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Kaptivate's Analysis of the Connecting Minority Communities Pilot Program: The Role of HBCUs as Economic Catalysts in Rural Southeast Digital Transformation

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Abstract

This working paper presents an integrated economic-contribution analysis of four Historically Black Colleges and Universities (HBCUs) and one Predominantly Black Institution (PBI) participating in the National Telecommunications and Information Administration's (NTIA) Connecting Minority Communities (CMC) Pilot Program. Launched in 2021, CMC allocated $268 million to improve broadband access at minority-serving institutions, with HBCUs serving as critical digital anchors in underconnected regions. Drawing on detailed campus narratives and a shared program framework, this paper investigates how localized investments in broadband infrastructure, devices, workforce development, entrepreneurship, and health services are shaping regional economies and catalyzing long-term community resilience.

Combining qualitative insights with regional input-output modeling, we trace the ripple effects of broadband-enhanced institutional initiatives at five campuses: Drake State Community and Technical College, Fort Valley State University, Fayetteville State University, Grambling State University, and the University of West Alabama. Early results suggest that CMC investments have closed capability gaps within these institutions; however, they have also repositioned these Community Anchor Institutions (CAIs) as economic accelerators for rural, urban, and mixed-regional communities.

The paper concludes by synthesizing cross-site learnings and offering a future research agenda for evaluating long-term impacts of digital infrastructure grants. It proposes a replicable framework for institutions, policymakers, and funders looking to align broadband expansion with workforce development, regional revitalization, and inclusive economic growth.

1. INTRODUCTION & SHARED PROGRAM CONTEXT

1.1 Panorama of Digital Disparity & the Role of CAIs

Over the last two decades, broadband access has emerged as both a prerequisite for economic participation and a mirror reflecting persistent disparities in infrastructure investment. While the urban-rural digital divide is well documented, an equally stubborn disparity persists across Southern communities where broadband deserts encircle institutions that historically have served as beacons of hope: Historically Black Colleges and Universities (HBCUs). The

communities surrounding many HBCUs often lack reliable high-speed internet, placing local residents, students, and small businesses at an economic disadvantage in a digitized world.

These service gaps are not incidental. According to a 2021 McKinsey report, approximately 82% of HBCUs are located in broadband deserts, severely limiting their capacity to serve as full digital stewards for their regions. In these places, inadequate connectivity is more than an inconvenience; this digital gap is a constraint on educational attainment, telehealth expansion, small-business viability, and civic engagement. Without meaningful intervention, such gaps can compound over time, further entrenching patterns of economic stagnation and systemic educational disadvantages.

And yet, the location of these institutions also represents a profound opportunity. HBCUs are frequently the largest employers in their counties, the epicenter of regional talent development, and the conveners of cultural and civic life. Anchored in both legacy and locality, these institutions are uniquely positioned to serve as “digital engines” for their surrounding communities. As a 2024 report from the Frederick D. Patterson Research Institute notes, HBCUs contribute over $16.5 billion annually to the U.S. economy. This amount can be bolstered significantly through strategic digital opportunity.

Moreover, research from the Federal Reserve Banks of Richmond and Philadelphia has shown that regional economic vitality is closely correlated with broadband adoption and use. High-speed internet boosts property values, enhances workforce mobility, and stimulates small-business formation. These benefits are particularly potent in rural areas, where physical infrastructure is often lacking and where digital networks can serve as essential bridges. When the same institutions that anchor these communities also drive digital access, the synergy can be transformative.

In this context, HBCUs are more than passive recipients of connectivity upgrades. They are active partners in redefining the contours of economic development. Recognizing this crucial role, the NTIA launched the Connecting Minority Communities (CMC) Pilot Program, positioning HBCUs and other Minority Serving Institutions (MSIs) at the heart of a nationwide broadband experiment.

1.2 NTIA Connecting Minority Communities (CMC) Pilot Program Overview

Against this backdrop of persistent digital exclusion, the National Telecommunications and Information Administration (NTIA) launched the Connecting Minority Communities (CMC) Pilot Program in 2021. Administered under the Office of Minority Broadband Initiatives (OMBI), the program was created as a targeted federal response to the intersecting challenges of underinvestment in digital infrastructure and the systemic exclusion of minority-serving institutions from broadband policy planning.

The CMC Pilot Program allocated $268 million in funding to 93 colleges and universities—43 of them HBCUs—to expand broadband capacity in historically underserved regions. Unlike traditional infrastructure initiatives, CMC emphasized institutional flexibility, allowing grantees to tailor their investments to local conditions and institutional strengths. This design principle reflected a growing awareness that broadband expansion cannot be achieved through one-size-fits-all strategies; it must instead emerge from localized, context-aware interventions rooted in trusted institutions.

The initiative unfolded in a moment of renewed national attention to infrastructure, post-pandemic recovery, and the increasing necessity of broadband. However, rather than isolating broadband access as a standalone goal, the program positioned digital connectivity as a tool for enabling a broader set of community outcomes, such as educational continuity, workforce opportunity, and civic participation. This holistic approach acknowledged the embeddedness of digital divide in other forms of economic and social exclusion and pointed to the role of minority-serving institutions as key conduits for closing these gaps.

1.3 Structure of the Paper

This paper examines the early outcomes and contributions of five CMC-funded institutions—Drake State Community and Technical College, Fort Valley State University, Fayetteville State University, Grambling State University, and the University of West Alabama—through the lens of regional economic development and community engagement.

Section 2 introduces the analytical framework for assessing economic contributions. Section 3 presents five campus-specific case studies, situating each institution's digital outreach strategy within its geographic and economic context. Section 4 synthesizes cross-site insights and identifies emergent themes across the cohort. The final sections offer a set of conclusions and propose future research directions for tracking the longer-term impacts of broadband expansion in underconnected regions.

Rather than offering a linear assessment of goal achievement, this paper seeks to understand how digital infrastructure, when entrusted to community-based institutions, can operate as a catalyst for regional transformation.

2. ECONOMIC-CONTRIBUTION ANALYSIS METHODOLOGY

2.1 Framing Economic Outcomes through Measurement and Timing

The outcomes targeted by the CMC program produce highly differential economic consequences that fall along two continuums: Directly Measurable Outcomes and Immediacy. Directly Measurable Outcomes include changes in output to final demand, gross regional product, employment, labor income, and government revenues. Immediacy is the timeline in which one would expect the outcomes to occur. Extensive, well-established academic literature on the impacts of telecommunications infrastructure and services on economic growth and development supports the expectation that improved access to broadband services will lead to measurable economic outcomes. A series of reports published in the 1970s and 1980s by the International Telecommunications Union established that telecommunications infrastructure investments catalyze economic growth, in some cases serving as the necessary condition for market development (see for example Tyler, 1981). Jipp (1963) and Dholakia and Harlam (1994), and many others since, connected the presence and density of telecommunications services to economic growth. Cronin, et al (1991) and Dutta (2001) offered an important extension applying Granger Causality modeling that showed that telecommunications infrastructure investments led to economic growth and that economic growth leads to infrastructure development, though the evidence for the latter is weaker than the former. Capello (1994) expanded the neoclassical production function for economic output to include Information, which itself is characterized by the specific technology of the network and the number of potential contacts on the network. In functional form, this economic output can be expressed as:

$V_i = f(K_i + L_i + N_i)$

where: V is total output, K is capital, L is labor and N is information.

$N_i = N_i(T_1, S_1)$

where: T is the specific technology of network 1 and S is the number of potential contacts on network 1.

There are positive marginal benefits to costs if:

$f(K_i, L_i, N_i) > f(K_i', L_i', N_i')$ for a given output V_i
where: $N_i' = N_i(T_2, S_1+1)$ and $K_i' < K_i$, and/or $L_i' < L_i$

Similarly, there are positive marginal benefits if:

$V_i' f(K_i, L_i, N_i') > V_i f(K_i, L_i, N_i)$ for increased output V_i' at constant values of K_i and L_i.

Capello (1994) further suggests that positive network externalities exist if:

$$N_1'(T_2, S_1+1) > N_1(T_2, S_1).$$

Clower (1997), extended Capello's work to distinguish the transmission capacity of the network T, expressed in functional form as:

$$T = T_{m,e} = T(M_i, E_i)$$

where: M_i is the transmission medium channel capacity expressed in bandwidth and E_i designates specific telecommunications applications, and $T_{m,e}$ indicates the usable combination of medium and application

Clower (1997) found that the adoption of near broadband (ISDN) telecommunications services contributed to both higher revenues and lower costs among adopting firms in a limited series of case studies. More recent research confirms these findings that broadband access enhances sales, profits, and labor productivity in small firms (Koutroumpis and Sarri, 2024). The literature also supports that enhanced telecommunications services (broadband) increases development opportunities in rural areas by supporting the capture of externalities from knowledge spillovers (Keene, et al, 2023) and reversing negative demographic trends in disadvantaged regions (Garashchuk, et al, 2025).

The findings of previous research clearly indicate that investing in telecommunications capacity leads to positive economic outcomes, *ceteris paribus*. Importantly, using Capello's (1994) characterization that the Information function is the combination of infrastructure and number of contacts (Si). The CMC program effectively contributes to both elements of Information: it supports the deployment of Technology and subsidizes network access, which increases the number of contacts and addresses the capacity of individuals to adopt and successfully use the technologies by allowing program applicants to focus on work-skills development.

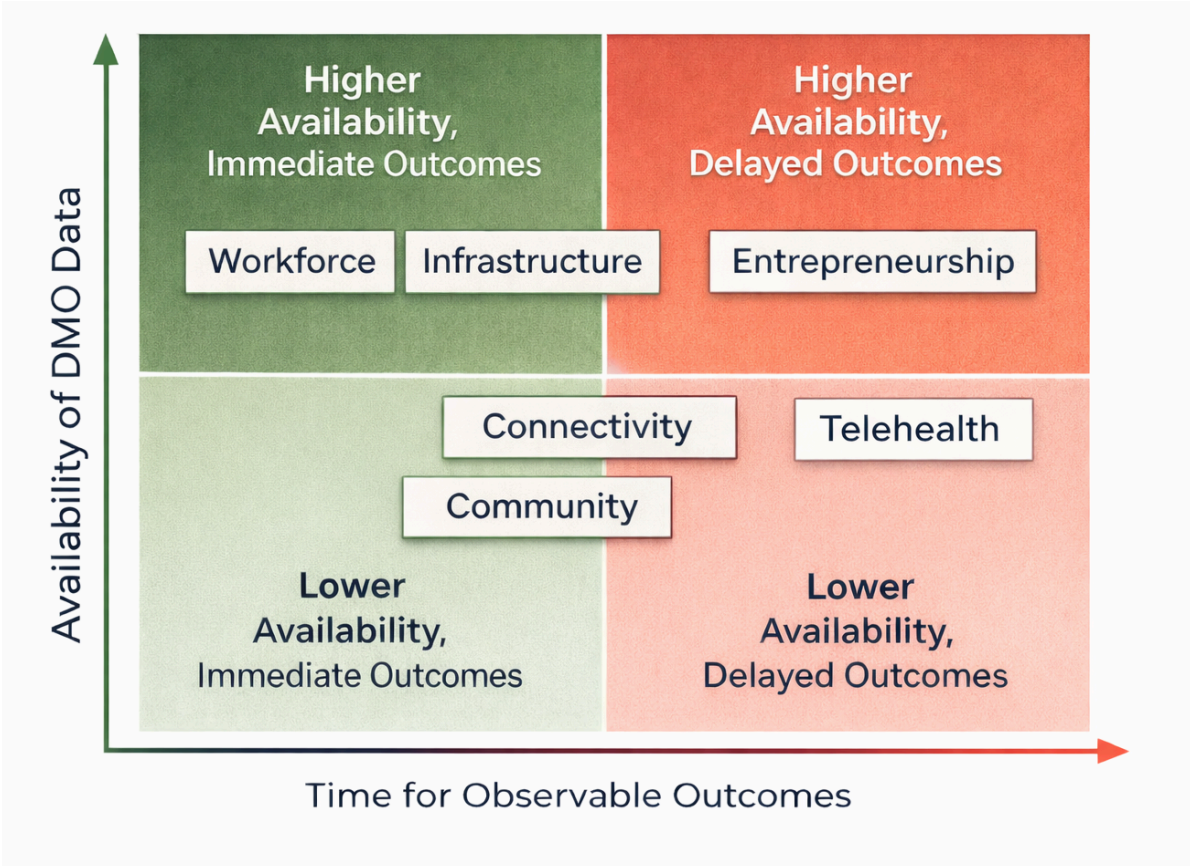
Directly Measurable Outcomes (DMO) can be found through government reporting (Bureau of Labor Statistics, Bureau of Economic Analysis, Census, local government records) or through estimation procedures, including the use of economic input-output frameworks, computable general equilibrium models, hybrid I-O/CGRE models, and other approaches. The focus on DMO represents a subset of all possible outcomes associated with enhanced access to broadband communications services. Factors such as quality of life can be measured, but are multi-factor indirect measures (Kreitler and Kreitler, 2006) that are beyond the scope of this assessment. Nevertheless, when assessing the value of any program, it is important to consider Directly Observable Outcomes (DOO), even if one must use qualitative case studies to illustrate observable outcomes. These observations offer early, concrete signals of the types of changes that may be captured as DMOs, helping to contextualize and substantiate model-based estimates. As such, the case studies in this analysis are designed not as peripheral illustrations but as integral sources of supporting evidence for understanding how measurable economic impacts emerge in practice.

Immediacy is effectively the consideration of the lag-structure one can reasonably expect between program implementation and detectable DMOs. This “lag structure” includes the lag effect related to the time period between programmatic interventions and an effect or outcome, and the additional time associated with public reporting of data on the chosen DMOs. The literature shows that lag structures are important for understanding how infrastructure investments impact various measures of economic performance (see for example Roller and Waverman, 2001). Observable measurable changes from infrastructure investments on economic performance can take years to materialize. Similarly, programs that support entrepreneurship also require extended time periods before observable measures show growth. This time lapse requirement can be attributed to scale, timing of patent awards, grant programs such as SBIR/STTR, and other factors. Programs that address labor skills needs can see measurable outcomes more quickly. If the skill training is filling existing local worker shortages, the “new” job can be realized almost immediately after a given student completes training. Social impacts on well-being, quality of life, and health can be realized in comparatively near terms (better grades for students with enhanced digital resources) to long run effects (improvement in health outcomes from rural tele-medicine programs).

The figure below provides a conceptual framework for interpreting how program activities supported by the CMC program vary in terms of both the immediacy of their observable outcomes and the ready availability of directly measurable outcome (DMO) data. Activities related to workforce development sit at the high end of data availability and the short end of the lag structure: placement rates, certifications earned, and employment outcomes are often captured through existing labor market reporting and institutional records, and they can appear quickly when training programs align with unmet local demand. Infrastructure investments, such as fiber expansion or equipment upgrades, are also highly measurable, with data available through regulatory filings, provider reports, and capital expenditure accounts, but their full economic impacts take longer to surface, as new capacity must diffuse into the broader economy before generating measurable changes in output and productivity. Similarly, SME support programs, such as entrepreneurship accelerators or digital business training, lend themselves to data collection—business creation, revenues, and capital raised are well-documented—but they tend to exhibit longer lag times before results materialize due to the inherently gradual process of firm growth and scaling.

By contrast, connectivity initiatives, including device distribution and subsidized access, generate immediate changes in usage and adoption, yet they sit lower on the DMO axis because formal reporting systems capture such impacts only indirectly through proxy indicators like household broadband subscriptions or survey data. Finally, community-focused programming, such as digital literacy outreach, health access initiatives, and civic engagement projects, falls lowest in terms of measurable outcomes despite producing some of the most immediate and tangible benefits. While the qualitative effects on well-being, inclusion, and trust may be observable quickly at the community level, they resist capture in standardized datasets. Taken together, the positioning of each activity type in the figure reflects this underlying tension between what can be readily quantified and when the effects become visible, underscoring the importance of combining DMO analysis with qualitative case study evidence in evaluating broadband-related interventions.

Figure 1. Interaction of Data Availability and Immediacy by Program Activity Type (not to scale)



2.2 Estimating Economic Contributions Using Input–Output Modeling

For each recipient CAI, we assess the economic contributions, sometimes called economic impacts, of spending related to the programs. This assessment includes a review of how the spending of grant dollars flow through the host regional economy. To perform these analyses, we use the IMPLAN economic input-output model developed by the IMPLAN Group. The IMPLAN model is widely used in academic and professional research projects. Grant funding is treated as direct spending into specified activities/industries using IMPLAN's sector scheme. The primary industry sectors used for this modeling included revenue to broadband telecommunications service providers, wholesalers of communications and technology related equipment, workforce training, and university operations. There are many excellent textbooks and articles that review the methods, strengths, and weaknesses of using an input-output framework in assessing how spending in a given sector(s) of an economy flow through industry interdependencies and worker household spending for a given geography (see Miller and Blair, 2009 as one example). In summary, input-output models are based on an analytical framework developed by Nobel Laureate Wassily Leontief in the 1930s that allowed researchers an effective approach to understand spending within and across industries without having to resort

to tedious and impractical examinations of purchasing and accounting records of every firm involved in a given firm's/industry's supply chain/value chain. Later, input-output modeling frameworks expanded to include the spending by households. In the United States, input-output models are based on benchmark tables developed by the Bureau of Economic Analysis that are derived from the economic census, data from the Bureau of Labor Statistics, and other sources. Input-output models provide estimates of three types of effects, direct, indirect, and induced.

Direct effects in input-output modeling represent the spending by the subject firm or industry. For example, using CMC grant funds, one of our subject CAIs purchases broadband level telecommunications services from a local vendor. That service provider spends this revenue on employees, equipment, utilities, furnishings, facilities, and professional services. In turn, one of those professional service providers is an accounting firm managing the books for the broadband vendor. The accounting firm hires employees, rents office space, purchases office equipment and supplies, and retains a janitorial service to clean their offices. The janitorial service hires workers, purchases cleaning supplies, and so on. The combined spending for each of the companies in the supply chain represent indirect effects. Induced effects capture the value of household spending for the employees of all these firms, including any employees at the anchor institution supported by the grant dollars. Importantly, the model adjusts for spending that flows outside of the study area, which is called an economic leakage. For example, given the rural nature of the selected case study regions, there is likely little of the spending for equipment that would be for goods manufactured in the study area. For the purposes of this research, the study area is the host county for the given CAI. Even with these adjustments for economic leakage, the sum of the direct, indirect, and induced effects will often total more than the original spending, which is the "multiplier effect."

The IMPLAN model provides estimates of economic output, value added, labor income, number of jobs, and revenues received by taxing jurisdictions.

- Economic Output: Total value of business transactions.
- Value Added: The regional equivalent to gross domestic product.
- Labor Income: Salaries, wages, and benefits plus proprietors' income.
- Employment: Headcount jobs.
- Tax Revenue: Federal, state, and local revenues from income taxes, sales taxes, fees for licenses, permits, fines, and other sources of government revenue, as applicable.

3. CAMPUS CASE STUDIES

3.1 Drake State Community & Technical College

Located in Huntsville, Alabama, home to a high-tech economy anchored by aerospace, defense, and advanced manufacturing, Drake State Community & Technical College serves a population that, despite geographic proximity to economic dynamism, has long faced barriers to digital opportunity and workforce entry. Prior to the CMC grant, the communities surrounding Drake State experienced low broadband penetration rates, limited access to digital devices, and a persistent disconnect between educational attainment and regional labor demand. The CMC grant enabled the institution to reframe this mismatch not simply as a problem of connectivity, but as an opportunity to build a systemic pathway between education, infrastructure, and inclusive economic participation. As Jipp (1963) and Cronin et al. (1991) observed, connectivity gains generate the strongest economic returns when channeled through institutions with embedded labor market linkages.

The cornerstone of Drake's initiative was a multi-pronged modernization of its digital infrastructure, designed to both enhance internal systems and project technological capacity outward. The college upgraded indoor and outdoor Wi-Fi access points, implemented enterprise-level secure switching hardware, and adopted a campus-wide single sign-on system. These foundational improvements created the conditions necessary for more advanced digital instruction, including virtual labs, cloud-based platforms, and synchronous online learning. In doing so, Drake upgraded its facilities and established the network architecture required to support its larger mission of outreach and skills development. These investments reflect Clower's (1997) emphasis on the importance of both medium capacity (Mi) and application relevance (Ei) in shaping broadband's utility.

This infrastructural backbone enabled the deployment of the Mobile Cyber-Lab, a flagship element of Drake's approach. Visually striking and programmatically strategic, the Mobile Cyber-Lab functioned as a roving extension of the college's cybersecurity and digital literacy programs. Outfitted with LTE connectivity, laptops, and instructional personnel, the lab traveled directly into underserved neighborhoods, housing developments, and community gathering spaces. This deployment strategy, grounded in community-based outreach, expanded not only access to digital instruction but also increased the number of network "contacts" in Capello's (1994) formulation, thereby enhancing the economic value of the broadband infrastructure itself. The lab's presence in local spaces also lowered psychological and logistical barriers to engagement, signaling that access to high-demand skills and remote learning tools did not require relocation or prior institutional familiarity. These efforts align with Garashchuk et al. (2025), who note that broadband achieves greater uptake when delivered through trusted institutional intermediaries.

Drake complemented its mobile lab with a robust Student Device and Home Connectivity initiative, aimed at sustaining digital access beyond the classroom. In partnership with Kajeet, the college distributed LTE-enabled laptops and broadband hotspots to Pell-eligible students

and adult learners. These devices were not given in isolation, they were paired with support resources and embedded within instructional programs to ensure that connectivity translated into sustained use. Students were empowered to complete coursework, conduct job searches, participate in virtual internships, and access telehealth appointments. This reflects Dholakia and Harlam's (1994) finding that service adoption is only effective when paired with user capacity, training, access support, and relevance to daily needs.

At the curricular level, Drake State took a deliberate approach to align its academic offerings with regional labor market needs. Working in collaboration with Western Governors University (WGU), Drake restructured its cybersecurity program to emphasize stackable digital badges and micro-credentials. This modular format allowed learners to earn recognition at multiple stages of program completion, making progress more transparent and transferable. WGU's articulation support further ensured that credits earned at Drake could seamlessly transfer to four-year institutions, effectively extending the value of the program, lowering opportunity costs for students seeking upward mobility, and accelerating workforce entry in high-demand sectors. These high demand sectors include fields like cybersecurity, where flexible credentialing aligns with the productivity-enhancing effects of broadband discussed in Koutroumpis and Sarri (2024) and Keene et al. (2023).

The institution also demonstrated strong operational capacity and cross-sector coordination, executing procurement and implementation without delays. In collaboration with Howard Tech Industries and AAMU, the college fast-tracked the delivery and installation of necessary hardware and devices. This timely implementation is not merely a logistical footnote; it represents a high level of institutional readiness. This readiness is an essential factor in maximizing the immediacy of Directly Measurable Outcomes (DMOs). As Roller and Waverman (2001) argue, lag effects often blunt the impact of infrastructure investment; Drake's rapid rollout helped collapse that lag, enabling early observation of economic and educational effects within the grant cycle.

Drake State's approach to broadband deployment achieved more than an upgraded infrastructure. Drake State translated that infrastructure into tangible access to opportunity. Its targeted use of mobile labs, community-based instruction, and home connectivity tools addressed the digital divide at multiple levels: technical, educational, and social. These layered interventions allowed Drake to compress the timeline between investment and impact, demonstrating how anchor institutions embedded in regional economies can catalyze broadband-driven transformation that is both immediate and sustainable. Drake's case underscores not just the promise of broadband infrastructure, but the power of institutional design rooted in local responsiveness and inclusive growth.

Table 1: Economic Contributions of CMC Grant Program Spending, Drake State Community & Technical College

Description	Metrics
Total Grant Award	$2,413,182
Economic Output	$2,906,555
Value Added	$1,738,838
Labor Income	$1,444,074
Employment	30
Jurisdiction Revenues	
Total	$336,354
Federal	$253,638
State	$57,351
Local	$25,365

Sources: NTIA, IMPLAN, Center for Regional Analysis

3.2 Fort Valley State University

Tucked among Georgia's peach orchards and farmland, Fort Valley State University (FVSU) has long been a quiet powerhouse of agricultural education in a region shaped by agriculture, persistent underinvestment, and infrastructural divides. Despite its academic reputation and deep community roots, the digital landscape surrounding FVSU remained fragmented for years. Limited broadband access, on top of structural barriers to digital literacy, disconnected large portions of the region from educational, civic, and economic participation. The CMC grant allowed FVSU to address this longstanding divide through a comprehensive, community-rooted strategy that combined physical infrastructure upgrades with digital outreach, workforce development, and civic co-governance.

The initiative's foundation was a robust set of infrastructure investments designed to enhance both on-campus capacity and off-campus reach. In partnership with the Georgia Public Service Commission and technical advisors from Urban Research, FVSU installed miles of new fiber-optic cable and modernized its switching network to support high-volume, low-latency digital activity. These upgrades were essential for supporting the university's own operations, including the delivery of virtual coursework and high-bandwidth academic research. However, unlike many conventional infrastructure projects, FVSU's improvements were explicitly designed

with outward-facing connectivity in mind. The goal was not only to increase institutional capacity, but to create a shared digital infrastructure that could reach households, farms, and public anchor sites across Macon County.

To achieve this outcome, FVSU implemented a network of strategically placed broadband hubs in trusted community institutions, including the Crawford County Senior Center, the Fort Valley Youth Center of Excellence, and the Peach Public Library. These hubs became more than internet access points; they were intentionally activated as sites of engagement and service delivery. At the senior center, older residents accessed telehealth appointments via wellness kiosks and maintained regular virtual contact with distant family members. At the youth center, broadband-supported afterschool programs provided not only internet access, but a structured environment for safe, creative learning. The public library, already a longstanding partner in community education, expanded its role through digital literacy workshops and 24/7 Wi-Fi availability. These investments produced not only technical capacity but network externalities—as Capello (1994) and Clower (1997) have theorized, infrastructure achieves economic value when the technology (T) aligns with the number and diversity of network contacts (S), and when transmission capacity (Mi, Ei) serves relevant and high-value applications.

The effort to increase household connectivity was similarly expansive. In partnership with Macon County Headstart, FVSU distributed mobile hotspots, LTE-enabled laptops, and signal boosters to families participating in early literacy programs. These efforts were not one-off distributions but embedded within wraparound supports: digital skills training, check-ins with program staff, and integration into structured learning environments. This comprehensive support reflects findings from Dholakia and Harlam (1994), who emphasized that service density contributes to developmental outcomes only when paired with usage capacity and training. In this context, broadband was installed and was also made usable, culturally relevant, and pedagogically supported.

Alongside these community-facing activities, the university launched a suite of workforce-aligned micro-credential programs designed to open new economic pathways for rural learners. Short-format certifications in cybersecurity, agricultural technology, and digital communications were designed with flexibility in mind. These courses were offered in hybrid and asynchronous formats to serve working adults and nontraditional learners. These credentials provided portable, stackable signals of achievement that could be recognized by regional employers or used as stepping-stones toward advanced degrees. Developed in partnership with Georgia College and State University, the programs also included joint faculty workshops and curriculum articulation pathways, ensuring consistency and transferability across institutions. These efforts align with literature highlighting broadband's role in driving productivity, small business growth, and labor market access—particularly in rural regions (Koutroumpis and Sarri, 2024; Keene et al., 2023).

One of the most distinctive features of FVSU's approach was its investment in participatory governance through the "Communi-versity" model, a structure that blurred the boundaries between university administration and regional community planning. Quarterly summits brought

together faculty, students, residents, local officials, and business leaders to collaboratively shape priorities for broadband expansion, refine program offerings, monitor progress, and effectively evaluate communal contributions. This model reinforced institutional trust while operationalizing community input. The decision to treat governance as a shared endeavor allowed the broadband initiative to reflect, and respond to, local preferences, constraints, and ambitions. In doing so, it established a civic infrastructure that paralleled the technical one.

FVSU's CMC initiative demonstrates how community-embedded institutions can function as both providers and conveners of broadband-driven transformation. By combining technical investment with educational innovation and democratic planning, the university created a model in which broadband is distributed and activated by weaving it into the fabric of student life, local governance, and workforce preparation. As later sections of this report make clear, this multi-layered approach resonates across the case studies. But in Fort Valley, the model stands out for its balance of infrastructure, pedagogy, and participatory design; each strategic pillar reinforced the others to form a cohesive, locally rooted ecosystem for growth.

Table 2: Economic Contributions of CMC Grant Program Spending, Fort Valley State University

Description	Metrics
Total Grant Award	$2,997,558
Economic Output	$2,061,206
Value Added	$639,367
Labor Income	$372,005
Employment	33
Jurisdiction Revenues	
Total	$217,481
Federal	$115,881
State	$51,227
Local	$50,373

Sources: NTIA, IMPLAN, Center for Regional Analysis

3.3 Fayetteville State University

Situated on the rural–urban fringe of North Carolina's Sandhills, Fayetteville State University anchors a diverse community shaped by military presence and economic precarity. Before

receiving the CMC grant, Fayetteville's digital divide forced many students to rely on unreliable household internet connections, while small businesses struggled to transition into the e-commerce economy. Recognizing these barriers, FSU crafted a broadband initiative that deliberately spanned infrastructure, educational access, workforce preparation, and entrepreneurial support. The program was designed not only for the campus itself but for the wider community of Cumberland County, where gaps in connectivity and skills had constrained growth for all.

At the heart of this initiative was the creation of the Entrepreneurship and Cybersecurity Hub, a facility made possible by the university's expanded broadband and campus Wi-Fi infrastructure. The improved digital backbone supported new instructional labs and enabled local firms to connect securely with university resources. Within the hub, faculty-led teams (supported by technical advisors from the Mary S. Peake Fellowship, a non-profit partner focused on upskilling HBCU scholars) conducted cybersecurity audits and digital marketing assessments for small manufacturing and technology businesses that had previously lacked access to such technical services. These engagements did more than identify weaknesses: they helped businesses adopt secure e-commerce practices, expand their customer bases, and establish sustainable online operations. As Cronin et al. (1991) and Dutta (2001) have shown, investments in telecommunications infrastructure catalyze growth by creating the enabling environment for firms to modernize—a dynamic FSU realized by coupling infrastructure upgrades with direct business support and training. The program also served a critical dual purpose in that these small businesses were also participating in the defense industrial supply chain. These audits and assessments built market relevant skills for FSU scholars but also addressed a critical vulnerability in the fifth tier of our defense industrial base and one that has been exploited by our strategic adversaries.

The university's device access strategy complemented these business supports. By distributing laptops through a loaner program and expanding outdoor Wi-Fi across campus commons, FSU ensured that students could move seamlessly between home, campus, and public spaces without disruption. Such improvements illustrate Roller and Waverman's (2001) finding that broadband access requires both infrastructure and usability to generate measurable outcomes.

Perhaps the most innovative feature of the program was the Anchor Community Navigator initiative. Trained student interns served as digital ambassadors, traveling to homes and businesses across the region to provide technical assistance and troubleshoot connectivity issues. These navigators extended the university's reach into spaces where broadband adoption had lagged, lowering barriers of both cost and knowledge. This approach mirrors Dholakia and Harlam's (1994) argument that infrastructure density alone is insufficient unless accompanied by user capacity; FSU's navigators translated technology into practice, enabling residents to become confident digital participants.

The university also invested in curricular innovation through its Entrepreneurship Lab, which incorporated virtual reality (VR)-based simulations into business and technical coursework. These tools allowed students to engage in immersive problem-solving environments, reducing the time to degree completion and preparing them for evolving job markets. In doing so, the lab

reflects Koutroumpis and Sarri's (2024) findings on broadband-enabled productivity gains, demonstrating how access to advanced digital platforms can accelerate both learning and innovation.

Workforce outcomes were further reinforced through partnerships such as the aforementioned Mary S. Peake Fellowship, which embedded cybersecurity instruction into broader workforce development programming. These collaborations helped FSU frame broadband not only as a tool for economic mobility but also as a pathway toward greater job security and institutional transformation. Keene et al. (2023) have highlighted how rural broadband can support externalities like knowledge spillovers and demographic resilience, and FSU's cross-sectoral model demonstrated these dynamics in practice.

Taken together, Fayetteville State's initiative reflects the multi-dimensional character of broadband's economic and social impact. By combining technical infrastructure, entrepreneurial supports, household outreach, and curricular innovation, the university extended the benefits of connectivity beyond campus boundaries into homes, businesses, and civic life. Its case demonstrates how investments in broadband, when aligned with governance and institutional mission, can help a region like the Sandhills overcome persistent digital unevenness, fostering outcomes that are both locally grounded and strategically significant. Most notably, FSU's partnership with the Mary S. Peake Fellowship has created a replicable pipeline for cybersecurity talent, one that not only strengthens local resilience but also supports the nation's fifth-tier defense capacity. As this model gains traction among peer HBCUs, it signals a broader alignment of broadband expansion, economic development, and national security that's rooted in the leadership of institutions historically positioned to serve both community and country.

Table 3: Economic Contributions of CMC Grant Program Spending, Fayetteville State University

Description	Metrics
Total Grant Award	$4,933,021
Economic Output	$4,893,312
Value Added	$2,710,794
Labor Income	$2,938,207
Employment	50
Jurisdiction Revenues	
Total	$686,280
Federal	$458,080
State	$61,044
Local	$167,156

Sources: NTIA, IMPLAN, Center for Regional Analysis

3.4 Grambling State University

Nestled in northern Louisiana's piney woods, Grambling is home to both a proud academic legacy and a rural population that continues to face profound infrastructural and technological divides. Known for its cultural significance and academic leadership, the university occupies a pivotal space in a region where agriculture, education, and public service shape the economic backbone. Yet surrounding parishes continue to grapple with deep-rooted digital disparities marked by limited broadband infrastructure and persistent service gaps. The CMC grant offered GSU the tools to meet these challenges head-on, enabling the university to reimagine its role in the digital ecosystem of rural Louisiana.

The initiative began with significant upgrades to GSU's network architecture, completed in partnership with Triumph. Exterior Wi-Fi access points were installed across campus and public spaces, ensuring continuous coverage for students and local residents. These infrastructure improvements laid the technical foundation for expanded access, allowing both campus and community members to participate in online coursework, digital services, and remote collaboration. At the same time, the university launched a hotspot lending program in collaboration with AT&T, providing rural students with portable connectivity that extended well beyond campus. This was particularly important for students commuting from remote family

farms and parishes, where traditional broadband service remained unavailable. As Clower (1997) argued, telecommunications capacity generates value when both the transmission medium (Mi) and applications (Ei) align with user needs; GSU's deployment strategy exemplified this principle by extending connectivity into the very environments where gaps had been most acute.

On the academic side, GSU introduced a cybersecurity pipeline embedded across all majors, ensuring that digital fluency and secure practices became integral to student preparation regardless of discipline. These modular micro-credentials offered training in secure data handling, digital ethics, and basic network defense. Students could complete them alongside any degree program, making the initiative both flexible and scalable. A summer bridge program extended this training to high school students, giving them early exposure to digital careers and demonstrating that pathways into technology did not require relocation to urban centers. This approach echoes findings from Jipp (1963), Dholakia and Harlam (1994), and Cronin et al. (1991), who emphasized that access to telecommunications services and skills development correlates strongly with regional growth and labor productivity. By embedding cybersecurity within the curriculum, GSU positioned itself to generate both short-term workforce skills and long-term resilience in the regional labor market.

Health access formed another important pillar of the initiative. Partnering with the Telehealth Certification Institute and equipment provider Mergent, GSU embedded tele-counseling modules into its nursing curriculum and developed remote care delivery simulations. These innovations were particularly significant in a region where healthcare shortages and transportation challenges limit access to services. By equipping students with telehealth competencies while simultaneously offering residents new modes of care, the program addressed both supply and demand, broadening the health infrastructure of rural parishes. Keene et al. (2023) point to rural broadband's role in enabling knowledge spillovers and service innovations; GSU's telehealth initiative illustrates this dynamic by linking digital technology directly to health outcomes.

Community engagement was also central to Grambling's model. Through tech fairs, community workshops, and regular parish meetings, the university positioned itself not only as a broadband provider but as a trusted convener. Residents learned to view digital tools as part of their lived experience rather than distant or abstract technologies. The trust built in these settings helped increase adoption and created a sense of shared ownership of the digital ecosystem. As Garashchuk et al. (2025) highlight, broadband access can reverse demographic decline in disadvantaged areas by supporting civic engagement and reducing barriers to participation; GSU's programming aligned with this perspective by making digital opportunity a visible, community-driven project.

Finally, GSU emphasized replication and scalability. Parish officials and peer HBCUs were invited to observe and adapt the program, positioning Grambling not only as an innovator but as a testbed for broader regional strategies. This outward-facing approach substantiates the broader economic literature's emphasis on multiplier effects, i.e. what begins as localized investment can ripple outward when institutions deliberately share practices and capacity.

Grambling State's case illustrates how a rural HBCU can leverage broadband to serve not only as an educational institution but as a linchpin in regional renewal. By upgrading campus networks, embedding cybersecurity across curricula, advancing telehealth education, and engaging residents through community-facing initiatives, the university transformed connectivity into a lived resource. In northern Louisiana's parishes, the CMC-funded initiative reinforced Grambling's role as both an economic and social anchor. It demonstrates how investments in digital infrastructure, when tailored to local realities, can help sustain rural communities facing population decline and limited service provision, ensuring that connectivity supports both the preservation of identity and the pursuit of economic growth.

Table 4: Economic Contributions of CMC Grant Program Spending, Grambling State University

Description	Metrics
Total Grant Award	$2,218,696
Economic Output	$2,601,485
Value Added	$1,471,007
Labor Income	$1,214,995
Employment	19
Jurisdiction Revenues	
Total	$369,177
Federal	$238,372
State	$64,113
Local	$66,692

Sources: NTIA, IMPLAN, Center for Regional Analysis

3.5 University of West Alabama

In the heart of Alabama's Black Belt, the University of West Alabama (UWA) has emerged as a critical node of opportunity. Located in Livingston, the university sits amid fields of cotton, cattle pastures, and communities where broadband access has long been inconsistent or entirely absent. In Sumter and Greene Counties, these digital divides have hindered everything from online education and job searches to healthcare and civic participation. The CMC grant enabled UWA to act decisively, leveraging its institutional infrastructure and rural partnerships to create a broadband-centered strategy for regional revitalization.

The initiative began with the modernization of UWA's internal network, laying the technical foundation for more ambitious off-campus deployment. Working with county partners, the university navigated right-of-way approvals and permitting requirements to accelerate infrastructure upgrades. Satellite internet ground stations and modern switching hardware were installed across campus, dramatically improving bandwidth and enabling high-demand applications such as remote learning and telehealth simulations.

But what distinguished UWA's approach was its commitment to regional reach beyond campus boundaries. In collaboration with local municipalities, the university installed Starlink satellite terminals and outdoor Wi-Fi radios at civic anchor points—town halls, libraries, and community centers. These locations became always-on digital access hubs, available to students, families, and job seekers long after business hours. In the town of Boligee, for example, outdoor digital access points transformed formerly underutilized spaces into vibrant public commons. These access points not only offered connectivity but fostered a new sense of digital opportunity, aligning with Capello's (1994) view that the value of broadband infrastructure increases as the number of potential contacts (S) in the network expands.

To address persistent household-level gaps, UWA distributed customized broadband access kits, including tablets, laptops, and mobile Zoom carts. These kits were piloted in Panola, a rural hamlet where residents co-designed usability features with university staff. This was complemented by a roving digital skills van, which provided one-on-one technical support to households across the region. These investments, guided by principles outlined in Dholakia and Harlam (1994), ensured that broadband access came with training and cultural fit. As Clower (1997) emphasized, connectivity only produces measurable gains when it is matched with applications tailored to local needs, a principle reflected in UWA's community-centered design.

Health access was another core domain of innovation. With support from the nursing faculty and Greene County extension agents, the university deployed telehealth technologies that expanded access to therapy, preventive care, and specialist consultations. These services were particularly valuable for elderly and mobility-limited residents who previously had to travel significant distances for care. Keene et al. (2023) and Garashchuk et al. (2025) both highlight the transformative potential of broadband to improve health and demographic outcomes in rural areas. These findings were echoed by UWA's integration of digital care tools into both training and service delivery.

The University of West Alabama's CMC initiative exemplifies how rural anchor institutions can lead with locally grounded solutions powered by emerging technologies. Rather than replicate urban broadband models, UWA tailored its strategy to the unique spatial and infrastructural constraints of the Black Belt by deploying satellite internet, outdoor Wi-Fi, mobile kits, and roving support vans to meet people where they are. These interventions were not just about bridging a connectivity gap; they reimagined how digital infrastructure could be delivered in regions long excluded from traditional broadband rollouts. By combining satellite-enabled access with health and workforce development, UWA created a model of rural innovation rooted in practicality, adaptability, and trust. In a region where exclusion has long been normalized, UWA's approach offered access and agency.

Table 5: Economic Contributions of CMC Grant Program Spending, University of West Alabama

Description	Metrics
Total Grant Award	$1,649,440
Economic Output	$1,909,133
Value Added	$637,035
Labor Income	$548,796
Employment	23
Jurisdiction Revenues	
Total	$186,322
Federal	$135,949
State	$26,537
Local	$23,836

Sources: NTIA, IMPLAN, Center for Regional Analysis

4. CROSS-SITE SYNTHESIS & EMERGENT THEMES

4.1 Qualitative–Quantitative Convergence

The convergence between qualitative insights and quantitative modeling in this research underscores the integrative value of a mixed-methods approach to understanding the impact of broadband infrastructure grants in underconnected regions. The five campus case studies presented in this analysis do not simply document isolated outcomes or stand-alone anecdotes. Rather, they provide a composite picture of how localized broadband interventions, designed and implemented through the lens of community anchor institutions, generate layered forms of economic value.

On one level, the qualitative data, narratives drawn from stakeholder interviews, campus implementation reports, programmatic materials, and public feedback, capture the texture of institutional decision-making and community response. These accounts allow for a grounded understanding of how strategies were developed, adapted, and translated into community contexts. They reveal not only what was done but how and why it mattered in a given setting, offering insight into motivations, constraints, and emergent adaptations.

On another level, the economic contribution modeling, generated through the IMPLAN input–output framework, provides a structured method for estimating the broader effects of spending on local and regional economies. Though limited by the lag in observable data and the complexity of modeling multi-sectoral outcomes, this approach yields directional evidence of multiplier effects in areas such as labor income, output, and value added. While the full economic trajectory of these investments will require longitudinal observation and richer datasets, these early indicators suggest that even modest broadband funding, when strategically deployed through trusted local institutions, can set in motion processes of regional economic revitalization.

Critically, the interplay between qualitative and quantitative data does not function as a simple validation exercise. The relationship is iterative and mutually reinforcing. The qualitative narratives inform the logic and assumptions underlying the economic modeling, ensuring that simulations reflect the nuanced realities of institutional and regional implementation. At the same time, the quantitative findings lend analytical weight to anecdotal observations, allowing initial stories of change to be situated within a broader economic logic. This convergence strengthens the basis of the paper's claims and offers a replicable template for future research examining the socio-economic impact of federally funded digital opportunity programs.

4.2 Emergent Themes and Implications

The cross-case synthesis of the five CMC grant recipients reveals a set of thematic patterns that emerged inductively from their implementation strategies, institutional contexts, and surrounding economic conditions. These themes are not offered as definitive outcomes or generalizable conclusions, but as emergent insights and observed alignments in practice that illustrate how

broadband infrastructure, when deployed through community-based institutions, may support broader goals of regional resilience and inclusive development.

Broadband Infrastructure as Foundational

- Across all five institutions, investments in broadband infrastructure were not treated as standalone upgrades but as foundational platforms for extending institutional reach. Whether through fiber expansion (FVSU), LTE-equipped mobile labs (Drake), or satellite-enabled civic hubs (UWA), campuses used technical investments to support community-facing programming. These efforts align with Capello's (1994) formulation of network value as a function of both technological capacity and the number of active social "contacts," suggesting that infrastructure becomes more economically and socially generative when embedded in local service networks.

Access Paired with Community-Centered Adoption

- Efforts to ensure broadband access were consistently accompanied by initiatives aimed at fostering adoption, trust, and sustained use. Institutions deployed a wide range of strategies including student-led navigator programs, mobile digital skills vans, culturally embedded instruction, community tech fairs, and participatory governance structures, all designed to meet people where they are. These interventions blurred the line between implementation and outreach, positioning broadband not just as a service but as a shared asset. Dholakia and Harlam (1994) emphasize that telecommunications investments yield returns only when matched with user capacity, and Garashchuk et al. (2025) argue that civic trust is essential to reversing demographic decline. Together, these insights are reflected in how institutions like FSU and FVSU embedded digital literacy into trusted community spaces and treated engagement as both a means and an end.

Workforce Development Tailored to Regional Labor Markets

- In nearly every case, institutions aligned their programming with local workforce demands through stackable credentials, micro-certifications, and asynchronous delivery models. Programs in cybersecurity and healthcare IT created on-ramps for adult learners, underemployed residents, and students without the flexibility for traditional degree pathways. These efforts reflect broader findings in the literature that associate broadband access with productivity growth, labor market flexibility, and skill formation (Cronin et al., 1991; Koutroumpis and Sarri, 2024). While long-term employment effects remain to be seen, these curriculum design choices illustrate how broadband infrastructure can catalyze new forms of local economic participation when paired with institutional responsiveness.

Entrepreneurship and Local Economic Participation

- Multiple institutions integrated broadband access into programs supporting small business resilience and local entrepreneurship. Through business resource centers (FSU), cybersecurity audits (Grambling), mobile professional development hubs (Drake), and agricultural innovation training (UWA), campuses sought to lower barriers to digital commerce and open new economic pathways for underserved populations. These initiatives did not attempt to replicate urban innovation ecosystems; instead, they were place-based strategies rooted in community assets and tailored to local constraints to effectively unlock economic agency for individuals and small firms. This echoes the work of Clower (1997) and Cronin et al. (1991), who emphasize that telecommunications investments yield the highest returns when localized applications (Ei) are aligned with community needs and institutional capacity. The emergence of entrepreneurial infrastructure as a broadband use case suggests that digital opportunity is not solely about consumption, but also about production and participation in evolving economies.

Health and Care as Domains of Digital Opportunity

- Telehealth was a recurring site of innovation across the case studies, with several institutions integrating broadband-enabled services into both care delivery and health training. From virtual counseling modules at Grambling to mobile care kiosks at FVSU and remote eldercare access at UWA, broadband became a tool for addressing long-standing gaps in health infrastructure. These initiatives reflect the potential for broadband to generate positive externalities in health, particularly in rural and low-access areas (Keene et al., 2023; Garashchuk et al., 2025). While the institutional approaches varied, they shared a recognition that health and digital opportunity are increasingly intertwined.

Taken together, these themes highlight broadband's capacity not only to connect, but to activate institutions, helping them engage more fully in the economic, civic, and social life of their regions. The case studies show that when digital infrastructure is deployed with intention and rooted in local context, it becomes more than a utility; it becomes a catalyst for regional empowerment. Importantly, these findings underscore the need for continued analysis as the CMC program unfolds. The full arc of these investments, particularly their effects on long-term economic growth, health access, labor market resilience, and small-business inclusion will take time to materialize. But already, these early patterns point to a core insight: broadband's most transformative potential lies not in megabits per second, but in the institutional and community systems it helps energize.

5. CONCLUSION

5.1 From Digital Opportunity to Economic Transformation

The five case studies presented in this report reveal that digital opportunity is not a binary transition from unconnected to connected, but rather a layered and context-specific process that unfolds within deeply rooted institutional, geographic, and cultural structures. The impact of CMC funding cannot be captured solely through infrastructure statistics or device distribution counts. Instead, it must be understood as a catalytic investment in institutions, particularly HBCUs and PBIs, that already serve as social anchors in under-resourced regions. These institutions did not simply expand access; they reshaped what broadband could mean in the daily lives of those they serve.

One of the most striking patterns across the grantees is that connectivity, on its own, rarely produces mobility. Access is only the first mile. Without hands-on digital skills support, device literacy, and culturally relevant outreach, broadband risks becoming an underused utility rather than an engine of opportunity. The institutions featured in this study avoided that pitfall by embedding adoption strategies directly into program design. Whether through roving digital vans, student navigator internships, or embedded device distribution, each grantee recognized that infrastructure alone does not generate outcomes unless paired with user-centered scaffolding. This pattern reflects the long-standing finding in the literature (Dholakia and Harlam, 1994; Clower, 1997) that service density leads to developmental returns only when matched with meaningful usage capacity.

Another consistent finding is that institutional presence, not just infrastructure, is the true delivery mechanism for impact. Broadband's potential was most fully realized when it flowed through trusted, community-embedded colleges and universities. These institutions served not just as technology providers but as civic intermediaries, translating broadband into forms of value that aligned with community priorities. Whether through agricultural extension, VR-based business labs, or telehealth training modules, institutions adapted broadband to their own mission and to the realities of their region. This aligns with Capello's (1994) conception of information value, where economic impact is a function of both the technology deployed and the number of relevant contacts (S) activated within a network. The result was not the mere provision of access, but the activation of a local system through which connectivity gained economic, social, and cultural meaning.

Digital opportunity, as evidenced in these cases, emerged not as an incidental outcome of better infrastructure but as a direct result of intentional design. Grantees crafted interventions to reach specific populations, not through generic digital inclusion programs but through tailored, place-based models that responded to hyperlocal needs. These efforts were not one-size-fits-all. They were specific, adaptive, and built on pre-existing community relationships. This strategic targeting helped reduce participation barriers and ensured that broadband became a relevant, usable resource rather than an abstract upgrade.

The case studies also complicate conventional narratives around workforce development. While credentials and micro-certifications played a central role across sites, they did not function as endpoints. Instead, they serve as bridges, constituting accessible entry points into broader educational and economic trajectories. Institutions like Drake and FVSU used stackable credentials and articulation agreements to create permeability across learning environments, offering students the flexibility to build skills at their own pace while maintaining alignment with regional labor markets. These models reinforced the notion that digital skills are not standalone assets but components of recursive learning and career systems. As Koutroumpis and Sarri (2024) and Keene et al. (2023) suggest, broadband-driven productivity and workforce revitalization are most effective when credentialing models mirror the modular, fast-changing nature of digital economies.

Trust and local identity surfaced repeatedly as hidden but essential forms of infrastructure. Whether in Fort Valley's Communi-versity summits or West Alabama's user-tested kits in Panola, program success hinged not only on what was delivered but on how and by whom it was delivered. These case studies reinforce the view advanced by Garashchuk et al. (2025) that digital adoption grows when broadband is mediated by credible local actors. Importantly, the institutions in this analysis did not take trust for granted, rather they built it, often through shared governance, transparency, and visible responsiveness. In this light, trust was not a soft value but a structuring condition that shaped the reach, uptake, and durability of CMC investments.

Taken together, these insights underscore that broadband infrastructure only delivers transformative outcomes when it is coupled with institutional strategy, community responsiveness, and programmatic design rooted in local realities. The cases analyzed here do not present a singular blueprint, but they do converge on a shared premise that when higher-education institutions are resourced, trusted, and positioned to lead, digital opportunity becomes a platform for lasting economic transformation.

5.2 Future Research Agenda

While the qualitative and preliminary economic evidence points to clear promise, deeper empirical investigation is needed to validate and scale the findings from this initial study. Several key research questions emerge:

- **Longitudinal Outcomes:** How do digital skill attainment and credential completion rates change over time as broadband access becomes normalized? What retention and graduation trends emerge in the years following device and connectivity interventions?

- **Labor Market Effects:** What are the wage trajectories, job placements, and entrepreneurship outcomes for residents who participate in broadband-linked training programs compared to control groups in similar regions without such interventions?

- **Telehealth Impact:** To what extent does the availability of telehealth options reduce non-emergency room visits, improve preventive care uptake, or alter chronic disease

management in rural areas served by these CAI's?

- **Local Multiplier Effects:** How do small businesses participating in digital accelerator programs perform over time relative to baseline firms? Can a digital small-business multiplier effect be quantified through changes in employment, revenue, or tax base?

- **Institutional Evolution:** How does participation in CMC-funded programming reshape the CAI's own identity, mission, and strategic plan? Do these projects catalyze institutional shifts in research, enrollment, or community engagement?

- **Civic Trust and Governance:** Do co-governance models, such as those seen at Fort Valley or Grambling, increase local participation in other public initiatives (e.g., elections, planning boards, school councils)? Can broadband access rebuild civic capital?

- **Replication and Scalability:** What factors influence the successful replication of these models by peer HBCUs or rural-serving institutions? Are there specific policy frameworks or funding formulas that enhance replicability?

These questions are not merely academic. They are vital to informing future public investments, philanthropic strategies, and institutional planning across the postsecondary and broadband development landscape.

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Note: All CMC campus narratives and internal reports cited throughout the paper are available in the Appendix or through institutional archives.

6.2 Appendices

Appendix A: IMPLAN Modeling Assumptions & Sectors

To ensure transparency in the economic contribution estimates presented in the case studies, this appendix outlines the IMPLAN modeling framework, sectoral assumptions, and geographic boundaries used in the analysis.

The study areas were defined at the county level, corresponding to the home counties of each anchor institution: Madison County, AL (Drake State Community & Technical College), Macon County, GA (Fort Valley State University), Cumberland County, NC (Fayetteville State University), Lincoln Parish, LA (Grambling State University), Sumter County, AL (University of West Alabama).

Models were run using IMPLAN's web-based platform using county level datasets. The datasets have a baseline reference to 2023, meaning that our current analysis makes the explicit assumption that the study region industry structure is the same as in 2023, which is generally correct for a time window of a few years. The model estimates are adjusted for inflation to 2025 based on IMPLAN's internal price indices. Grant expenditures were assigned to a consistent set of IMPLAN sectors that represent the primary activities supported by the CMC program. The current IMPLAN sector scheme includes 528 individual sectors, which generally align with aggregated NAICS codes. For this analysis, we estimated spending generally into four categories. For some grant recipients, these categories were altered due to model limitations or to better reflect the programs supported by the subject grant program.

- Wired telecommunications services (415) represents purchased broadband telecommunications services
- Wholesale trade electronics (384) represents equipment purchases. We chose wholesale trade under the assumption that the broadband related equipment being purchased is not manufactured within the study region, and that it is likely that such equipment would be obtained through a purchasing contract and not through a retailer. Since this assumption does not allow for the retention of local retail trade margins, it is a conservative approach for estimating total local impacts associated with equipment purchases.
- Other education services (464) represent program spending on workforce training. This is a catch all category that includes a broad range of education and training, but in terms of how this spending flows through payments to instructors and materials, we judge it to be the best fit for the category of spending.
- Higher education operations accounts for facilities and administrative expenses (overhead) allowed in the grant program. To be clear, the technically correct IMPLAN code for public universities is to model only employment and payroll for state government education (521). However, we do have information on how each subject university spends their facilities and administration funds, so we categorize these expenditures as revenue to private junior colleges, universities, and professional schools (463) as the most representative sector.

In some of the smallest jurisdictions, the IMPLAN may not recognize a given industry as being "present" in the region. For example, for Fayetteville State (Cumberland County, NC), IMPLAN does not have multipliers for industry sector 463 (private institutions of higher education. In that case, we categorized facilities and administrative expenses as sector 464 as the closest related sector. For Drake, we determined that some of their spending was best categorized "research," which was modeled using sector 445 "other technical consulting."

This common framework reflects the fact that, while individual campuses varied in implementation strategies, the underlying expenditure categories were broadly similar and therefore modeled through the same sectoral lens.

Table A.1: IMPLAN Sectors Used in Modeling

Category of Spending	IMPLAN Sector Code(s)	Description	Example of Application in CMC Grants
Broadband Telecommunications	415	Telecommunications services, including broadband providers	Contracts with ISPs to expand campus and community connectivity
Equipment & Devices	384	Merchant wholesalers, durable goods (communications and tech-related equipment)	Laptops, routers, switches, mobile hotspots
Workforce Training	464	Educational services (junior colleges, vocational training)	Digital skills programs, cybersecurity credentials, short-format certificates
University Operations	463	Colleges, universities, and professional schools	Expanded use of facilities, program administration, academic staffing

Modeling Assumptions:

- **Geography:** Impacts measured at the host county level.
- **Localization:** Spending was localized whenever possible; leakage was assumed for specialized equipment procured outside the county.
- **Effects Traced:** Models captured direct, indirect, and induced effects of spending.
- **Multiplier Effects:** As is typical in input–output modeling, total contributions exceeded direct expenditures due to supply-chain linkages and household re-spending.

By consolidating CMC expenditures into these common sectors, the modeling approach provides a consistent baseline for comparing economic contributions across the five institutions, while still allowing for variation in local multipliers and regional economic structures.

Appendix B: Definition & Context of IMPLAN Metrics

Economic Output

- **Definition:** The total dollar value of all goods and services produced in the regional economy as a result of the activity. This represents the sum of all business transactions—both intermediate (business-to-business) and final (business-to-consumer or export).
- **Context:** Output captures the broadest measure of economic activity but may involve double counting when intermediate inputs are included (e.g., the sale of raw materials and the later sale of finished goods). For this reason, it is useful primarily as an indicator of the scale of economic transactions.

Value Added

- **Definition:** The regional equivalent to Gross Domestic Product (GDP). Value added is the net contribution to the economy after accounting for intermediate inputs and includes labor income, proprietor income, other property income, and indirect business taxes.
- **Context:** This measure avoids double counting and provides a clearer view of the economic contribution to the region. Value added is often considered the most reliable measure of overall economic significance at the regional level.

Labor Income

- **Definition:** All forms of employee compensation and proprietor income, including wages, salaries, benefits, and payments to self-employed individuals.
- **Context:** Labor income indicates the direct financial benefit accruing to households and workers in the study region. This measure reflects the extent to which the activity supports local earnings and household consumption capacity.

Employment

- **Definition:** The number of jobs supported by the activity, measured in headcount terms rather than full-time equivalents (FTEs). One job may be full-time, part-time, or seasonal.
- **Context:** Employment estimates capture both direct positions funded through the grant and indirect or induced jobs supported through supply-chain and household-spending effects. IMPLAN's use of headcount means comparisons with FTE-based statistics should be made cautiously.

Tax Revenue (Jurisdictional Revenues)

- **Definition:** Federal, state, and local government revenues generated as a result of the economic activity, including income taxes, sales taxes, property taxes, business licenses, fees, fines, and other sources as modeled by IMPLAN

- **Context:** These revenues represent public sector fiscal benefits resulting from private sector activity. Federal collections typically dominate, but state and local governments also experience meaningful increases in revenues due to multiplier effects in sales, property, and income bases.

Appendix C: Regional Context Data (Socioeconomic Indicators)

The socioeconomic conditions of each host county provide important context for interpreting the impacts of CMC-funded broadband initiatives. Counties varied widely in poverty levels, household incomes, and broadband adoption rates, shaping how grant dollars translated into measurable outcomes.

Table L.1: Selected Socioeconomic Indicators for Host Counties

Anchor Institution	County/Region	Population (2020)	Poverty Rate (%)	Median Household Income ($)
Drake State Community & Technical College	Madison County, AL	388,153	10.5	83,528
Fort Valley State University	Macon County, GA	12,082	25.5	37,177
Fayetteville State University	Cumberland County, NC	334,728	17.2	58,780
Grambling State University	Lincoln Parish, LA	48,396	30.7	38,035
University of West Alabama	Sumter County, AL	12,345	28.1	37,981

Sources: U.S. Census Bureau ACS (2020)

This variation underscores the heterogeneity of context: while Drake State operates in a relatively affluent county with high broadband penetration, UWA and Grambling function in areas of persistent poverty and low subscription rates, amplifying the transformative potential of even modest broadband investments.

Appendix D: Cross-Site Theme Matrix

To synthesize the qualitative and quantitative findings, this appendix presents a cross-case matrix showing the presence or absence of major emergent themes.

Table M.1: Emergent Themes Across Institutions

Theme	Drake State Community & Technical College	Fort Valley State University	Fayetteville State University	Grambling State University	University of West Alabama
Broadband Infrastructure	☑	☑	☑	☑	☑
Community-Centered Adoption	☑	☑	☑	☑	☑
Workforce Development	☑	☑	☑	☑	☑
Entrepreneurship	☑	☐	☑	☐	☑
Telehealth & Healthcare	☐	☑	☐	☑	☑

☑ = strong evidence; ☐ = limited or no evidence

This matrix makes clear that some themes, particularly infrastructure, workforce development, and entrepreneurship, were universal, while others (telehealth, participatory governance) were more unevenly distributed across sites. It illustrates how shared funding inputs were mediated by local institutional choices and contexts, producing varied but overlapping pathways toward digital opportunity and regional resilience.