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Impact of Formal Credit on Tomato Trader's Welfare in the Upper East Region of Ghana: A Propensity Score Matching Estimation



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RESEARCH PAPER

Impact of Formal Credit on Tomato Trader's Welfare in the Upper East Region of Ghana: A Propensity Score Matching Estimation

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ABSTRACT

PURPOSE: This study examines the impact of formal credit on tomato trader's welfare in the Upper East Region of Ghana.

DESIGN/METHODOLOGY/APPROACH: A total of 282 tomato traders were sampled for the study. Logistic regression and propensity score matching was used to determine factors influencing formal credit access and the impact of formal credit on tomato trader's welfare, respectively.

FINDINGS: The logistic regression revealed that different sets of demographic and institutional factors have varying influences on formal credit access. Having access to formal credit has significant positive impacts on the outcome variables: annual income, consumption expenditure, health expenditure, education expenditure, and value of assets.

ORIGINALITY: The research provides relevant information on the impact of formal credit on tomato trader's welfare in the Upper East Region of Ghana.

KEYWORDS: *Formal credit; Welfare; Impact; Ghana*

INTRODUCTION

Tomatoes (*Solanum Lycopersicum*, L.) are a nutritious ingredient used in the preparation of many foods and remain vital in most Ghanaian diets (Yenihebit *et al.*, 2020). In some cultures, it is eaten raw as a salad ingredient (Adenuga *et al.*, 2013). Total production covers wide areas in Africa, increasing to about 660,215ha in 2007 from an initial production area of 159,593ha in 1961 (FAO, 2009).

Considering Ghana's production estimates, the Ministry of Food and Agriculture (MFA) reported that tomatoes are cultivated on 50,000ha with production standing at 48% of its achievable yield (MFA, 2013). However, despite the huge production, supply still falls short of demand resulting in imports from neighbouring Burkina Faso, amounting to some US\$99.5m worth of tomatoes yearly (Ghana Business News, 2018) to supplement domestic demand. The Upper East Region also shares similar climatic conditions with Burkina Faso. This enables the region to produce tomatoes in larger quantities, over any region in Ghana, mostly during the dry season when irrigation cultivation is key. As a result, its production and marketing activities form a major trade for the people of the Upper East Region of Ghana (Yenihebit *et al.*, 2020).

Meanwhile, most studies have mainly focused on formal financial credit access by farmers with little literature on tomato traders. Almost all available literature on the tomato sector of the

region points to the production and farmer-related issues rather than marketing-related matters. For example, Puozaa (2015), Ayerh (2015), and Yenihebit *et al.* (2020) studied technical, allocative, and economic efficiencies of production of tomatoes in the area, respectively. It is only Amikuzuno (2015) who studied spatial price transmission; however, his study failed to shed any light on the trading aspect of tomatoes from which prices are engineered. This, therefore, leaves a dearth of information on the effect of credit facilities on the livelihood of tomato traders of the region. Against this backdrop, the research objectives are two-fold: the study (1) identifies the determinants of tomato traders' access to formal credit, and (2) estimates the impact of formal credit access on tomato traders' welfare.

The remainder of the paper is structured as follows. The literature review is next, then a section on materials and methods. This is followed by the results and discussion section, and finally the conclusions and recommendations section.

LITERATURE REVIEW

Impact Assessment of Formal Credit Access on Welfare

Formal credit markets in rural areas are usually characterised by strict conditions and high transactions costs, making the sector unattractive to small agri-business enterprises. Over the years, however, smallholder farmers and traders have creatively generated self-capital for production to meet their consumption and market demands (Ortmann and King, 2006). Okurut *et al.* (2004) assert that formal credit markets have had a positive influence on the productive capacity of the poor through investment in both their physical resources and human capital.

Regarding income, it has been found that formal credit positively impacts income (Sam, 2021). Using household consumption as a measure of household welfare, Khandker and Faruquee (2003) revealed that formal credit access generally improved the welfare of farm households; however, the impact was more substantial for small-scale farmers than large-scale farmers. This implies that the standard of living of small-scale farmers has proliferated due to formal credit access. Formal credit transcends into food, health, and education expenditure, which is linked with activities that could enhance the quality of lives. Empirically, Truong *et al.* (2020) found that formal credit access positively influenced health and education expenditure in Vietnam. Additionally, Das (2019) contended that formal credit access would be an effective approach to poverty reduction. In terms of assets, formal credit has a positive impact on borrowers' productive assets vis-à-vis non-borrowers (Thu and Duong, 2018).

MATERIALS AND METHODS

Study Area

The Upper East Region of Ghana lies between latitude 10° 30'N and 11°N and longitude 0° and 1°W (Antwi-Agyei and Nyantakyi-Frimpong, 2021), with Bolgatanga as the regional capital. The rainfall pattern in the region is unimodal, with an average rainfall of 1,000mm/year (Antwi-Agyei

and Nyantakyi-Frimpong, 2021). In consequence, several water conservation technologies, such as irrigation dams, wells, and rainfall harvest dug-outs, are available to ensure farmers produce throughout the year, particularly during the dry season (Nakuja *et al.*, 2012). Tomatoes, onions, sorghum, millet, and groundnut are predominantly the on-farm economic activities in the region (Nakuja *et al.*, 2012). These crops are cultivated at the banks of the dug-out for easy irrigation of the farm. Figure 1 gives further details of the study area:

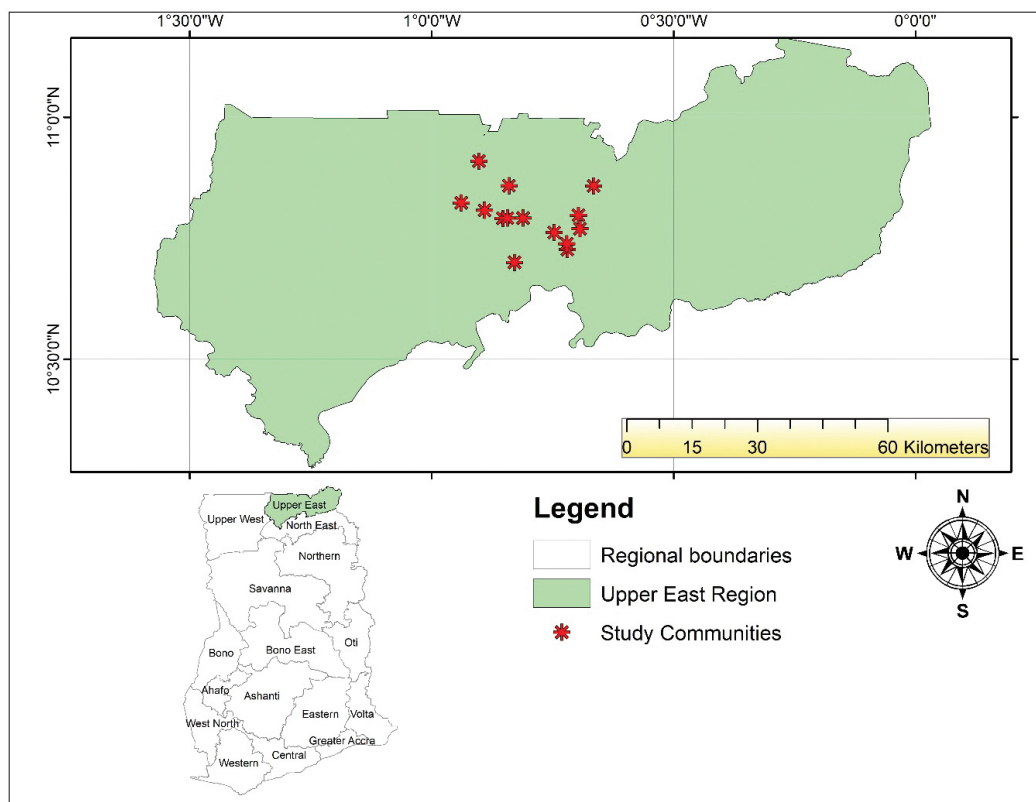


Figure 1: Map of the Study Area

Source: Author's construct, 2021

Sampling and Data

In this study, multi-stage cluster sampling was employed. This is because the tomato trader population is large and would have to be divided into stages to make the sampling process more pragmatic. In the first stage, although there are several administrative regions in Ghana,

the Upper East Region was purposively selected. In the second stage, since the region has six administrative areas (Bolgatanga, Kassena-Nankana, Builsa, Bongo, Bawku East, and Bawku West), the Bolgatanga Municipality was selected for the study. In the third stage, as a result of a list collected from the tomato trader's association, 14 communities, namely Bukere (Bolga Central market), Yoroko, Zaare, Yikenne, Tindonsobligo, Dorongo, Sirugu, Sorkabisi, Pobaga, Kalibeo, Tanzui, Nyariga, Sumbrungu, and Bolga-Soe, were purposively selected from the municipality. Given the said communities, tomato traders were simple randomly selected in the fourth stage. According to the Ghana Statistical Service (2014), Bolgatanga municipality has a total population of 131,550, accounting for 12.6% of the Upper East Region's population (1,046,545). Therefore, following the sample size determination approach of Slovin, $n = \frac{N}{1 + N(e)^2}$ where n = Sample size, N = Population number (131,550), and e = error rate (10%), the computed sample size is ~100. A total of 300 questionnaires were circulated, with 282 fully completed questionnaires returned, a response rate of 94%. The central limit theorem indicates that a sample size ≥ 30 is appropriate for statistical analysis because it satisfies a normal distribution (Mensah *et al.*, 2021). Thereby, the sample size of 282 is scientifically justified for the study.

Method of Data Analysis

Determinants of Tomato Traders' Access to Formal Credit

The study employed a logit model to investigate the determinants of formal credit access. On modelling dichotomous decisions, the logit and probit models are appropriate (Hoetker, 2007). Respondents were given two alternatives, formal credit access or otherwise. Worthy of note is that the use of the logit model is consistent with other credit demand studies (see, Akudugu, 2012; Ololade and Olagunju, 2013; Hananu *et al.*, 2015). The determinants of formal credit access were based on the decision-making threshold theory proposed by Hill and Kau (1973) and Pindyck and Rubinfeld (1998). The theory suggests that when traders face the decision of whether or not to adopt an innovation, in our case formal credit access, each trader has a threshold of reaction that is based on some established factors. As a result, at a certain value of stimulus below the threshold, adoption is unobserved. However, at the critical threshold value, a reaction is motivated by some determinants that can be socio-economic and institutional characteristics of the target population. Generally, such a phenomenon is modelled using the association:

$$Y_i = \beta K_i + \pi_i \quad (1)$$

$Y_i = 1$, When a decision is made to adopt and 0, otherwise.

This implies that: $Y_i = 1$ when $K_i \geq$ critical value K^* and $Y_i = 0$ if $K_i <$ a critical value K^* $\varphi^* =$ Joint effect of the regressors (K_i) at the level of threshold. Equation (1) denotes a binary choice

model involving the estimation of the adoption probability of a given innovation, technology, or intervention (Y) as a function of regressors (K). Expressing mathematically:

$$Prob(Y_i = 1) = F(\beta'K_i) \quad (2)$$

$$Prob(Y_i = 0) = 1 - F(\beta'K_i) \quad (3)$$

Y_i = Response observed for the i^{th} observation of the response variable, Y . Implying that $Y_i = 1$ represents an adopter (i.e., traders who demand credit from formal institutions), $Y_i = 0$ otherwise. K_i = Regressors such as age, education, and interest rate. F = Logistic function.

Using the logistic cumulative distribution function, the logit model estimates the P as:

$$P(Y = 1) = \frac{e^{\beta'K}}{1 + e^{\beta'K}} \quad (4)$$

$$P(Y = 0) = 1 - \frac{e^{\beta'K}}{1 + e^{\beta'K}} = \frac{1}{1 + e^{\beta'K}} \quad (5)$$

Inferring from Greene (2008) the probability model is a regression of the conditional expectation of Y on K giving:

$$E\left(\frac{Y}{K}\right) = 1[F(\beta'K)] + 0[1 - F(\beta'K)] = F(\beta'K) \quad (6)$$

The non-linear nature of the model prevents the parameters from being the marginal effects of the various regressors. Therefore, the effect of each of the regressors on the adoption probability (i.e., decision to demand credit) is derived by differentiating Equation (6) concerning K_{ij} ensuing in Equation (7) (Greene, 2008):

$$\frac{\partial P_i}{\partial K_{ij}} = \left[\frac{\lambda \beta'K}{(1 + \lambda \beta'K)^2} \right] \beta = F(\beta'K)[1 - F(\beta'K)]\beta \quad (7)$$

Parameters were estimated with the maximum likelihood approach.

The application of the logit model is that, at some point in time, the tomato trader would decide to request credit from formal financial institutions when the joint effect of some factors transcends the inbuilt resistance to change him/her.

Table 1: Description of Variables Used for the Analysis

Variable	Description	Measurement	Expected Sign
Dependent variable			
Formal credit access	A farmer has access to formal credit	1=Access	
		0=Otherwise	
Outcome variables			
Income		Amount in Ghana Cedis	+
Asset value		Amount in Ghana Cedis	+
Consumption expenditure		Amount in Ghana Cedis	+
Education expenditure		Amount in Ghana Cedis	+
Health expenditure		Amount in Ghana Cedis	+
Independent variables			
Demographic factors			
Age	Number of years from birth	Age in years	+
Age square	Square of age		−
Education	Had formal education	Number of years of schooling	+
Household size	Size of household	Number	+
Institutional factors			
Association membership	Member of an association	1=Yes 0=No	+
Distance	Distance to the nearest financial institution	Distance in kilometres	−
Political	Actively affiliated to a political party	1=Low	+
		2=High	
		3Highest	
Interest rate	Banks interest rates	1=Low	−
		2=High	
		3Highest	

Note: 1 US\$ = GH¢ 5.78

Source: Author's compilation based on field data and literature review, 2020

Impact of Formal Credit Access on Tomato Traders' Welfare

Estimating the impact of formal credit access on tomato traders' welfare, the propensity score matching (PSM) was employed via the average treatment effect on the treated (ATT) approach. Supplementing the estimation, the average treatment effect (ATE) and average treatment effect on the untreated (ATU) were estimated. Despite the robust estimate of PSM in estimating impact, it is susceptible to the possible presence of unobserved covariates (Caliendo and Kopeinig, 2008). Redressing this drawback, the Rosenbaum bounds was used to inspect the robustness of the PSM estimates. Following Iddrisu *et al.* (2020), the ATT was computed using the formula:

$$ATT = E[(Y_1 - Y_0) | X, W = 1]$$

ATT = Expected treatment outcome for the treated traders (i.e., traders with formal credit access)

$Y_1 - Y_0$ = Difference in outcome between both treated and untreated traders

X = Regressors

W = Binary treatment variable (Formal credit access)

Further, the estimate for ATE and ATU was respectively articulated by Imbens (2004) and Dontsop *et al.* (2013) as:

$$ATE = E[Y(1) - Y(0)]$$

$$ATU = \frac{1}{n - n_1} \sum_{i=1}^n (1 - d_i) g(x_i, \beta)$$

Where n = sample size $n_1 = \sum_{i=1}^n d_i$ is the number of samples treated, g as a known (possibly non-linear) function of the vector of covariates x , and the unknown parameter vector β .

RESULTS AND DISCUSSION

Table 2: Determinants of Formal Credit Access by Tomatoes Traders

Variables	Probit Regression	
	Coefficient	Marginal Effect
Demographic factors		
Age	−0.046 (0.228)	−0.011
Age square	0.001 (0.003)	0
Education	0.050 (0.035)	0.012
Household size	***−0.511 (0.194)	−0.121
Institutional factors		
Association membership	**0.884 (0.395)	0.192
Distance	***−0.751 (0.239)	−0.178

(continued)

Table 2: Determinants of Formal Credit Access by Tomatoes Traders (continued)

Variables	Probit Regression	
	Coefficient	Marginal Effect
Political	***0.094 (0.345)	0.022
Interest rate	***-1.937 (0.306)	-0.449
Constant	-1.999 (4.270)	
Goodness of fit		
Prob > chi ² = 0.000		
LR chi2(8) = 79.04		
Pseudo R2 = 0.2077		
Log likelihood = -150.74444		

, * denote significance at 5 or 1%, respectively. Figures in parenthesis are the standard errors

Source: Author's computation based on field data, 2020

Table 2 shows the determinants influencing access to formal credit by tomato traders: the probabilities of accessing formal credit are quite diverse. On demographic factors, only household size was significantly different from zero ($p < 0.01$). In effect, an increase in household size decreases the probability of a tomato trader having formal credit access by 12.1%. One possible reason could be that traders with more household members are within the working age bracket, therefore less likely to borrow from formal financial firms. Surprisingly, a positive coefficient sign was expected (refer to Table 1) yet the result proved otherwise. We expect a positive sign because the larger the household size the more traders are incited to access formal credit; this is because proceeds obtained from tomato commercialisation is expended on the increasing size of the household, so formal credit is used to substitute the expended proceeds. The result is contrary to Anang and Kabore (2021) who reported a positive relationship between access to credit and household size.

Regarding institutional factors, all factors were statistically significant (association membership, distance, political and interest rate). A tomato trader being a member of an association increases the probability of receiving formal credit by 19.2%. This is possible because the association becomes a collateral that positively affects a manager's decision to advance credit to the association. If a large amount is received, the credit is equitably disbursed among members for business proliferation. The result is the same as Denkyirah *et al.* (2016) who found a positive influence between association membership and credit access.

The negative coefficient of distance to the nearest financial institution suggests that the longer the distance, the less probability that traders will access formal credit (about 17.8%). This may be due to the fact that credit from formal financial institutions is normally in monthly instalments; this

means that shorter distances and good traffic conditions reduce transaction costs, especially for traders in neighbouring rural areas of Bolgatanga (Ding and Abdulai, 2020). The result validates the findings of Kiplimo *et al.* (2015) who found that distance is negatively related to credit access.

The estimates also show that traders who are actively affiliated to a political party are more likely (2.2%) to access credit from formal financial firms. This implies that traders who have high political affiliation to a political party are more often than not successful on formal credit advancement as their supposed political party is in power. This subsequently translates into bad debt on the records of the financial firms as beneficiaries (politically affiliated) perceive the advanced credit as a donation from their political godfathers. The result is consistent with Akudugu (2012) who found that active political affiliation positively affected credit access. Also, the coefficient of interest rate was negative and statistically significant at 1% significance level. This implies that an increase in interest rate decreases the probability of accessing credit from financial firms by 44.9%. Simonyan *et al.* (2019) hold a similar view on the negative relationship between interest rate and credit access.

Table 3 presents the impact of access to formal credit on tomato traders' welfare. From the results, the treatment effects (ATT, ATU and ATE) are positive and statistically significant at 1%. Participation in formal credit improves annual income at 1% significant level. The average treatment effect on the annual income of those who received formal credit is GH¢4,419.26 higher than non-participants. If the non-participants had participated, they would have had, on average, an annual income of GH¢4,289.93 higher. The average treatment effect (ATE) on the sample's annual income is GH¢4,342.21. This finding corroborates the study of Okoyo *et al.* (2021) who revealed that access to formal credit has a positive impact on income. Further, the Rosenbaum Sensitivity analysis was deployed to analyse the robustness of the PSM estimates' results. Appendix Table A shows that the positive impact of formal credit on annual income is not sensitive to the possible presence of unobserved covariates.

The impact of formal credit on consumption expenditure is presented in Table 3. Participation enhances expenditure on consumption. On average, participants contribute GH¢445.19 to household consumption expenditure. If the non-participants had participated, they would have spent, on average, GH¢424.81 on consumption. The sample's average consumption expenditure is GH¢439.01. The result is consistent with Annim and Frempong (2018) finding that formal credit increased participant's consumption expenditure. The robustness of the estimated impact was verified with the Rosenbaum bounds sensitivity analysis. Appendix Table A's critical values of gamma (Γ) (i.e., 1-3) were significant. Therefore, it should be noted that the positive impact of formal credit on consumption expenditure is not subject to confounders; therefore the result can be interpreted without caution.

Table 3: Impact of Formal Credit Access on Tomato Traders' Welfare

Outcome Variables	Matching Algorithm: PSM			TREATED		UNTREATED	
	ATT	ATU	ATE	Off-support	On-support	Off-support	On-support
Annual income	4419.26*** (10.97)	4289.93*** (9.48)	4342.21*** (11.69)	23	91	7	161
Cons Exp	445.19*** (11.10)	424.81*** (9.61)	439.01*** (11.84)	23	91	7	161
Health Exp	305.78*** (9.27)	308.05*** (9.30)	307.23*** (10.66)	23	91	7	161
Educ Exp	2209.62*** (10.97)	2144.96*** (9.48)	2171.11*** (11.69)	23	91	7	161
ASS value	2626.95*** (7.92)	2823.13*** (6.01)	2752.29*** (7.24)	23	91	7	161

NB: Average Treatment Effect on the Treated (ATT). Average treatment effect on the untreated (ATU). Average treatment effect (ATE). NB: 1 \$ = GH¢ 5.78

t-values are in parenthesis; *** denotes significance level at 1%

Source: Author's computation based on field data, 2020

Table 3 summarises the impact on the health expenditure of traders. Participants in formal credit increase expenditure on health by GH¢305.78 more than non-participants. Non-participants would have spent much higher (GH¢308.05) if they participated. The sample's ATE on health expenditure is GH¢307.23. A lower ATT health expenditure value of GH¢305.78 compared to relatively higher ATE and ATU figures of GH¢307.23 and GH¢308.05 respectively, suggests that improved income positively impacts on better health conditions for participants, leading to lower health expenditure. The result follows the findings of Chireshe and Ocran (2020) who acknowledged that formal credit improves health expenditure. The robustness of the estimated PSM was checked with the Rosenbaum bounds sensitivity analysis from Appendix Table B. The critical values of gamma were statistically significant. They indicate that the positive impact of formal credit on traders' total health expenditure is not susceptible to hidden bias.

The impact of formal credit on education expenditure is also shown in Table 3. The result shows a positive impact of formal credit on the education expenditure of participants: participants spent GH¢2,209.62 more than non-participants. If the non-participants had participated, they would have spent GH¢2,144.96 more. The average treatment effect on education expenditure by the sample is GH¢2,171.11. The result is in agreement with Thai (2018) who revealed that formal credit positively affects expenses on education. The sensitivity analysis presented in Appendix Table B shows that, in gamma's critical values across the range of 1-3, the sig² is significantly different from zero. Therefore, the result is not susceptible to hidden bias, and can be interpreted without caution.

Table 3 shows the impact of formal credit on the value of assets. The treatment effects (ATT, ATU and ATE) on the value of assets are positive and significant at 1%. The average treatment effect on the treated (ATT) increases the value of assets by GH¢2,626.95. The value of assets for non-participants would be GH¢2,823.13 more if they had participated. The sample's average treatment effect on the value of assets is GH¢2,752.29. Given a lower ATT than ATU and ATE indicates that participants might have prioritised other welfare outcomes over acquiring assets. For example, participants might have chosen to spend more on education than the acquisition of assets. Baiyegunhi *et al.* (2010) hold a similar view on the asset result. Checking the robustness of the estimated PSM result, the Rosenbaum sensitivity analysis was employed. The sensitivity analysis presented in Appendix Table B shows that in gamma's critical values across the range of 1-3, the sig² is significantly different from zero. Therefore, the result is not susceptible to unobserved heterogeneity and can be interpreted without caution.

CONCLUSIONS AND RECOMMENDATIONS

This paper investigated the impact of formal credit on tomato trader's welfare in the Upper East Region of Ghana. On the determinants of formal credit access, household size, association membership, distance, political and interest rate were the significant determinants of formal credit access. Except for household size, distance and interest rate, the remaining determinants had a positive influence on formal credit access in the study site. Having access to formal credit has a significant positive impact on the outcome variables: annual income, consumption expenditure, health expenditure, education expenditure and value of assets.

Therefore, it is recommended that traders and other NGOs or stakeholders in the tomato value chain should endeavour to encourage and promote the formation and participation of associations since it boosts their credit participation. Creditors prefer to lend to groups rather than to individual traders. It is recommended that a study should be conducted to assess creditors' requirements for advancing loans/credit to tomato traders of the municipality.

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APPENDIX

Table A: Rosenbaum Bounds Sensitivity Analysis Results

Gamma	Annual Income		Consumption Expenditure	
	Sig +	Sig –	Sig +	Sig –
1	6.1e-15	6.1e-15	5.1e-15	5.1e-15
1.5	3.2e-10	0.000	2.7e-10	0.000
2	7.5e-08	0.000	6.6e-08	0.000
2.5	2.0e-06	0.000	1.8e-06	0.000
3	0.000019	0.000	0.000017	0.000

*gamma - log odds of differential assignment due to unobserved factors

sig⁺ - upper bound significance level

sig[–] - lower bound significance level

t-hat + - upper bound Hodges-Lehmann point estimate

t-hat – - lower bound Hodges-Lehmann point estimate

CI⁺ - upper bound confidence interval (a = 0.95)

CI[–] - lower bound confidence interval (a = 0.95)

Table B: Rosenbaum Bounds Sensitivity Analysis Results

Gamma	Health Expenditure		Education Expenditure		Asset Value	
	Sig +	Sig –	Sig +	Sig –	Sig +	Sig –
1	3.4e-15	3.4e-15	6.1e-15	6.1e-15	3.9e-12	3.9e-12
1.5	2.0e-10	0.000	3.2e-10	0.000	6.0e-08	0.000
2	4.9e-08	0.000	7.5e-08	0.000	7.4e-06	0.000
2.5	1.4e-06	0.000	2.0e-06	0.000	0.000133	0.000
3	0.000013	0.000	0.000019	0.000	0.000902	0.000

*gamma - log odds of differential assignment due to unobserved factors

sig⁺ - upper bound significance level

sig[–] - lower bound significance level

t-hat + - upper bound Hodges-Lehmann point estimate

t-hat – - lower bound Hodges-Lehmann point estimate

CI⁺ - upper bound confidence interval (a = 0.95)

CI[–] - lower bound confidence interval (a = 0.95)

