PALM BEACH STATE COLLEGE

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STATE COLLEGE

TAACCCT Project: gEHRing up for HIT (EHR)

THIRD-PARTY EVALUATION FINAL REPORT

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WorkED. Consulting

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About This Publication

WorkED Consulting, LLC, a small business management consulting firm located in Burke, Virginia, and its evaluation partner, MN Associates located in Fairfax, Virginia, wish to thank and acknowledge staff at Palm Beach State College for their many hours of time and effort spent providing qualitative and quantitative data. In particular, the evaluators wish to thank Dr. Jacqueline Rogers, Mollie Rhodes, and Cara Good for providing leadership and constant collaboration, and Maureen Capp for facilitating continuous improvement at Palm Beach State College based on evaluation results. A special thank you goes to Dr. Janelle Christensen who demonstrated constant diligence in tracking outcomes and performance, and deserves special recognition for integrating sound methodologies and evidence-based practices into the program design and implementation.

1.0 Executive Summary

Palm Beach State College (PBSC), located in Lake Worth, Florida, is a comprehensive state college that offers certificates, associates degrees and bachelor's degrees in a number of fields of study. With a total student body of nearly 48,000, PBSC provides a wide array of job training and education tied to local employers' needs for a skilled workforce.

In 2012, PBSC applied for, and was successfully awarded, a Round 2 Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant from the U.S. Department of Labor. PBSC's ***gEHRing up for HIT (EHR)*** project is a single institution award that targets Palm Beach County's trade-impacted workers, other dislocated workers and unemployed veterans, who need skills' upgrades in order to pursue jobs and careers in the high-growth, high-demand Health Information Technology (HIT) field.

The EHR project implemented two significant service interventions: (1) implementation of the "REACH" Advising Model—an intensive advising model designed to improve recruitment, enrollment, and persistence of students in the HIT pathway, which was the particular intervention of focus for the impact study; and (2) overall implementation of improved classroom and online curriculum for the HIT field. In particular, PBSC's HIT curriculum and pathways aligned to industry standards developed by the American Health Information Management Association (AHIMA), the premier national industry association that accredits training institutions and credentials students for occupations in HIT. Underlying PBSC's development of enhanced curriculum and courses in HIT was the premise that a "higher quality" of academic instruction and competency development was necessary for EHR participants to gain employment in HIT demand occupations in Palm Beach County. Therefore, a key component of the evaluation design was conducting observations and collecting qualitative data to determine the impact of incorporation of AHIMA-accredited and more rigorous HIT curriculum and instruction on participant time to completion and credentialing.

The PBSC EHR evaluation design incorporated the two major required study elements—a program implementation analysis and an outcomes/impact study—and utilized a Theory of Change framework to assess the primary service intervention—incorporation of the REACH Advising Model—as well as evaluate overall implementation of improved classroom and online curriculum for the HIT field.

The **program implementation study** was designed to answer sets of research questions in four key areas: (1) Curriculum Review, Use and Selection; (2) Program Delivery, Design and Administration; (3) Assessment Tools and Processes; and (4) Partner Contributions. While the program implementation study design incorporated these required research areas, it also extended further in assisting PBSC program staff and administration with continuous improvement by cross-walking the activities and deliverables in PBSC's Statement of Work (SOW) with the research questions in the four research areas and providing a comprehensive picture of ongoing implementation progress, accomplishment of deliverables, and continuous improvement. Therefore, the implementation design became much more than information gathering and analysis, it provided PBSC leadership with qualitative information and feedback on areas of improvement as the program progressed over the four-year period of performance.

Additionally, over the course of the evaluation, three key activities were conducted to accomplish the implementation analysis:

(1) Steps taken by institution to create and run the training program. At the commencement of the program and evaluation, PBSC staff and the third party evaluation team held weekly conference calls to establish baselines, develop data collection protocols, and communicate on implementation progress. As the program matured, calls became bi-weekly and then monthly. Six site visits were conducted, which consisted of classroom observations and interviews with EHR program staff, REACH Advisors, deans and faculty, the new PBSC College President, employers during an on-campus event, CareerSource Florida (WIB) staff, and participants. Interview protocols were developed prior to site visits, and site visit reports were completed and provided to PBSC staff.

(2) Operational strengths and weaknesses of project after implementation. After the first year of implementation and the August 2013 site visit, an ***Early Implementation Report*** was issued after year 1 of the period of performance that outlined progress-to-date and highlighted any potential adjustments that PBSC staff were able to consider. Because delays in hiring, equipment purchases, and implementation of sound program and business practices in year 1 have ripple effects, and thus impacts on final outcomes, the *Early Implementation Report* served as both a baseline document and a "red flag" warning for areas that PBSC program staff needed to address. The *Early Implementation Report* then became a "check back" document to track updates on progress in meeting program deliverables and potential impacts on outcomes.

(3) How operations might be strengthened. During the course of the implementation analysis, PBSC was provided with analysis, recommendations, and information to be used for continuous improvement and best practices to consider sustaining after the end of the grant-funded program. Additionally, the program implementation analysis design, which incorporated program deliverables, allowed PBSC to track items also subject to core monitoring by the Federal Project Officer (FPO). In fact, items raised by the FPO in PBSC's core monitoring visit had already been flagged by the evaluators through the *Early Implementation Report* and subsequent site visit reports, allowing PBSC to work and make improvements prior to, and after, the FPO core monitoring visit.

The **outcomes and impact analysis** aggregated individual-level data across the four-years of the grant period of performance. Data regarding participant employment and wages were deemed inconsistent to perform a robust analysis. These data were inconsistent in their reporting times as well; therefore, the lag time between a participant's completion date and when his or her wage records were available was typically several quarters. Smaller sample size of the treatment group also precluded the evaluators from achieving statistically significant results. Additionally, analysis with a second comparison group such as business students was not possible due to an antiquated college data warehouse system that did not provide updated program completion data in time for report completion.

Participant data analysis consisted of frequencies of outcome measures by program track and in the aggregate. Evaluators cross-tabulated the number of completed certificates and credentials with variables including college, technical track, TAA eligibility, age, gender, and ethnicity. Evaluators also created variables to determine the number of students who completed a certificate or credential, did not complete and withdrew, and did not complete and were still enrolled. These data were then cross-tabulated with variables such as TAA eligibility, Priority of Service status (veterans and spouses of veterans who take precedence over non-covered individuals in ETA-funded programs), gender, ethnicity, and developmental education needs (e.g., math, reading, or English). Lastly, the evaluators created variables for participants who completed their certificate or credential within the appropriate amount of time for their program and those who took longer. These data were cross-tabulated by TAA eligibility, Priority of Service status, and developmental education needs.

Analyses of data pertaining to the EHR evaluation consisted of a variety of qualitative and quantitative methods. Data from each collection source were analyzed separately, and then compared for consistent or conflicting findings. Advising case management data from over 500 case notes from all years of the program were coded manually for common themes. Statistical analyses were conducted using the software package R. Rigorous Bayesian analysis was conducted to make inference(s) about the difference in post-completion mean wages between the treatment and control groups.

IMPLEMENTATION FINDINGS

- ***Palm Beach State College has implemented a high-quality curriculum that meets AHIMA/CAHIIM accreditation standards.*** An important "best practice" which PBSC can share with the community college network is the development of ongoing rigorous curriculum and implementation of requirements to attain and maintain national industry accreditation, which is a lot more challenging than many colleges anticipate.
- ***Palm Beach State College developed and made available the seven (7) stackable certificates; however, these certificates were mainly valuable and targeted to incumbent workers or individuals with HIT professional experience who need skills upgrades, so EHR participants had limited access to these credentials.*** While PBSC met its deliverable for development of the stackable certificates, the focus of those credentials ended up being for individuals already working in HIT or having experience in HIT, which was not the vast majority of the EHR participants. Therefore, from a program performance standpoint, the value of the stackable certificates will be realized after the program period ends.

- ***Technology was procured for online course development and availability, and additional faculty was hired aligned to AHIMA/CAHIIM accreditation requirements.*** PBSC met timeframes to get technology equipment and supplies purchased and a technology implementation specialist hired to meet online curriculum development milestones. While initially delayed due to the applicant pool, PBSC was able to hire qualified faculty for additional HIT course teaching and learning tied to AHIMA/CAHIIM accreditation standards and development of online courses.
- ***EHR participants took longer to complete than initially anticipated, partially due to the rigor of courses and depth of teaching and learning, and partially due to self-imposed course scheduling and course sequencing barriers.*** Class scheduling remained a persistent challenge, including the sequencing of courses, that likely impacted the time to completion for some EHR participants.
- ***While online courses were developed, they were not offered to EHR participants.*** Online course development was initially delayed, but faculty report completion of online courses, and are uploading related curriculum to SkillsCommons. However, online and hybrid courses, while developed, were not offered to EHR participants.
- ***PBSC did not implement a process for either employer or peer review of curriculum.*** PBSC should have policies and processes in place globally to allow for SME employer, industry, and peer review of workforce-related courses and curriculum.
- ***Palm Beach State College designed and implemented an effective administrative structure that implemented the deliverables of the program.*** PBSC hired new grant staff in a timely manner that allowed staff and faculty to maximize the time needed during the period of performance to implement grant strategies and complete grant deliverables.
- ***With the exception of the full-time faculty position, PBSC administrators met budget expenditure timelines including hiring staff, purchasing equipment, and executing contracts.***
- ***Qualitative data shows that the REACH advising model was seen by participants as a successful intervention that helped them navigate program entry and persistence and provides PBSC with an opportunity to bolster its academic advising function.***
- ***Having a Data Analyst with a Ph.D. who was focused on data collection and analysis for the grant-funded program provided a level of data quality, information collection, and continuous feedback that allowed program and college administrators to make more informed decisions and assisted the third-party evaluation team.*** PBSC was able to hire a Ph.D. credentialed individual, and over the period of performance, was able to demonstrate value in having this level of expertise involved as many of the up-front processes, program definitions, and data collection procedures allowed program administrators the benefit of outcomes documentation and continuous improvement.

- ***The program experienced communications gaps, primarily: (1) gaps between program staff and faculty; and (2) gaps between the REACH Advisors and college advising in student services.*** Throughout the duration of the program, there was clearly a lack of continual communication and program updates between grant program staff and faculty involved in curriculum development and teaching. While it is difficult to ascertain from a qualitative standpoint exactly why these communications gaps existed, program staff expressed ongoing concerns about not having information on program deliverables (particularly Business Partnerships and outreach) and actions taken to address needed improvements in curriculum and course design.
- ***The Palm Beach State College program model did not emphasize formal assessment; however, the focus on a consistent and intensive advising model seemed to adequately identify participant interests and aptitudes.*** During the grant period of performance, the State of Florida eliminated requirements that recent high school graduates utilize the TABE or that colleges could provide separate remedial education courses. Therefore, PBSC focused program efforts on implementation of the REACH advising model and worked to ensure consistency in how participants were approached and advised in lieu of a formal assessment. In addition, between the REACH Advisors, HIT faculty and CareerSource Palm Beach, participants received career guidance services and direct linkages to employment.
- ***The EHR program provided PBSC and CareerSource Palm Beach with a means to improve collaborative work and ways to better communicate.*** As a result of the TAACCCT grant and the EHR program, PBSC and CareerSource Palm Beach were able to leverage funding for a position at CareerSource Palm Beach dedicated to serving participants and co-enrolling in Workforce Innovation and Opportunity Act (WIOA) programs to provide tuition assistance.
- ***The annual FIRE Seminar provided a forum for interaction between participants and employers, which can serve as a model for deeper and more coordinated interactions.***
- ***PBSC should implement a more coordinated and strategic approach to engaging employers, including implementing a customer relationship management tool in order to document interactions and successes.*** Relying on one faculty member to coordinate, document, and engage all potential employer partners in a field of study or industry is not practical or realistic from a workload standpoint.
- ***PBSC formalized articulation agreements, but it is a challenge due to accreditation requirements.*** PBSC was only able to execute one articulation agreement with Charter Oaks State College in April 2016.

PARTICIPANT IMPACTS AND OUTCOMES FINDINGS

Indicators	Number from APR[1]	Target from SOW	Target Achieved?
1. Total Unique Participants Served	335	310	YES
2. Total Number of Participants Completing a TAACCCT-Funded Program of Study	83	255	NO
3. Total Number of Still Retained in Their Program or Other TAACCCT-Funded Program	130	55	YES
4. Total number of Participants Completing Credit Hours	335	248	YES
5. Total Number of Participants Earning Credentials	83	228	NO
6. Total Number of Participants Enrolled in Further Education After TAACCCT-Funded Program of Study Completion	0	125	NO
7. Total Number of Participants Employed After TAACCCT-Funded Program of Study Completion	20	226	NO
8. Total Number of Participants Retained in Employment After TAACCCT-Funded Program of Study Completion	20	168	NO
9. Total Number of Those Employed at Enrollment Who Receive a Wage Increase Post-Enrolment	93	84	YES

- While there were substantial gains in enrollment and completion, several target numbers were not met. A total of four targets were achieved.
- During the course of the grant implementation period, a total of 126 credentials was awarded during the program period of 2013-1 to 2016-3. The number of participants earning credentials was 83 out of a target of 228 certificates and degrees. This goal was a mathematical impossibility given the **baseline completion rates of ~6 (5.66) completions per year** (duplicated). The average annual completion rate **increased to 27 certificates or degrees awarded per year** (duplicated) during grant activities. This is more than four the baseline rate, however, was not enough to meet the target. The project staff needed to assist in the completion of approximately 43 more certifications per year to reach this goal. This assumes that the program would be able to accommodate at least 40 new participants each

[1] These numbers are the data compiled at time of publication and may be slightly different from the final numbers reported to USDOL.

year. Though not a grant-required target, the average enrollment in the introductory course increased.

- Participants in the control group showed better academic progress overall than the treatment group. Evidently, on average, number of credentials awarded per participant is found to be higher for the control group. They had more time to complete the certificates or degrees. While the treatment participants had 3.5 years the control group had 6.5 years. At the time of reporting, 25 control students are still enrolled. A majority of them either left or completed their program.
- Treatment participants appear to have attained their first credentials in a shorter period than the control participants. This difference is found to be statistically significant.
- Part-time participants in both groups appear to have shorter completion time than the full-time participants. However, because of small number of full-time enrollments in the program, these differences are not statistically significant.
- Although observed average completion time is found to be longer for participants who were Pell Grant eligible than those who were not, the difference is not statistically significant.
- Most participants (control – 50% and treatment – 75%) for whom post-completion wage information was available have seen their wages increase after completion.
- Rigorous Bayesian analysis was conducted to make inference(s) about the difference in post-completion mean wages between the treatment and control groups. The analysis revealed greater uncertainty in the estimated parameters due to sample size limitations of the observed wage data and finds no credible difference between the two groups, given the data.

CONCLUSIONS

The following conclusions are drawn from Palm Beach State College's TAACCCT-funded EHR program:

1. ***Developing and implementing nationally accredited Health Information Technology (HIT) programming is challenging and likely takes longer than anticipated to implement.*** Due to changes in the healthcare sector and push toward electronic health records, many community colleges are developing new HIT programs. While lower skill occupations such as Medical Coding and Billing may not require extensive academic programming, if a college is implementing nationally accredited certifications and targeting higher skill HIT occupations, it is a rigorous and time-consuming process and resource allocation must accommodate this reality.
2. ***At a minimum, intensive advising and intake provides an increase in program enrollment, even if full impacts cannot be captured.*** PBSC realized an enrollment increase and met the overall 'number of participants' outcome, which qualitatively can be attributed to the intensive and up-front advising efforts that assisted prospective participants with course sequencing, financial assistance, and referrals to other services.

3. ***Challenges in the EHR program highlighted larger, more comprehensive efforts that PBSC can tackle.*** Activities such as employer engagement were limited based upon perceived, or real, policies and practices at PBSC. These limitations are opportunities for college leadership to address comprehensive improvements across all departments and divisions.
4. ***Program administration and communication is critical for maximizing impact.*** There was a continual gulf between faculty and staff in the EHR program that hampered communication and teamwork. While difficult to measure impact on students, these administrative inefficiencies likely do limit the full impact of resources on program improvements. Additionally, strategies for sustaining best practices were not a primary focus of the project; therefore, impact is limited from that perspective.

2.0 Introduction

Palm Beach State College (PBSC), located in Lake Worth, Florida, is a comprehensive state college that offers certificates, associates degrees and bachelor's degrees in a number of fields of study. With a total student body of nearly 48,000, PBSC provides a wide array of job training and education tied to local employers' needs for a skilled workforce.

In 2012, PBSC applied for, and was successfully awarded, a Round 2 Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant from the U.S. Department of Labor. PBSC's ***gEHRing up for HIT (EHR)*** project is a single institution award that targets Palm Beach County's trade-impacted workers, other dislocated workers and unemployed veterans, who need skills' upgrades in order to pursue jobs and careers in the high-growth, high-demand Health Information Technology (HIT) field.

As a condition of the award, PBSC implemented a third-party evaluation plan and hired a third-party evaluator, WorkED Consulting, LLC, based out of Burke, Virginia. In turn, WorkED procured the services of MN Associates, based in Fairfax, Virginia, to co-design and assist with the methodological and impact structures of the evaluation. The third-party evaluation plan contains two major components: (1) a program implementation study, and (2) an outcomes and impact study based on a comparison cohort methodology. Each of these components has been designed to inform PBSC, the larger community college network, and the workforce investment system regarding successful services and interventions designed to improve the employment and earnings prospects for unemployed and underemployed individuals.

This Final Evaluation Report provides the results of the program implementation study and outcomes/impacts study. It is organized to highlight the following:

- The service intervention that was the basis of the outcomes/impact study
- The Best Practices of program implementation, which highlight areas of particular success, and Lessons Learned of program implementation, which highlight areas that served as challenges and can be worked on after the end of the grant period of performance
- Detailed findings from the outcomes/impact study, including whether differences in outcomes are statistically significant

2.1 SERVICE INTERVENTION

The specific focus of the EHR evaluation study is measuring the extent to which a specific service intervention—**the "REACH" Advising Model**—impacted program outcomes. To this end, the outcomes and impact study tracked the following:

- Total unique participants served

- Total number of participants completing EHR
- Total number of participants retained in EHR
- Total number of participants completing credit hours
- Total number of participants earning credentials
- Total number of participants enrolled in further education after program completion
- Employment rate in the quarter after program completion
- Job retention rate for the following two quarters after program completion
- Earnings increase after program completion

REACH Advising was previously offered to participants in other health occupations training during a demonstration period funded by a local foundation; however, the REACH Advising Model has not been rigorously evaluated prior to TAACCCT funding. Therefore, this EHR evaluation study not only lent itself to determining the extent to which the intervention had an impact on EHR participants, but also for an evaluation of the effectiveness of the intervention overall and PBSC's ability to sustain and institutionalize impactful elements.

2.2 LITERATURE REVIEW—IMPACT OF ADVISING ON STUDENT OUTCOMES

A review of the literature indicates that coaching and advising do have an impact on students' academic outcomes. According to a Hanover Research Report (2011) article titled, *Improving Student Retention and Graduation Rates,* "institutional approaches to improving participant retention rates must address both academic and non-academic factors of participant happiness and success. However, the majority of factors proven to improve participant retention are related to academic goals, academic-related skills, and academic self-confidence. Thus, the presence of an academic advisor is essential in encouraging participants to progress and achieve success in their academic careers." [emphasis added] In other words, the presence of an academic advisor who is able to holistically address a student's needs is likely to affect that student's retention and completion in his/her chosen field of study.

Furthermore, an article published by the Advisory Committee on Student Financial Assistance, (2012) drew lessons from a study by Metzner & Bean (1987). The Metzner and Bean study focused on four sets of variables that impacted non-traditional students'—in particular low-income students'—decision to withdraw from academic programs. One of the key findings of that study was that "high-quality academic advising may decrease the likelihood of attrition." [emphasis added]

Also underscoring the importance of advising on student outcomes, Nutt (2003) "determined that the persistence or retention rate of students is greatly affected by the level and quality of their interactions with peers as well as faculty and staff" [emphasis added] and that retention rates could be positively affected by "enhancing student interaction with campus personnel. These findings are important in that Nutt found that among some of the factors that caused students to drop out—academic difficulty, adjustment problems, lack of clear academic and career goals, uncertainty, lack of commitment, poor integration with the college community, incongruence, and isolation—could almost all be mitigated by increasing the level and quality of interactions with the campus personnel. Lastly, Lau (2003) also found that campus personnel play a vital role in improving student retention by helping students navigate the financial, academic, supportive, multicultural, and social landscape.

Taken together, the literature suggests that students who are able to connect with their educational communities through relationships with advisors and campus personnel are more likely to be retained in and to complete their academic programs. This supports the undertaking of the PBSC EHR service intervention of instilling a more focused advising effort aimed at helping a non-traditional participant population with access and completion of enhanced and accredited Health Information Technology (HIT) academic pathways tied to employment in the regional economy.

3.0 Evaluation Design

The PBSC EHR evaluation design incorporated the two major required study elements—a program implementation analysis and an outcomes/impact study—and utilized a Theory of Change framework to assess the primary service intervention—incorporation of the REACH Advising Model—as well as evaluate overall implementation of improved classroom and online curriculum for the HIT field. In particular, PBSC's HIT curriculum and pathways are aligned to industry standards developed by the American Health Information Management Association (AHIMA), the premier national industry association that accredits training institutions and credentials students for occupations in HIT. Underlying PBSC's development of enhanced curriculum and courses in HIT was the premise that a "higher quality" of academic instruction and competency development was necessary for EHR participants to gain employment in HIT demand occupations in Palm Beach County. Therefore, a key component of the evaluation design was conducting observations and collecting qualitative data to determine the impact of incorporation of AHIMA-accredited and more rigorous HIT curriculum and instruction on participant time to completion and credentialing.

3.1 IMPLEMENTATION DESIGN

The program implementation study was designed to answer sets of research questions in four key areas: (1) Curriculum Review, Use and Selection; (2) Program Delivery, Design and

Administration; (3) Assessment Tools and Processes; and (4) Partner Contributions. While the program implementation study design incorporated these required research areas, it also extended further in assisting PBSC program staff and administration with continuous improvement by cross-walking the activities and deliverables in PBSC's Statement of Work (SOW) with the research questions in the four research areas and providing a comprehensive picture of ongoing implementation progress, accomplishment of deliverables, and continuous improvement. Therefore, the implementation design became much more than information gathering and analysis, it provided PBSC leadership with qualitative information and feedback on areas of improvement as the program progressed over the four-year period of performance.

The research questions addressed by the implementation design include the following:

How was the particular curriculum selected, used or created? PBSC set out to build seven advanced HIT courses, including a fully online learning approach. The implementation evaluation monitored curriculum implementation both in the classroom and online. The approach to evaluating curriculum development included: 1) documenting curriculum already in place at PBSC; 2) assessing new curriculum implemented, including the rationale for the new curriculum and its alignment with national industry and accreditation/certification standards; 3) describing the rationale for new curriculum or refinements to curriculum implemented as a result of employer feedback; 4) assessing curriculum differences between online and classroom; and 5) monitoring curriculum implementation progress and whether timelines were met.

How were programs and program design improved or expanded using grant funds? What delivery methods were offered? What was the program administrative structure? What support service and other service were offered? At the outset of the EHR program, PBSC focused on three major program design improvements: (1) REACH advising, (2) new course development with the creation of seven new advanced training courses, and (3) expanded online course offerings. The program implementation analysis centered on how program funds impacted each of these three program components; in particular, how funds were used with regard to positions funded, curriculum created or modified, and new technologies implemented or equipment purchased.

Was an in-depth assessment of participants' skills, abilities and interests conducted, and how was it conducted? What assessment tools and processes were used? Who conducted the assessment? Were the assessment results useful in determining the appropriate program and course sequence for participants? Was career guidance provided, and if so, through what methods? The focus of the assessment analysis centered on the REACH advising "screening" and intake interview. Further, the EHR program is focused on a very particular career track, so analysis documented and considered any career guidance provided and how it was provided, specifically linked to particular employment opportunities.

What contributions did partners make? What factors contributed to partners' involvement or lack of involvement? Which contributions from partners were most critical

to the success of the program? Which contributions from partners had less of an impact? The implementation analysis focused specifically on the role of CareerSource Florida (WIB) as a contractual partner in the EHR program and how that role may/may not have impacted participant outcomes. In addition, the implementation analysis attempted to document employer involvement in the program and improvements in the relationships between employers and PBSC.

The PBSC EHR evaluation plan outlined three activities for accomplishing the implementation analysis. These three areas are outlined below along with the methodology for accomplishing the activities:

(1) Steps taken by institution to create and run the training program. At the commencement of the program and evaluation, PBSC staff and the third party evaluation team held weekly conference calls to establish baselines, develop data collection protocols, and communicate on implementation progress. As the program matured, calls became bi-weekly and then monthly. WorkED Consulting conducted six site visits to PBSC to gather qualitative data—August 2013, February 2014, January 2015, June 2015, November 2015, and July 2016. Site visits consisted of classroom observations and interviews with EHR program staff, REACH Advisors, deans and faculty, the new PBSC College President (November 2015), employers during an on-campus event during November 2015 site visit, CareerSource Florida (WIB) staff, and participants. Interview protocols were developed prior to site visits, and site visit reports were completed and provided to PBSC staff.

(2) Operational strengths and weaknesses of project after implementation. After the first year of implementation and the August 2013 site visit, WorkED Consulting produced an *Early Implementation Report* that was issued after year 1 of the period of performance that outlined progress-to-date and highlighted any potential adjustments that PBSC staff were able to consider. Because delays in hiring, equipment purchases, and implementation of sound program and business practices in year 1 have ripple effects, and thus impacts on final outcomes, the *Early Implementation Report* served as both a baseline document and a "red flag" warning for areas that PBSC program staff needed to address. The *Early Implementation Report* then became a "check back" document for WorkED Consulting to use when working with PBSC program staff on the Interim Evaluation Report and updates on progress in meeting program deliverables and potentially impacts on outcomes.

(3) How operations might be strengthened. During the course of the implementation analysis, WorkED Consulting continually communicated and provided PBSC with recommendations and information to be used for continuous improvement and best practices to consider sustaining after the end of the grant-funded program. Additionally, the program implementation analysis design, which incorporated program deliverables, allowed PBSC to track items also subject to core monitoring by the Federal Project Officer (FPO). In fact, items raised by the FPO in PBSC's core monitoring visit had already been flagged by WorkED

Consulting through the *Early Implementation Report* and subsequent site visit reports, allowing PBSC to work and make improvements prior to, and after, the FPO core monitoring visit.

3.2 OUTCOMES/IMPACT DESIGN

HIT student participant data, such as demographics (e.g., age, gender, race/ethnicity), special status (e.g., veteran, Pell grant, TAA-eligible), and program performance (e.g., credits received, completion), were made available to the evaluation team in excel spreadsheets. The evaluation team aggregated individual-level data across the four-years of the grant period of performance. Due to the process of aggregating quarterly and semi-annual data submissions, data such as the last date of participation, credits earned, completion, and certificates earned in the sample may not reflect what was included in PBSC's Annual Performance Report to the Employment and Training Administration (ETA). Data regarding participant employment and wages were deemed inconsistent to perform a robust analysis. These data were inconsistent in their reporting times as well; therefore, the lag time between a participant's completion date and when his or her wage records were available was typically several quarters. Smaller sample size of the treatment group also precluded the evaluators from achieving statistically significant results. Additionally, analysis with a second comparison group such as business students was not possible due to an antiquated college data warehouse system that did not provide updated program completion data in time for report completion.

Participant Data

Participant data analysis consisted of frequencies of outcome measures by program track and in the aggregate. Evaluators cross-tabulated the number of completed certificates and credentials with variables including college, technical track, TAA eligibility, age, gender, and ethnicity. Evaluators also created variables to determine the number of students who completed a certificate or credential, did not complete and withdrew, and did not complete and were still enrolled. These data were then cross-tabulated with variables such as TAA eligibility, Priority of Service status (veterans and spouses of veterans who take precedence over non-covered individuals in ETA-funded programs), gender, ethnicity, and developmental education needs (e.g., math, reading, or English). Lastly, the evaluators created variables for participants who completed their certificate or credential within the appropriate amount of time for their program and those who took longer. These data were cross-tabulated by TAA eligibility, Priority of Service status, and developmental education needs.

Data Analyses

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Data Caveats

Although, HIT advising is one of the main interventions in the grant program, its direct impact on participant outcomes remains inconclusive. Quantitatively, it is not possible to attribute its exact contribution to the participant outcomes. Beyond the academic and career advising and the personal interactions the adviser may have with the EHR participant, the ability to capture accurately and comprehensively the full weight of advising was difficult. For instance, in the case of the EHR program, knowledge of what work the advisor did with the participant over the course of the grant depends upon what was recorded by the advisor in her case notes. There were no other means to corroborate or supplement the information provided. Furthermore, there was no standard, comprehensive training on what should be recorded in the case notes, nor to what level of detail. Thus, it is possible that whatever impact or added value the adviser may have had on a participant's experience within the program was not recorded/captured, or was recorded only partially. With this caveat in mind, research-wise, no definitive connections or impacts can be made regarding possible and direct effects that advising may have had on a participant's outcomes. In general, while retention and completion might be a standard for "college success," for some participants and advisers, "success" can also mean something very different. Success may be the participant who meets with an adviser to discuss his/her struggles to keep up with studies and improve grades, or to strategize on how to balance the competing demands of work, school, and family. The participant might decide that rather than struggling with his/her studies, s/he needs to take some time off to rethink career plans and program of study or reduce course load. Thus, in these instances, success means collaborating and even negotiating to find a resolution or a means to alleviate a difficult situation in order for a participant to move forward with life plans. There are several strong anecdotes from the case notes provided by the three REACH Advisors, and text from EHR video clips of participants who received advisement, that provide snapshots of a more intensive and personalized definition of success. These examples are present throughout the report.

4.0 Implementation Findings

At the commencement of the EHR program, PBSC engaged in an important early implementation step, which was a mapping of participant intake and applying early definitions of "participant" and "participant entry" into the program. These steps and decisions allowed for precise and accurate tracking of participants and provided program staff with a continual pipeline of interested individuals with whom REACH Advisors could conduct early intake services. The participant intake mapping led to development of a "Decision Tree" graphic that provided documentation for participation, as well as an understanding of which new participants were control and which were treatment based on customer choice of receipt of REACH advising services. This framework was an important early best practice for outcomes reporting and program design.

4.1 "DECISION TREE" PARTICIPANT INTAKE, DEFINITION, AND PROCESS FLOW

The PBSC-developed "Decision Tree" faced a few iterations but the final product was a process map that highlighted the point of participant intake, when the participant interfaced with a REACH Advisor and, through self-selection, whether the participant became part of the control or treatment group. The Decision Tree had a twofold purpose—establish a process for determining whether a participant was a member of the treatment or control based on participant informed choice of whether to avail him/herself of REACH advising, and document the intake process to ensure a consistent approach to conducting outreach and intake to maximize the number of participants potentially served by the program.

The final iteration is detailed below.

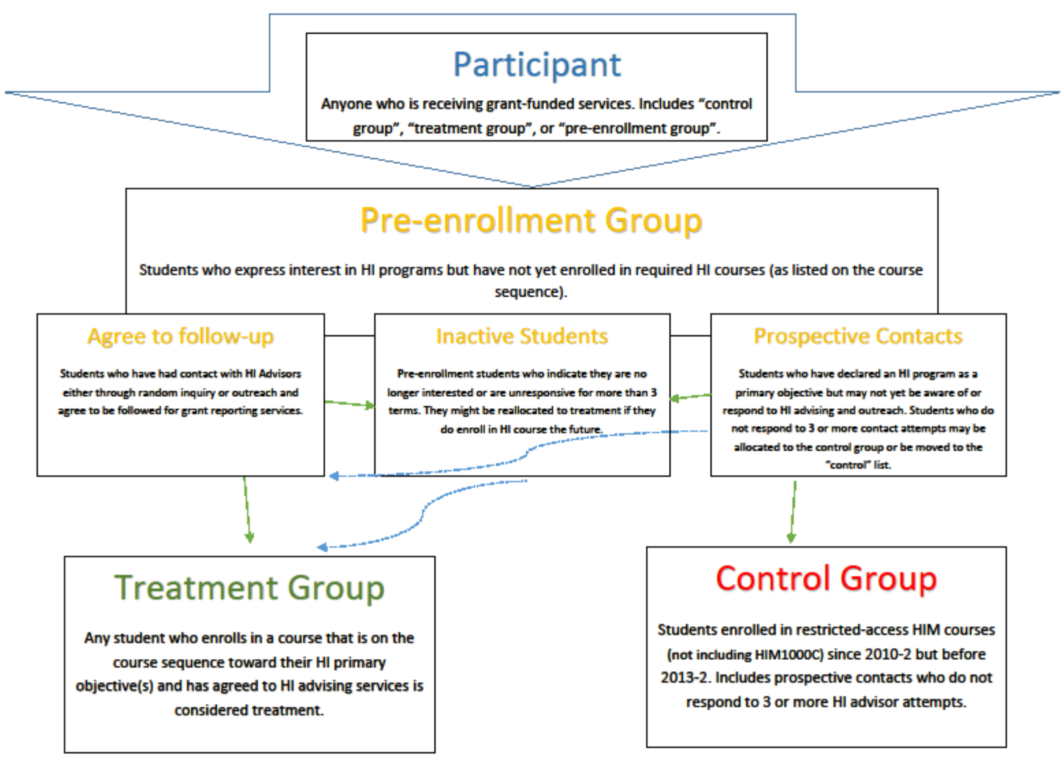


Figure 1: PBSC "Decision Tree"

Initial TAACCCT program guidance at the onset of this Round 2 grant provided flexibility for community colleges to decide who was a TAACCCT participant and at what point was a person a participant, as well as a completer. The Employment and Training Administration issued further guidance in August 2014 regarding the definition of a participant, and PBSC's approach was consistent with the new guidance. The third-party evaluation team worked closely with the PBSC Institutional Data Analyst to develop the appropriate definition of a participant based on the program design and intake process.

The current participant definition document is detailed below. An evolution of this definition was the creation of a "pre-enrollment" participant, who is someone that has expressed interest in the HIT program but has not entered "Restricted Access" courses—the courses that are specialized and together make up the educational pathway that leads to the receipt of an HIT credential and related employment. The development of this document at the start of the program allowed PBSC officials to report outcomes and manage performance in a consistent manner.

4.11 PARTICIPANT DEFINITION DOCUMENT

Participant: A participant is anyone receiving grant-funded services. This can include a member of the "control" group, "treatment group" or "pre-enrollment" group. We will examine barriers to successful enrollment and HIT completion for all participants.

1. **Control Group**: The control group is defined as any student who has enrolled in restricted-access, for-credit HIT classes since 2010-2 (which is when these courses began to be offered as "for-credit"). (Note: this does not include HIM1000C, which has been an unrestricted course since 2011.)
    a. Control group students have either self-advised, received advising from the Health Sciences Advisor, or from general advisors.
    b. Any student who approaches the REACH advisors but **"opts out"** of REACH advising will be moved to the "control group".
    c. Students who enroll in restricted access courses after 2012-3 but **do not contact or respond to contact attempts** from HI advisors. It will be assumed that they "opted out".

2. **Treatment Group:** Any student who enrolls in restricted-access, for-credit HIT classes after 2012-3 **and** agree to be advised by the REACH advisors.

3. **Pre-Enrollment Group**: "The Pre-Enrollment Group" consists of students who express interest in the HIT programs but, for any number of reasons, **do not enroll** in the restricted access courses.
    a. Students who contacted a REACH advisor with an **informational inquiry**.
        i. If they eventually enroll in upper division courses, they will be **reallocated** into the treatment or control groups (if they opt out).

   ii. If the student does not respond to 3 contact attempts after initial contact, consider the student "Control". It is assumed the student has opted out.
   iii. They will be allocated to the **treatment group** unless they stop responding to HIT contact attempts (3 attempts must be made) and begin to go to the Health Science Advisor. The student will then be moved to the control group.

b. Contacts made through outreach that advisors do not hear back from.

c. **Official Unenrolled Advisees** (opted in for follow-up) and are completing prerequisite courses.
   i. Students who are **not yet enrolled in restricted access courses and receive pre-enrollment services but** then change major/primary objective.
   ii. Students who receive pre-enrollment services then eventually **enroll** in HIT programs will be switched to "**treatment group".**

4. **Enrollment Services:** Enrollment services refer to all grant-funded services offered by the REACH advisors. This includes advising and outreach for all student groups.

Note: Advising frequency will be considered for both treatment and control groups.

4.2 STRATEGIES AND DELIVERABLES

As part of their application to the Employment and Training Administration, Palm Beach State College provided a list of major strategies and deliverables to be conducted with grant funds. This Project Management Plan is now part of the PBSC Statement of Work, and provides a framework and cross-walk with which to conduct program implementation analysis.

Table 1: PBSC EHR Program Strategies and Deliverables

Strategy	Deliverables
Strategy 1: Increase course accessibility 1.1 Develop online courses for the Medical Transcription ATD, Medical Information Coder/Biller CCC, Health Informatics CCC and HIT A.S. programs 1.2 Increase HIT information technology infrastructure	**Year 1:** • Health Information Business Analyst hired • HIT software, hardware and servers installed • Online courses developed • TAA-eligible and other dislocated workers enrolled in online courses in 4th quarter **Years 2 and 3:** • TAA-eligible and other dislocated workers completed ATD and CCC programs • TAA-eligible and other dislocated workers enrolled in ATD and CCC programs **Year 3:** • TAA-eligible and other dislocated workers completed ATD and CCC programs • TAA-eligible and other dislocated workers enrolled in ATD and CCC programs • TAA-eligible and other dislocated workers graduated AS program
Strategy 2: Expand HIT career pathway 2.1 Develop advanced certification courses 2.2 Enhance articulation agreements	**Year 1:** • Software necessary for advanced certification courses purchased and installed • Advanced certification online courses developed • TAA-eligible and other dislocated workers enrolled in advanced certification courses in 3rd and 4th quarters **Year 2:** • TAA-eligible and other dislocated workers completed advanced certification courses • TAA-eligible and other dislocated workers enrolled in advanced certification courses • Advanced placement agreement in place **Year 3:** • TAA-eligible and other dislocated workers completed advanced certification courses • TAA-eligible and other dislocated workers enrolled in advanced certification courses • Advanced Placement agreement with university in place

Strategy	Deliverables
Strategy 3: Improve participant support services and outreach 3.1 Expand dedicated HIT support services and outreach by including HIT in PBSC's allied health participant support services model program 3.2 Enhance community and employer outreach	**Year 1:** • Grant Manager and 3 FTE Advisors hired • HIT advising model developed and implemented • Community and employer outreach models developed and implemented • TAA-eligible and other dislocated workers receive participants support services **Year 2:** • TAA-eligible and other dislocated workers receive participants support services **Year 3:** • TAA-eligible and other dislocated workers receive participants support services

For each of the four program implementation analysis areas, this Final Evaluation Report highlights the strategies and deliverables most pertinent to those areas. Then, a description of final progress and results is included along with a set of findings that includes "Best Practices," which are areas where PBSC excelled and can inform the greater TAACCCT and community college sector, and "Lessons Learned," which are components of the program where challenges or barriers may have existed and PBSC can use these lessons to inform future practice.

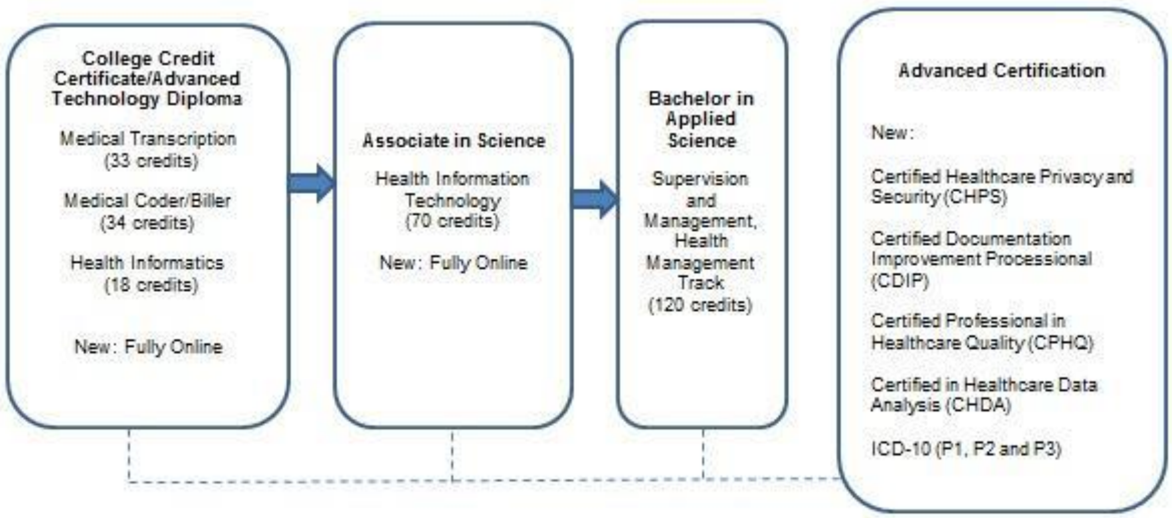
4.3 CURRICULUM REVIEW, USE AND SELECTION

Strategy 1: Increase course accessibility
1.1 Develop online courses for the Medical Transcription ATD, Medical Information Coder/Biller CCC, Health Informatics CCC and HIT A.S. programs 1.2 Increase HIT information technology infrastructure
Strategy 2: Expand HIT career pathway
2.1 Develop advanced certification courses

Research Question: How was the particular curriculum selected, used or created?

Palm Beach State College's stated strategies for curriculum included the development of online Health Information Technology (HIT) courses and the development of a series of HIT advanced certification courses that serve as "stackable credentials" for the targeted participant population. In the development of new curriculum, courses and credentials, PBSC aligned with both Florida higher education standards and processes, as well as HIT industry standards as defined by the American Health Information Management Association (AHIMA) and its accrediting body, The Commission on Accreditation for Health Informatics and Information Management (CAHIIM).

In its Statement of Work for the TAACCCT grant, PBSC proposed the following educational pathways and new curriculum:



PBSC's new curriculum efforts focused on two components:

(1) The development of seven "advanced certification" stackable credential courses that are non-credit, but allow an individual to update or build on skills in the profession:

- Certified Healthcare Privacy and Security (CHPS)
- Certified Documentation Improvement Professional (CDIP)
- Certified Professional in Healthcare Quality (CPHQ)
- Certified in Healthcare Data Analysis (CHDA)
- ICD-10 (Parts 1, 2 and 3)

(2) The development of new online courses in the HIT Associate in Science degree in order to implement a hybrid learning model.

The EHR program contained three occupational cores for program participants, two of which are appropriate for entrants who have no healthcare or information technology experience – *Medical Transcriptionist* (Applied Technology Diploma) and *Health Informatics Specialist* (College Credit Certificate). The third core, *Medical Information Coder/Biller* (College Credit Certificate) was most appropriate for entrants who work in or have education-based exposure to information technology or healthcare.

To appropriately answer the research question for curriculum use, the evaluation tracked the success and progress PBSC made in implementing the seven advanced certifications, and whether EHR participants accessed them, and the extent that online and hybrid learning options were implemented for use by participants.

BEST PRACTICES

Palm Beach State College has implemented a high-quality curriculum that meets AHIMA/CAHIIM accreditation standards. An important "best practice" which PBSC can share with the community college network is the development of ongoing rigorous curriculum and implementation of requirements to attain and maintain national industry accreditation, which is a lot more challenging than many colleges anticipate. PBSC had many existing courses and curriculum in place for traditional learning methods prior to receipt of TAACCCT funding. Therefore, initial efforts focused on aligning courses to create educational pathways leading to college and/or industry-recognized credentials. Faculty and academic leadership report that meeting AHIMA/CAHIIM accreditation standards are challenging, including meeting teaching and curriculum requirements. Faculty also report that during the TAACCCT grant period, ongoing continuous improvement was implemented to update curriculum and make adjustments based on industry standards and pragmatic streamlining. To assist participants, course sequencing guides were created and used by REACH Advisors and others.

Palm Beach State College developed and made available the seven (7) stackable certificates; however, these certificates were mainly valuable and targeted to incumbent workers or individuals with HIT professional experience who need skills upgrades, so EHR participants had limited access to these credentials. The main educational pathways for participants with no HIT or health-related educational background was the associate's degree and the occupational tracks within that degree. With completion of the associate's degree, participants were eligible for hire with the skills that are necessary for HIT jobs. While PBSC met its deliverable for development of the stackable certificates, the focus of those credentials ended up being for individuals already working in HIT or having experience in HIT, which was not the vast majority of the EHR participants. Therefore, from a program performance standpoint, the value of the stackable certificates will be realized after the program period ends.

Technology was procured for online course development and availability, and additional faculty was hired aligned to AHIMA/CAHIIM accreditation requirements. PBSC met timeframes to get technology equipment and supplies purchased and a technology implementation specialist hired to meet online curriculum development milestones. While initially delayed due to the applicant pool, PBSC was able to hire qualified faculty for additional HIT course teaching and learning tied to AHIMA/CAHIIM accreditation standards and development of online courses.

LESSONS LEARNED

EHR participants took longer to complete than initially anticipated, partially due to the rigor of courses and depth of teaching and learning, and partially due to self-imposed course scheduling and course sequencing barriers. Class scheduling remained a persistent challenge, including the sequencing of courses, that likely impacted the time to completion for some EHR participants. PBSC implemented a "program wheel" scheduling model that was intended to provide more flexibility in the times of the day when courses were offered and provide a rational sequencing of courses to meet participant milestones toward program completion. However, the program wheel model had some unintended consequences, such as sequencing courses in a way that meant a participant missing a course offered during a particular semester had to wait up to a year to take the course. Because the HIT pathway sequenced courses to build skills and competencies semester-by-semester, missing a course had adverse impacts for participants that could not be mitigated immediately. While staff and faculty reported ongoing adjustments during the EHR period of performance, challenges that arose likely impacted the completion and related program performance outcomes.

While online courses were developed, they were not offered to EHR participants. Online course development was initially delayed, but faculty report completion of online courses, and are uploading related curriculum to SkillsCommons. However, online and hybrid courses, while developed, were not offered to EHR participants. Faculty report that the main reason for this discrepancy is AHIMA/CAHIIM requires separate accreditation for online and hybrid courses, and PBSC did not have time or faculty capacity to undertake the steps needed obtain industry accreditation.

PBSC did not implement a process for either employer or peer review of curriculum. The PBSC Statement of Work and budget anticipated subject matter expert (SME) review of curriculum, such as use of external employers or peers. During year 1, PBSC full-time faculty were paid as SMEs to review the curriculum developed internally by adjunct faculty. While faculty contended that AHIMA/CAHIIM standards drive curriculum development, SME review should have occurred, and PBSC should have policies and processes in place globally to allow for SME employer, industry, and peer review of workforce-related courses and curriculum.

4.4 PROGRAM DESIGN, DELIVERY AND ADMINISTRATION

Strategy 1: Increase course accessibility
1.1 Develop online courses for the Medical Transcription ATD, Medical Information Coder/Biller CCC, Health Informatics CCC and HIT A.S. programs
Strategy 2: Expand HIT career pathway
2.1 Develop advanced certification courses
Strategy 3: Improve participant support services and outreach
3.1 Expand dedicated HIT support services and outreach by including HIT in PBSC's allied health participant support services model program

Research Questions: How were programs and program design improved or expanded using grant funds? What delivery methods were offered? What was the program administrative structure? What support service and other service were offered?

Palm Beach State College's improvements in program design included creation of online courses and new stackable credentials (as discussed in section above), as well as the focus of the outcomes and impacts analysis—implementation of the REACH advising model. The REACH advising model was a highly-focused advising approach that utilized advisors to help participants with enrollment, educational options in HIT and ongoing persistence in the program. PBSC hired three REACH Advisors using TAACCCT grant funds, who all worked full-time serving only EHR participants.

The organizational chart displayed below details the administrative structure for the EHR program. The Dean of Health Sciences and Public Safety was responsible for oversight of all details of the project, including both the academic and non-TAACCCT funded elements of the program, as well as the program administration and services, such as the REACH advising.

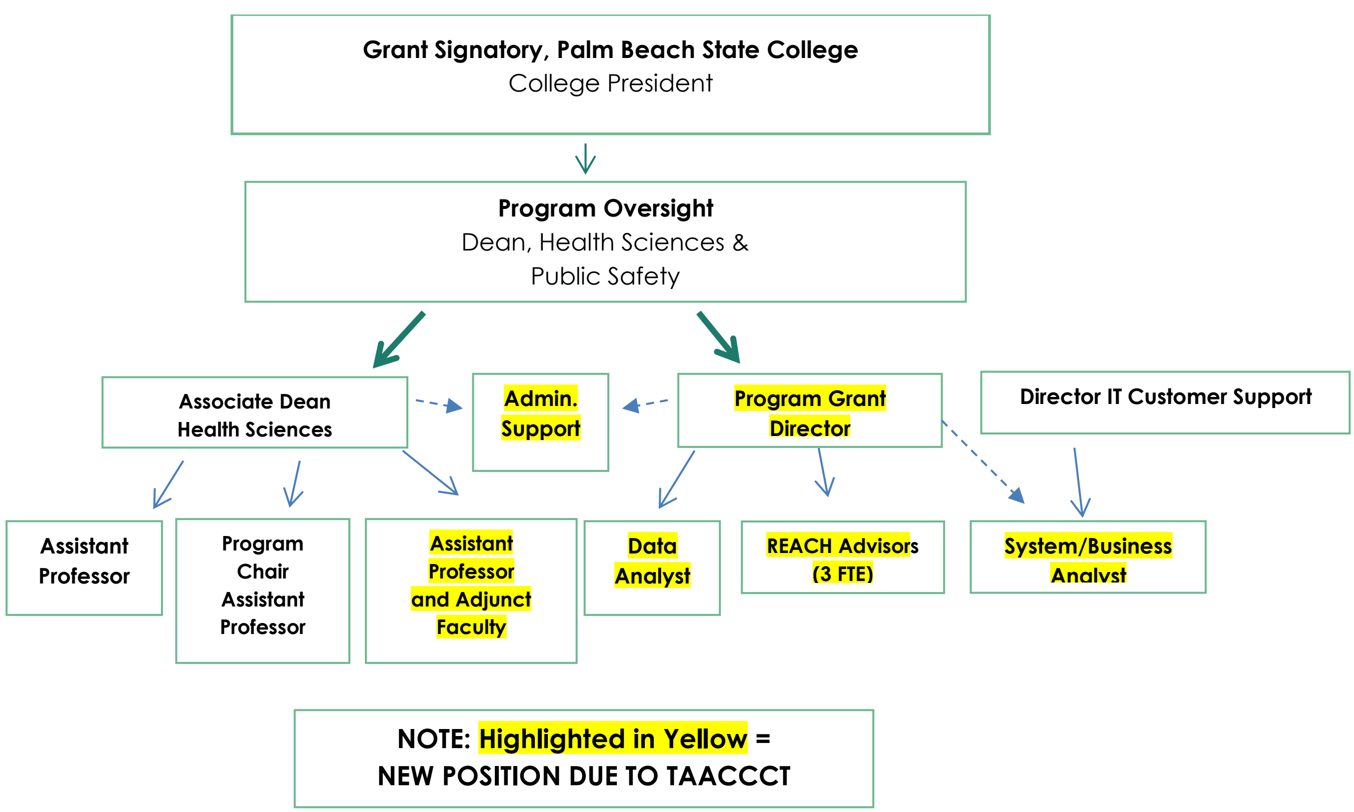
PBSC developed and implemented a program design model that sought to expand access and success to completion of Health Information Technology educational pathways through the development of new stackable credentials and improved credit pathways, and the expansion of the REACH advising model. The PBSC work plan, budget, and administrative structure were all built in a manner that enhanced REACH advising in order to help the target participant population with entry into the program and removal of barriers that prohibited successful completion of the course sequence and thus, credential attainment and program completion.

PBSC's administrative structure consisted of a Grant Program Director, an Institutional Research Analyst and a Health Information Business Analyst. The Grant Program Director reported to the Dean of Health Sciences and Public Safety in order to promote coordination and cohesion between administration of the grant and implementation of academic elements and participant supports. The Institutional Research Analyst was responsible for collecting and analyzing data, assisting with performance reporting, and liaising with the third-party evaluator. The Health Information Business Analyst was responsible for the technical and operational support of the HIT computer network system and supported the implementation of the online curriculum.

In addition to the administrative structure, the EHR program funded direct participant support positions including one new HIT full-time faculty position, 2 part-time adjunct HIT faculty positions, 3 REACH Advisor positions and an administrative support position. Each of these positions was intended to either implement and teach new curriculum and courses or provide support through the REACH advising model—thus in all cases supporting the major program strategies.

An important distinction to understand when evaluating how PBSC implemented the EHR program is that the REACH Advisors were the coordinating positions for helping participants access the full array of services needed to successfully complete the program. For instance, the REACH Advisor was often the first individual an interested person interacted with when determining whether the program was a right fit. The REACH Advisors provided participants with information on courses, credentials and employment, coordinated with faculty, and even assisted with referrals to CareerSource Palm Beach (local WIB) to receive services and apply for financial assistance.

Organizational Chart for EHR Program



BEST PRACTICES

Palm Beach State College designed and implemented an effective administrative structure that implemented the deliverables of the program. PBSC hired new grant staff in a timely manner that allowed staff and faculty to maximize the time needed during the period of performance to implement grant strategies and complete grant deliverables. The one exception to timely hiring was the full-time faculty position where PBSC needed multiple recruitments to find a qualified individual that met AHIMA/CAHIIM accreditation requirements. The delay in hiring this faculty position impacted online course development initially, but faculty were able to "catch up" and meet the curriculum development accomplishments described above.

With the exception of the full-time faculty position, PBSC administrators met budget expenditure timelines including hiring staff, purchasing equipment, and executing contracts. A review of PBSC's TAACCCT budget demonstrated the following:

- All initial program staff were hired, typically within the first six months of program implementation. The program experienced some turnover, particularly the grant director position; however, replacement staff were incumbent employees who had familiarity with the EHR program and continued appropriate program activities.
- The two adjunct faculty were hired by April 2013; however, the full-time faculty position was not hired until spring 2014, which impacted the timeliness of curriculum development.
- Equipment purchases were approved by the U.S. Department of Labor, and equipment was installed in a timely manner, contracts were executed in a timely manner, and supplies, including computer software, was purchased in a timely fashion.

Qualitative data shows that the REACH advising model was seen by participants as a successful intervention that helped them navigate program entry and persistence and provides PBSC with an opportunity to bolster its academic advising function. The REACH Advisors were physically present in the PBSC building that housed the HIT classes, and programmatically aligned to the Health Sciences Department rather than Student Services, where advising resides at PBSC. The rationale was that REACH advising would be accessible where participants are taking classes, meeting with faculty, and looking for ongoing information and support. While this presented some disconnect between the REACH Advisors and student services advising (see "Lessons Learned" below), it did provide more seamless customer service for participants. To sustain the REACH advising model, PBSC has migrated REACH Advisors to a Title V funded program with the intent to leverage the entire period of experience through TAACCCT and Title V to sustain these intensive advising services permanently.

Having a Data Analyst with a Ph.D. who was focused on data collection and analysis for the grant-funded program provided a level of data quality, information collection, and continuous feedback that allowed program and college administrators to make more informed decisions and assisted the third-party evaluation team. PBSC added the Data Analyst position in its TAACCCT application to have an "in-house" specialist dedicated to data collection and analysis. While not anticipated initially, PBSC was able to hire a Ph.D. credentialed individual, and over the period of performance, was able to demonstrate value in having this level of expertise involved as many of the up-front processes, program definitions, and data collection procedures allowed program administrators the benefit of outcomes documentation and continuous improvement. Thus, the EHR program utilized performance information ongoing in order to make program adjustments and continuously track outcomes.

LESSONS LEARNED

PARTICIPANT COMMENTS:

My name is [withheld] and I am an adult learner here at PBSC. I can't say enough good things about the guidance office here. They have sent me emails. They have called me personally. It was a great experience. They led me right through the program and what the benefits are and what I would need to take. They kept me on track by getting my transcripts in and evaluated. I have never had a guidance office where people called me to check on me. In fact, I would say, at one point, at the beginning of this year, because I was taking a statistics course, they called me to check in on how I was doing and it really made a difference for me because the Statistics turned out to be a little bit harder than I thought it would be. And what they did is they called me and they let me know when the next course was available and they kept me right on track.

I love the fact that advising at Palm Beach is an open door. You can go to the counselors and the people there help you with the program, and they facilitate everything. They answer all of your questions. They are always there when you need them. They are always a phone call or an email away. They always call you if you do something important, pass a milestone: if you pass your course, if you get a good grade, or even [have a] birthday! They are always there to assist you. They know you personally, they know you by name, which makes it feel special. It makes it feel like if you have a problem you can count on them. And I think this is the way to go, I feel it has opened the door for me.

It is always nice to get friendly emails. You don't always feel like you are not looking forward to opening up your emails. There is always either a birthday email or a "Congratulations, we see you did a very good job last semester with mentioning the grades that you got." And also there are the friendly reminders that, "Ok, the summer semester is starting, you know, get ready to register." Those friendly reminders that you are on top of getting everything done.

I was in publishing for many years, at consumer magazines, and my field was shrinking, so I knew I needed to change fields. So I came here, and immediately, even before I started my pre-requisites, I went to meet with the advisors and they were just wonderful because it is very intimidating changing careers after such a long time in one field, and I am not young. So, every step of the way, in terms of which courses I should take, how I should go about it, they have just been incredibly helpful. And they put me into CareerSource (which used to be called Workforce Alliance), and I would never even have heard of them if it wasn't for the Health Information Advisors. And it turns out they are giving me additional resources. And I hope that when I finish the program, they can help me get work. [NOTE: This participant received Individuals Training Account (ITA) assistance from CareerSource.

The program experienced communications gaps, primarily: (1) gaps between program staff and faculty; and (2) gaps between the REACH Advisors and college advising in student services. Throughout the program, during site visits and discussions with staff, there was clearly a lack of continual communication and program updates between grant program staff and faculty involved in curriculum development and teaching. While it is difficult to ascertain from a qualitative standpoint exactly why these communications gaps existed, program staff expressed ongoing concerns about not having information on program deliverables (particularly Business Partnerships and outreach) and actions taken to address needed improvements in curriculum and course design. It is challenging to quantify any impact on participants; however, PBSC could have provided more enhanced services to participants if REACH Advisors and faculty, who were also informally advising participants on career and educational options, were able to better leverage time and effort and collaborate on participant needs.

REACH Advisors expressed frustrations that they were not able to partake of staff training that other PBSC advisors received and were not part of the "advising community" within PBSC. While this was a missed opportunity, moving forward, PBSC should better integrate REACH Advisors into advising staff communications and professional development in order to implement best practices college-wide.

4.5 ASSESSMENT TOOLS AND PROCESSES

Strategy 3: Improve participant support services and outreach
3.1 Expand dedicated HIT support services and outreach by including HIT in PBSC's allied health participant support services model program

Research Questions: Was an in-depth assessment of participants' skills, abilities and interests conducted, and how was it conducted? What assessment tools and processes were used? Who conducted the assessment? Were the assessment results useful in determining the appropriate program and course sequence for participants? Was career guidance provided, and if so, through what methods?

Palm Beach State College did not implement a formal assessment process to determine participant skill levels or aptitudes due to the role of the REACH advising in providing a level of up-front screening of participants. Due to Florida legislation enacted during the implementation of this project, state colleges are prohibited from requiring students to take college placement tests. Therefore, participants who enrolled in EHR as part of an associate's degree track (nearly all) were exempt from placement testing. However, PBSC developed a "REACH Advisor Methodology" to consistently approach service provision to participants and case document interactions. Below is a description of the steps stated in the "REACH Advisor Methodology":

REACH Advisor Methodology

1. Encourage all prospective participants to view the Online Information Session for the program they are interested in.

2. Follow up with participants who viewed the Online Information Session (as indicated by email to general email boxes).
   - Explanation: Students who view the info session and take the quiz have an automatic email to the general email box.

3. Introductory Initial In-Person Meeting with Advisor
   - Script:
     - Briefly review with participants the 4 programs HIT advisors work with (Medical Transcription, Health Informatics Specialist, Medical Coder/Biller, & HIT) and how the CCC and ATD programs build toward the AS Degree.

     - Describe components of advising program
       - 3 advisors dedicated to working with HIT participants only
       - *Highly recommend* participants to meet with an advisor in person at least twice per semester
       - Connect via phone or email with advisor once per month
       - Advisor will follow up virtually via PantherNet/Student Advising on a monthly basis to evaluate testing scores, grades, etc.
       - Inform participant they can contact any of the three HIT advisors between meetings via email, phone, and walk-in.

     - Give participant option to opt out of HIT advising program
       - Inform participant: "The HIT advising program is not mandatory. There are other options for advisement. You can choose to see another advisor who advises any prospective or current Health Sciences participant. You can choose to see any General Academic Advisor who advises any prospective or current participant on all PBSC programs of study. Or, you may self-advise."

     - If participant chooses to participate in the HIT advising program, explain the Prospective Student Participant Form. "We ask that all participants intending to pursue one of the HI programs complete a participant form. It asks for your demographic information and some specific questions that will assist the advisors in guiding you to various resources that may be available to you. Your information is kept confidential. Because the advising program is grant funded, the statistics gathered are reported to our funder (DOL) but your name is not reported. "

- o Explain the Informed Consent to Disclose SS# for comparison cohort study.

- o Review steps to enroll. Utilize appropriate Student Checklist specific to participant's situation. Student Checklist titles include but are not limited to: "Recent HS Graduates", "Returning to the Workforce", "Dislocated Worker", "Veteran", & "Current PBSC Student". Checklist details steps to admission to PBSC and/or admission to the program including information about participant email, PantherCard, educational planning, deadlines for applications, pre-requisite classes, challenge exams, core classes, typing test, & placement.

- o Review participant resources (counseling center, math/reading labs, tutoring, career center, clubs, etc.)

- o Clarify that the primary email advisors will use to contact a participant is their PBSC email. Encourage participant to check PBSC email every day. Advisor should obtain a back-up email as well.

- o Give financial aid (FA) referrals as needed. Encourage every participant to complete the FAFSA even if they believe they will not be eligible for FA. Students are required to complete the FAFSA form to apply for PBSC scholarships.

  - ▪ Provide opportunities for participants to view FA informational videos and/or complete their FAFSA on participant computer in HIT office.

  - ▪ If the participant is eligible for financial assistance, encourage the participant to obtain a work-study position on campus for a limited number of hours per week. Note: Research cited by Wilkie and Jones (1994) indicates campus employment is associated with higher retention.

- o Provide hard copy program course sequence information and show participant how to access PBSC resources online (Panther Web, online tutoring, live chat, participant learning centers, career center, etc.)

4. Monthly email to pre-program participants (participants in Preps or Gen Ed classes) to remind participants of HIP news, upcoming application deadlines, available tutoring services, study tips, other participant services available to them such as career center, disability services and counseling, FAQs, etc.

5. Offer Orientation for participants accepted into CCC or ATD programs similar to the new participant orientation for degree seeking participants (review registration process, participant services, program guidelines, campus tour, course sequence, educational planning).

6. Monthly email to program participants to remind them of HIP news, exam deadlines, career center, graduation information, club news, FAQs, etc.

7. Quarterly E-Newsletter to all program participants spotlighting a different HIP program each edition, introducing a new instructor, campus activities, etc.

8. Monthly contact with participant. Ideally, participant will meet with Advisor in person. Alternative is by phone but security/confidentiality standards must be in place. Possibly, blackboard advising?

9. Create an email distribution list of general academic advisors. Email monthly reminders of HIP program requirements, new info (online classes), referral process to HIP advisors, etc.

10. Provide education/awareness presentations about HIT programs and referral procedure with other departments and participant services.

11. Use Panther Trail (P-Trail) to track in person advisement sessions for statistical purposes.
    - Customize P-Trail to HIT Programs/Advisors. Add options to document email advising and phone advising. (Not sure if this is an option yet.)

12. Make notes in PantherNet/Student Advising after each session with participant to detail what was discussed.

13. When faculty report participant problems, e.g. course performance or class absences, advisors should immediately send an e-mail expressing care/concern. Request that the participant reply to the advisor so they can discuss options for addressing the issues. Use "read receipt" on outlook.
    - Collaborate with SCORE advisor when faculty refers HIT program participants

BEST PRACTICES

The Palm Beach State College program model did not emphasize formal assessment; however, the focus on a consistent and intensive advising model seemed to adequately identify participant interests and aptitudes. At the onset of the program, PBSC optionally allowed participants to take the Test for Adult Basic Education (TABE) to assess their skill levels and then recommend remedial courses, if necessary. REACH Advisors did refer participants to testing administered at CareerSource Palm Beach then use assessment results to make course recommendations. However, during the grant period of performance, the State of Florida eliminated requirements that recent high school graduates utilize the TABE or that colleges could provide separate remedial education courses. Therefore, PBSC focused program efforts on implementation of the REACH advising model and worked to ensure consistency in how participants were approached and advised in lieu of a formal assessment. In addition, between the REACH Advisors, HIT faculty and CareerSource Palm Beach, participants received career guidance services and direct linkages to employment. Grant participants sometimes needed help making the connection between their career goals and the courses they needed or the kind of work they were required to do to complete a program—including basic math, English, and reading and lab work. This work integrated academic advising, soft-skill development, and career advisement that potentially helped the participants commit to work, manage time well, and become professionals once they completed their programs of study.

Every participant accepted into HIT program received a welcome packet that included: A congratulatory letter to student upon acceptance into program for the year and semester, reminder of availability of advising services, an offer to consider memberships in Health Information Student Association, and information on CareerSource Palm Beach.

MET WITH STUDENT IN PERSON. REVIEWED CLASSES NEEDED. ADVISED TO DROP CGS1100 FROM SPRING CLASSES. PROVIDED UPDATED COURSE SEQUENCE FOR STUDENTS ENTERING PROGRAM FALL 2014 OR LATER. DEMONSTRATED HOW TO USE GPA CALCULATOR. ADVISED STUDENT HE MUST BRING OVERALL GPA UP TO 2.0 TO BE ACCEPTED INTO LIMITED ACCESS MICB PROGRAM. MET WITH [STUDENT]. THE STUDENT IS FINISHING AA DEGREE REQUIREMENTS THIS SEMESTER AND WANTS TO DO HIT AS DEGREE NEXT. WE DISCUSSED THE HIT PROGRAM AND LIMITED ACCESS APPLICATION PROCESS, ALONG WITH DEGREE AUDIT AND REMAINING PREREQUISITES NEEDED TO APPLY. STUDENT ALSO STATED THAT SHE IS INTERESTED IN NURSING FOR FUTURE. SHE PURPOSELY COMPLETED SOME PREREQUISITES & GENERAL EDUCATION CLASSES THAT APPLY TO HIT/NURSING PROGRAMS IN CONJUNCTION WITH AA STUDIES. WHILE LOOKING AT OPTIONS FOR SPRING REGISTRATION, WE DISCUSSED COURSE LOAD, SCHEDULING, AND EFFORTS TO BALANCE SCHOOL/WORK/FAMILY. GIVEN HER HEALTH EXPERIENCE, ALSO INFORMED HER THAT THERE IS A HSC2531 MEDICAL TERMINOLOGY CHALLENGE EXAM.
SOURCE: REACH ADVISOR NOTES

4.6 PARTNER CONTRIBUTIONS

Strategy 2: Expand HIT career pathway
2.2 Enhance articulation agreements
Strategy 3: Improve participant support services and outreach
3.2 Enhance community and employer outreach

Research Questions: What contributions did partners make? What factors contributed to partners' involvement or lack of involvement? Which contributions from partners were most critical to the success of the program? Which contributions from partners had less of an impact?

Palm Beach State College's partner contributions fall into three main areas: employers, other institutions of higher education (articulation) and CareerSource Palm Beach (workforce partner). Of the three groups of partners, the most progress has been made with CareerSource Palm Beach. As a result of the TAACCCT grant, PBSC and CareerSource Palm Beach worked collaboratively to define the relationship between the two organizations, and the TAACCCT is serving as a "test case" for how more institutionalized work can occur between the PBSC and CareerSource Palm Beach. CareerSource Palm Beach is under contract to conduct referrals of participants and assist with job placement after the participant completes education. Further, executive leadership of PBSC and CareerSource Palm Beach met to discuss longer-term collaboration and how to build upon strengths of both personnel and the institutions.

Employer outreach was an area of overall concern because information on types of employer engagement, success in employer engagement, and the numbers of employers visited was not transparent. The only EHR team member allowed to interact with employers at the direction of the Dean was the Program Chair, and no specific employer notes or documentation was provided to the third party evaluation team other than links to program advisory committee meeting minutes. Annually each November, PBSC held a "FIRE Seminar" which was a half day event where employers and industry representatives met with participants and discussed job opportunities, industry trends, and internship opportunities. The FIRE Seminar was well attended and provided important exposure to participants of employers and job opportunities. According to program faculty and staff, PBSC had 2-3 strong employer partners, which was not to the level indicated in the program application/statement of work.

PBSC did engage CareerSource Palm Beach in promoting the Health Information Technology program and conduct limited employer outreach through CareerSource Palm Beach's Business Services Unit. In one program quarter, information regarding the programs at PBSC was provided to 36 employers by the Business Services Unit. In addition, the evaluation team was able to conduct interviews with a handful of employers during the program, and employers indicated a need for credentialed individuals for abundant job opportunities. PBSC does have a program advisory committee that it relies on heavily, but again, only faculty are allowed to interact with members of the committee.

BEST PRACTICES

The EHR program provided PBSC and CareerSource Palm Beach with a means to improve collaborative work and ways to better communicate. As a result of the TAACCCT grant and the EHR program, PBSC and CareerSource Palm Beach were able to leverage funding for a position at CareerSource Palm Beach dedicated to serving participants and co-enrolling in Workforce Innovation and Opportunity Act (WIOA) programs to provide tuition assistance. While large numbers of participants did not co-enroll, grant funding and program maturity allowed for exploration of better working relationships and process flows for future and ongoing work together. Palm Beach County did not have high numbers of TAA-eligible workers, so PBSC's program did not have many TAA-eligible participants.

The annual FIRE Seminar provided a forum for interaction between participants and employers, which can serve as a model for deeper and more coordinated interactions. In observing the FIRE Seminar in November 2015, and speaking with participants and employers attending, while not specifically measurable, the event did serve as a potential model for expansion with Health Sciences and other departments at PBSC as a way to provide student exposure to business and industry. Because clinical sites and other work-based learning experiences are a necessary part of the career pathway for HIT, the Health Sciences department seems to have a core network of employer partners who support job development and internship activities. However, this network could be more effectively expanded with a more comprehensive and involved employer engagement strategy.

LESSONS LEARNED

PBSC should implement a more coordinated and strategic approach to engaging employers, including implementing a customer relationship management tool in order to document interactions and successes. In its TAACCCT application/statement of work, PBSC indicated that it had an "HIT Business Partnership Council (BPC)" made up of 19 local employers. The BPC was supposed to assist with curriculum development and hiring of trained HIT participants. However, the only evidence provided as to the active engagement of employer partners was Bethesda Memorial Hospital and the VA Medical Center. In addition, relying on one faculty member to coordinate, document, and engage all potential employer partners in a field of study or industry is not practical or realistic from a workload standpoint. With the recent hiring of a "Grants Compliance" staff member at PBSC, one major activity that should be undertaken is development of a college-wide employer engagement and communications strategy to develop an "account manager approach" and ensure that there is accountability for employer engagement at PBSC.

PBSC formalized articulation agreements, but it is a challenge due to accreditation requirements. PBSC was only able to execute one articulation agreement with Charter Oaks State College in April 2016. PBSC can provide additional focus to this activity ongoing, but also clearly document challenges with articulation as a result of AHIMA/CAHIIM accreditation.

5.0 Participant Impacts & Outcomes

Palm Beach State College (PBSC) committed to a series of nine outcome targets in its EHR Statement of Work (SOW). Section 5.0 reviews the outcomes targets for the program, and provides analysis and findings regarding the outcomes, impacts, and an operational understanding of why the outcomes and impacts were realized and/or fell short of anticipated goals.

5.1 SUMMARY OF PROGRAM OUTCOMES

The data analyses presented in this section were completed and shared by the EHR Program Director on July 11, 2016. PBSC's final outcome numbers will be slightly different as final reporting will incorporate all results through September 30, 2016. In addition, some counts in Table 1 may differ from those presented in Section 5.2.

Table 2: Actual to Target Comparison (Y1 – Y4)

Indicators	Number from APR[2]	Target from SOW	Target Achieved?
1. Total Unique Participants Served	335	310	YES
2. Total Number of Participants Completing a TAACCCT-Funded Program of Study	83	255	NO
3. Total Number of Still Retained in Their Program or Other TAACCCT-Funded Program	130	55	YES
4. Total number of Participants Completing Credit Hours	335	248	YES
5. Total Number of Participants Earning Credentials	83	228	NO
6. Total Number of Participants Enrolled in Further Education After TAACCCT-Funded Program of Study Completion	0	125	NO
7. Total Number of Participants Employed After TAACCCT-Funded Program of Study Completion	20	226	NO
8. Total Number of Participants Retained in Employment After TAACCCT-Funded Program of Study Completion	20	168	NO
9. Total Number of Those Employed at Enrollment Who Receive a Wage Increase Post-Enrolment	93	84	NO

NOTE: The data in this table reflect the most recent outcomes prior to submission of this Final Evaluation Report. However, the data analysis in the sections below was conducted using data provided by PBSC on July 11, 2016.

5.11 KEY FINDINGS

While there were substantial gains in enrollment and completion, several target numbers were not met. A total of 126 credentials was awarded during the program period of 2013-1 to 2016-3. The number of participants earning credentials was 83 out of a target of 228 certificates and degrees. This goal was a mathematical impossibility given the **baseline completion rates of ~6 (5.66) completions per year** (duplicated). The average annual completion rate **increased to 27 certificates or degrees awarded per year** (duplicated) during grant activities. This is more than four times the baseline rate, however, was not enough to meet the target. The project staff needed to assist in the completion of approximately 43 more certifications per year to have

[2] See note on page 6.

reached this goal. This assumes that the program would be able to accommodate at least 40 new participants each year. Though not a grant-required target, the average enrollment in the introductory course increased.

5.12 BASELINE DATA

Control Students: 81 Total (45 completed over 6 years)
Baseline Control: **28** (Y1-NR)
Ongoing Control: **45** (Y1 Control)
Opt-out Control: **8** (CY2 and CY3)

Treatment Students: 254 (34 completed over 4 years)
Year 1: **45** Treatment Students recruited by HI Advisors
Year 2: **86** Treatment Students recruited by HI Advisors
Year 3: **97** Treatment Students recruited by HI Advisors
Year 4 (6 months): **26** Treatment Students recruited by HI Advisors

5.13 ENROLLMENT

Baseline enrollment in HIM1000C (first HIM course required for all HI certificates and degrees), as displayed in Figure 2, shows a marked increase over time. The semester of 20162 (Spring 2016) had the highest enrollment in HIM1000C to date (this was also the last semester of implementation for the grant). Of these, all but two participants successfully completed the course.

- **The average number of participants enrolled in HIM1000C per semester was 6.63 before grant activities began.**
- **The average number of participants enrolled in HIM1000C per semester was 14.42 after grant activities began.**

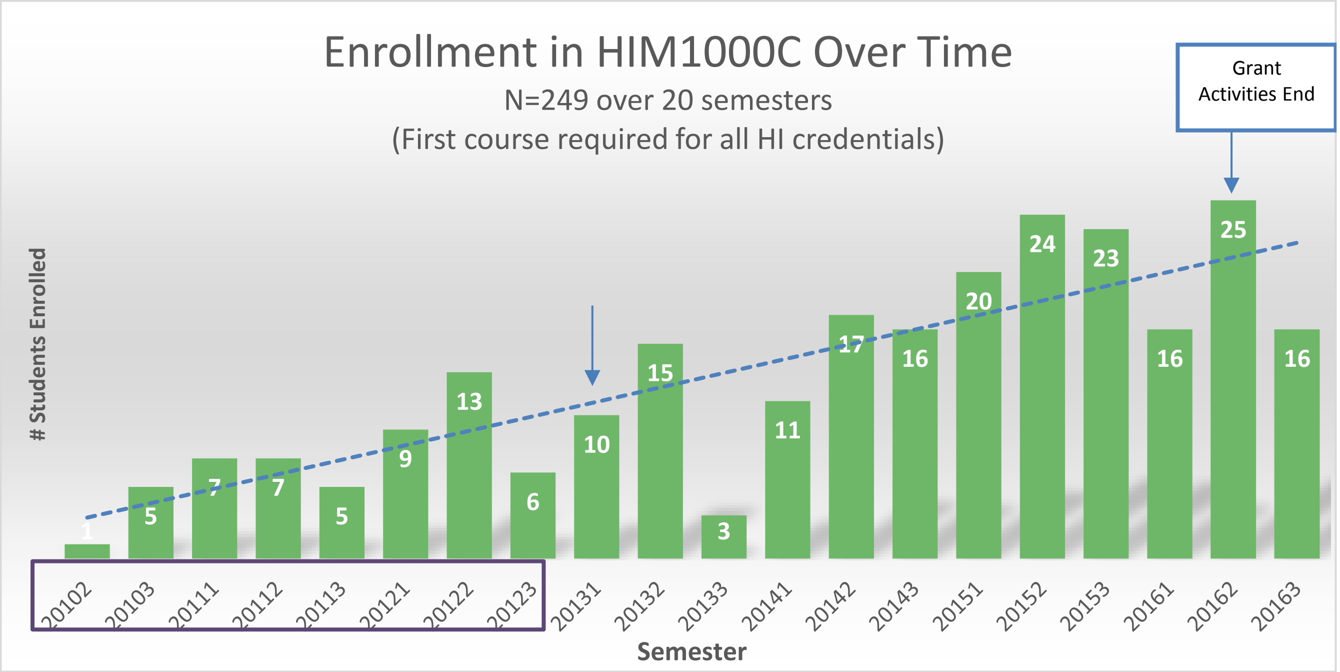


Figure 2: Enrollment in HIM1000C Over Time (N = 249 over 20 semesters)

Figure 3 shows the successful completion in HIM 1000C by semester. It is noteworthy that grant staff successfully advocated for increasing the course capacity for HIM1000C (from 20 to 30 participants), HIM 1433C (from 15 to 20), and HIM1442C (from 15 to 20).

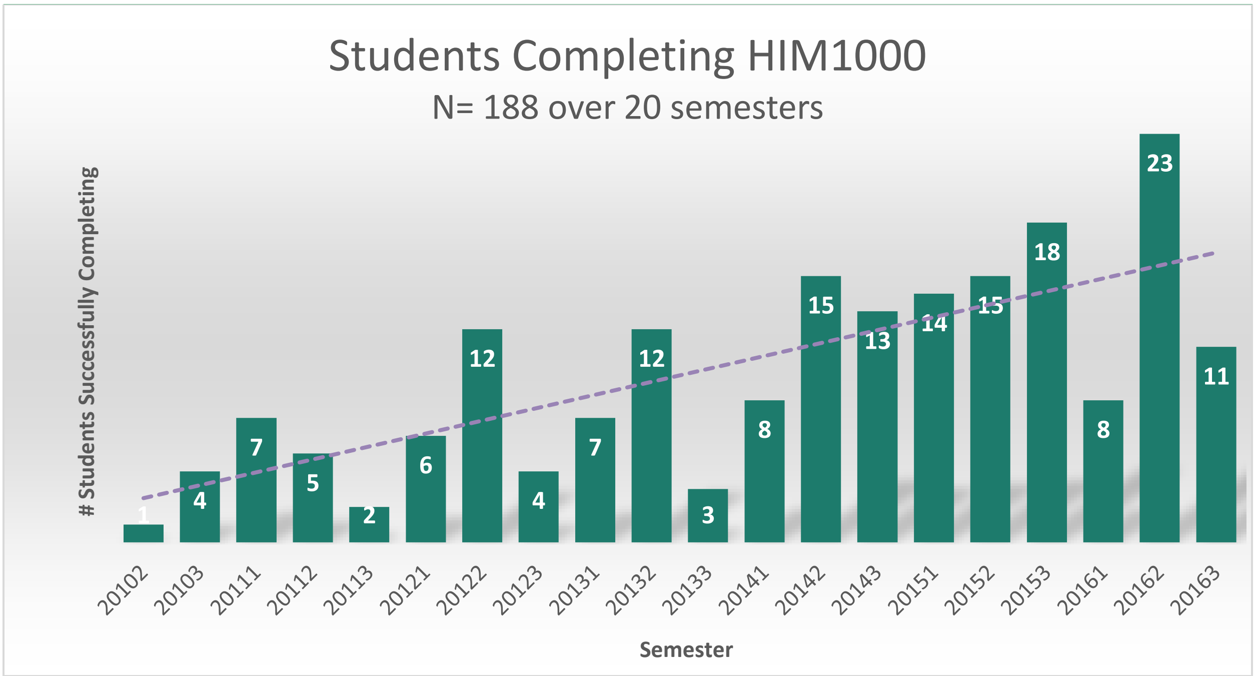


Figure 3: Completion in HIM1000C Over Time (N = 188 over 20 semesters; 20163 completion data was not available at the time of this analysis)

5.14 CERTIFICATE AND DEGREE COMPLETION

Below are charts that show both the duplicated and unduplicated increase in completion over time. Figure 4 demonstrates a marked increase in duplicated (all certificates and degrees awarded are counted) certificates and degrees awarded over time. Some participants received more than one certificate or degree, with a total of 126 awarded since January 2010.

- **Average annual duplicated completions before the grant started was 5.66.**
- **Average annual duplicated completions after the grant started was 23.**

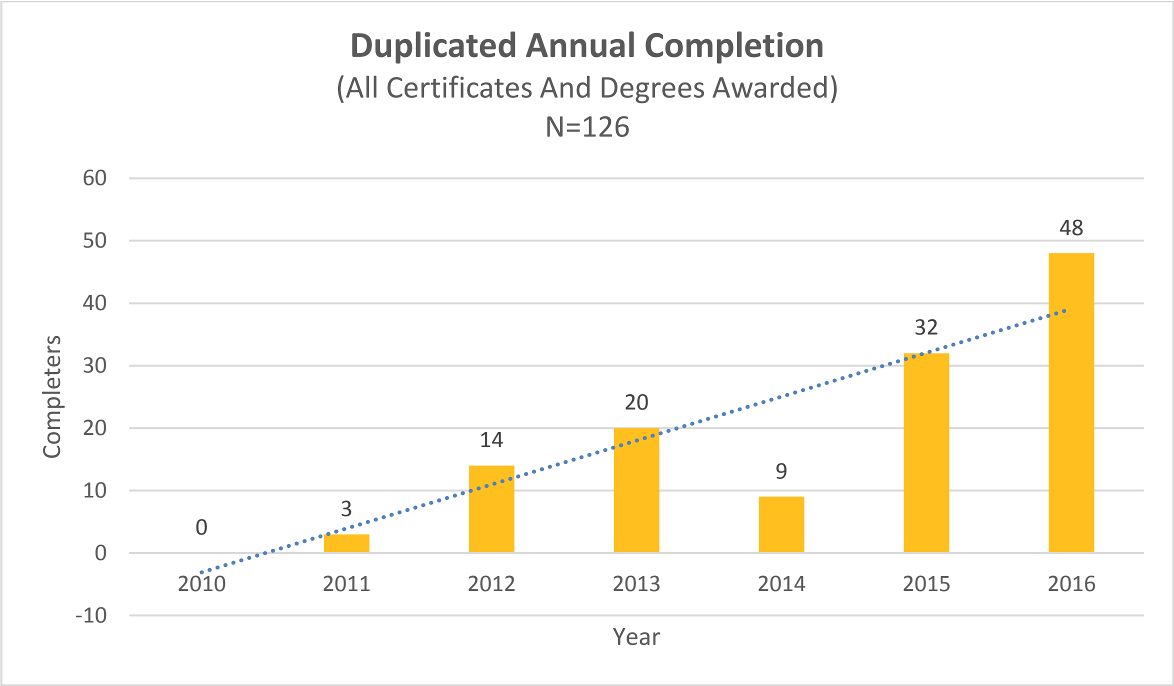


Figure 4: Duplicated Annual Completion (All Certificates and Degrees Awarded, N = 126)

Figure 5 shows the unduplicated annual completion (each person who completed one certificate or degree – only first completion counted). Even when considering only single certificates or degrees, there was an improvement in completion over time.

- **Average number of annual unduplicated completions before the grant started was 4.67.**
- **Average number of annual unduplicated completions after the grant started was 17.25.**

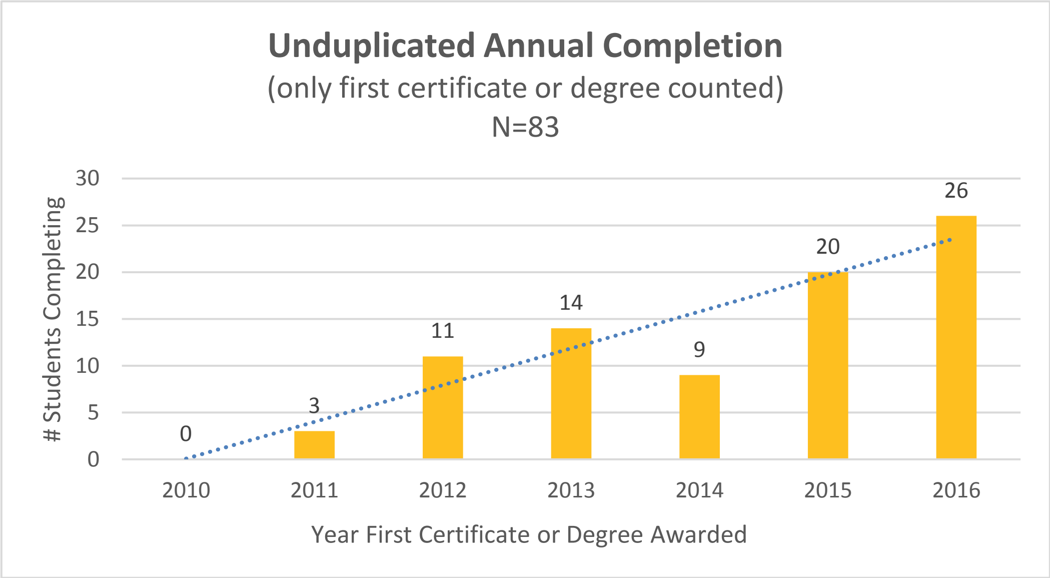


Figure 5: Unduplicated Annual Completion (Only First Certificate or Degree Counted, N = 83)

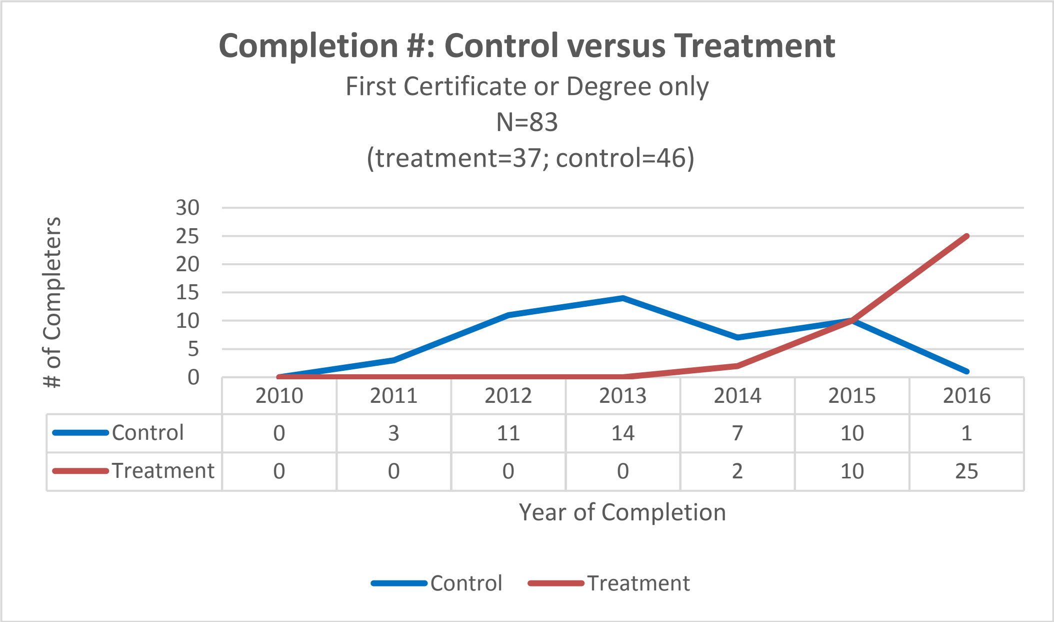


Figure 6: Unduplicated Annual Completions (Control, N = 45, versus Treatment, N = 34)

5.15 TIME TO COMPLETION

Since the beginning of the EHR program, there have been a total of 83 (unduplicated) completers. Of these, 45 Control participants completed over the past six years. In the past 3.66 years (since the beginning of the grant), there have been 34 Treatment completers. The increase in the rate of completion can be seen in Figure 6.

The time for grant activities was limited to 12 semesters or 4 academic years. The advertised length for the HIT AS degree is 7 semesters or 2.33 years. This is the estimate for participants attending full-time. The MICB certificate is estimated to be 5 semesters or 1.66 years. The shortest degree is the HIS certificate.

Table 3: Advertised Program Length

Palm Beach State College Programs	Credits	Program Length
Health Information Technology (HIT) Associate in Science Degree	70 credits	7 semesters (2.33 years) on a full-time basis; longer if part-time
Medical Information Coder/Biller (MICB) College Credit Certificate	34 credits; all may be applied to the HIT A.S. degree	5 terms (1.66 years); offered part-time only
Health Informatics (HIS) College Credit Certificate	18 credits; all may be applied to the HIT A.S. degree	3 terms + prerequisites (1 year); offered part-time only
Medical Transcription (MT) College Credit Applied Technology Diploma	33 credits; 18 credits may be applied to the HIT A.S. degree.	6 terms (2 years); offered part-time only

There have been 83 unduplicated participants who completed a HI certificate or degree since it started to be offered for credit in January 2010. **The average number of semesters to complete the first certificate or degree was 7.45 (2.48 years).** This means that participants were usually enrolled long enough to complete the HIT AS degree. *The first degree awarded, however, was usually the MICB* (though some participants did receive both the MICB and the HIT AS at the same time since many courses overlap). What the chart below suggests is that the MICB degree took longer than anticipated.

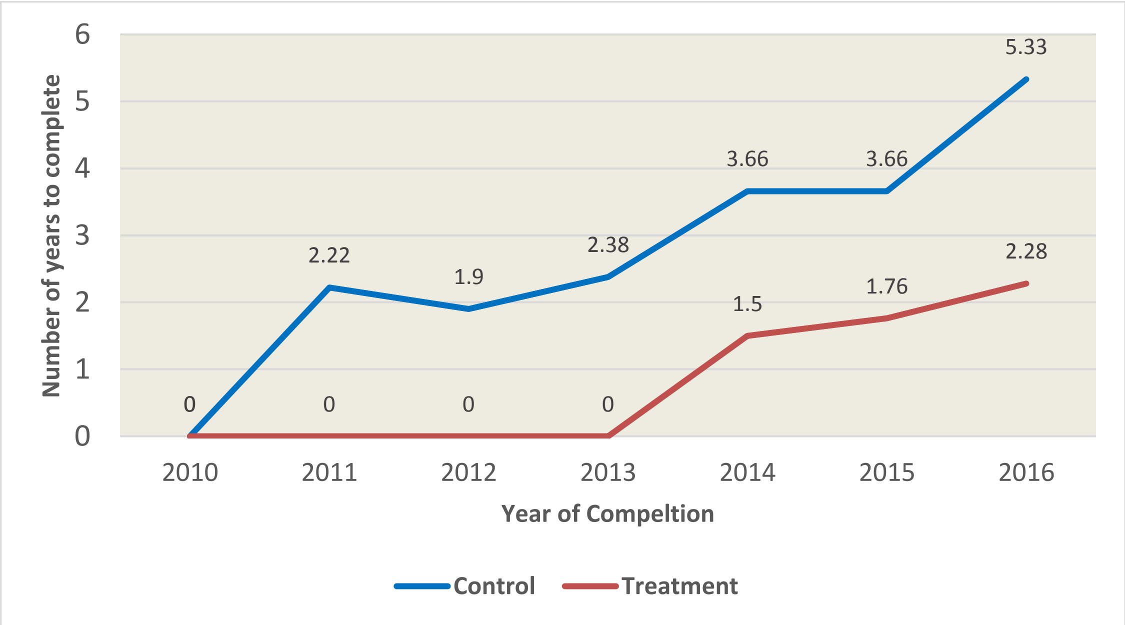


Figure 7: Avg. Number of Years to Completion of First Certificate or Degree (Control vs Treatment)

As Figure 7 demonstrates, the time to completion was shorter for Treatment participants than for Control participants. This may be in part because of the window of time that we are observing. **Control participants, by their very nature, had more time to complete a certificate or degree.** With only 3.66 years of grant activities, only the most advanced Treatment (participants who came in with some prerequisites completed) were captured. If we continued to observe completion, it is likely that the time to completion for Treatment participants would increase as well.

Some participants take a semester or two off before returning at a later date. Others take one course at a time to manage work and family constraints, which can extend time to completion. However, the preliminary results of the HI Advising appear promising. In addition, the HIS certificate was finally implemented around year 2 of the grant, allowing some participants to complete a certificate somewhat quicker.

However, there are remaining barriers that challenge time to completion: some required courses are not offered on a continuous basis. Even when offered, participants are sometimes told they should not be taking certain courses concurrently (even if the "suggested course sequence" recommends that they take those courses at the same time). This caused confusion and delayed participant completion.

"ADVANCED CERTIFICATION" PREPARATION COURSES

PBSC agreed to create seven continuing education courses for individuals interested in taking an advanced certification course or to retrain staff for the ICD-10 updates. At the end of the period of implementation, three courses had been developed and offered (CPHQ, CHDA, ICD-10 for Physicians).

Number Who Enrolled in Grant-Funded Non-credit Advanced Training courses (HIO0004, HIO0005)	Y1	Y2	Y3	Y4	Total
	0	3	10	20	33

The number of enrollees are expected to increase now that the full range (n=7) of continuing education courses are developed and six are offered.

5.2 OUTCOMES ANALYSIS[3]

5.21 Summary Findings

- Participants in the control group show better academic progress overall than the treatment group. Evidently, on average, number of credentials awarded per participant is found to be higher for the control group. They had more time to complete the certificates or degrees. While the treatment students had 3.5 years the control group had 6.5 years.
- At the time of reporting, 25 control students are still enrolled. A majority of them either left or completed their program.
- Treatment participants appear to have attained their first credentials in a shorter period than the controlled participants. This difference is found to be statistically significant.
- Part-time participants in both groups appear to have shorter completion time than the full-time participants. However, because of small number of full-time enrollments in the program, these differences are not statistically significant.
- Although observed average completion time is found to be longer for participants who were Pell Grant eligible than those who were not, the difference is not statistically significant.
- Most participants (control – 50% and treatment – 75%) for whom post-completion wage information was available have seen their wages increased after completion.

Rigorous Bayesian analysis was conducted to make inference(s) about the difference in post-completion mean wages between the treatment and control groups. The analysis reveals great uncertainty in the estimated parameters due to sample size limitations of the observed wage data and finds no credible difference between the two groups, given the data.

This section presents a comparative analysis of the completion data released on June 20, 2016 for the control and treatment groups. **Table 4** presents the completion data for both groups. The treatment group consists of 254 participants and the control group consists of 81 participants. As of Q2 2016, a total of 50 certificates were awarded to 40 participants in the treatment group and a total of 84 certificates were awarded to 34 participants in the control group.[4] Average completion of first degree or certificate is found to be 2 years and 3 months for the treatment group and about 3 years for the control group. Forty participants in the treatment group are still enrolled in the program, whereas 25 participants in the control group are currently enrolled. Average GPA of completers in both groups is around 3.00.

[3] As the participant database is being continuously updated by PBSC, some counts presented in this section may differ from those shown in the previous section.

[4] When the data was available in June 2016, some participants already met credit hour requirements, but were awaiting their degree and/or certificate.

Table 4: Comparison of Completion Data

	Treatment	Control
Group Size (N)	254	81
Certificates Awarded by Program		
HIS	11	17[5]
MICB	32	42
HIT	4	23
MT	3	2
TOTAL	**50**	**84**
No. of Students Completed Credit Hours	40	81
Average completion time of first degree/certificate	27 mo.	35 mo.
Still Enrolled	49	25
Average GPA of Completers	3.03	3.00

5.22 Subgroup Analysis

This section presents sub-group analysis of the completers. The analysis is based on 72 participants with complete information. Table 5 shows the demographic characteristics of the participant sample drawn for this analysis. The participant population in the HIT program is primarily female and non-Hispanic White. Due to lack of diversity in the participant body, in terms of gender and race/ethnic characteristics, there is not a large enough sample size in other groups to conduct a reasonable sub-group analysis based on these factors. Therefore, completion data is analyzed based on enrollment and Pell Grant eligibility status. In the treatment group, 26% of the participants were enrolled full-time, whereas 16% were enrolled full-time in the control group. Proportion of completers who were Pell Grant eligible in the treatment was 32% and in the control group it was 24%.

[5] Many of these were awarded retroactively with the "auto graduation" process and was due to advisors' identifying potential awards for those who completed the courses.

Table 5: Demographic Characteristics of Completers

	Treatment	Control
Group Size (N)	38	34
Female	85%	95%
Race		
Black	18%	8%
White	53%	63%
Other	29%	29%
Ethnicity		
Hispanic	18%	18%
English spoken as second language	9%	18%
Enrolled full-time	26%	16%
Pell Grant eligible	32%	24%

5.22.1 Completion by Enrollment Status

Figures 8 and 9 show the average number of degrees or certificates awarded by enrollment status. Both full-time and part-time participants in the control group show higher averages in terms of number of degrees or certificates completed. However, on average, both part-time and full-time participants in the treated group appear to take shorter time to complete their first credential. The time to completion of part-time treated participants is almost one year shorter than their counterpart in the control group. Note that the difference is found to be statistically significant.

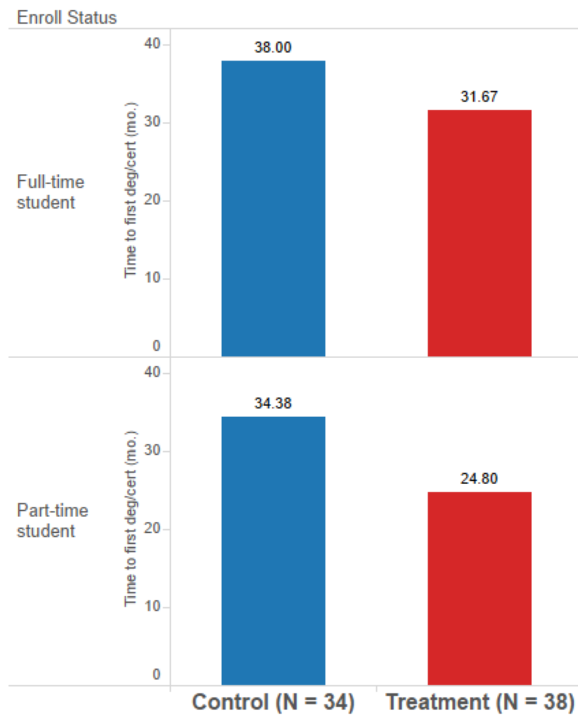


Figure 8: Average Number of Degree/Certificates Awarded by Enrollment Status

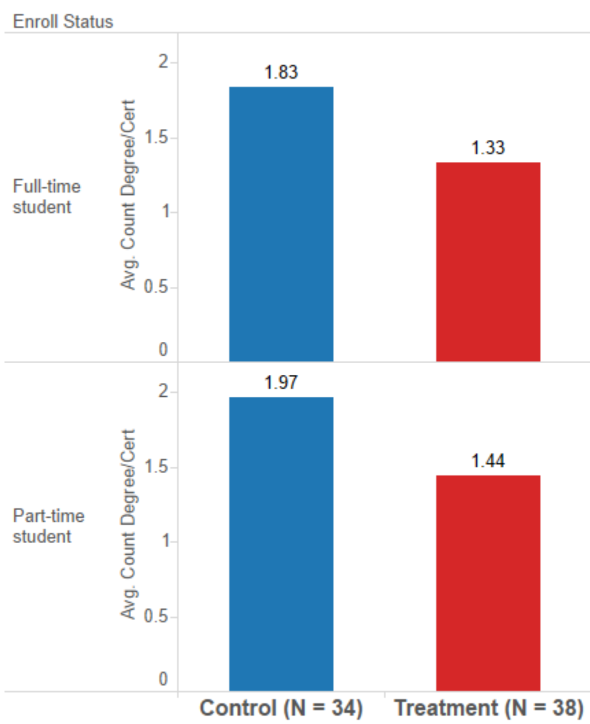


Figure 9: Average time (in mo.) to First Degree/Certificate Completion by Enrollment Status

5.22.2 Completion By Pell Grant Eligibility Status

Figures 10 and 11 show the average number of degrees or certificates awarded by Pell Grant eligibility status. Pell Grant status appears to show no difference in terms of average number of degrees/certificates awarded in both treatment and control groups. However, participants who were Pell eligible show slightly higher average time to completion of their first credential. This pattern is consistent in both treatment and control group. The difference is three months for the control group compared to one month for the treatment group. Note that these differences are not statistically significant.

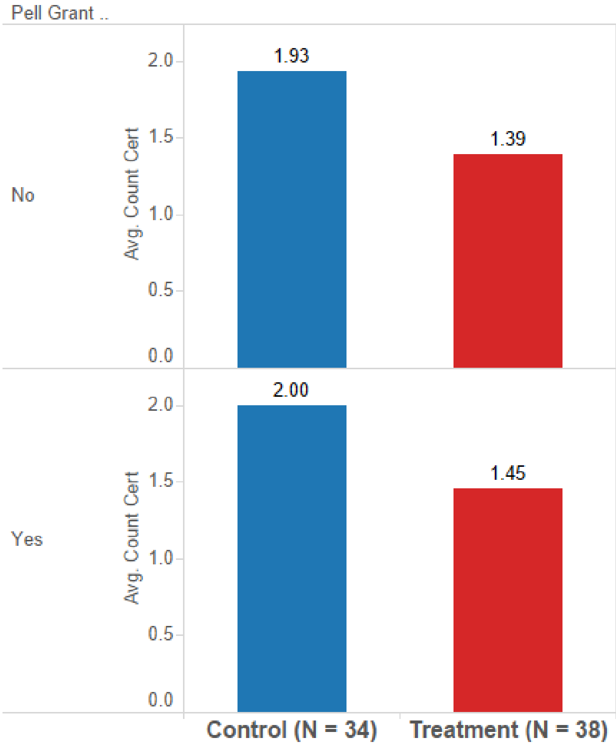


Figure 10: Average Number of Degree/Certificates Awarded by Pell Grant Eligibility Status

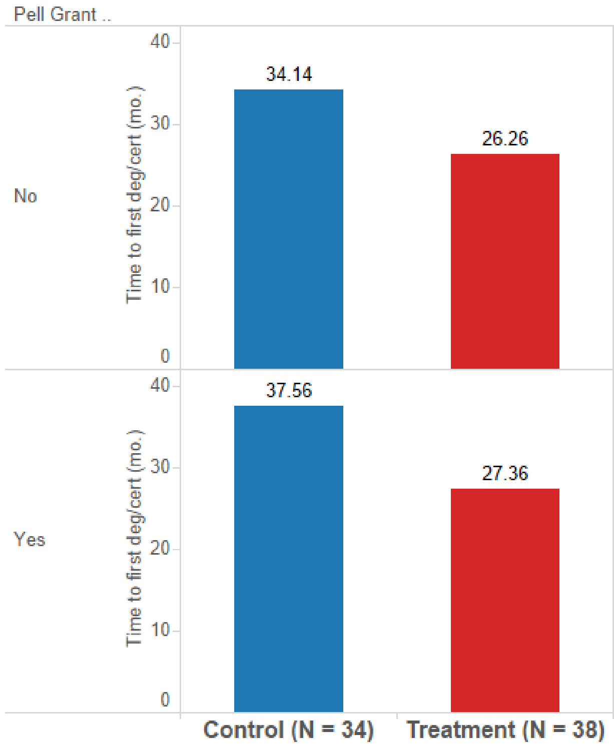


Figure 11: Average time (in mo.) to First Degree/Certificate Completion by Pell Grant Eligibility Status

5.3 IMPACT ANALYSIS: BAYESIAN ESTIMATION OF THE DIFFERENCE OF MEAN WAGE PARAMETERS IN CONTROL AND TREATMENT GROUPS

This section attempts to answer various comparative questions related to the impact of the intervention on the treatment group, such as: **How much is the treatment group's post-treatment mean wage different from the mean wage of the control group observed during the same period? Is there reasonable assurance that the difference is non-zero? How much certainty exists about the magnitude of difference?**

These questions are not easy to answer because data are often contaminated by random variability despite earnest efforts to minimize extraneous influences on the data. Because of 'noise' in the data, the evaluation methodology relied on statistical methods of probabilistic inference to interpret the data. When data are interpreted in terms of meaningful parameters in a mathematical description, such as the difference in mean parameters in two groups, it is Bayesian analysis that provides complete information about the credible parameter values. Bayesian analysis is also more intuitive than traditional methods of null hypothesis significance testing (NHST) (Dienes, 2011[6]; Kruschke, 2013[7]). The analysis is implemented in statistical programming languages R and JAGS.

5.31 Bayesian Inference

Bayesian inference is based on fundamentally different assumptions about data and parameters than classical methods, such as null hypothesis significance testing (NHST). In the Bayesian world, all quantities are divided into two groups: observed and unobserved. Observed quantities are typically the data and unobserved quantities include parameters of interest to be estimated. All observed quantities are fixed and are conditioned as such. All unobserved quantities are assumed to possess distributional qualities and therefore are treated as random variables. Thus parameters are no longer treated as fixed unmoving in the total population and all inferential statements are made in probabilistic terms.

The inference process starts with assigning *prior distribution* for the unknown parameters. For example, prior distribution of the wage in the health information technology (HIT) occupation in the state of Florida can be based on what observed in the census data. The prior distribution also gives an opportunity to systematically include qualitative, narrative, and intuitive knowledge into the statistical model. The next step is to stipulate a likelihood function in the conventional manner by assigning a parametric form for the data and inserting the observed quantities. The final step is to produce a *posterior distribution* by multiplying the prior distribution and the likelihood function. Thus the likelihood function uses the data to update the prior knowledge conditionally.

The process, as described, can be summarized as follows:

Posterior Probability ∝ Prior Probability × Likelihood Function

What the expression above shows is that the posterior distribution is a compromise between the prior distribution, reflecting research beliefs or prior knowledge, and the likelihood function, which is the contribution of the data at hand.[8]

The following sections present Bayesian inference procedures applied to both unmatched and matched samples of treated and control group wage data.

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[6] Dienes, Z. (2011). Bayesian versus orthodox statistics: Which side are you on? *Perspective on Psychological Science, 6,* 274-290. doi: 10.1177/1745691611406920

[7] Kruschke, J. K. (2013). Bayesian estimation supersedes the *t* test. *Journal of Experimental Psychology: General, 142(2),* 573-603.

[8] Gill, J. Bayesian Statistical Methods. https://wustl.box.com/shared/static/5wjrf6sq661jas4lks1j15xuunrv0wnc.pdf [accessed on 6/19/2016]

5.32 Analysis of Unmatched Sample

This section presents Bayesian estimation of the difference of mean wage parameters drawing on unmatched control and treatment group samples. Bayesian approach is particularly appropriate in this context for several reasons:

First, flexible and robust prior definition retains the extreme outliers in the analysis without imposing significant bias on estimated parameters.

Second, Bayesian analysis works with very small size as is the current case. Therefore, the posterior is simply expected to reveal broad, uncertain estimates.

Third, Bayesian approach is not affected by unbalanced sample sizes as is often the case with unmatched groups.

5.32.1 A Descriptive Model for Two Groups

The first step of most statistical analysis is specifying a descriptive model for the data. In this analysis, means (μ_1 and μ_2) and standard deviations (σ_1 and σ_2) describe meaningful aspects of the wage data. In particular, the difference of the mean parameters ($\mu_1 - \mu_2$) describes the magnitude of the difference between the central tendencies of the groups, and the difference of the standard deviation parameters ($\sigma_1 - \sigma_2$) describes the magnitude of the difference between the variabilities of the groups. The main goals are to estimate those magnitudes and to assess uncertainty in those estimates. The Bayesian method provides answers to both goals simultaneously.

5.32.2 Bayesian Prior Distribution

Central to the Bayesian philosophy is that all unknown parameters are described probabilistically, even before the data has been observed. Specifying Bayesian models necessarily means providing prior distributions for these unknown parameters. As mentioned above, priors are actually an opportunity to systematically include qualitative, narrative, and intuitive knowledge into statistical models. They play a central role in Bayesian inference through updating information about the parameters as new data becomes available. For example, Bayesian posterior of a past trial could be used as the prior of the present trial.

In this analysis, an informative prior is used for the unknown parameters of interest. Informative priors are those that deliberately insert information that researchers have at hand. In the attempt to make inference about the difference between the mean wages of two groups (control vs. treatment), the following four unknown parameters are used:

1. mean (μ_1) and standard deviation (σ_1) of Group 1 ("Control") wage
2. mean (μ_2) and standard deviation (σ_2) of Group 2 ("Treatment") wage

Deriving Wage Priors from the American Community Survey

Prior distributions for the above unknown parameters are derived from the American Community Survey's (ACS) 2014 five-year PUMS that provides individual level wage information in the health information technology (HIT) occupation. It is assumed that the majority of the graduates from the PBSC's HIT program are employed in the state of Florida. Hence, a sample of individuals who were employed in the HIT occupation and reported Florida as their place of work is selected.

Figure 12 shows the wage distribution of ACS HIT sample. Income distribution in the population is typically skewed to the right with a long tail because income data often contain outliers. Similar skewed distribution is also observed in the ACS HIT sample. A useful way to accommodate outliers is by describing data with a distribution that has taller tails than the traditional normal distribution. A skewed income distribution like the one observed here is described empirically by a gamma probability density function (*shape parameter* = *3.196; scale parameter* = *16,699*)[9] ("blue curve" shown in Figure 1). Because no prior information on the wage distributions of the treatment and control groups is available, the gamma density function is adopted to describe the likelihood function of the wage data for both groups.

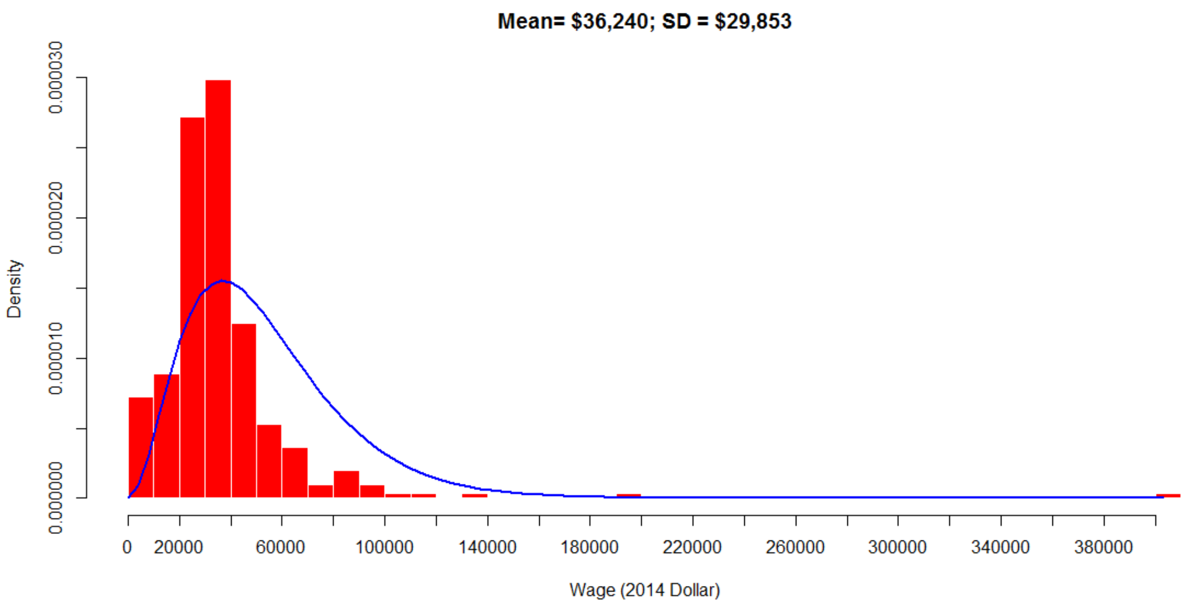

Figure 12: Distribution of Annual Wages in the ACS HIT Sample (Unweighted N = 305) and Fitted Gamma Probability Density Function

[9] These parameters are derived from the mode = $36,667 and standard deviation = $29,853 of the distribution.

Figure 13 demonstrates the model specification adopted here. Same specifications are used for both control and treatment group wage data. Wage data, y_i, are assumed to be generated by a **gamma likelihood function** with shape parameter[10] - Sh and rate parameter - R or scale parameter - R^{-1}, which can also be expressed as a function of mean μ and standard deviation σ. To accommodate uncertainty about mean and standard deviation, prior distributions are assigned on μ and σ, also described by gamma density functions. The subscript i indicates i^{th} observation in the data vector y. The following paragraphs describe how the parameters for the priors are determined.

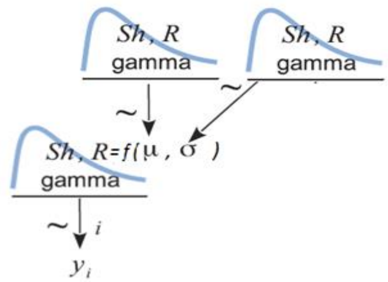

Figure 13 Dependency Diagram for Estimation of Group Level Parameters

In order to construct priors for unknown mean parameters μ_1 and μ_2, we first examine the distributions of post-completion annual wage data observed in the treatment (N = 12) and control groups (N = 25). It appears that average wages of both groups ($\mu_{control}$ = \$24,498[11] and $\mu_{treatment}$ = \$29,680[12]) are smaller than that in the ACS sample (μ = \$36,240). It is not surprising because average wages of these groups probably reflect entry-level wages in the HIT occupation, whereas ACS sample is likely to include more experienced workers with higher wages. Hence, it would be reasonable to adjust the priors accordingly by shifting the peaks of the density functions to the left and position them at about where group wage distributions peak, while at the same time we impose wider spread (i.e. larger standard deviation) to the distribution drawn from the gamma function fitted to the ACS wage data. This makes the distributions more diffused for the purpose of incorporating uncertainty, as well as addressing ignorance about the unknown mean wage parameters. This specification of an uncertain prior implies that the prior has minimal influence on the estimates of the parameters, and even a modest amount of data will overwhelm the prior assumptions when conducting Bayesian parameter estimation. The process of defining the priors are pictorially presented in Figures 14 and 15.

Figure 14 shows the wage distribution of the control group. Based on the process described above, we construct the prior distribution (shown in dark green) with a gamma density function (*shape parameter, Sh = 1.939; scale parameter,* R^{-1} *= 16,699*).

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[10] $Shape, Sh = \frac{\mu^2}{\sigma^2}$ and Rate, $R = \frac{\mu}{\sigma^2}$; *Scale =* R^{-1}

[11] Expressed in 2014 dollars.

[12] Ibid.

Figure 15 shows the wage distribution of treatment group. In this case, we construct the prior distribution (shown in dark green) with a gamma density function (*shape parameter, Sh = 2.449; scale parameter,* R^{-1} *= 16,699*).

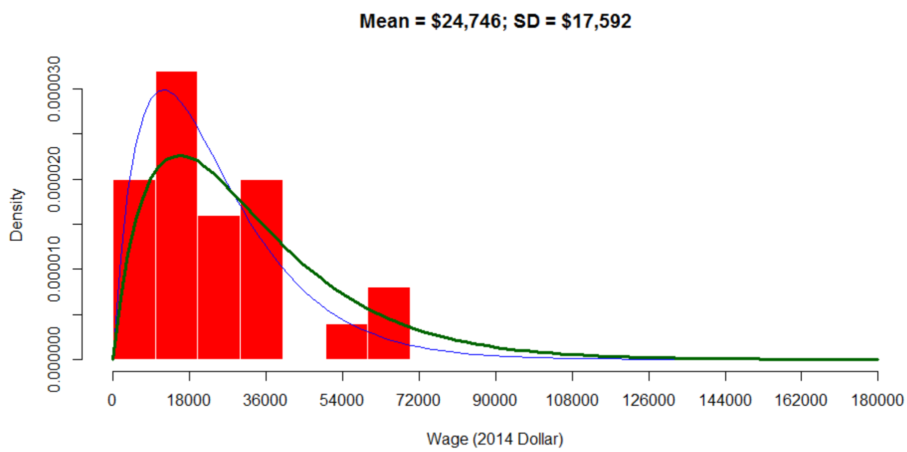

Figure 14: Wage Distribution of the Control Group (N = 25) and Prior Distribution Assigned to the Unknown Parameter μ_1

Figure 15: Wage Distribution of the Treatment Group (N = 12) and Prior Distribution Assigned to the Unknown parameter μ_2

Using the same principle described above, prior distributions were assigned for the unknown standard deviation parameters σ_1 and σ_2. Figure 16 shows the gamma distribution (*Sh* = 2.6180; R^{-1} = 18,450) assigned to SD prior for the control group and Figure 17 shows the gamma distribution (*Sh* = 2.6180; R^{-1} = 18,450) assigned to SD prior for the treatment group. In both cases, the gamma functions peak near the SD estimated from the observed wage data.

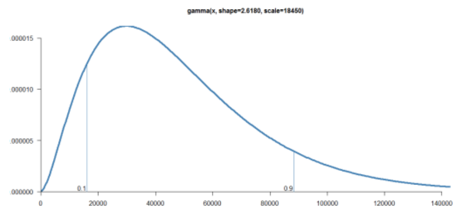

Figure 16: Prior Distribution Assigned to the Unknown Standard Deviation Parameter σ_1

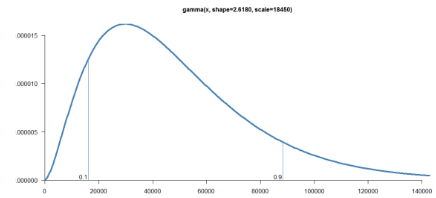

Figure 17: Prior Distribution Assigned to the Unknown Standard Deviation Parameter σ_2

5.32.3 Markov Chain Monte Carlo Diagnostics

The simulation method that produces accurate approximations to Bayesian posterior distributions is called Markov chain Monte Carlo (MCMC). This section presents some commonly used diagnostics to evaluate the quality of the MCMC sample drawn to represent the posterior distributions of the estimated parameters. What is looked for is the chains should not be unduly influenced by the arbitrary initial value of the chain, and they should fully explore the range of the posterior distribution without getting stuck. To ensure that these goals are achieved, three parallel chains are run with length of each more than 3 million steps and assign them with unequal initial values.

Current practice often focuses on two diagnostic methods: visual examination of the trajectory of the chains, and consideration of a numerical description of their convergence. Figures 18-21 show various MCMC diagnostics for the parameters estimated. The upper-left panel in each figure presents the *trace plot* – a graph of the sample parameter values as a function of step in the chain. As has been done here, one way to enhance the visibility of unrepresentative parts of the chain is to superimpose two or more chains. If the chains (three chains in this case) are all representative of the posterior distribution, they should overlap each other. In all four figures, the chains overlapped each other very well although they started at different initial values.

The plots in the lower-right panel are the *density plots.* The plots generated for each of the three chains overlapped almost perfectly for all four parameters (Figures 18-21), which affirm that in all four cases each chain has drawn representative sample from the posterior distribution.

Another statistic that measures chain convergence is the "shrink factor' or "Gelman-Rubin statistics" – plotted in the lower-left panel. Intuitively, its value is 1.0 if the chains are fully converged. In all four cases, the shrink factor gets to 1.0.

Now that assurance exists that the chains are genuinely representative of the samples from the posterior distributions, the second goal is to have a large enough sample for stable and accurate numerical estimates of the distribution. The larger the sample, the more stable and accurate (on average) will be the estimates of the central tendency and High Density Interval

(HDI) limits (discussed in the later section). How much independent information about the posterior distribution the chains generate is measured by the *effective sample size* (ESS), which divides the actual sample size by the amount of autocorrelation. Autocorrelation in the context of MCMC is the correlation of the chain values with the chain values *k* steps ahead. As observed in all four cases, the three chains (superimposed in the plot) are highly autocorrelated, insofar as the autocorrelation remain above zero for lags as many as 20. Three chains were run, each with N = 3.33 million, yielding 10 million steps overall. But the auto-correlation is so high that the ESS in each case is only about one million. In other words, a sample of one million of a completely non-autocorrelated chain yielded the same information about the posterior distribution as a sample of size 10 million of a highly correlated chain. Nevertheless, ESS in the analysis is well above N = 10,000 - the recommended ESS limit for reasonable estimates of the 95% HDI.

Another useful measure of the effective accuracy of the chain is the Monte Carlo standard error (MCSE). It is expressed as:

$$MCSE = \frac{SD}{\sqrt{ESS}}$$

where SD is the standard deviation of the chain.

The MCSE indicates the estimated SD of the sample mean in the chain, on the scale of the parameter value. The value of estimated MCSE is shown in the lower-right panel in each figure. It is very small, which suggests that the mean of the posterior appears to be estimated stably.

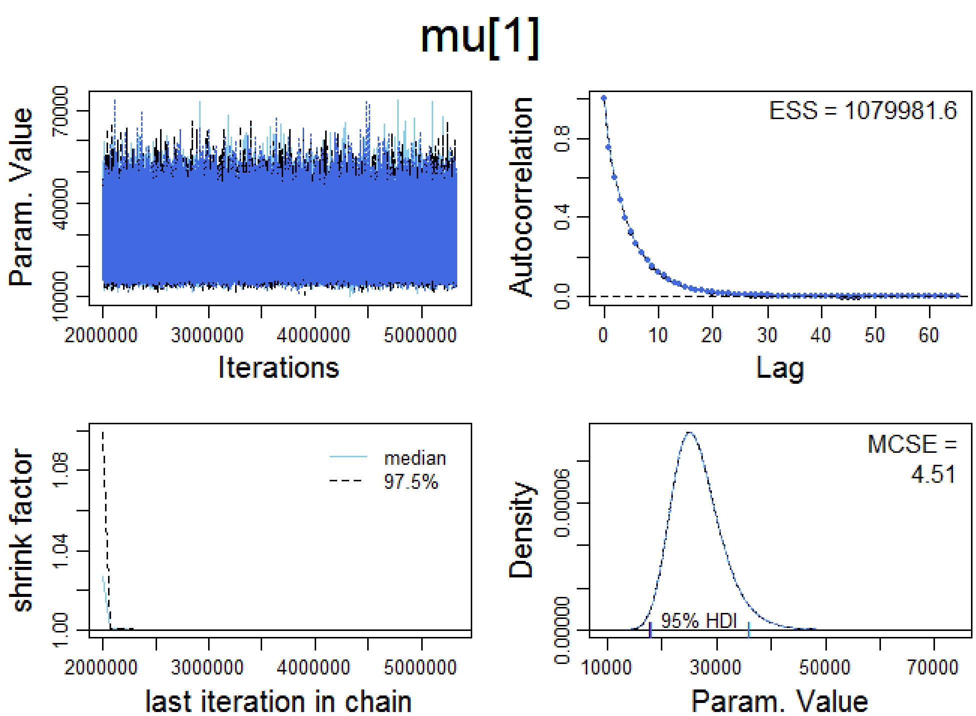

Figure 18: MCMC Diagnostics for Estimated Parameter (μ_1)

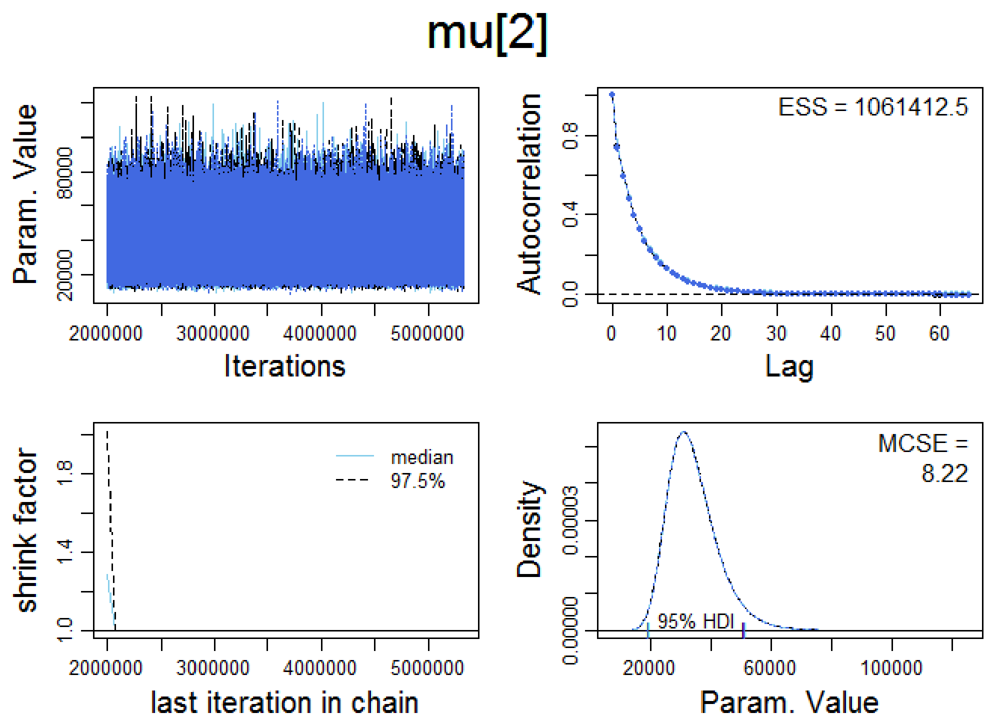

Figure 19: MCMC Diagnostics for Estimated Parameter (μ_2)

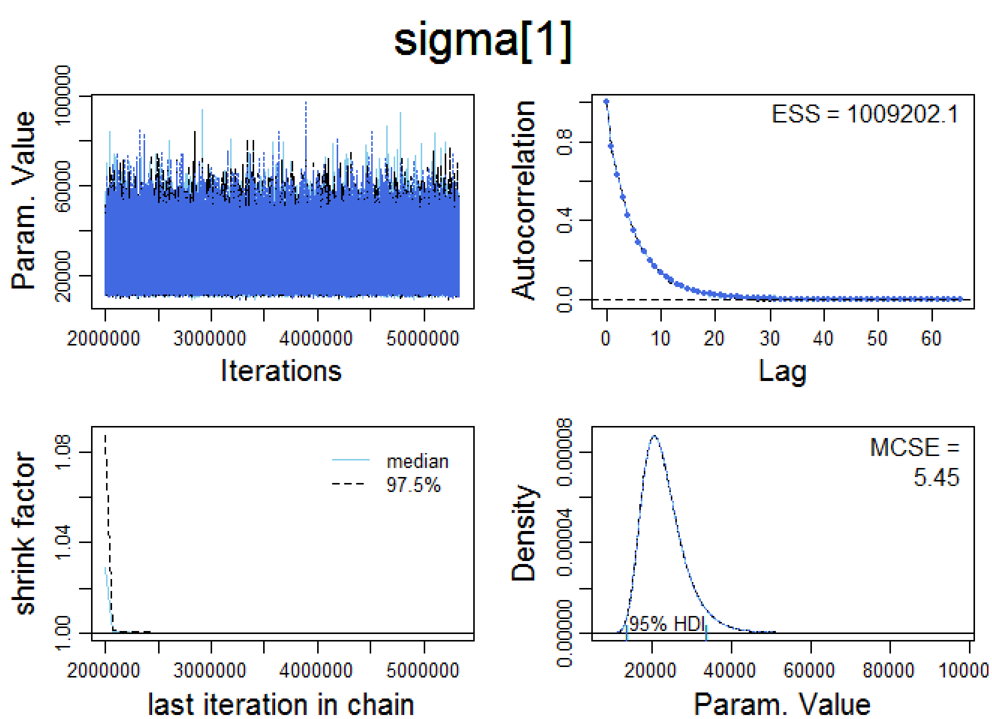

Figure 20: MCMC Diagnostics for Estimated Parameter (σ_1)

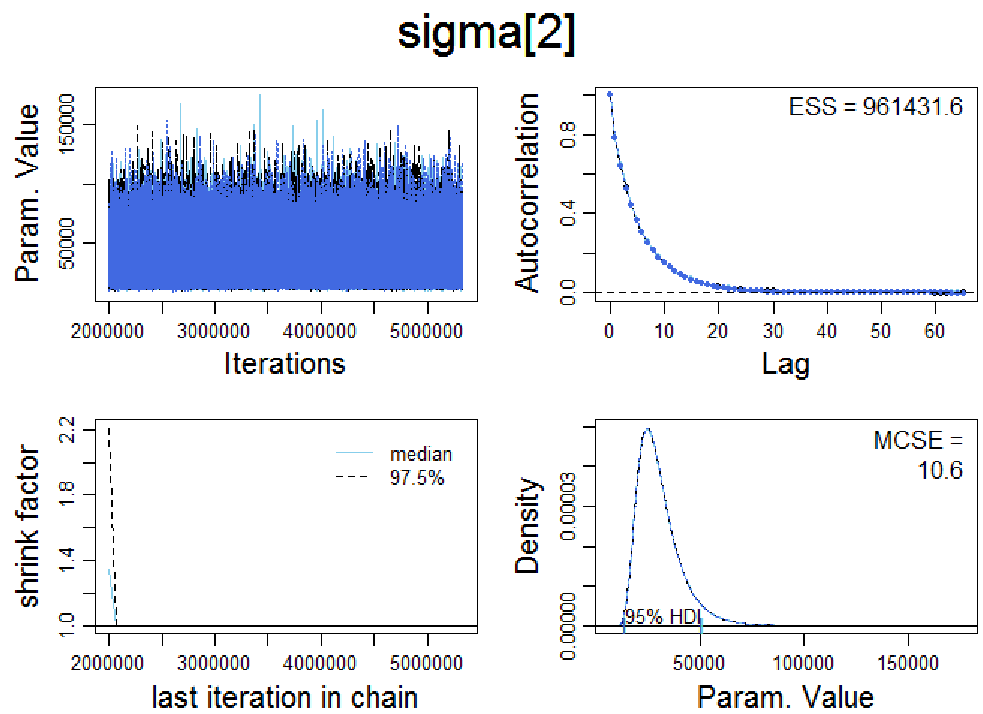

Figure 21: MCMC Diagnostics for Estimated Parameter (σ_2)

5.32.4 Bayesian Estimation Results

Robust Bayesian estimation yields rich information about the differences between groups. The MCMC method generates a very large number of parameter combinations that are credible, given the data. Figures 22-28 show histograms of 10 million credible parameter-value combinations. It is important to understand that these are histograms of parameter values; they are not histograms of simulated data. The histograms display 10 million parameter values from the posterior distributions, given the single set of actual data. Each histogram is annotated with its central tendency – mode in this case because the distributions are noticeably skewed. Each histogram is also marked with its 95% **highest density interval (HDI).** By definition, every value inside the HDI has higher probability density than any value outside the HDI, and the total mass of points inside the 95% HDI is 95% of the distribution.

Figure 22 shows that the mode of the credible values of control group's mean wage parameter $\boldsymbol{\mu_1}$ is $24,900,[13] with a 95% HDI from $18,100 to $36,000, and Figure 23 shows that the mode of the MCMC chain for treatment group's mean wage parameter $\boldsymbol{\mu_2}$ is $31,200, with a 95% HDI from $19,500 to $51,300.

The mode of the difference $(\boldsymbol{\mu_1} - \square_2)$ is -$5,470, as displayed in Figure 13. 95% HDI of the difference of mean includes zero, and 79.4% of the credible values are less than zero, meaning that there is 20.6% probability that the mean wage of the control group is higher than the mean wage of the treatment group. Although the observed mean wage of the treatment group

[13] This and all subsequent dollar figures are expressed in 2014 dollars.

appears to be larger than the control group, the posterior distribution reveals great uncertainty in the estimate of the difference of means.

Therefore, the conclusion is that the group means are not credibly different, given the data.

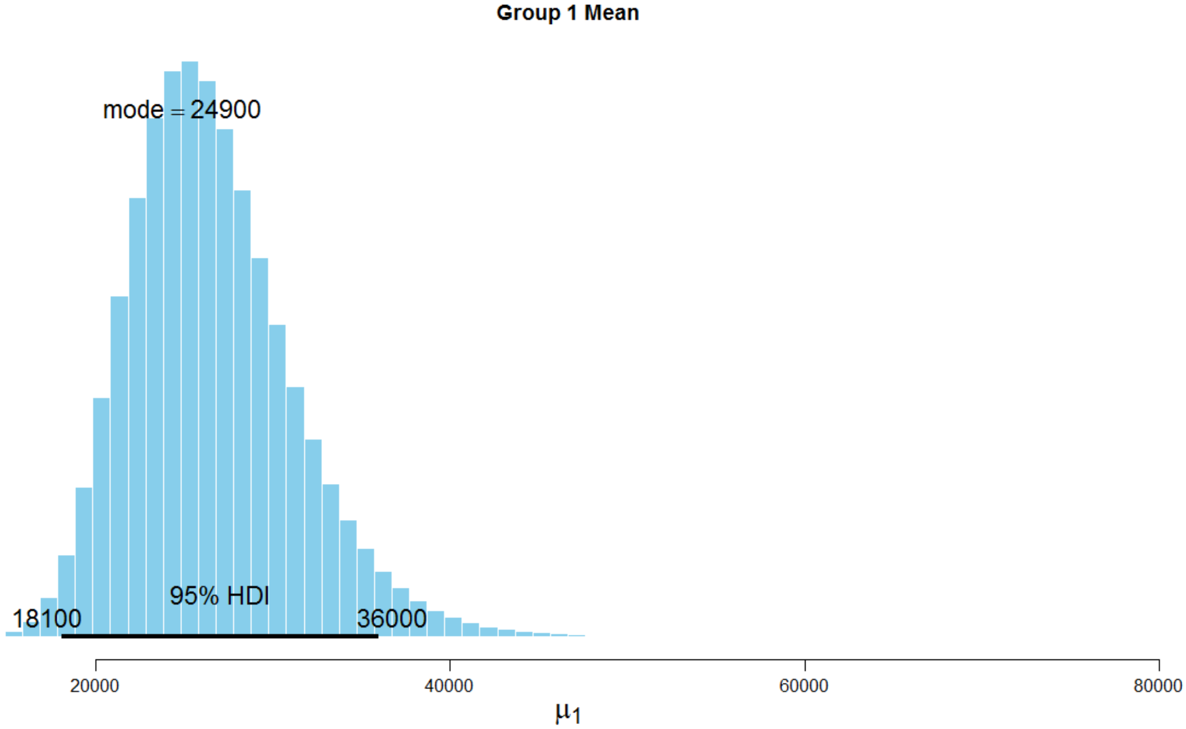

Figure 22: Posterior Distribution of Control Group Mean Wage Parameter (μ_1)

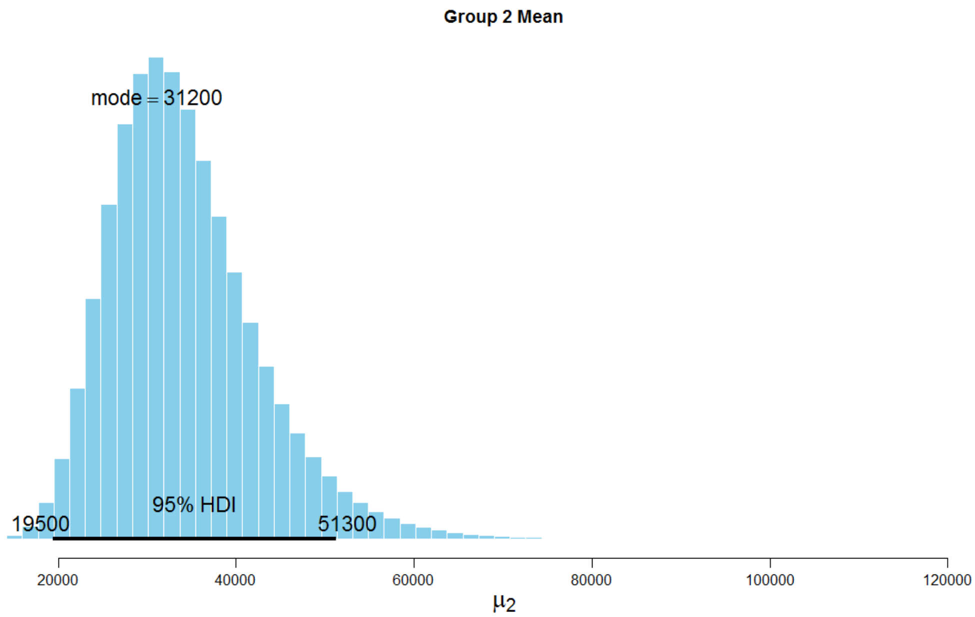

Figure 23: Posterior Distribution of Treatment Group Mean Wage Parameter (μ_2)

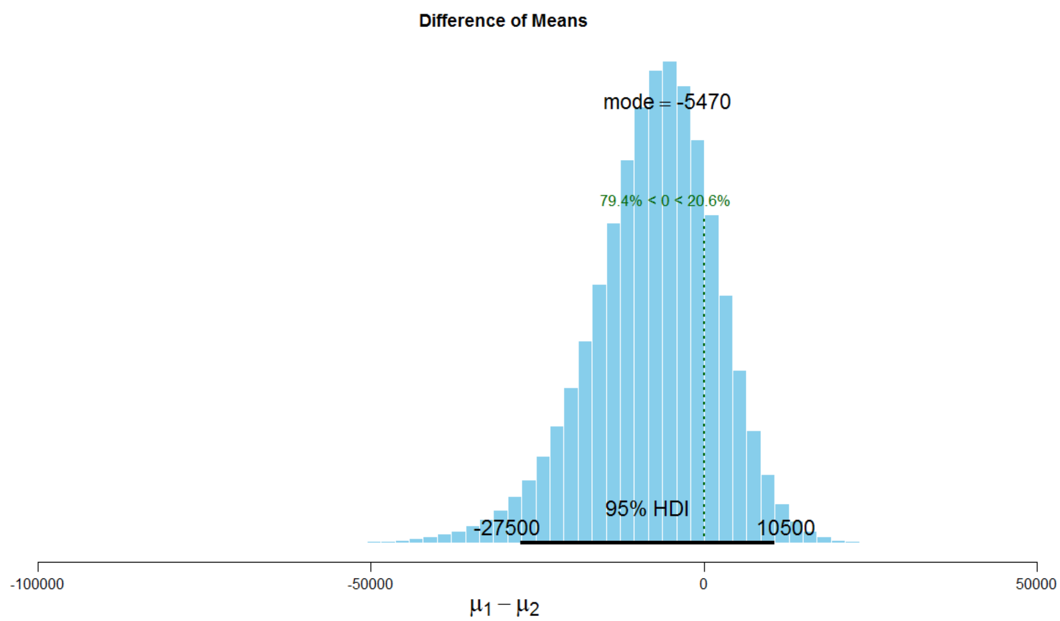

Figure 24: Posterior Distribution of the Difference in Mean Wage Parameters ($\mu_1 - \mu_2$)

Figures 25 and 26 show histograms of credible values of the standard deviations for the control and treatment groups, respectively. The difference of the standard deviations is shown in Figure 27, where a difference of zero is, again, among the 95% most credible differences. **Hence, the conclusion is that the standard deviations of the wage distributions of the two groups are not credibly different.**

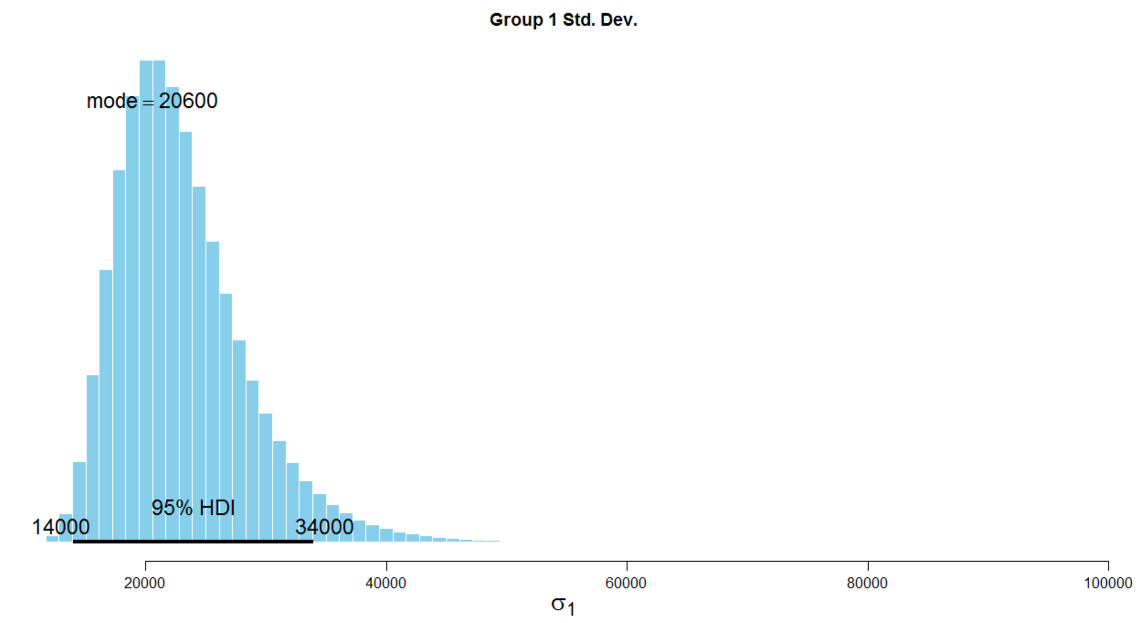

Figure 25: Posterior Distribution of Control Group Std. Dev. Parameter (σ_1)

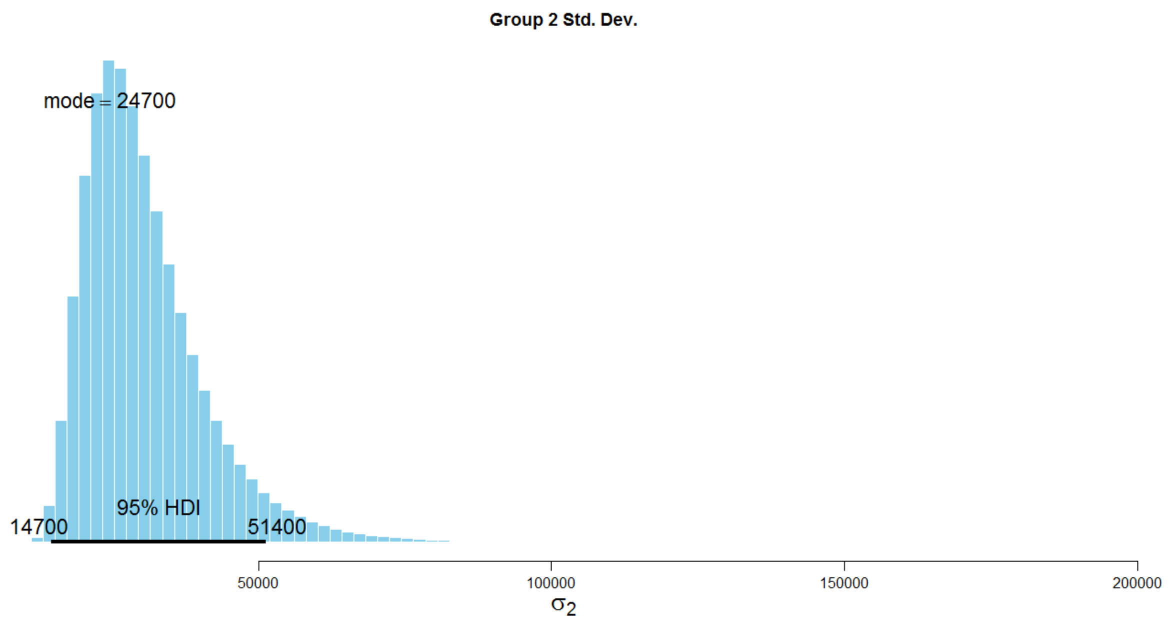

Figure 26: Posterior Distribution of Control Group Std. Dev. Parameter (σ_2)

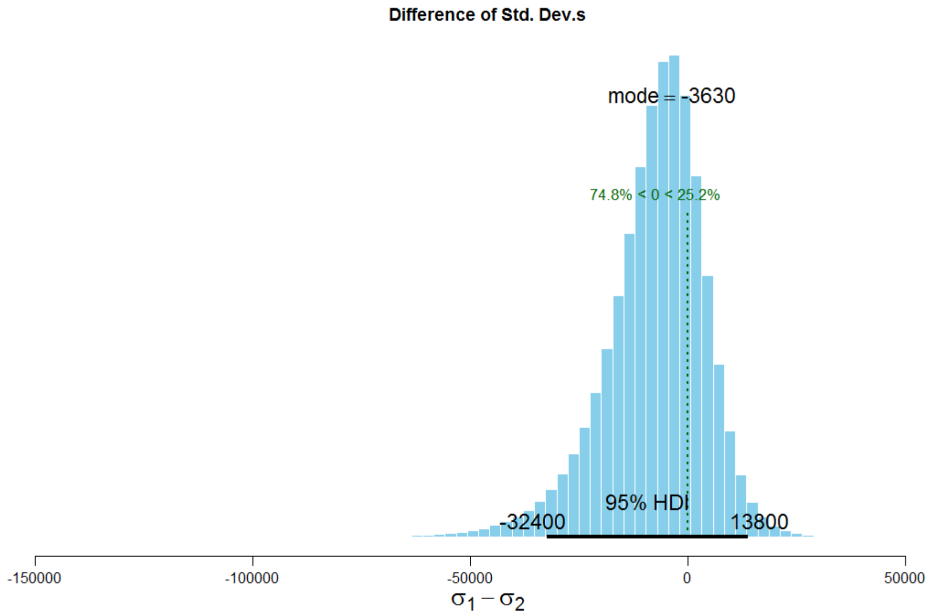

Figure 27: Posterior Distribution of the Difference in Std. Dev. Parameters ($\sigma_1 - \sigma_2$)

Figure 28 shows the distribution of credible effect sizes, given the data. For each credible combination of means and standard deviations, the sample size weighted effect size is computed as:

$$(\mu_1 - \mu_2)/\sqrt{[\sigma_1^2(N_1 - 1) + \sigma_2^2(N_2 - 1)]/(N_1 + N_2 - 2)}$$

The histogram of the 10 million credible effect sizes has mode of -0.292, and a 95% HDI that includes zero. Bayesian estimation can also be used to assess the credibility of a null value. The posterior distribution of the credible parameter values is examined and where the null value falls is observed. Specified in the figure is a **region of practical equivalence (ROPE)**, extending from -0.1 to +0.1 around the null value, which encloses those values of the effect size that are deemed to be negligibly different from the null value for practical purposes. The size of the ROPE depends on the specifics of the application domain. Because an effect size of 0.1 is conventionally deemed to be small, the ROPE on effect size is set from -0.1 to +0.1. When nearly all of the credible values fall within the ROPE, the null value is said to be accepted for practical purposes. When the credible values within 95% HDI falls outside ROPE, the null value is said to be rejected. In this case, such conclusions cannot be reached with certainty because the entire ROPE falls within 95% HDI of the credible values. In general, 95% HDI in all posterior distributions of the estimated parameters is spread over a wide region, which indicates that the estimates are not precise. Large sampling noise due to small sample size contributed to imprecise estimates of the parameters. As the sample size gets larger, the precision of the parameter estimates also increases, because sampling noise tends to cancel out.

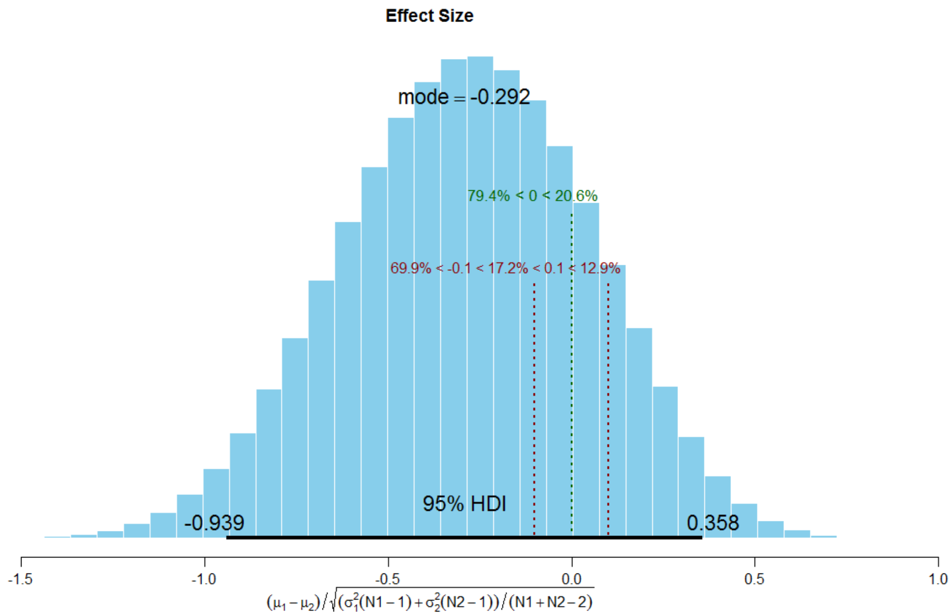

Figure 28: Posterior Distribution of Effect Size

5.32.5 Posterior Predictive Check

The final step of the Bayesian process is to assess whether the model is reasonably good description of the data. Figures 29 and 30 show credible gamma distributions superimposed on histograms of the data. The curves are produced by selecting only 500 random steps in the MCMC chain and at each step plotting the gamma distributions with parameters μ_1 and σ_1 for control group and μ_2 and σ_2 for treatment group data. The plots demonstrate that the credible gamma distributions are reasonably good description of the data. Of course, there are some credible curves that do not follow the distribution of the data. These curves reveal great uncertainty in the estimates and, as mentioned before, can be attributed to both broad prior definitions and very limited information contributed by the data due to large sampling noise. In case of large sample size, information provided by the data tend to overwhelm information provided by the prior distributions.

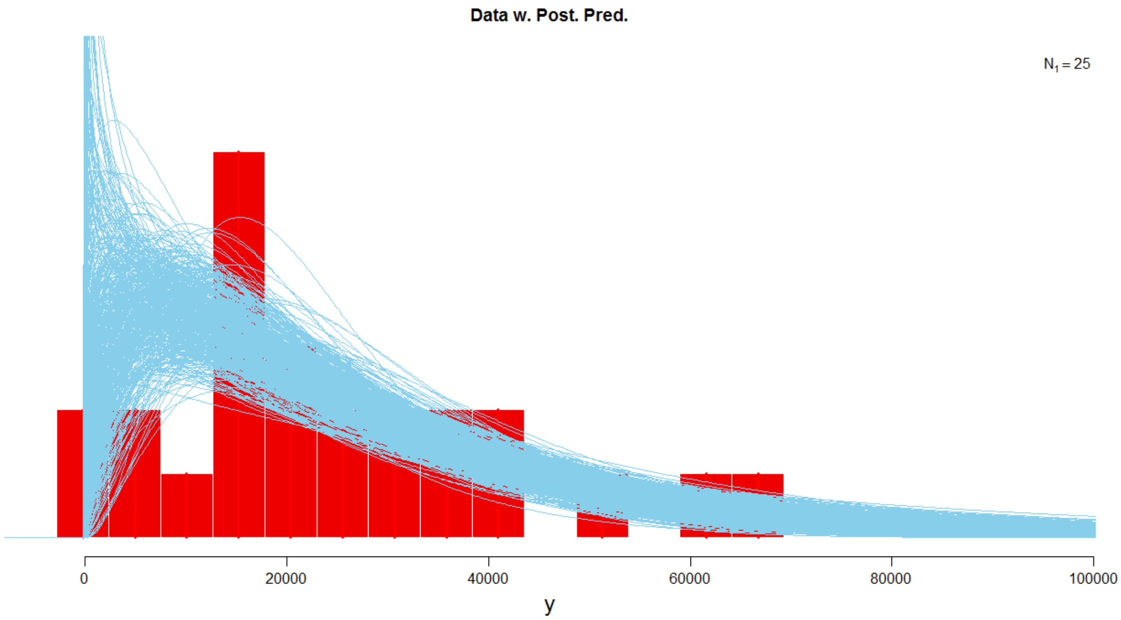

Figure 29: Posterior Predictive Check for Control Group Wage Data

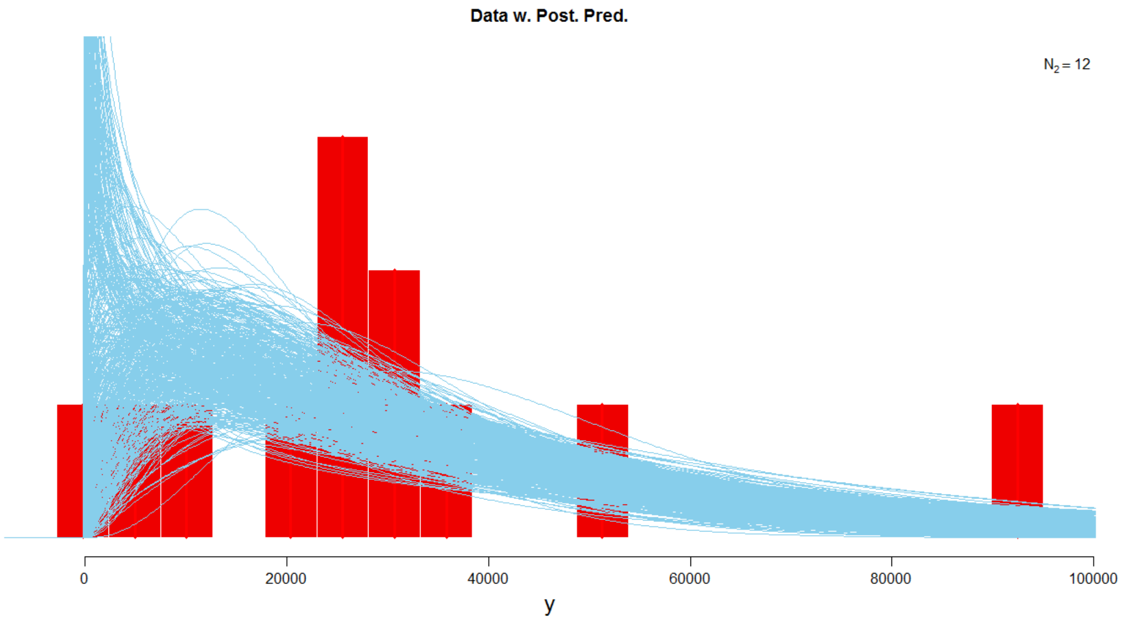

Figure 30: Posterior Predictive Check for Treatment Group Wage Data

5.32.6 Summary of Results

Table 6: Summary of Results from Bayesian Analysis of Unmatched Sample

Parameter	mean ($)	median ($)	mode ($)	HDI High ($)	HDI Low ($)	% gt. zero
mu1	26,580	26,048	24,900	36,000	18,100	-
mu2	32,244	33,045	31,200	51,300	19,500	-
mu2 – mu1	7,664	6,894	5,470	27,500	-10,500	79%
sigma1	23,050	22,135	20,600	34,000	14,000	-
sigma2	30,618	28,489	24,700	51,400	14,700	-
sigma2 – sigma1	7,569	6,162	3,630	32,400	-13,800	75%
effect size	0.292	0.280	0.262	0.939	-0.358	79%

[1]control; [2]treatment

5.32.7 Power Analysis for Bayesian Estimation

One of the goals of this data analysis is to obtain a precise estimate of the descriptive parameters. Success in achieving this goal can be expressed as the width of the 95% HDI being less than some critical maximum. Other goals regard specific parameter values of interest, such as null values. For example, it can be determined whether the 95% HDI falls entirely outside or inside the ROPE and thereby declare the null value to be rejected or accepted. The Bayesian posterior distribution provides complete information to address these goals.

Now, what is the probability of achieving these goals, if the sampled data were generated by hypothetical parameter values? A traditional case of this issue is null hypothesis significance testing (NHST) power analysis. In NHST, the power of an experiment is the probability of rejecting the null hypothesis if the data were generated from a particular specific alternative effect size. In the context of the analysis, a retrospective power analysis was conducted, in which the effect size was estimated from an observed set of data, and then for the sample size was computed that was actually used. In contrast with NHST, which uses a point value for the hypothetical effect size, Bayesian power analysis uses an entire distribution of parameters. Thus, every value of effect size is considered, but only to the extent that it is considered credible.

For Bayesian retrospective power analysis, the distribution of credible parameter values is the posterior distribution from an observed set of values. At every step in the MCMC chain of the posterior, parameter values are simulated to produce new data, then conduct Bayesian analysis on the new data, and then check whether the desired goals are achieved. From many simulations, the proportion of times that each goal is achieved is used to estimate the probability of achieving each goal.

Table 7 shows the results from Bayesian retrospective power analysis for the posterior distributions of the estimated parameters. Three goals are indicated in the table. The power analysis generated simulated data from 3,000,000 steps in the MCMC chain (selected evenly from across the entire chain). The analysis reveals that the power for the first goal, regarding the effect size being greater than the ROPE of (-0.1, 0.1), is 0.4%, with a 95% HDI on the estimate extending from 0.1% to 0.8%. The power for the second goal, regarding the effect size being less than the ROPE of (-0.1, 0.1), is 21.8%, with a 95% HDI on the estimate extending from 19.2% to 24.3%, and the Bayesian power of the third goal, regarding the effect size being within the ROPE of (-0.1, 0.1), is extremely small 0.1%. It is worth noting that these precise power estimates incorporate the full uncertainty of the parameter estimates and are not based on a single hypothetical parameter value as in NHST power analysis. In all three cases, the estimated power is extremely small, which indicates that none of these goals could be achieved, given the data.

Table 7: Bayesian Retrospective Power Analysis for the Posterior Distribution

Goal	Based on 1,000 simulated replications		
	Bayesian Power	95% HDI Lower Bound	95% HDI Upper bound
95% HDI on the effect size greater than ROPE of (-0.1, 0.1)	**0.4%**	**0.1%**	**0.8%**
95% HDI on the effect size less than ROPE of (-0.1, 0.1)	**21.8%**	**19.2%**	**24.3%**
95% HDI on the effect size within ROPE of (-0.1, 0.1)	**0.1%**	**0.0%**	**0.3%**

5.32.8 Conclusion

According to Bayesian estimation procedure, the evaluators conclude that the post-completion mean wage of the treatment group is not credibly different from the post-completion mean wage of the control group, given the data. The analysis also reveals great uncertainty in the parameter estimates due to large sampling noise, which can be attributed to small sample size. As richer wage data become available in the future, re-running the same model on larger dataset could produce more precise estimates.

The evaluators also recommend that in future analysis the control and treatment groups be divided into two sub-groups for comparison purposes: (1) individuals whose highest level of degree is an associate's degree; and (2) individuals who earned some college credits but no degree. The academic profiles of the vast majority of the HIT participants in the control and treatment groups fall into one of the two groups. Small sample size limits the ability to make such distinctions in the present analysis.

5.33 Analysis of Matched Sample

This section presents Bayesian estimation of the difference of mean wage parameters drawing on matched control and treatment group samples. Ten pairs of control and treatment records with post-completion wage data were identified.

Next, the same steps as described above were followed to conduct Bayesian analysis on the matched group wage data (N = 10).

5.33.1 A Descriptive Model for Two Groups

Again, means (μ_1 and μ_2) and standard deviations (σ_1 and σ_2) describe meaningful aspects of the wage data. The difference of the mean parameters ($\mu_1 - \mu_2$) describes the magnitude of the difference between the central tendencies of the groups, and the difference of the standard deviation parameters ($\sigma_1 - \sigma_2$) describes the magnitude of the difference between the variabilities of the groups. Goals are to estimate those magnitudes and assess uncertainty in those estimates. The Bayesian method provides answers to both goals simultaneously.

5.33.2 Bayesian Prior Distribution

This analysis again uses an informative prior for the unknown parameters of interest. Informative priors are those that deliberately insert information that researchers have at hand. In the attempt to make inference about the difference between the mean wages of two groups (control vs. treatment), the following four unknown parameters are used:

1. mean (μ_1) and standard deviation (σ_1) of Group 1 ("Control") wage
2. mean (μ_2) and standard deviation (σ_2) of Group 2 ("Treatment") wage

Deriving Wage Priors from the American Community Survey

The same process as described in section 5.32 was used to derive priors from ACS data. Prior distributions were drawn for the unknown parameters from the American Community Survey's (ACS) 2014 five-year PUMS that provides individual level wage information in the health information technology (HIT) occupation. It is assumed that the majority of the graduates from the PBSC's HIT program are employed in the state of Florida. Hence, a sample of individuals who were employed in the HIT occupation and reported Florida as their place of work was selected.

Figure 31 shows the wage distribution of ACS HIT sample. Income distribution in the population is typically skewed to the right with a long tail because income data often contain outliers. Similar skewed distribution is also observed in the ACS HIT sample. A useful way to accommodate outliers is by describing data with a distribution that has taller tails than the traditional normal distribution. A skewed income distribution like the one observed here is described empirically by a gamma probability density function (*shape parameter* = 3.196; *scale parameter* = 16699)[14] ("blue curve" shown in Figure 31). This gamma density function was adopted to describe the likelihood function of the wage data for the control and treatment groups.

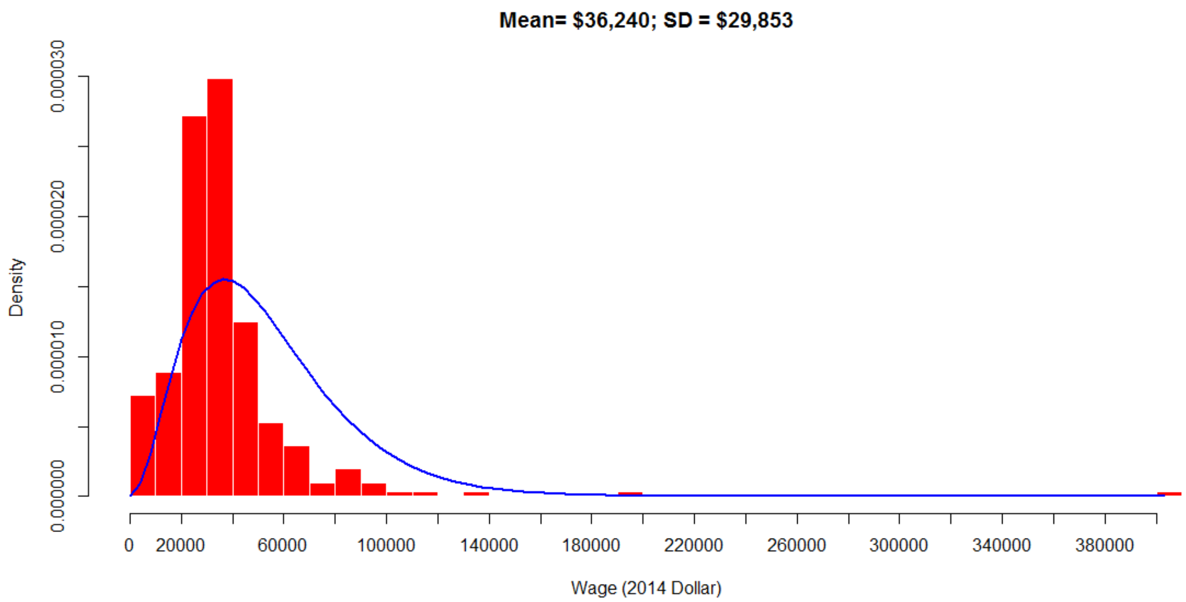

Figure 31: Distribution of Annual Wages in the ACS HIT Sample (Unweighted N = 305) and Fitted Gamma Probability Density Function

Figure 32 demonstrates the model specification adopted here. Same specifications are used for both control and treatment group wage data. Wage data, y_i, are assumed to be generated by a **gamma likelihood function** with shape parameter[15] - *Sh* and rate parameter *R* or scale parameter R^{-1}, which can also be expressed as a function of mean μ and standard deviation σ. To accommodate uncertainty about mean and standard deviation, priors distributions were

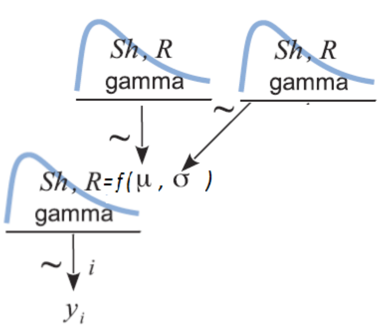

Figure 32: Dependency Diagram for Estimation of *Group Level Parameters*

[14] These parameters are derived from the mode = $36,667 and standard deviation = $29,853 of the distribution.

[15] $Shape, Sh = \frac{\mu^2}{\sigma^2}$ and Rate, $R = \frac{\mu}{\sigma^2}$; *Scale* = R^{-1}

assigned on μ and σ, also described by gamma density functions. The subscript i indicates i^{th} observation in the data vector y. The following paragraphs describe how the parameters for the priors were determined.

In order to construct priors for unknown mean parameters μ_1 and μ_2, the distributions of post-completion annual wage data observed in the treatment (N = 10) and control groups (N = 10) were examined. It appears that average wages of both groups ($\mu_{control}$ = $27,889[16] and $\mu_{treatment}$ = $22,219[17]) are smaller than that in the ACS sample (μ = $36,240). Hence, the prior distributions were adjusted by shifting the modes of the density functions to the left and position them at about where group wage distributions peak, while at the same time impose wider spread (i.e. larger standard deviation) to the distribution drawn from the gamma function fitted to the ACS wage data. This makes the distributions more diffused for the purpose of incorporating uncertainty, as well as ignorance about the unknown mean wage parameters. This specification of an uncertain prior implies that the prior has minimal influence on the estimates of the parameters, and even a modest amount of data will overwhelm the prior assumptions when conducting Bayesian parameter estimation. The process of defining the priors are pictorially presented in Figures 33 and 34.

Figure 33 shows the wage distribution of the control group. Based on the process described above, the prior distribution (shown in dark green) was conducted with a gamma density function (*shape parameter, Sh = 2.338; scale parameter,* R^{-1} *= 19,525*).

Figure 34 shows the wage distribution of treatment group. In this case, the prior distribution (shown in dark green) was constructed with a gamma density function (*shape parameter, Sh = 2.371; scale parameter,* R^{-1} *= 19,387*).

[16] Expressed in 2014 dollars.

[17] Ibid.

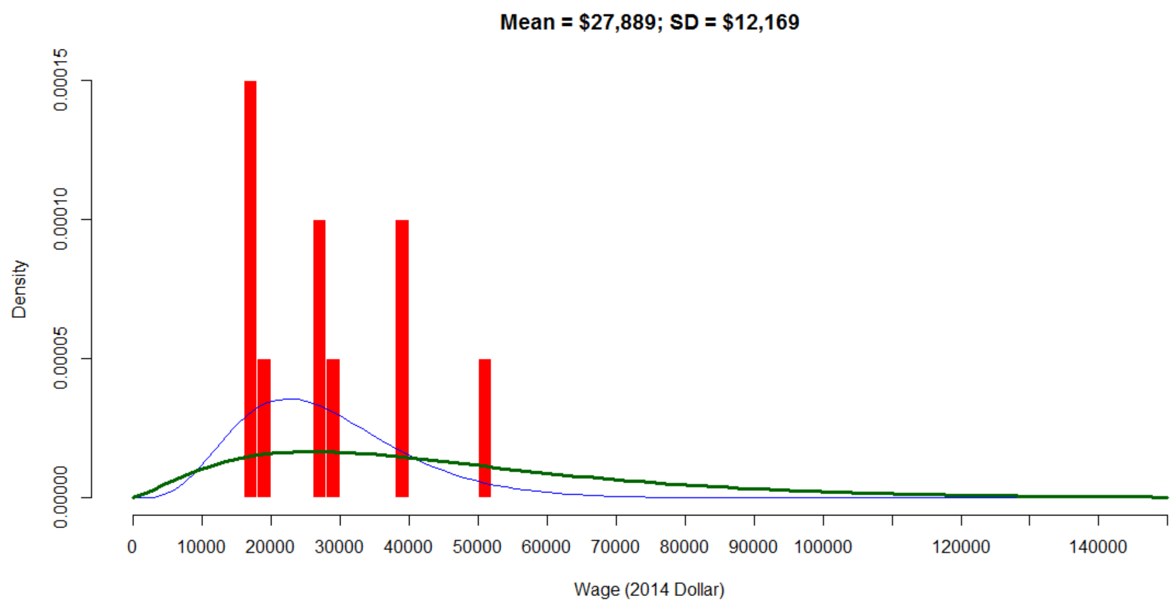

Figure 33: Wage Distribution of the Control Group (N = 10) and Prior Distribution Assigned to the Unknown Parameter μ_1

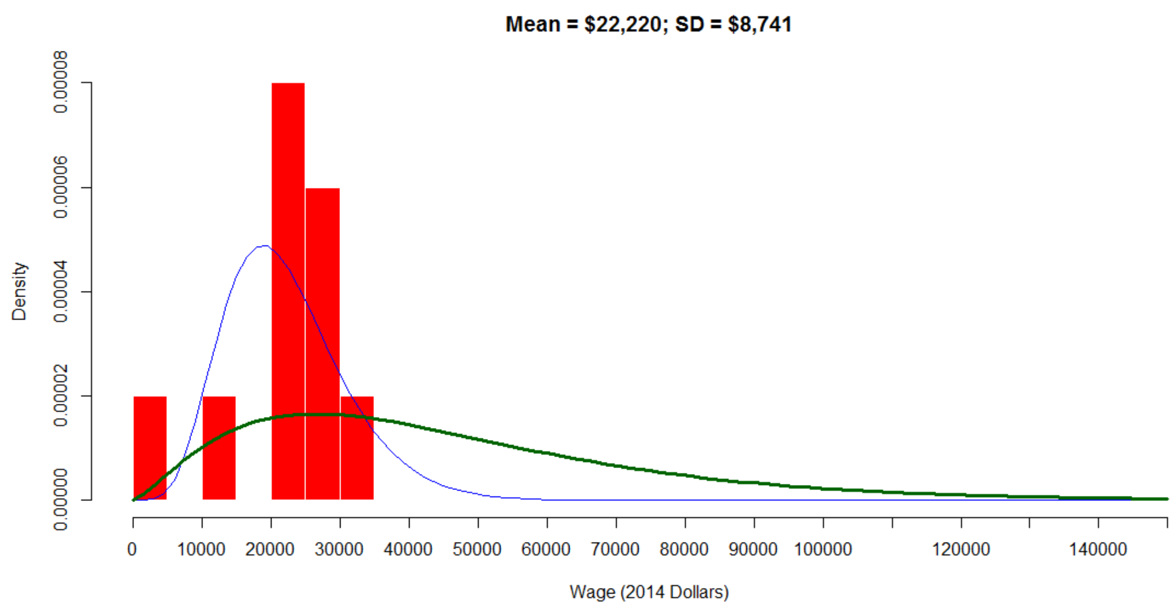

Figure 34: Wage Distribution of the Treatment Group (N = 10) and Prior Distribution Assigned to the Unknown parameter μ_2

Using the same principle described above, prior distributions were assigned for the unknown standard deviation parameters σ_1 and σ_2. Figure 35 shows the gamma distribution (*Sh* = 2.6180; R^{-1} = 18,450) assigned to SD prior for the control group, and Figure 36 shows the gamma distribution (*Sh* = 2.6180; R^{-1} = 18,450) assigned to SD prior for the treatment group. In both cases, the gamma functions peak near the SD estimated from the observed wage data.

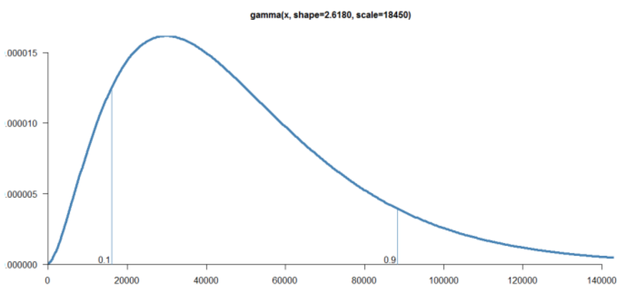

Figure 35: Prior Distribution Assigned to the Unknown Standard Deviation Parameter σ_1

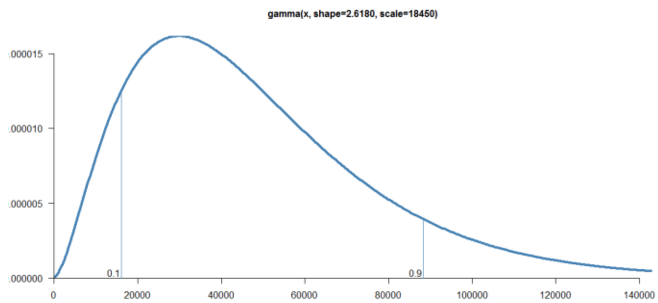

Figure 36: Prior Distribution Assigned to the Unknown Standard Deviation Parameter σ_2

5.33.3 Markov Chain Monte Carlo Diagnostics

Figures 37-40 show various MCMC diagnostics for the parameters estimated. The *trace plots* show that the chains (three chains in this case) are all representative of the posterior distribution as they overlapped each other very well although they started at different initial values. The *density plots* also show that the three chains overlapped almost perfectly for all four parameters (Figures 37-40), which again affirms that in all four cases each chain has drawn representative sample from the posterior distribution. The "shrink factor' or "Gelman-Rubin statistics" — plotted in the lower-left panel indicates that the chains are fully converged as it gets to 1.0.

As observed in all four parameters, the three chains (superimposed in the plot) are highly auto-correlated, insofar as the auto-correlation remain above zero for lags as many as 20. Three chains were run, each with N = 5 million, yielding 15 million steps overall. But the auto-correlation is so high that the ESS in each case is only about 1.5 million. Nevertheless, ESS in the analysis is well above N = 10,000 - the recommended ESS limit for reasonable estimates of the 95% HDI.

The MCSE indicates the estimated SD of the sample mean in the chain, on the scale of the parameter value. The value of estimated MCSE is shown in the lower-right panel in each figure. Its small magnitude suggests that the mean of the posterior appears to be estimated very stably.

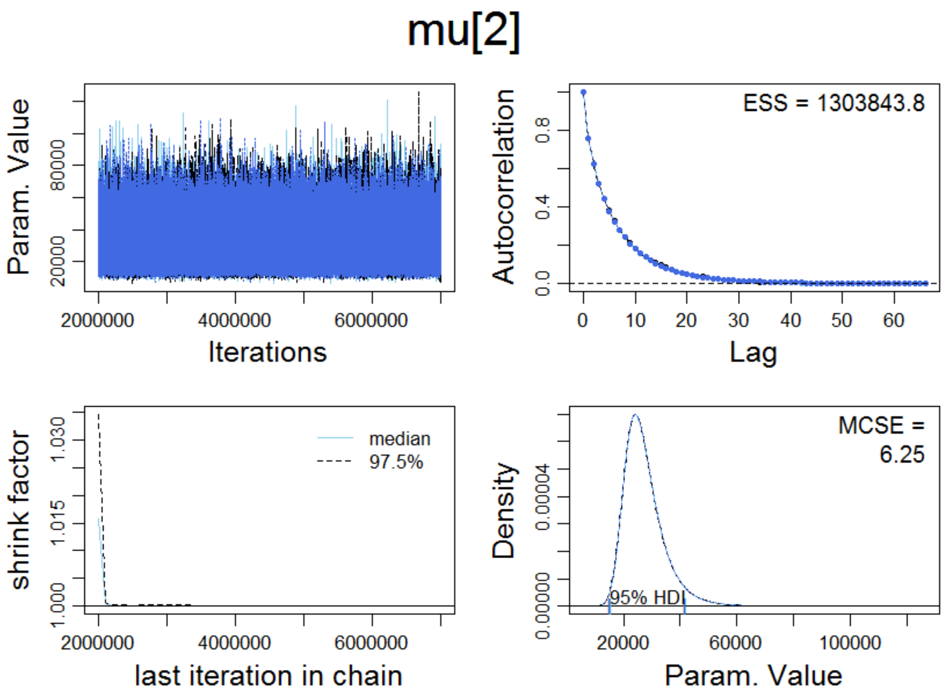

Figure 37: MCMC Diagnostics for Estimated Parameter (μ_1)

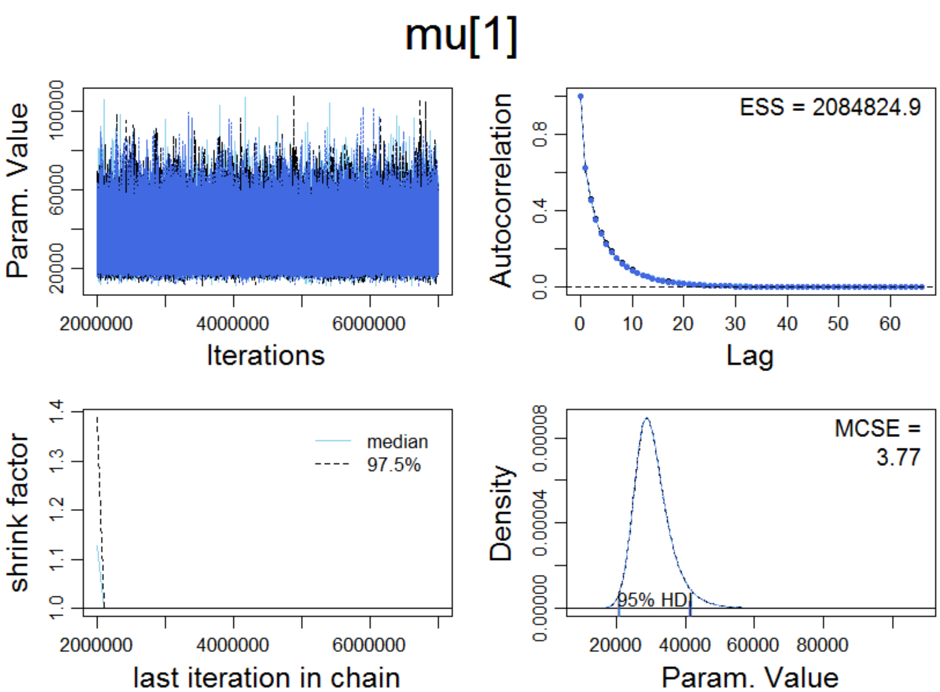

Figure 38: MCMC Diagnostics for Estimated Parameter (μ_2)

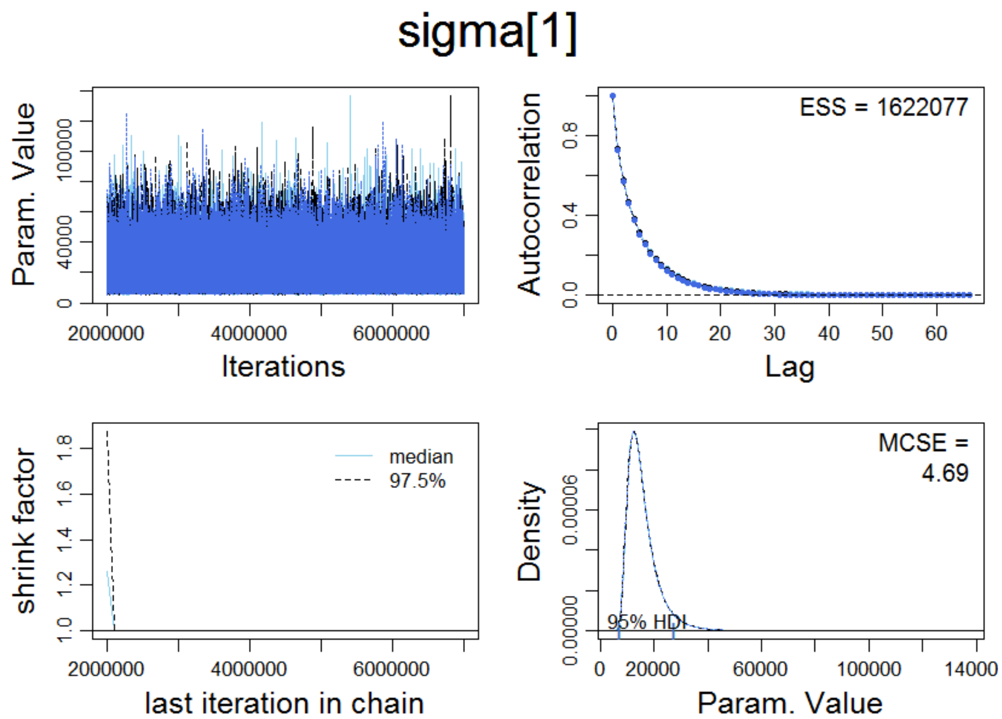

Figure 39: MCMC Diagnostics for Estimated Parameter (σ_1)

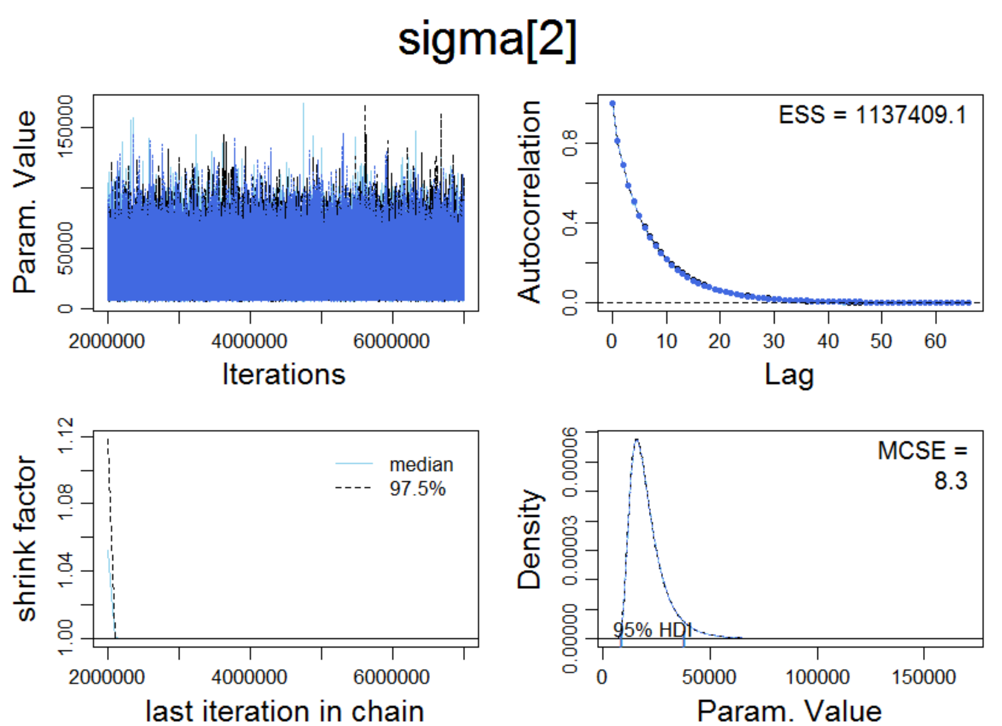

Figure 40: MCMC Diagnostics for Estimated Parameter (σ_2)

5.33.4 Bayesian Estimation Results

Figures 41-47 show histograms of 15 million credible parameter-value combinations. The histograms display 15 million parameter values from the posterior distributions, given the single set of actual data. Each histogram is annotated with its central tendency – mode and marked with its 95% **highest density interval (HDI).**

Figure 41 shows that the mode of the credible values of control group's mean wage parameter μ_1 is $28,900,[18] with a 95% HDI from $21,200 to $41,700, and Figure 42 shows that the mode of the MCMC chain for treatment group's mean wage parameter μ_2 is $24,100, with a 95% HDI from $15,400 to $41,700.

The mode of the difference ($\mu_1 - \mu_2$) **is** $4,420, as displayed in Figure 43. 95% HDI of the difference of mean includes zero, and 68.7% of the credible values are greater than zero, meaning that there is 31.3% probability that the mean wage of the treatment group is higher than the mean wage of the control group. Although the observed mean wage of the control groups seems to be larger than the treatment group, the posterior distribution reveals great uncertainty in the estimate of the difference of means.

Therefore, the conclusion is that the group means are NOT credibly different, given the data.

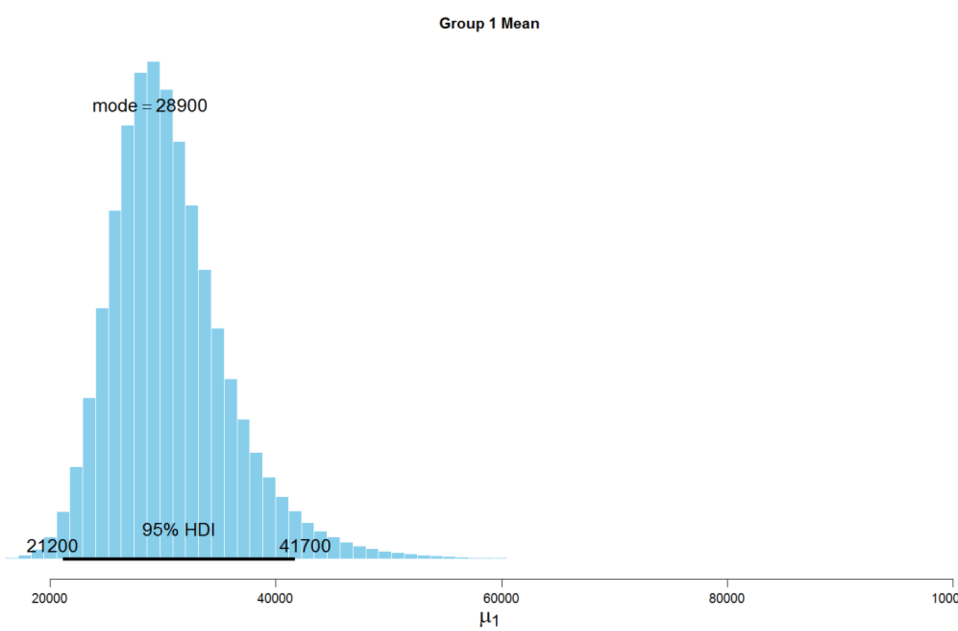

Figure 41: Posterior Distribution of Control Group Mean Wage Parameter (μ_1)

[18] This and all subsequent dollar figures are expressed in 2014 dollars.

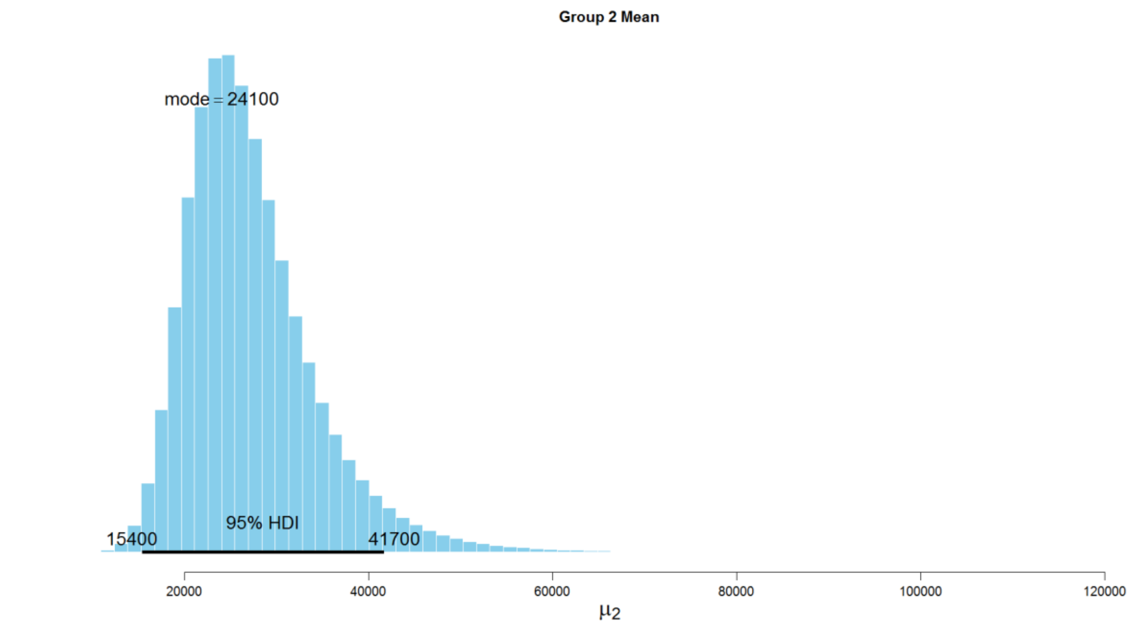

Figure 42: Posterior Distribution of Control Group Mean Wage Parameter (μ_2)

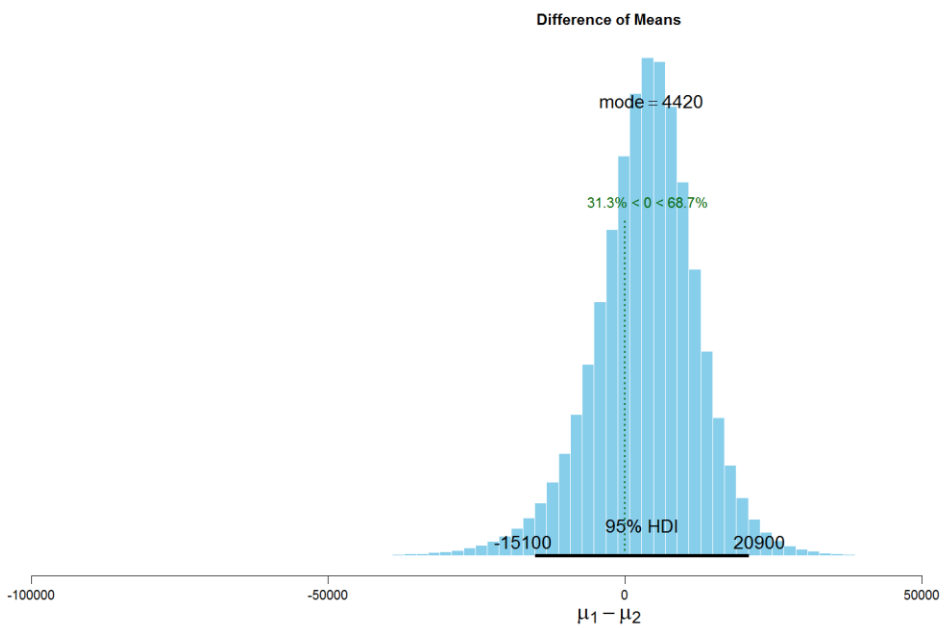

Figure 43: Posterior Distribution of the Difference in Mean Wage Parameters ($\mu_1 - \mu_2$)

Figures 44 and 45 show histograms of credible values of the standard deviations for the control and treatment groups respectively. The difference of the standard deviations is shown in Figure 46, where the difference of zero is among the 95% most credible differences. **Hence,**

the conclusion is that the standard deviations of the wage distributions of the two groups are not credibly different.

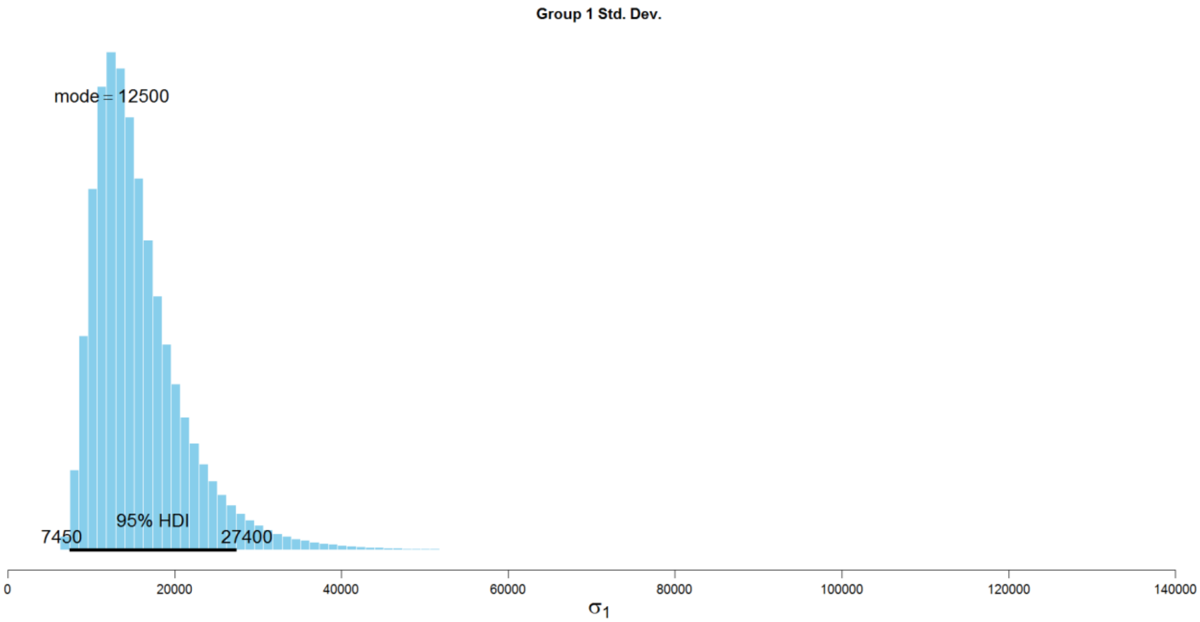

Figure 44: Posterior Distribution of Control Group Std. Dev. Parameter (σ_1)

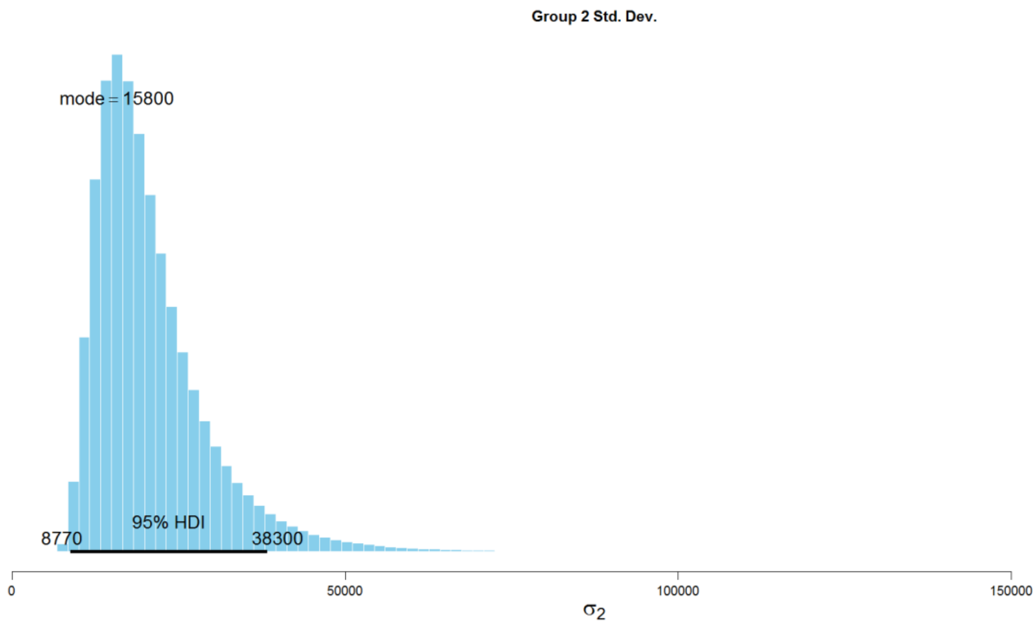

Figure 45: Posterior Distribution of Control Group Std. Dev. Parameter (σ_2)

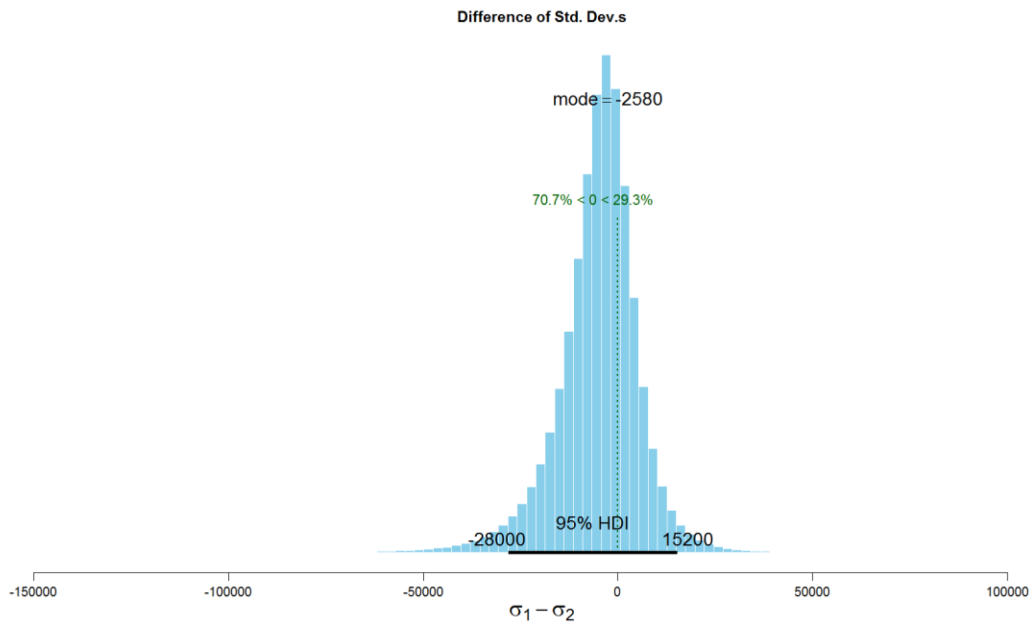

Figure 46: Posterior Distribution of the Difference in Std. Dev. Parameters ($\sigma_1 - \sigma_2$)

Figure 47 shows the distribution of credible effect sizes, given the data. For each credible combination of means and standard deviations, the sample size weighted effect size is computed as:

$$(\mu_1 - \mu_2)/\sqrt{[\sigma_1^2(N_1 - 1) + \sigma_2^2(N_2 - 1)]/(N_1 + N_2 - 2)}$$

The histogram of the 15 million credible effect sizes has mode of 0.236, and a 95% HDI that includes zero. Bayesian estimation can also be used to assess the credibility of a null value by simply examining the posterior distribution of the credible parameter values and seeing where the null value falls. Specified in the figure is a **region of practical equivalence (ROPE)**, extending from -0.1 to +0.1 around the null value, which encloses those values of the effect size that are deemed to be negligibly different from the null value for practical purposes. The size of the ROPE depends on the specifics of the application domain. Because an effect size of 0.1 is conventionally deemed to be small, the ROPE size is set from -0.1 to +0.1. When nearly all of the credible values fall within the ROPE, the null value is said to be accepted for practical purposes. When the credible values within 95% HDI falls outside ROPE, the null value is said to be rejected. In this case, such conclusions cannot be reached with certainty because the entire ROPE falls within 95% HDI of the credible values. In general, 95% HDI in all posterior distributions of the estimated parameters is spread over a wide region, which indicates that the estimates are not precise. Large sampling noise due to small sample size contributed to imprecise estimates of the parameters. As the sample size gets larger, the precision of the parameter estimates also increases, because sampling noise tends to cancel out.

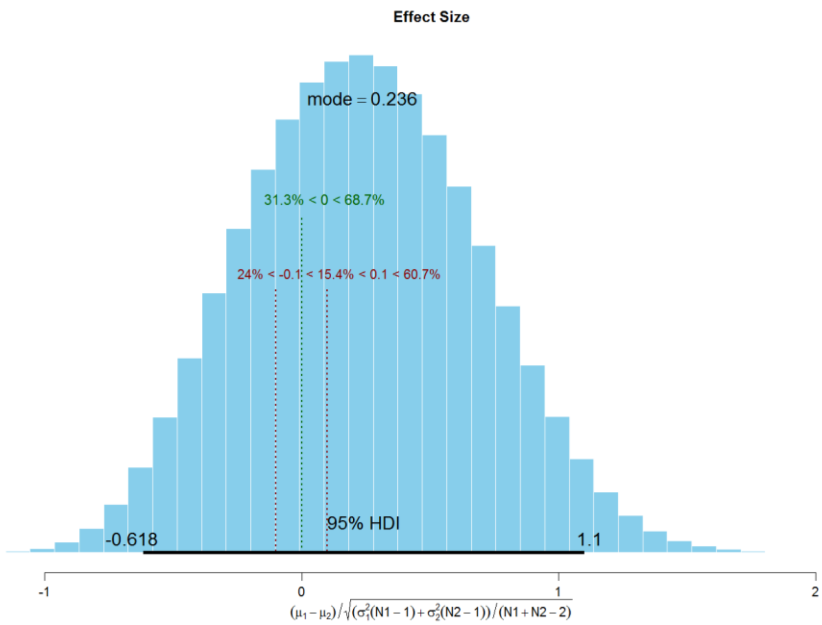

Figure 47: Posterior Distribution of Effect Size

5.33.5 Posterior Predictive Check

The final step of the Bayesian process is to assess whether the model is a reasonably good description of the data. Figures 48 and 49 show credible gamma distributions superimposed on histograms of the data. The curves are produced by selecting only 500 random steps in the MCMC chain and at each step plotting the gamma distributions with parameters $\boldsymbol{\mu_1}$ and $\boldsymbol{\sigma_1}$ for control group and $\boldsymbol{\mu_2}$ and $\boldsymbol{\sigma_2}$ for treatment group data. From the plots, the credible gamma distributions are a reasonably good description of the data. Of course, there are some credible curves that do not follow the distribution of the data. These curves reveal great uncertainty in the estimates and, as mentioned before, can be attributed to both broad prior definitions and very limited information contributed by the data due to large sampling noise. In case of large sample size, information provided by the data tend to overwhelm information provided by the prior distributions.

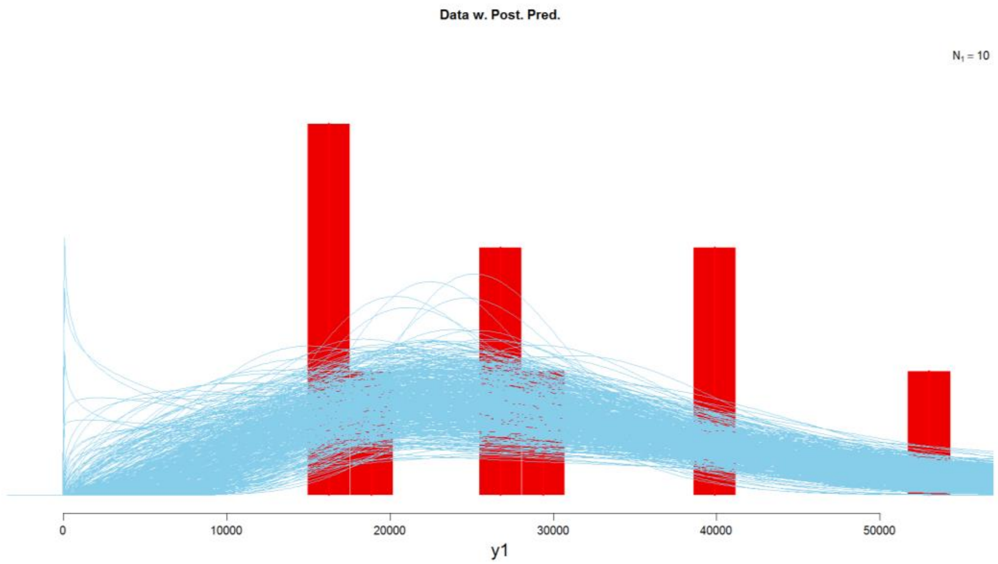

Figure 48: Posterior Predictive Check for Control Group Wage Data

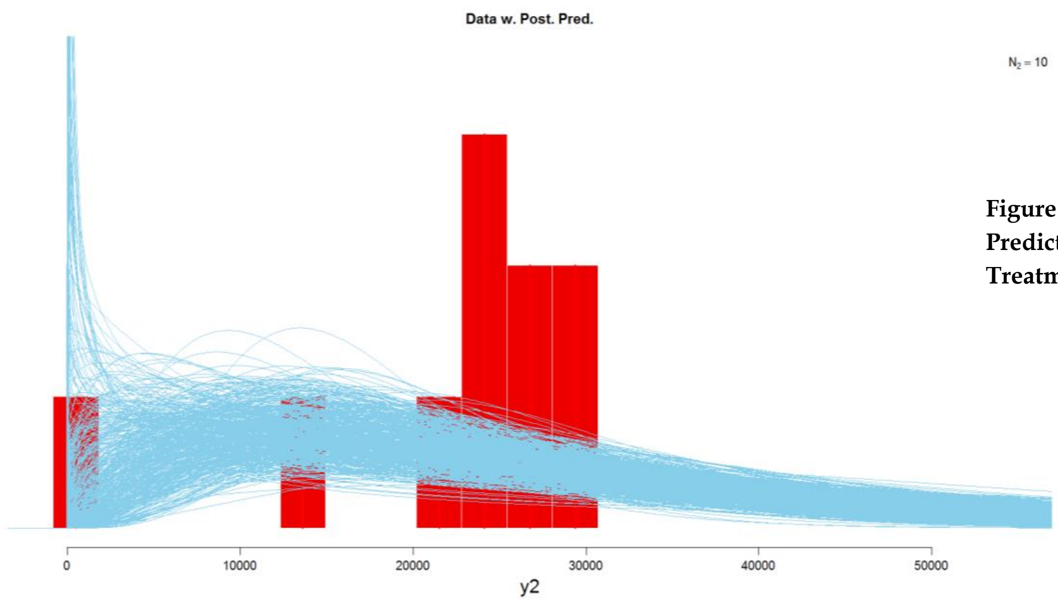

Figure 49: Posterior Predictive Check for Treatment Group Wage Data

5.33.6 Summary of Results

Table 8: Summary of Results from Bayesian Analysis of Matched Sample

Parameter	mean ($)	median ($)	mode ($)	HDI High ($)	HDI Low ($)	% gt. zero
mu1	30,689	29,930	28,873	41,693	21,155	-
mu2	27,266	26,036	24,080	41,686	15,441	-
mu1 – mu2	3,423	3,895	4,423	20,886	-15,091	69%
sigma1	15,811	14,439	12,470	27,407	7,451	-
sigma2	20,907	18,784	15,775	38,339	8,769	-
sigma1 – sigma2	-5,096	-4,119	-2,579	15,203	-28,017	29%
effect size	0.236	0.228	0.236	1.099	-0.618	69%

[1]control; [2]treatment

5.33.7 Power Analysis for Bayesian Estimation

Table 8 shows the results from Bayesian retrospective power analysis for the posterior distributions of the estimated parameters. Three goals are indicated in the table. The power analysis generated simulated data from 3,000,000 steps in the MCMC chain (selected evenly from across the entire chain). The analysis reveals that the power for the first goal, regarding the effect size being greater than the ROPE of (-0.1, 0.1), is 9.6%, with a 95% HDI on the estimate extending from 11.4% to 7.8%. The power for the second goal, regarding the effect size being less than the ROPE of (-0.1, 0.1), is 5.3%, with a 95% HDI on the estimate extending from 6.7% to 3.9%, and the Bayesian power of the third goal, regarding the effect size being within the ROPE of (-0.1, 0.1), is extremely small – 0.1%. It is worth noting that these precise power estimates incorporate the full uncertainty of the parameter estimates and are not based on a single hypothetical parameter value as in NHST power analysis. In all three cases, the estimated power is extremely small, which indicates that none of these goals could be achieved, given the data.

Table 9: Bayesian Retrospective Power Analysis for the Posterior Distribution

Goal	Based on 1,000 simulated replications		
	Bayesian Power	95% HDI Lower Bound	95% HDI Upper bound
95% HDI on the effect size greater than ROPE of (-0.1, 0.1)	9.6%	7.8%	11.4%
95% HDI on the effect size less than ROPE of (-0.1, 0.1)	5.3%	3.9%	6.7%
95% HDI on the effect size within ROPE of (-0.1, 0.1)	0.1%	0.0%	0.3%

5.33.8 Conclusion

According to Bayesian estimation procedure, the **mean wage of the treatment group is not credibly different from the mean wage of the control group, given the data**. The analysis also reveals great uncertainty in the parameter estimates due to large sampling noise, which can be attributed to small sample size. As richer wage data become available in the future, re-running the same model on larger dataset could produce more precise estimates.

Note that while observed wage data based on matched and unmatched samples lead to different conclusions about the difference in mean wages between the treatment and control groups, Bayesian analysis accounted for uncertainty in the data and came to the same conclusion in both cases.

6.0 References

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