral or hiring arrangement with local biomanufacturing employers.

Job placement = college provides contacts with biomanufacturing employers to enrollees and help preparing for interviews, resumes, etc.

Human resources in the curriculum = extensive 'soft-skills' training is integrated into the BioWork curriculum.

Employer linkages = college has developed close relationships with more than one biomanufacturing employer in the county.

Equipment or US\$ = college has received equipment donations and/or financial assistance from local biomanufacturing employers.

Instructors = college hires staff from local biomanufacturing employers for BioWork instruction.

Internship = college's BioWork curriculum involves an internship or job-shadowing experience with local biomanufacturing employers.

Although the seven community colleges offering BioWork included in this study are all relatively spatially clustered, both demand and supply conditions vary considerably, in part as a result of institutional arrangements mentioned above. Table 1 provides selected indicators of the local labour market and economic conditions in the areas served by each of the BioWork programmes; while Table 2 summarizes the intermediary functions served by each of the programmes.⁶

METHODS, DATA, HYPOTHESES

The study population comprises all of the enrollees in the BioWork training programme entering in spring 2006 at seven community college sites. Although there were twelve community colleges that administered BioWork in 2006, schools with fewer than eight enrollees were excluded. All enrollees were asked while taking the course to complete an initial questionnaire

about some of their personal, educational, and employment histories. Almost all – approximately 250 in total – completed this first questionnaire. A follow-up questionnaire was administered about six months later between November 2006 and February 2007 to those who completed the first questionnaire. These questions were oriented to employment and other outcomes after completion of the BioWork programme. One-half of the completers of the first questionnaire – 125 enrollees – completed the second questionnaire.

Of the 125 completers of the second questionnaire, eighty-four had submitted at least one job application after completing the BioWork programme and up until the time of the administration of the second questionnaire.⁷ A set of logit models is estimated to answer the following question: What factors explain who receives a job offer in bioprocessing? The units of analysis are the eighty-four completers of the BioWork programme who also applied for at least one job in bioprocessing. The dependent variable is whether the

Table 3. Selected characteristics of the study population by community college attended

College	<i>n</i>	Percentage <i>Female</i>	Percentage <i>Black</i>	Mean age (years)	Percentage <i>Associates</i>	Percentage <i>SciMath</i>	Percentage <i>Micro</i>	Percentage <i>Layoff</i>	Percentage <i>Pre-BioWork</i>
A	24	83.3	66.7	43.2	4.2	25.0	0.0	25.0	16.7
B	10	50.0	90.0	38.9	30.0	90.0	40.0	60.0	20.0
C	18	77.8	50.0	38.9	22.2	55.6	11.1	22.2	16.7
D	9	66.7	55.6	42.0	33.3	55.6	0.0	33.3	55.6
E	4	75.0	50.0	48.0	25.0	50.0	0.0	25.0	0.0
F	15	40.0	26.7	39.9	40.0	73.3	33.3	33.3	13.3
G	4	50.0	75.0	39.6	0.0	50.0	0.0	50.0	0.0

individual receives a job offer in bioprocessing (1) or not (0). Selected characteristics of the study population, by community college attended, are given in Table 3.

As indicated above, four groups of explanatory variables are included:

- Individual demographic characteristics and human capital variables, including enrollees' previous labour market experiences.
- An access measure of the spatial distance between the residence of a job seeker and the physical site of a job opening.
- Institutional characteristics of the particular community college's BioWork programme.
- Local economic and labour market conditions of the area served by the particular community college.

Of the individual demographic and human capital variables, *Female*, *Above40*, and *Black* are all discrete variables. *Associates* is a discrete variable to measure whether the individual has a previous associate degree or higher. *SciMath* is another discrete variable measuring whether the individual had ever taken a college-level course in mathematics, biology, or chemistry. *Pre-BioWork* measures whether an enrollee had taken the pre-BioWork course, offered at a number of community colleges, as a way to be better prepared for the actual BioWork programme.⁸

Traditional is a discrete variable to indicate whether the individual's previously longest-held or current job was in one of the three major traditional sectors of the North Carolina economy: tobacco, furniture, or textiles. *Micro*, another discrete variable, measures whether an individual has previously been employed in the micro-electronics industry, an important high-technology sector in the state, but which had been shedding jobs. *Unemployed* measures whether the enrollee was officially unemployed at the time of beginning the BioWork programme. *LayoffPost00* is a variable to measure whether the enrollee had ever been laid off in the previous five years due to a plant closing or downsizing.

The status of each community college as an *intermediary* is measured in two alternative ways. *InterSum* is equal to the sum of the number of intermediary functions a given community college provides, and can range from 0 to 7. *InterWSum* is similar to *InterSum*, except that the individual functions are given weights to

indicate some are considered to be more important than others in serving a workforce intermediation role.⁹ Values for this variable also range from 0 to 7. The seven intermediary functions and how each of these functions is attributed to the seven community college programmes are summarized in Table 2. Ideally, the authors would have included each of these intermediary functions as a separate discrete variable, but because of the small number of colleges and a high degree of multicollinearity among the functions, the composite measures just described were used. The data for attributing the functions to each programme came from interviews with community college BioWork directors and others involved in developing the BioWork programme.

Several alternative measures of the accessibility of BioWork completers to the location of bioprocessing facilities were tested. For these enrollees the residential location of each applicant was assigned as the location of the particular community college attended. Using data on the total employment, the number of new hires during 2007, and the location for all bioprocessing facilities within North Carolina, measures of accessibility based upon a negative exponential function were calculated with alternative decay parameters and alternative maximum distances from the community college. Two alternative measures of job potentials at each facility were considered: total employment at the establishment, and the number of new hires in 2007 from a survey of firms conducted by the North Carolina Biotechnology Center.¹⁰ Based upon 'goodness-of-fit' criteria when included in the logit model, the measure chosen for final inclusion used a decay parameter of -1.0 , a maximum distance of 80 miles from the community college, and total employment at each facility.¹¹

UrbanLive is a discrete variable for whether or not the BioWork programme was located in an urban county. *Growth9403* is measured by the compounded annual employment growth rate from 1994 to 2003 in the individual's county of residence. Finally, *UR2006* is a measure of the average unemployment rate in 2006 for the enrollee's county of residence. Several variables that interact individual with locational characteristics, as discussed below, were also created.

The measures and data sources used for all variables are summarized in Table A1 in the Appendix.

Table 4. *Expected signs*

Independent variable	Dependent variable: <i>Job offer</i>
<i>Female</i>	–
<i>Above40</i>	–
<i>Black</i>	–
<i>Associate degree</i>	+
<i>SciMath</i>	+
<i>Pre-BioWork</i>	?
<i>Traditional</i>	–
<i>Micro(electronics)</i>	+
<i>Unemployed</i>	–
<i>Layoff</i>	–
<i>InterSum</i>	+
<i>InterWSum</i>	+
<i>Accessibility</i>	+
<i>UrbanLive</i>	+
<i>Growth9403</i>	+
<i>UR2006</i>	–

Hypothetical relationships between each explanatory variable and the dependent variables are briefly discussed here and summarized in Table 4. The expected signs are consistent with human capital theory, workforce development theory, and the standard regional science and regional development literature, respectively, where pertinent. In cases where there is no clear theoretical basis for the expected relationship, a question mark is shown.

Receiving a job offer may tend to favour males over females due to potential discrimination in the labour market. The same could be true for specific racial and ethnic groups. To the extent that employers may be able to hire women at lower wages might serve as a market ‘correction’, however, which would reduce or remove a negative relationship between *Female* and each of the dependent variables. Being older (*Above40*) is expected to be a disadvantage because of the employer often having to offer higher pay, and a shorter period for the employer to receive a return on training and other investments in the worker.

Having a higher level of human capital investment – measured as having an associate degree (or higher) – should be positively associated with receiving a job offer. Whether the enrollee had ever taken a college-level course in mathematics, biology or chemistry would increase his or her human capital and should lead to a higher likelihood of receiving a job offer. An individual in BioWork enrolling in one of the pre-BioWork courses offered through one of the community colleges would be expected to enhance his or her preparation and skills for success in the BioWork programme and, thus, increase the likelihood of receiving a job offer, but, on the other hand, taking the pre-BioWork course also indicates the absence of basic skills. Thus, the hypothesized direction of the relationship with the dependent variable is ambiguous.

If an individual’s prior longest-held or current job was in one of the traditional North Carolina industries – tobacco, furniture, or textiles – then this should decrease the likelihood of receiving a job offer in

bioprocessing because of skill mismatch and perhaps a perception of employers that the individual is less suited for a high-technology job. On the other hand, if an individual has previously held a job in the micro-electronics industry, this should increase the likelihood of receiving a job offer because of transferability of some skills and favourable experience working for a high-technology company. If a BioWork completer were unemployed at the time of completion of the BioWork programme, then this should lower the likelihood of receiving a job offer because of the stigma of being unemployed and also having fewer resources or ties for successful outcomes in the labour market. Having been laid-off from a job within the last five years due to plant closure or downsizing should also decrease the chances of receiving a job offer because of the negative stigma and/or signals to an employer that the individual has obsolete skills.

The degree to which the particular community college attended acted as an intermediary should be positively related to the chances of receiving a job offer. As discussed above, being in a programme in which the institution provides the intermediary role should help enrollees become ‘introduced’ to employers by participation in ‘first hiring’ or otherwise render skills between previous and prospective work more obvious and explicit to potential employers.

Considering the regional and spatial variables, being located in an area with higher accessibility to employers in bioprocessing is expected to lead to a higher likelihood of receiving a job offer. That is, greater accessibility should increase the amount of information available to individuals about which employers might be hiring, and provide an incentive to apply to a larger number of prospective employers. Living in an urban area, everything else being equal, should increase the chances of receiving and accepting a job offer because bioprocessing facilities are disproportionately located in urban areas. Living in an area whose economy has been growing quickly should lead to higher chances of receiving and accepting a job offer because of less competition on the supply side, while living in an area of higher unemployment should decrease the chances of receiving a job offer for the obverse reason.

Of the eighty-four BioWork completers who reported submitting at least one job application, twenty-eight received offers in the bioprocessing sector, broadly defined. The question then becomes: What variables explain which of the BioWork graduates received a job offer in the bioprocessing field?

MODEL RESULTS

Several alternative logit regression model specifications for the dependent variable of whether the BioWork graduate received a job offer in bioprocessing were estimated. The models differ in (1) how the intermediary variable is measured; and (2) the subsequent inclusion of particular interaction variables after getting

Table 5. Logit regression models

Variable	Model A	Model B	Model C	Model D	Model E
<i>Female</i>	-0.430*	-0.356	-0.454*	-0.405	-0.503
<i>Above40</i>	-0.449	-0.495	-0.607	-0.636	0.516
<i>Black</i>	0.138	0.183	-0.068	-0.019	-0.11
<i>Associate</i>	0.884	0.899	0.869	0.863	0.888
<i>SciMath</i>	0.769**	0.830**	0.772*	-0.252	-0.198
<i>PreBioWork</i>	-1.171**	-1.110*	-1.178*	-1.185**	-1.169*
<i>Traditional</i>	0.719	0.672	0.399	0.291	0.119
<i>Micro</i>	1.959***	2.023***	2.124***	2.190***	2.516***
<i>Unemployed</i>	-0.525	-0.533	-0.58	-0.647	-0.579
<i>LayoffPost00</i>	-1.422***	-1.518***	-0.825	-0.829	-0.713
<i>Accessibility</i>	-0.013	-0.004	0.004	-0.07	-0.024
<i>UrbanLive</i>	-1.663**	-1.924***	-1.378**	-1.481*	-1.529*
<i>Growth9403</i>	-0.091	-0.14	-0.15	-0.125	-0.113
<i>UR2006</i>	-0.442	-0.683	-0.621	-0.684	-0.593
<i>InterSum</i>	0.279***				
<i>InterWSum</i>		0.425***	0.383***	0.423***	0.424***
<i>UrbanLive* Layoff</i>			-2.090*	-2.149*	-2.458**
<i>SciMath* Access</i>				0.085	0.078
<i>Above40* Access</i>					-0.088*
Constant	1.434	2.589	2.477	3.482	2.47
<i>n</i>	84	84	84	84	84
<i>ll</i>	-40.073	-39.552	-38.614	-38.371	-37.899
<i>AIC</i>	92.145	91.104	89.228	88.743	87.798
<i>Pseudo</i>	0.216	0.227	0.245	0.25	0.26

Notes: AIC, Akaike information criterion.

***Significant at 0.01; **significant at 0.05; and *significant at 0.1.

unexpected and counter-intuitive coefficient estimates on the accessibility and locational variables in Models A and B. The coefficients are interpreted in the standard way for logit models: how much the log-odds change of receiving a job offer for a one unit increase in the value of the independent variable, holding constant all other variables in the model. Variables with positive coefficients increase the odds of receiving a job offer, while those with negative coefficient estimates decrease the odds. The results for the models are shown in Table 5.¹²

The explanatory variables that are statistically significant in at least one of the alternative models include: *Female* (-), *SciMath* (+), *Pre-BioWork* (-), *Micro* (+), *Layoff* (-), *UrbanLive* (-), and both *InterSum* (+) and *InterWSum* (+). The signs on these coefficients are all expected, except for *UrbanLive*, which is hypothesized to be positive because living in one of the urban counties would provide higher proximity to biomanufacturing facilities. However, living in one of the urban counties is also associated with inner-city poverty and with being disadvantaged in terms of skills, education, and labour market experience. When *UrbanLive* is interacted with *Layoff*, a significant negative coefficient estimate is obtained, while *Layoff* ceases to be significant, indicating the propensity of those laid-off from their jobs to be disproportionately afflicting inner-city minorities. The variable that interacts *Above40* and *Accessibility* also is negatively related to receiving a job offer, indicating that older workers enrolled in the BioWorks programme, who tend to face additional barriers in the labour market, are disproportionately located in the inner city areas of the region.

All in all, the set of factors that are consistently significant in explaining the outcomes of job search for BioWork graduates are a mix of labour market experience variables, some human capital factors, and the intermediary role of the community college attended. Regional and demographic factors by themselves are not important explainers of the outcomes of receiving a job offer until they are interacted to bring out the geographical concentration of those with the most disadvantages in competing for jobs in the high-technology sector.

Goodness-of-fit measures of all the alternative models indicate a moderate level of explanatory power. The best-fitting model in terms of the log-likelihood and pseudo- R^2 -value is Model E; it includes all three interaction variables and the weighted measure of intermediation (*InterWSum*), but the differences among the five models are relatively small.

DISCUSSION AND CONCLUSIONS

First and foremost, the results provide strong support for the hypothesis that an institution that serves a workforce intermediary role between job seekers/trainees and employers – in this case, some of the community colleges – matters in the outcomes of the job-search process. That is, even when controlling for demographic and human capital factors and previous labour market experiences, success in receiving a job offer was more likely when an enrollee attended a community college BioWork programme which was proactive in establishing linkages with employers in the bioprocessing sector

and in providing additional services to enrollees beyond the BioWork curriculum. This suggests that workforce intermediaries can play an important role of 'opening the door' for some individuals who, because of lack of formal educational or previous employment credentials, might not otherwise be considered by employers.

Second, it appears that the recent job and local labour market experience of the enrollee affects the probability of a successful outcome. In particular, whether the enrollee had been laid off from a job within the past five years (before enrolling in the BioWork programme) is strongly negatively related to receiving a job offer, controlling for other factors. Whether this experience represents a stigma to potential employers, or is related to lower levels of human capital that were not captured in the other independent variables included in the model, is unclear and deserves further exploration. It could also be that those who had been laid off have more demanding conditions in their job search, including a higher reservation wage. For whichever reason, it is an important finding that one of the principal targeted groups for retraining – those who have lost their jobs due to declining firm competitiveness, globalization, or automation – have not been as successful as others in getting placed in the 'new economy'. If the specific reasons underlying this can be identified, then it may be that the retraining programmes can build-in customized services that can help this particular group. In addition, being *previously employed* in the microelectronics sector strongly increases the chances of receiving a job offer in bioprocessing. This result indicates that the benefits of the retraining programme extend beyond the principal targeted workers – those who had been 'stuck' either in low-wage service jobs or in declining traditional manufacturing industries – to those who are seeking alternatives to the more cyclically volatile high-technology jobs in microelectronics and perhaps information technology. Because degree of education (and which is *not* significant) is controlled for, it is suggested that having worked in microelectronics represents to employers a record working in a high-technology work environment – perhaps with sophisticated machinery or instruments or that adhere to similar manufacturing practice regulations – rather than possessing specific advanced skills that come with higher education degree programmes. From a policy perspective, those with greater advantages in the local labour market due to workplace experience become potential competitors to the more disadvantaged and targeted workers in the bioprocessing job market, especially when the regional economy as a whole is not growing robustly. On the other hand, there may be an upside to this result in terms of enhanced political support for a job-training programme that has a wider set of beneficiaries (LOWE, 2007b).

Third, the results provide some indication that particular demographic groups that might be expected to

face disadvantages in receiving job offers – women, Blacks, older workers – do not overall. Rather, it may be a combination of belonging to a 'disadvantaged group' and living in inner city areas, rather than living in suburban areas, smaller towns, or rural areas, that leads to a lower likelihood of a successful job search. Unfortunately, the authors were not able to probe analytically whether this result is an artefact of the particular economic geography of North Carolina or is more generalized, but it deserves further consideration.

Fourth, accessibility to job vacancies in the broadly defined bioprocessing industry is *not* significant for explaining job-search outcomes when controlling for other factors. As discussed above, perhaps distance from residence to work is not an important factor when deciding where to apply for jobs as the 'cost' of applying is relatively low. Even still, this cost is not zero, and distance *should* diminish the enrollee's knowledge of job vacancies. The disadvantage of distance should, in principle, be ameliorated by the intermediary role of community colleges in providing information and employer contacts to the enrollee that might be otherwise missed if the programmes could achieve a longer geographical reach.

Fifth, the strength of the local economy based upon the residential location of the enrollee does *not* make a significant difference in the chances of receiving a job offer. Moreover, living in an *urban* county becomes significant in the direction *opposite* than would be expected after controlling for the extent to which the community college acts as an intermediary. Since demographic and human capital variables are already controlled for, it can be speculated that, in addition to the discussion above about the interaction of an inner-city location and disadvantages in human capital or previous job experience, this result might also be due to a subset of the BioWork completers living in urban counties – and especially in the suburban areas of those counties – having more attractive alternatives. These might include having further education opportunities, job offers outside of bioprocessing, or else higher reservation wages perhaps because of higher living costs in cities.

While the results confirm the importance of regional policy innovation in the form of designing institutions with intermediary roles, they also present some dilemmas about the appropriate spatial scale for such innovations vis-à-vis the spatial dimensions of local and sub-regional labour markets. Specifically, the effectiveness of intermediation depends upon developing close relationships with employers. Yet, there is apparently a strong spatial decay in the willingness and/or ability for the intermediary organizations to develop such relationships and shape hiring practices outside their immediate jurisdictions. This mismatch between institutional jurisdictions and the geography of sub-regional labour markets is likely diluting the effectiveness of the strategy and explains why a portion of the job seekers turn down job offers as they seek jobs outside their college-specific labour market boundaries. To preserve

the advantages of a high degree of spatial decentralization, without giving up economies of scale and internalization of demand-and-supply actors in sub-regional labour markets, a high degree of coordination is required among the spatially disaggregated institutions.

In considering the generalizability of the results, it is acknowledged that the size of the present study population ($n = 84$) places some limits on the analysis. Ideally, multilevel (hierarchical) models would have been used to account for having explanatory variables at both the individual and the community college levels, but the number of cases ($n = 84$) made that infeasible. The relatively small n also could lead to unstable estimates of standard errors using maximum likelihood estimation. However, robustness is checked by specifying a number of different models and to what extent the standard errors and significance tests varied among alternative models is examined.

The BioWork programme in North Carolina is also quite specific, and the factors that show up as most important here in explaining job-search success might

not apply to all types of retraining programmes. Nevertheless, the relative success of the BioWork programme in North Carolina plus the wide appeal of the bioprocessing sector as a target for many other state's economic development strategies have rendered BioWork a national model for job retraining. In that sense, it would be valuable to conduct studies of similar programmes in other states – possibly pooling the data – to examine to what extent the results of this particular, innovative approach to job retraining hold in differing settings.

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APPENDIX

Table A1. Measures and data sources

Variable	Measure	Source
<i>Female</i>	1 if female; 0 if male	Questionnaire to enrolees
<i>Above40</i>	1 if forty years or more; 0 otherwise	Questionnaire to enrolees
<i>Black</i>	1 if African-American; 0 otherwise	Questionnaire to enrolees
<i>Associates</i>	1 if an associate degree or higher; 0 otherwise	Questionnaire to enrolees
<i>SciMath</i>	1 if previously took a college-level course in mathematics, biology, or chemistry; 0 otherwise	Questionnaire to enrolees
<i>Pre-BioWork</i>	1 if enrolled in a pre-BioWork course just before BioWork; 0 otherwise	Questionnaire to enrolees
<i>Traditional</i>	1 if the previous longest held or current job was in tobacco, furniture, or textiles; 0 otherwise	Questionnaire to enrolees
<i>Micro</i>	1 if had previously worked in the microelectronics industry; 0 otherwise	Questionnaire to enrolees
<i>Unemployed</i>	1 if unemployed just before BioWork enrolment; 0 otherwise	Questionnaire to enrolees
<i>LayoffPost00</i>	1 if experienced a layoff post-2000; 0 otherwise	Questionnaire to enrolees
<i>InterSum</i>	Sum of the number of individual intermediary attributes; range from 0 to 7	Questionnaire to community colleges
<i>InterWSum</i>	Weighted sum of the number of individual intermediary attributes. Weights are: First source = 1.5 Internship = 1.5 Employer linkages = 1.0 Equipment = 1.0 Instructors = 1.0 Job placement = 0.5 Human resources = 0.5	Questionnaire to community colleges
<i>Access</i>	Index of accessibility to bioprocessing job openings in 2006: $I_j = \sum E_i \times d_{ij}^\alpha$ where E_i is the number of job openings in location i ; d_{ij} is the airline distance between the location of the community college and job openings, up to maximum of 80 miles; and $\alpha = -1.0$	NC Biotechnology Center, Arcview
<i>UrbanLive</i>	1 if enrolee residence is in an urban county; 0 otherwise	Questionnaire to enrolees, Census
<i>Growth9403</i>	Compound per-annum employment growth rate, 1994–2003, of the enrolee's county of residence	Questionnaire to enrolees, Bureau of Economic Analysis (BEA)
<i>UR2006</i>	Enrolee's county of residence unemployment rate, annual average 2006	Questionnaire to enrolees, Bureau of Labor Statistics (BLS)

NOTES

1. Spatial mismatch theories are often used to explain limited minority access to new jobs (KAIN, 1968; FERNANDEZ and SU, 2004). According to this logic, minority job seekers and especially African-Americans are likely to face longer commute times due to segregated residential patterns that do not match up with emergent areas of regional employment growth. As such, they are likely to be less successful with the job search compared with non-minority applicants.
2. North Carolina lags the United States in the percentage of the population aged twenty-five years or more with a bachelor's degree (22.5% versus 24.4%). But this gap is considerably larger in many of North Carolina's non-metropolitan counties where textiles, furniture, and tobacco production has been concentrated.
3. The route to getting a job through prior industry experience partially explains why only twenty-eight of the eighty-four completers who applied for jobs received offers.
4. Most counties have their own community college: there are 100 counties in North Carolina and fifty-eight different community colleges.
5. Despite the downturn in the macro-economy, many biopharmaceutical companies were facing chronic shortages of specific labour skills. Hence, recruitment support with referrals from the community colleges was highly valued by the employers.
6. Intermediation functions as they relate only to BioWork, not to other programmes at the college, were examined.
7. Enrolees who chose not to submit a job application in bioprocessing cited a number of different reasons. The most often-cited were decisions to continue their education in an associate degree programme.
8. For five of the community colleges, attendance in the Pre-BioWork programme was required to be eligible for enrolment in BioWork if the applicant was not able to pass a test measuring basic verbal and math skills at a 10th-grade level.
9. The weights are shown in Table A1 in the Appendix. The highest weight is given to First Source and Internship provisions, as these channels establish direct connections between BioWork participants from a specific college and human resources personnel at local biomanufacturers who are involved in hiring decisions. Next in rank are three aspects of college-employer relationships: those entailing frequent communication between BioWork administrators and local biomanufacturing employers and those in which a local biomanufacturing employer donates equipment or volunteers their staff time to the programme. Job placement assistance and human resource development are ranked last on the list. This is not to say that they are unimportant. Rather, most colleges provide these basic services. Furthermore, many colleges face significantly greater difficulty in penetrating the local business community and establishing strong employer connections. This, in turn, limits their ability to function as workforce intermediaries. Because of this existing challenge, greater weight were assigned to all aspects of intermediation support that involve a local biomanufacturing employer.
10. While many enrolees in the study began their job search in late 2006, firms acknowledged little difference in hiring levels between 2006 and 2007. Therefore, the 2007 job-openings data serve as reasonable estimates of hires across both years.
11. Airline distances rather than travel distances on the road grid were used; differences in the results were very slight.
12. In lieu of being able to use multilevel modelling, the individual observations were clustered by their community colleges and robust standard errors were used that remove the assumption that observations within community colleges are fully independent of one another.

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