SSRG International Journal of Humanities and Social Science
ISSN: 2394-2703/ https://doi.org/10.14445/23942703/IJHSS-V12I2P108

Volume 12 Issue 2, 72-83, Mar-Apr 2025

Original Article

Reconsidering University Economic Impact: Evidence from Propensity Score Matching Analysis in Rural Bangladesh

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Received: 20 February 2025 Revised: 30 March 2025 Accepted: 18 April 2025 Published: 30 April 2025

Abstract *- Universities are increasingly recognized as economic catalysts in rural areas, contributing to employment, technological innovation, and local development. Despite its importance, little empirical data exists about the financial benefits of universities, especially at the household level in rural Bangladesh. With an emphasis on factors like income, spending, borrowing, and saving, this study attempts to investigate the socioeconomic effects of Hajee Mohammad Danesh Science and Technology University (HSTU) on surrounding households. The goal is to offer data-driven insights into how a university's presence changes the local economy. In August 2017, 303 families were surveyed for the study. Propensity Score Matching (PSM) was used to compare households in the treatment group-those within 5 kilometres of HSTU-with those in the control group, those from more remote areas. Monthly expenses, savings, agricultural income, fixed income, and total annual income were among the key outcome variables that were measured. Techniques like kernel matching, nearest neighbour matching, and balance checks were used to ensure reliable results. The findings indicate that households located near the university incur significantly lower monthly expenses, ranging from 2,035 to 3,118 BDT ($p < 0.05$), and experience reduced loan amounts averaging 63,511 BDT ($p = 0.034$). However, the analysis also uncovers that their annual fixed income is considerably lower, approximately 7,600 BDT ($p < 0.05$), suggesting a tendency towards informal employment options. Moreover, there were no statistically significant variations in annual income, savings, or agricultural output. Being close to HSTU clearly impacts economic behaviours; fixed incomes are negatively impacted while expenses are reduced. This shows that specific policies that can strengthen the beneficial economic effects of universities in rural areas are desperately needed. To optimize these advantages, recommendations include enhancing community involvement and offering easily accessible educational initiatives.*

Keywords *- University economic impact, Rural Bangladesh, Propensity score matching, Household economics, Regional development.*

1. Introduction

Higher education institutions play a crucial role in shaping the economic landscapes of the regions they serve. Historically, universities have been regarded as providers of knowledge and developers of human capital, primarily focusing on education and research. However, their influence on local economies-especially in rural and semi-urban areas-has garnered increasing attention in recent years (Pedagogue, 2024). These institutions are not just educational centres but can function as economic catalysts by fostering employment, supporting innovation, and stimulating local industries (Becker, 1994; Goldstein & Drucker, 2006). The impact of universities on regional development is especially crucial in developing nations, as they can drive economic growth and create opportunities for social advancement (Chatterton & Goddard, 2000). In Bangladesh, where approximately 63% of the population lives in rural areas, establishing universities in these communities is vital (World Bank, 2023). Hajee Mohammad Danesh Science and Technology University (HSTU), founded in 1999 in Dinajpur district, is a case study of how higher education institutions can impact rural economies. Even though the economic contributions of universities are becoming more widely recognized, most research has concentrated on urban institutions in wealthier nations, largely ignoring rural areas in developing countries like Bangladesh. Policymakers and educators who aim to use universities as catalysts for rural development but lack precise knowledge of their effects face great difficulty due to this evidence gap. Although the economic impact of urban universities has been extensively studied (Bloom, 2004), little

is known about the economic implications for rural areas (Guerrero et al., 2015). To better understand how (HSTU) can affect local economic conditions beyond their educational roles, the study will assess the socioeconomic impact of the institution on nearby households. The increasing concentration of higher education institutions in rural areas, particularly in developing countries like Bangladesh, calls for deeper investigation into the broader socioeconomic effects of universities.

Universities in rural regions have been recognized for their potential to drive innovation, create jobs, and support local industries (Urbano & Guerrero, 2013). In rural Bangladesh, little research has been done on how local universities affect household economic factors like income, spending, borrowing, and savings. Our study attempts to close this important research gap. However, limited empirical research quantifies these effects, especially in Bangladesh. As economic challenges in rural areas persist, there is a need for targeted strategies that leverage higher education institutions as tools for regional economic development. Recent findings by Alam and Kaneko (2019) and others underscore the importance of understanding these dynamics to inform regional development policies better. This study is timely and significant as it aims to address the gap in the literature on the rural economic impact of universities in Bangladesh.

Existing studies on the economic impact of universities have primarily focused on high-income countries and urban areas, leaving a significant gap in understanding their role in rural contexts, particularly in developing countries like Bangladesh (Bloom, 2004). While some research touches on the benefits of university proximity, such as employment generation and technological innovation, the detailed mechanisms through which universities influence local economies remain insufficiently explored (Guerrero et al., 2015). Furthermore, studies often overlook how universities in rural regions affect household-level economic outcomes, such as income, expenditure, savings, and borrowing behaviour. This study seeks to fill this gap by investigating the socioeconomic impacts of HSTU on households in rural Bangladesh, offering a comprehensive view of how university proximity alters local economic structures.

This study explores the economic impact of Hajee Mohammad Danesh Science and Technology University (HSTU) on adjacent households in rural Bangladesh. This study explores how being close to a university can affect the local economy, looking at various factors such as income, spending, savings, and borrowing habits. By doing so, the research aims to measure the economic effects of university proximity and offer practical, evidence-based recommendations to boost the positive economic impact of higher education institutions in rural areas. The study is focused on three main objectives:

Measuring the Economic Impact: It seeks to understand how HSTU affects nearby households' borrowing, saving, spending, and income patterns.

Determining Influential Mechanisms: Determining the effects of proximity to a university on local economic conditions is another study objective. Finally, to develop evidence-based policy recommendations for maximizing the positive economic spillovers of higher education institutions in rural areas. This study contributes to the field of higher education and economic development by offering new insights into the role of universities in rural economies, particularly in developing countries like Bangladesh.

The findings of this study have important implications for policymakers, university leaders, and development experts looking to harness the potential of universities for regional economic growth. By shedding light on the specific economic impacts of HSTU, this research provides a foundation for developing strategies to maximize the benefits that higher education institutions can bring to rural communities. Moreover, the study adds to the growing body of research on university-community relationships, offering valuable insights for future research and policy-making (Koekkoek, Ham, & Kleinhans, 2021). The research provides a clear picture of the university's local impact, focusing on the socioeconomic effects of HSTU on households within a 5-kilometre radius of the university and comparing them with those from rural areas farther away. Propensity Score Matching (PSM) is used in the study to separate the causal effect of university proximity and account for potential confounders. The study is focused exclusively on the HSTU case, offering valuable insights into the economic impact of universities in rural Bangladesh.

However, its findings may not apply to other universities or regions within Bangladesh or developing countries. Furthermore, since the study relies on cross-sectional survey data, this may restrict the ability to conclude long-term effects. The benefits of universities for regional employment and innovation have been highlighted by earlier studies conducted in developed nations and urban areas (e.g., Goldstein & Drucker, 2006; Valero & Van Reenen, 2019). This research takes a unique approach by examining the everyday effects of the economy, whereas many studies usually rely on more general economic or institutional data. It focuses on household income, borrowing patterns, savings, and spending. This study sheds light on the impact of living close to a university on the financial circumstances of people in rural Bangladesh. It offers insightful information about how this relationship is affected. Additionally, although studies like Guerrero et al. (2015) and Urbano & Guerrero (2013) have looked at university-community relationships in urban or industrialized settings, they frequently ignore the precise mechanisms of influence, especially the shift to informal employment and the decreased dependence on formal loans that this study

highlights. By making borrowing and fixed income patterns important outcomes and highlighting financial decisions beyond simple income and expense measurements, this study brings a fresh viewpoint to the discussion. This is the first study to identify and measure the causal relationship between a rural university in Bangladesh and the economic indicators of surrounding households using propensity score matching techniques. This study adds to and expands the body of knowledge on university-driven regional development by examining the existence and type of economic changes the university brings. This paper begins with an introduction, then with the literature review, followed by an explanation of the methodology used to collect and analyze the data. The results section will present the Propensity Score Matching analysis findings, followed by a discussion of these findings about prior research. Finally, the paper concludes with policy recommendations based on the study's findings.

2. Literature Review

Universities have long played a significant role in regional development; more and more studies show how they can spur innovation, increase local spending, improve social outcomes, and create jobs. However, since a large portion of this research focuses on universities in developed cities, it raises a crucial question: how applicable are these findings to universities in rural areas of developing nations like Bangladesh? Significant scholarly research on the economic effects of higher education institutions is compiled in this study, which also identifies important areas that need more investigation, especially household-level and rural analyses. It is structured around four major themes: first, how universities contribute to the creation of jobs in the region; second, how universities serve as centres for innovation and knowledge sharing; third, how these factors influence household economic behaviour; and fourth, the empirical approaches taken and the methodological gaps that still exist. With an emphasis on universities in rural areas, this literature review gives a broad overview of the body of knowledge regarding the economic effects of higher education institutions.

The review summarizes important research on the different economic impacts of universities on the communities in which they are located, such as the creation of jobs, the transfer of knowledge, and local economic growth. The review identifies critical trends, gaps, and areas for further investigation in rural Bangladesh by examining these studies. The purpose of this review is to explore the relationship between universities and local economic growth, providing a foundation for understanding the specific impacts of Hajee Mohammad Danesh Science and Technology University (HSTU) on the rural economy in Bangladesh. The economic role of universities has evolved significantly over the last few decades. In the early 20th century, universities were considered academic pursuits and intellectual development centres. However, as global economies shifted towards knowledge-based industries, universities began to be recognized as vital contributors to economic growth and regional development. The first significant studies on the economic impact of universities were conducted in the 1980s, with research primarily focused on high-income countries (Becker, 1994). Over time, this research expanded to consider the role of universities in urban areas and, more recently, in rural and developing country contexts. In the case of developing countries, the role of universities has become more pronounced, especially in rural regions where universities are seen as drivers of economic growth by contributing to employment, technology transfer, and the development of human capital (Bloom, 2004). However, studies specifically addressing the economic impacts of universities in rural Bangladesh remain sparse, with the need for more empirical work to evaluate their local effects (Guerrero et al., 2015). One of the key themes in the literature on university economic impact is job creation. Universities have long been recognized for generating local communities' direct and indirect employment opportunities. Studies have consistently shown that universities contribute to job creation not only through direct employment on campus but also through creating businesses, services, and industries around the university.

According to research by Koekkoek et al. (2021), the local economy may see a sharp decline in employment if there were no university, with estimates indicating up to 3,375 fewer jobs. This research emphasizes how important universities are to the health of regional labour markets. Huggins & Cooke (1997) reported that Cardiff University was responsible for generating a gross local output of approximately £100 million per year and sustaining over 3,000 jobs in the surrounding community. These studies underscore the importance of universities as major employers and sources of job opportunities in rural areas. Universities are often regarded as hubs of knowledge creation, and their role in research and development is another key aspect of their economic impact. Research (Garrido-Yserte & Gallo-Rivera, 2010) highlights the dual impact of universities on local economies: through the direct creation of new knowledge and the development of innovative technologies that are transferred to local industries. Knowledge transfer is essential in universities located in developing countries.

These organizations can contribute substantially to closing the technological gap by sharing their knowledge with nearby companies and sectors. Urbano and Guerrero (2013) investigate how entrepreneurial universities can promote technology transfer and innovation. They draw attention to how universities can help local businesses by providing research expertise and facilitating the establishment of innovation hubs. This support is critical in rural areas where access to cutting-edge technologies and research resources may be restricted. However, universities' benefits go beyond job creation and knowledge sharing. In rural regions, universities also drive local economic growth by making

education more accessible, boosting human capital, and preparing a skilled workforce to meet the needs of the local job market. This creates a ripple effect that helps strengthen the entire community. According to Valero & Van Reenen (2019), universities have a broader societal impact that includes enhancing the local quality of life and contributing to social cohesion. Findler et al. (2019) explore how universities contribute to sustainable development, particularly through community engagement initiatives and promoting environmentally sustainable practices. Through their research and outreach activities, universities play a crucial role in addressing local challenges, such as environmental degradation and public health, which are especially prevalent in rural regions. A significant theme in the literature is the impact of university proximity on household economic behaviour. Studies have shown that households living near universities often experience changes in their economic behaviours, particularly regarding income, expenditure, and borrowing patterns.

For example, proximity to a university can lead to increased income opportunities through new job markets while also altering household expenditure patterns due to the availability of goods and services associated with the university. Research by Rosenbaum & Rubin (1983) on propensity score matching (PSM) suggests that using this methodology allows for a more accurate assessment of the causal effects of university proximity on local economies, especially when studying the impact on household-level variables such as income, savings, and borrowing. In the context of Bangladesh, where many rural households struggle with financial stability, understanding the economic impact of universities on household-level decisions is crucial for developing targeted policies to maximize the benefits of university proximity. Most studies on the economic impact of universities use a combination of qualitative and quantitative methodologies. Economic impact studies typically rely on input-output models to estimate universities' direct and indirect effects on local economies, as seen in studies by Huggins & Cooke (1997) and Armstrong (1993).

These models allow researchers to quantify the gross output generated by universities and the associated job creation. One of the most common methodologies used to control for potential biases in observational studies is Propensity Score Matching (PSM), which has been successfully employed in numerous studies to assess the causal effects of university proximity on local economic outcomes (Rosenbaum & Rubin, 1983). PSM allows researchers to create matched pairs of university-adjacent and non-adjacent households, enabling a more accurate comparison of economic outcomes. Despite a wealth of studies on the economic impact of universities, there are significant gaps in the literature, particularly in developing countries like Bangladesh. While studies have focused on the economic impacts of universities in urban settings, there is limited research on the specific effects of rural universities on surrounding communities. Furthermore, while many studies examine the direct economic effects of universities, fewer investigate the long-term impacts on local economic structures and household-level behaviours. There is also a lack of research on how universities influence local economies in rural regions. The literature reviewed supports the theory of universities as engines of economic growth and development, contributing to local and national economies through job creation, knowledge transfer, and community engagement. The findings from studies such as those by Guerrero et al. (2015) and Goldstein & Drucker (2006) suggest that universities are essential players in the economic development of both urban and rural regions. However, some studies, like the one by Mbah (2019), question the assumption that universities always bring positive economic outcomes. They contend that the advantages are not guaranteed and rely on the extent to which colleges interact with their communities and the availability of additional resources.

This literature review shows recurring patterns in the economic impact of universities, especially in knowledge transfer, job creation, and community involvement. However, there is a need for further exploration of the specific effects of universities in rural areas, especially in developing countries like Bangladesh. This gap in the literature justifies the current study, which seeks to investigate the socioeconomic impact of Hajee Mohammad Danesh Science and Technology University (HSTU) on local households in rural Bangladesh.

By focusing on the mechanisms through which universities influence local economies, this study aims to build upon the existing literature and contribute to a more nuanced understanding of the role of higher education institutions in rural development.

3. Data and Methodology

The first crucial methodological issue was to define the catchment area. The university's area is 85 acres (.344km²). The study has taken Chehelgazi Union as the treatment village (where the university is located) and Auliapur Union (8.5 km south of Dinajpur) as the Control village. These two unions are the most densely populated and are approximately the same distance from Dinajpur Municipality (Bangladesh National Portal, 2024).

Table 1. Basic demographic information of the two Union parishad

Region of Intervention	Chehel Gazi Union	Auliapur Union
Area	9109 acres	8313 acres
Total Households	9912	11225
Population	43697	46925
Population Density (sq. km)	1185	1395

Source: Bangladesh Population and Housing Census 2011; Community Report Dinajpur

A primary survey was carried out in both unions. In August 2017, 303 households were surveyed. Even though the data is from 2017, it is still beneficial today. Since socioeconomic conditions in rural areas typically change gradually, this data is a good place to start when understanding long-term trends. The robust methodology of the study further guarantees the continued relevance of the conclusions derived from this data. Both household and individual-level data were carefully gathered across the two unions involved in the study.170 households in Chehelgazi and 133 households from Auliapur union were selected. Systematic sampling was used to select villages in the study area. Out of 33 villages, 17 were chosen. Only odd-numbered villages were selected in the village list of the Dinajpur community report by the Bangladesh Bureau of Statistics. The same method was followed in the Auliapur union. In Auliapur, out of 27 villages, 14 were chosen by systematic samplings. Then, the households were selected using simple random sampling. This study employed the Propensity Score Matching method to analyze the potential difference between the two areas.

3.1. Propensity Score Matching (PSM) Analysis

To assess the impact of Hajee Mohammad Danesh Science and Technology University (HSTU) on households in the locality where the university is located, we employ Propensity Score Matching (PSM). This quasi-experimental method reduces selection bias by comparing treated and control groups with similar characteristics (Rosenbaum & Rubin, 1983a). The treatment group comprises households near HSTU, while the control group comprises households from other areas. The key outcome variables include monthly expenses, savings, agricultural income, fixed income, and total yearly incomeThe treatment variable is defined as 1 if household i is located near HSTU (treated group) and 0 if household i is located elsewhere (control group). Households near HSTU are assumed to be directly influenced by the university's presence, while households in other areas serve as the counterfactual. The propensity score, p(Xi), represents the probability of a household being in the treated group given its observed covariates Xi. It is estimated using a logistic regression model:

$$p(X_i) = \Pr(\text{ treat }_i = 1 \mid X_i) = \frac{\exp(\beta X_i)}{1+\exp(\beta X_i)} \quad (1)$$

Xi represents a vector of covariates, including land for dwelling houses, total cultivable land, daily hours of electricity, type of housing, market decision-making, and source of drinking water. The logistic regression model is specified as follows:

$$\log\left(\frac{p(X_i)}{1-p(X_i)}\right) = \beta_0 + \beta_1$$

land for dwelling house $i + \beta_2$ total cultivable land $i + \beta_3$ electricity hour daily $i + \beta_4$ type of housing $i + \beta_5$ market decision-making $i + \beta_6$ source of drinking water $i + u_t$ (2)

3.2. Matching Methods

We employ three matching methods to estimate the Average Treatment Effect on the Treated (ATT). First, we use Nearest Neighbor Matching (1:1), where each treated household matches the control household with the closest propensity score (Rosenbaum & Rubin, 1983a). Second, we implement Nearest Neighbor Matching (4:1), where each treated household is matched with up to four control households with the closest propensity scores (Abadie & Imbens, 2006). Third, we utilize Kernel Matching, where treated households are matched with a weighted average of all control households (Heckman et al., 1997), with weights inversely proportional to the distance between propensity scores.

The ATT is calculated as:

$$\text{ATT} = \frac{1}{N_T}\sum_{i\in T}\left(Y_i - \hat{Y}_i(0)\right) \quad (3)$$

Where N_T is the number of treated households, Y_i is the observed outcome for the treated household Yi(0), and I is the estimated counterfactual outcome for the treated household I, obtained from the matched control households.

3.2.1. Balance Checks and Outcome Variables

To ensure the quality of the matching, this study conducted balance checks by comparing the standardized differences in covariates between the treated and control groups before and after matching (Austin, 2009). The standardized difference is calculated as follows:

$$\text{Standardized Difference} = \frac{\bar{\tilde{X}}_T - \bar{\tilde{X}}_C}{\sqrt{\frac{s_T^2 + s_C^2}{2}}} \quad (4)$$

$\bar{\tilde{X}}_T$ and $\bar{\tilde{X}}_C$ are the means of the covariate for the treated and control groups, respectively, and s_T^2 and s_C^2 are the variances. A good match is achieved if the standardized differences are minor (typically less than 0.1) and the variance ratios are close to 1(Austin, 2009). The key outcome variables analyzed include monthly expenses (total monthly expenditures of the household), savings (monthly savings of the household), agricultural income (yearly income from farm activities), fixed income (yearly income from fixed sources such as salaries and pensions), and total annual income (sum of agricultural and fixed income).

3.2.2. Robustness Checks and Limitations

Several robustness checks were carried out to guarantee the accuracy of the findings. First, by removing any observations that fell outside the shared support region, the propensity scores of the treated and control households were sufficiently overlapped. This step made it easier to ensure we were comparing like with like.

Additionally, we assessed how sensitive the results might be to any unobserved factors that could affect the findings. We used the Rosenbaum bounds method (Rosenbaum & Rubin, 1983b). However, we couldn't fully implement this method as planned due to technical limitations. All the analyses were carried out using Stata 17, with the 'psmatch2' package for the propensity score matching and balance checks. We used the 'outreg2' package to summarize and export the findings into tables to present the results. While PSM reduces selection bias by controlling for observed covariates, it cannot account for unobserved confounding. Additionally, the quality of the matches depends on the availability of relevant covariates and the overlap in propensity scores between treated and control groups. Future studies could address these limitations by incorporating additional data or alternative methods, such as instrumental variables or difference-in-differences.

4. Results

4.1. Descriptive Statistics and T-Test Results

Table 2 provides a snapshot of the leading economic indicators, comparing households near the university (treatment group) with those living farther away (control group). The t-test results reveal noticeable differences between the two groups, suggesting that HSTU may influence how nearby households manage their finances and make economic decisions. Households in university-adjacent areas report significantly lower mean monthly expenses (10,424.70 BDT vs. 12,429.17 BDT), which may be attributed to greater access to university services, lower reliance on external markets, or differences in consumption patterns influenced by the university environment. Fixed income is also lower in university-adjacent areas (10,835.54 BDT vs. 16,666.06 BDT), indicating potential differences in employment structures, with fewer stable salaried positions and possibly greater engagement in informal or university-related employment. Households living near the university tend to take out significantly fewer loans-on average, 44,502 BDT compared to 60,970 BDT for those farther away. This could mean that these families have lower borrowing needs, better access to informal or alternative financial support, or perhaps more excellent financial stability thanks to the university's presence. Interestingly, households closer to the university report slightly higher average savings (1,144 BDT compared to 923 BDT). While this difference is not statistically significant, it may suggest better financial planning, lower living expenses, or a more cautious approach to saving in response to uncertain or irregular employment opportunities.

Table 2. Descriptive statistics and T-test results by treatment group

Variable	Control Mean	Treatment Mean	Difference	Std.Dev.	T-stat	P-value
Monthly Expense	12,429.17	10,424.70	2,004.47	7,949.19	2.01	0.045
Savings	923.33	1,143.83	-220.50	2,351.63	-0.57	0.572
Amount of Loan	60,969.92	44,502.35	16,467.57	119,295.70	1.19	0.234
Agricultural Income	94,600	80,915.09	13,684.91	178,557.80	0.50	0.616
Fixed Income	16,666.06	10,835.54	5,830.53	17,772.01	2.43	0.016
Total Yearly Income	115,576.60	68,059.87	47,516.76	114,619.10	2.33	0.021

Note: Standard deviations and sample sizes (N) are reported for each variable. T-tests compare means between treatment and control groups.

To rigorously estimate the impact of Hajee Mohammad Danesh Science and Technology University (HSTU) on nearby households, the study employed Propensity Score Matching (PSM) to control for baseline differences between university-adjacent and non-adjacent households.

This methodological approach ensures that households being compared are similar across key characteristics, thereby allowing us to isolate the effect of university proximity on economic outcomes with greater precision.

4.2. Matching Methodology

The research implemented three distinct matching techniques to ensure the robustness of the findings:

- Nearest neighbor matching with a 1:1 ratio (1-NN)
- Nearest neighbour matching with a 4:1 ratio (4-NN)
- Kernel matching

For each technique, this study estimated the Average Treatment Effect on the Treated (ATT), representing the average effect of university proximity on households in university-adjacent areas compared to their matched counterparts in non-adjacent regions.

Key Economic Indicators

Table 3 presents the ATT estimates for six key economic indicators: monthly expenses, savings, loan amount taken, agricultural income, fixed income, and total yearly income. The results reveal several significant findings regarding the economic impact of university proximity.

Table 3. Propensity score matching results

Outcome Variable	Method	ATT	T-stat	P-value
Monthly Expense	1-NN	-3,118.49	-1.98	0.048
	4-NN	-2,709.40	-2.07	0.039
	Kernel	-2,035.10	-1.70	0.089

Savings	1-NN	-115.81	-0.19	0.847
	4-NN	75.43	0.16	0.874
	Kernel	225.39	0.50	0.616
Amount of Loan	1-NN	-63,511.59	-2.13	0.034
	4-NN	-23,793.60	-0.99	0.322
	Kernel	-24,664.49	-1.31	0.191
Agricultural Income	1-NN	-2,293.48	-0.06	0.951
	4-NN	-25,779.71	-0.81	0.416
	Kernel	-23,616.92	-0.79	0.430
Fixed Income	1-NN	-7,669.90	-2.70	0.007
	4-NN	-7,090.05	-1.83	0.067
	Kernel	-7,638.45	-2.39	0.017
Total Yearly Income	1-NN	-36,655.15	-0.90	0.369
	4-NN	-30,277.94	-0.98	0.329
	Kernel	-44,809.69	-1.60	0.109

Note: ATT = Average Treatment Effect on the Treated. P- Values are reported for two-tailed tests.

Monthly Expenses

University-adjacent households demonstrated significantly lower monthly expenses across all matching methods:

1-NN: -3,118.49 BDT (p = 0.048)
4-NN: -2,709.40 BDT (p = 0.039)
Kernel: -2,035.10 BDT (p = 0.089)

This consistent reduction in monthly expenditures suggests that proximity to HSTU creates a more economical living environment for nearby households. Several mechanisms may contribute to this effect. Lower transaction costs: Living close to the university can save families both money and time-especially for those with members who work or study there. Shorter commutes mean less spending on transportation and more time for other activities. Changes in spending habits: The University's presence can shift how local markets operate. With more students, staff, and faculty around, demand for everyday goods and services increases, which can lead to more competitive prices and greater variety-benefiting the whole community. University-affiliated economic activities: Households near the university may have more significant opportunities to participate in campus-related economic activities, which could reduce their dependency on external markets for certain goods and services.

4.3. Fixed Income

Another striking finding is the significantly lower yearly fixed income in university-adjacent areas across all matching methods:

1-NN: -7,669.90 BDT (p = 0.007)
4-NN: -7,090.05 BDT (p = 0.067)
Kernel: -7,638.45 BDT (p = 0.017)

This consistent adverse effect on fixed income suggests a structural difference in employment patterns between university-adjacent and non-adjacent areas. Several factors may explain this phenomenon:

4.4. Shift toward Informal Employment

The university ecosystem may foster entrepreneurial activities and self-employment opportunities not captured in traditional fixed-income measures.

4.5. Prevalence of Part-Time Work

University-adjacent areas may offer more opportunities for flexible, part-time employment related to university operations, which might not be classified as fixed income. Student-driven economic activities:

The presence of students may create demand for informal services like tutoring, accommodation, food services, and other support activities that generate income outside formal employment structures.

4.6. Transformation of the Local Labour Market

The university may fundamentally alter the local labour market, shifting it away from traditional salaried positions toward more diverse income-generating activities with different payment structures.

4.7. Amount of Loan

The amount of loans taken showed a significant reduction in university-adjacent areas under the 1-NN method:

1-NN: -63,511.59 BDT (p = 0.034)

Although this effect was not statistically significant under the 4-NN and Kernel methods, the direction of the effect remained consistent:

4-NN: -23,793.60 BDT (p = 0.322)
Kernel: -24,664.49 BDT (p = 0.191)

This pattern suggests that living near the university can shape how households manage their finances and access credit in several meaningful ways.

4.8. Lower Need for Borrowing

Since households near the university tend to have lower monthly expenses, they may not need to rely on loans as much to meet their daily needs.

- Access to alternative funding: Being close to the university may open doors to other financial resources, such as scholarships, research grants, or university-run assistance programs.
- Support through informal networks: University communities often foster informal lending circles among students, staff, and faculty, which can provide a more flexible alternative to traditional loans.
- Improved financial awareness: The University's presence and educational resources help boost financial literacy in the surrounding community, encouraging smarter financial choices and better money management.

4.8.1. Other Economic Indicators

The remaining economic indicators-savings, agricultural income, and total yearly income-did not observe statistically significant differences between university-adjacent and non-adjacent households across any matching method. However, the direction of the effects provides valuable insights:

Savings

1-NN: -115.81 BDT (p = 0.847)
4-NN: 75.43 BDT (p = 0.874)
Kernel: 225.39 BDT (p = 0.616)

The inconsistent direction and lack of statistical significance suggest that university proximity may not substantially influence household savings behaviour.

Agricultural Income

1-NN: -2,293.48 BDT (p = 0.951)
4-NN: -25,779.71 BDT (p = 0.416)
Kernel: -23,616.92 BDT (p = 0.430)

The consistently negative-but not statistically significant-coefficients point to a possible decline in agricultural activity in areas near the university. This trend might reflect a shift towards alternative income sources or changes in land use brought about by the university's presence.

Total Yearly Income

1-NN: -36,655.15 BDT (p = 0.369)
4-NN: -30,277.94 BDT (p = 0.329)
Kernel: -44,809.69 BDT (p = 0.109)

These consistently negative values for total yearly income-primarily the result from the Kernel method, which comes close to statistical significance-suggest that households living near the university may earn less overall. A different kind of economic balance is depicted when this is considered in conjunction with the notable decline in monthly expenses: households may be making less money but are also spending less. This might point to an economic way of life influenced by the particular circumstances surrounding the university.

4.9. Implications of the PSM Findings

According to the Propensity Score Matching (PSM) analysis, the university has a complex effect on surrounding households. These households tend to take out fewer loans, but they also have fixed incomes and lower monthly expenses. This pattern hinted at a change in economic structure away from traditional employment and spending patterns.

The university changes the local economy by lowering living expenses in some places, creating new kinds of informal employment, and influencing how locals handle their money. These changes suggest that living near the university may lead to a different, more adaptive economic lifestyle-less reliant on formal income and less burdened by debt or high expenses. These findings highlight the multifaceted nature of university impact on surrounding communities, which extends beyond simple income effects to encompass broader changes in economic structures and behaviours.

4.10. Covariate Balance before and after Matching

Table 4 reports the covariate balance before and after matching. Before matching, significant differences exist in several covariates, such as land for a dwelling house (mean bias = 25.0%) and source of drinking water (mean bias = 41.9%). After matching, the mean bias is substantially reduced, with most covariates showing a bias reduction of over 90%. The variance ratios also fall within acceptable limits, indicating successful balancing of covariates.

Table 4. Covariate balance before and after matching

Covariate	Mean Bias (Before)	Mean Bias (After)	Bias Reduction (%)	Variance Ratio
Land for Dwelling	25.0	0.0	100.0	1.17
Electricity Hours	4.2	3.2	23.9	0.98
Type of Housing	24.2	7.6	68.7	1.50
Market Decision	12.3	2.5	80.0	1.16
Source of Drinking Water	41.9	4.5	89.4	0.61

Note: Mean bias is reported as a percentage. Variance ratios are reported for matched samples.

4.11. Common Support and Sensitivity Analysis

Figure 1 illustrates the common support for propensity scores, confirming that the matching procedure effectively created comparable treatment and control groups. A sensitivity analysis was attempted to assess the robustness of the results to unobserved confounding, but technical limitations prevented its completion. Future work should address this limitation.

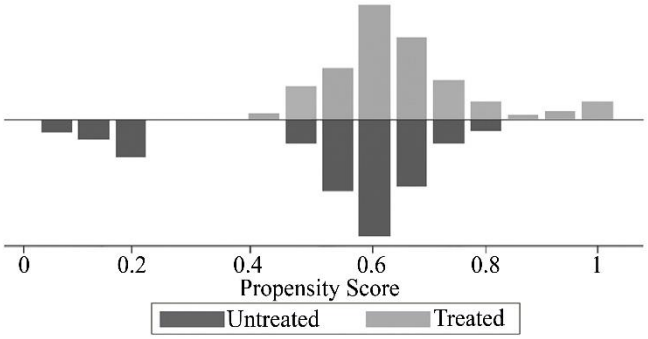

Fig. 1 Common support for propensity scores

Balanced covariates, as evidenced by the substantial reduction in mean bias and acceptable variance ratios. The standard support graph (Figure 1) further validates the matching process.

5. Discussion

This study explored how Hajee Mohammad Danesh Science and Technology University (HSTU) influences the economic lives of households within a 5-kilometer radius in rural Bangladesh. By applying Propensity Score Matching (PSM) techniques, the research examined key indicators like monthly expenses, savings, agricultural and fixed income, and total yearly earnings. The results revealed a complex and sometimes surprising pattern. On the one hand, families living near HSTU spent significantly less each month-by 2,035 to 3,118 BDT ($p < 0.05$)-and took out fewer loans, with borrowing reduced by about 63,511 BDT ($p = 0.034$). On the other hand, these same households reported consistently lower yearly fixed incomes-about 7,600 BDT less than those living farther away ($p < 0.05$). However, the two groups had no meaningful differences in savings, agricultural income, or total yearly income. The drop in monthly expenses suggests that HSTU's presence is reshaping the local economic environment.

This could be due to lower transportation costs-especially for university staff and students-or more affordable local goods and services influenced by the university's economic activity. Similar trends have been noted in studies on the rural impact of universities (Goldstein & Drucker, 2006; Valero & Van Reenen, 2019). At the same time, the decrease in fixed income points to a shift in how people earn money. Rather than relying on traditional, salaried jobs, residents might turn to more flexible or informal work opportunities connected to the university.

This reflects findings from scholars like Guerrero et al. (2015) and Huggins & Cooke (1997), who argue that universities can spark alternative employment pathways, especially in developing or rural regions. The lower loan amounts among nearby households could reflect a few things: less need to borrow money, easier access to informal funding options, or better financial knowledge gained through proximity to an educational institution. These ideas echo earlier studies on how universities influence local economic behaviour (Bloom, 2004; Mbah, 2019). The study found no discernible variations in total household income, farm income, or savings. This implies that a university's economic influence can be selective, improving some facets of life while maintaining others. The data's cross-sectional nature may have made finding long-term economic shifts more difficult. Overall, these findings closely align with previous research. For example, universities generally contribute to local income and job creation, according to Valero and Van Reenen (2019).

However, as this study shows, the effects might not always be immediately apparent, underscoring the significance of weighing the benefits and drawbacks of setting up a university in a rural area. However, the adverse effects on yearly fixed income observed in this study contrast with findings from urban-focused studies where universities have been shown to enhance local economic growth through formal employment opportunities (Huggins & Cooke, 1997; Goldstein & Drucker, 2006). Additionally, this study's observation of reduced borrowing among university-adjacent households adds a novel dimension to the literature. While prior studies have emphasized the role of universities in creating economic opportunities, this finding suggests that proximity to higher education institutions may also alter financial decision-making processes within households (Guerrero et al., 2015).

5.1. Comparative Advantage and Methodological Strengths

This study makes a meaningful contribution to the existing literature by combining intense methodological rigour with a deep understanding of the local context-producing insights beyond what many earlier approaches have achieved. Unlike the more traditional input-output or regional multiplier models often used in university impact studies (such as those by Huggins & Cooke, 1997; Garrido-Yserte & Gallo-Rivera, 2010), this research employs Propensity Score Matching (PSM). Using this method creates statistically comparable groups of households-those living near the university and those further away. Selection bias is reduced by using this quasi-experimental method. It makes it possible to draw more trustworthy conclusions regarding cause and effect, which have not been adequately covered in many earlier studies, particularly in the context of developing nations. The emphasis on the household level is another

significant difference. This research focuses on specific households, providing a more thorough and nuanced understanding of how a university's presence can influence everyday economic outcomes.

In contrast, previous studies frequently relied on macroeconomic indicators or broad regional data. Examining key variables such as income, savings, expenditure, and borrowing behaviour offers a nuanced understanding of how proximity to a university alters financial patterns in rural communities. This level of granularity is absent mainly in existing research, which tends to focus on employment figures or GDP contributions at the regional level. Most previous research has focused on universities in developed economies or busy urban areas, where these establishments flourish in well-established economic environments. However, this study takes a different approach by examining a Bangladeshi rural area. In this case, the university is essential to changing the local economy. Examining this context reveals crucial information often missed, such as the shift from formal to informal labour markets, changes in household spending, and new borrowing patterns. These findings demonstrate a university's unique ways of impacting its community, especially when it is one of the few significant players in local development. Lastly, the robustness of this study's findings is reinforced through multiple matching methods (1:1 Nearest Neighbor, 4:1 Nearest Neighbor, and Kernel Matching) and balance checks, ensuring consistency and reliability across different estimation techniques. This multi-method approach improves upon single-estimator designs found in much of the literature and confirms that the observed effects are not artefacts of a particular matching method.

5.2. Theoretical Implications

The results of this study challenge the widely held notion that institutions of higher learning always have a positive economic impact on the communities in which they are located and deepen our understanding of how universities engage with their local communities. The contradictory findings show that context-specific elements like access to informal financial networks and local employment structures must be considered when evaluating the impact of universities. The theoretical claim that universities can serve as catalysts for economic transformation-albeit in non-traditional ways that might not be consistent with conventional economic growth metrics-is also supported by this study (Urbano & Guerrero, 2013).

5.3. Practical Implications

For legislators, college administrators, and community leaders focused on enhancing the economic impact of higher education, this study offers essential insights. HSTU can significantly improve local socioeconomic outcomes by actively engaging with the community. Key strategies include forming partnerships with local vendors, implementing targeted training programs, and advancing technology transfer to strengthen economic ties.

Additionally, initiatives to boost financial literacy and provide educational resources will empower residents to make informed financial decisions. Government organizations should play an active role by encouraging universities to deepen their involvement in local economic development and to include socioeconomic impact indicators in their evaluations, solidifying their role as catalysts for regional growth.

6. Conclusion with Policy Recommendations

Utilizing Propensity Score Matching (PSM) techniques, this study examined the socioeconomic effects of a university on neighbouring households in rural Bangladesh. The findings reveal a complex economic landscape shaped by the university's presence. A more economical living environment is suggested by the significantly lower monthly expenses reported by households near the university, which ranged from 2,035 to 3,118 BDT ($p < 0.05$). These savings could result from improved access to informal economic activities, altered consumption patterns, and lower transaction costs. Remarkably, these households also had lower annual fixed incomes (about 7,600 BDT less; $p < 0.05$), suggesting a move away from formal, traditional employment and toward more flexible or informal work arrangements. Additionally, their loan intake was much lower-roughly 63,511 BDT ($p = 0.034$)-which might indicate a reduction in borrowing requirements or better money management. However, savings, agricultural income, and total annual income showed no discernible variations, indicating that the university's influence varies depending on the financial metric.

6.1. Policy Recommendations

To increase the positive economic effects that universities like HSTU have on rural communities, we suggest the following actions:

- Create Official Job Openings: The ongoing decrease in steady income indicates the urgent need for reliable employment options. The university should collaborate with local businesses to organize job fairs, conduct skill-development workshops, and support internships.
- Encourage Local Procurement and Entrepreneurship: We can encourage entrepreneurial endeavours and boost the local economy by giving preference to local vendors and setting up business incubators.
- Improve Financial Literacy: Since borrowing has significantly decreased, there is a clear chance to support households with initiatives emphasizing saving, budgeting, and income diversification.
- Use the University's Strengths: Considering HSTU's focus on technology and agriculture, the institution should provide customized training programs and transfer

pertinent innovations to nearby farmers and small businesses.

- Institutionalize Community Engagement: To ensure clear goals and accountability systems, the university should make regular meetings with local leaders and residents essential to its operations.
- Promote Socioeconomic Contributions: Policymakers should integrate economic impact metrics into their evaluations of universities and consider offering financial incentives to institutions that significantly contribute to community development.

6.2. Limitations and Future Research

This study highlights the significant socioeconomic impacts of a rural university while noting some limitations. The reliance on cross-sectional data restricts insight into long-term changes, and focusing on a single region may limit the applicability of the findings. Future research should adopt longitudinal methods and conduct comparative studies across rural universities to deepen our understanding of how institutional differences affect local economic outcomes.

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