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Economic Analysis of Anti-Retroviral Therapy (ART) Task Shifting in Limited Resource Setting Using Econometric Model: Ethiopia Case Study

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Economic Analysis of ART Task Shifting in Limited Resource Setting Using Econometric Model: Ethiopia Case Study

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Abstract

Objective: To estimate the cost difference associated with anti-retroviral therapy (ART) task shifting in a limited resource setting in Ethiopia, and to analyze the determinant factors for length and the cost of a visit.

Method: A stratified random sample of health facilities across four regions of Ethiopia (Addis Ababa, Amhara, Benishangul Gumuz and Oromia) was surveyed. An ordinary least square (OLS) regression model was employed. The dependent variables were "cost of visit" and "length of visit", while independent variables include the type of profession (physician, health officers, and nurses), health facility (hospitals, health centers) and visit (follow-up, initiation).

Result: A total of 79 health facilities were covered during the survey. Of the 665 interviews, the majority of patients (77.0%) were seen by a nurse, while 19.6% and 3.5% were seen by health officers and doctors, respectively ($p<0.01$). The average time spent by patients in ART services was estimated to be 8.5 minutes (*Range: 1 to 60 minutes*). The duration of hospital visits (8.68 minutes) was slightly higher than at health centers (8.32 minutes) ($p<0.05$). The OLS model estimated that the median cost per visit for doctors was 15% higher than that for nurses, when controlling for type of facility and type of visit. No statistically significant differences were found in the cost per visit or length of a visit between hospitals and health centers after controlling for type of staff and visit.

Recommendations: We found that ART services were less costly when delivered by nurses and health officers, compared with doctors. Since task-shifting to less specialized health-care workers yields economic benefits, the expansion of ART task-shifting should be considered by all concerned stakeholders in limited resource settings, but should be done so in a manner that patients' benefits and public health outcomes are not undermined.

Key words: Anti-retroviral therapy, task shifting, visit cost, econometric model, Ethiopia.

Introduction

Sub-Saharan Africa is facing a crisis in human health resources, with a critical shortage of health workers exacerbated by a high burden of disease, brain drain, and low motivation (Zacharia et al. 2009). According to recent WHO estimates, the current workforce in some of the most affected countries in sub-Saharan Africa would need to be scaled up by as much as 140% to achieve international health development targets such as those in the Millennium Declaration (Kinfu et al. 2009, UNAIDS 2013). The problem is so serious that in some instances there is not sufficient human capacity to absorb, deploy, and efficiently use the additional funds that are considered necessary to improve health in these countries.

In particular, the burden of HIV/AIDS has led to task shifting - the name now given to a process of delegation whereby tasks are moved, where appropriate, to less specialized health workers (WHO 2007) - as a way of expanding human resource capacity. For example, providing anti-retroviral therapy to 1,000 people in settings in which resources are constrained requires an estimated one or two doctors, up to seven nurses, and about three pharmacy staff as well as support from community workers (WHO 2007). The World Health Organization has promoted a "public health" approach to scaling-up ART, and many countries have adopted a standardized ART treatment protocol in which services can be provided by non-physician clinicians, i.e., clinical officers or nurses, moving away from the physician-managed, western model of treatment (Gilks et al. 2006). In terms of the public health approach, nurse or clinical officer-led ART treatment has emerged in the HIV programs of many developing countries at decentralized levels of care (Harries et al. 2006) as tasks are shifted from physicians to non-physician clinicians through in-service training and/or training of new cadres.

In Ethiopia, the ART delivery model has shifted from a physician-led, hospital-based program to decentralized service delivery at health centers by nurses and health officers. This strategy contributed to the radical expansion of ART providing facilities from three in 2004/5 to 743 in 2010/11, with ART service recipients increasing from 8,276 in 2004/5 to 24,7805 in 2010/11 (National AIDS Resource Center 2012). This was the result of the government and other stakeholders' commitment to expanding services for people in need. However, there is little information on the cost differences associated with task shifting and decentralization and the determinants of such differences. The length of visit and type of health professional providing these services affect the magnitude of the cost difference. This analysis seeks to fill this information gap in the literature.

Objective

While previous studies in sub-Saharan Africa countries, including Ethiopia, have reviewed the relationship between task performance, access and

task shifting (Gessessew et al. 2011, O'Malley et al. 2014), there is limited analysis of the economic significance associated with ART task shifting. More specifically, there is a paucity of evidence on the application of micro-econometric modeling to ART task-shifting. This research study examines the relationship between the length of a visit and the labor cost of that visit, using the explanatory variables of the health profession type (doctors, health officers and nurses), type of health facilities (hospitals, health centers) and purpose of the visit (initiation, follow-up). We seek to assess if there is a relationship between the health profession type and the type of health facility and both the length and cost of a visit, while controlling for other factors.

Materials and Methods

A stratified random sample of health facilities across four regions of Ethiopia (Addis Ababa, Amhara, BenishangulGumuz and Oromia) was used for the study. The unit of randomization was the health network, consisting of one hospital and its associated health centers. A health network was sampled with certainty if regional staff reported that a physician was involved in ART care at the hospital; the remaining health networks were sampled at random. The hospital and two or three health centers were selected for each health network, out of an average of 5.7 (Range 2-15) health centers per network. The cost of resources used to deliver ART services was obtained from the sampled health facilities and the Federal Ministry of Health.

All data collectors were given three days of training before the data collection commenced, and were accompanied by senior supervisors who checked the data each day. The data collection tools were piloted at one hospital and one health center, finalized, and then applied to all health facilities in the analysis.

Data were collected on the number of staff working at the ART clinic, how much time they spend there, how much time they work overall, and staff salaries. Using a time motion study and task checklist, staff roles and time spent on ART care were assessed. Salary costs are defined as fixed at facilities where there is a stand-alone ART clinic, since staff must work in the clinic however many patients attend. Salary costs at integrated clinics are defined as variable. Finally, the labor cost of the visit was calculated and estimated by multiplying the length of the visit by average salary of a particular cadre of worker per minute. All costs are presented in 2011 Ethiopian Birr. The related evidence on the cost effectiveness of ART task shifting and patient satisfaction has been published elsewhere.

Ethics Statement

The study received scientific ethical review, follow-up and approval from the Scientific and Ethical Review Office (SERO) of the Ethiopian Public Health Institute. The research was also approved by the Institutional Review Board of Abt Associates. Oral informed consent was received from all patients

interviewed during the survey. The data were kept confidential through the course of the study and analyzed anonymously. The collected data was stored with both the Ethiopian Public Health Institute and Abt Associates Inc.

Econometric Model

A review of the literature shows that many factors are associated with ART treatment task shifting (MacPake and Mensah 2008, Monyatsi et al. 2011, Zacharia et al. 2009). Although many determinant variables contribute to ART task shifting success, this study emphasizes the variation in the length of visit/cost of visit associated with decentralization from a physician-led, hospital-based program to the nurse/health officer-led health center delivery modality. The model assessed the association between the type of health professional (doctors, health officers and nurses), health facility (hospital and health center) and visit (initiation and follow-up) and the length and cost of a visit (Table 1).

Table 1. *Detail Description of the Model Variables in the Econometric Model*

Dependent Variable for Model one			
Variables	**Description**	**Data Type**	**Value**
Log Length of Visit	Time spent with the patient	Continuous Variable	Minutes
Dependent Variable for Model two			
Log Cost per Length of Visit	Log transformation to measure labor cost per length of visit	Continuous Variable	Minutes* Salary rate
Independent Variables			
Facility Type	Type of facility for ART	Dummy Variable	1=Hospital, 0=Health center
Professional Type	The professional at that particular visit	Dummy Variable	1=Nurse/Health officer, 0=Otherwise
			1=Doctor, 0=Otherwise
Type of Visit	Type of visit	Dummy Variable	1=Continuing 0=Initiation

The first (1) and second (2) models were constructed with the basic assumption of two separate models with similar, independent variables but different dependent variables in order to assess both the length and the cost of the visit.

The functional form of the models is as follow:

$$YL_i = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 D_{4i} + U_i \qquad (1)$$

$$\boldsymbol{YC_i = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 D_{4i} + U_i} \quad (2)$$

where: YL_i = the length of visit,
YC_i = the cost of visit,
D_{2i} = a set of dummy variables for the type of professional (doctors, nurses/health officers),
D_{3i} = a set of dummy variables for the type of health facility (hospital, health center) and
D_{4i} = a set of variables for type of visit (initiation, follow-up).

Following Gujarati (2002), the coefficients of dummy variables would give the median/mean value through comparing the dummy variables considered in the model estimation. However, the dependent variables (length of visit, cost of visit) were required to have symmetrical distribution, low skewness and low kurtosis value. Since most health economics data shows skewed outcome and high kurtosis and skewness values, we explore and apply the log transformation of the dependent variables and generalized linear models.

As shown in Table 2, the transformed dependent variable (log of cost per length of visit) would result in low kurtosis (2.81) and skewness values (-0.04) compared with the non-transformed values of skewness (2.34) and kurtosis (15.1). Applying similar techniques, the transformed value of length of visit kurtosis decreased to (2.8) from (14.86), and the skewness value decreased from (2.35) to (-0.41).

Table 2. *Comparison of Log Transformation of the Dependent Variable*

	Cost of Visit	**Log of Cost of Visit**	**Length of Visit**	**Log of Visit**
Number of observations	665	665	665	665
Mean	1.72	0.35	8.42	1.95
Median	1.42	0.35	7.00	1.94
Std.Dev.	1.14	0.61	5.67	0.61
Skewness	2.34	-0.04	2.35	-0.41
Kurtosis	15.1	2.81	14.86	2.80

Considering the above factors, OLS regression was applied to the log transformed dependent variable to estimate the difference among health professional types, type of health facility and type of visit. After transforming the dependent variable, the econometric equation to be estimated has the following functional form:

$$\boldsymbol{Ln\mathrm{YL_i}/Ln\mathrm{YC_i} = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 D_{4i} + U_i} \quad (3)$$

where: $Ln\mathrm{YL_i}/Ln\mathrm{YC_i}$ = log of cost per length of visit/log of length of visit,

D_{2i} = a set of dummy variables for the type of professional (1 if the professional is a nurse/health officer, 0 otherwise),
D_{3i} = a set of dummy variables for the type of health facility and
D_{4i} = a set of variables for type of visit.

The detailed illustration of the models was explained in Table 1. Finally the log-transformed model was tested for multi-collinearity and heteroskedasticity using the Cook-Weisburg test (Gujarati 2002).

Results

Seventy nine health facilities were covered during the survey. At each health facility we conducted a minimum of 10 and a maximum of 15 patient exit interviews. A total of 665 time-motion studies were conducted to estimate the length of visit and cost per visit. The majority of patients (77%) saw nurses, while 19.6% and 3.5% were treated by health officers and doctors, respectively. Sixty-two percent of the patients visited a health center, while the remainder (38%) attended a hospital. More than 60% of the patients examined were categorized as WHO stage I or II. The smallest proportion of patients (2.6%) was WHO stage IV patients.

Table 3. *The Length of the Visit (by the minutes) among the Surveyed Health Facilities*

Length of visit by facility type					
Facility type	*Mean*	*Median*	*Std.Dev.*	*Min*	*Max*
Hospital	8.9	7	6.56	1	60*
Health Centre	8.3	7	4.99	<1	34*
Length of visit by professional type					
Health professional	*Mean*	*Median*	*SD*	*Min*	*Max*
Doctor	8.7	9	2.93	3	15*
Health Officer	7.6	6	5.17	1	24*
Senior nurse	8.7	7	5.82	<1	60*
Cost of visit by facility type					
Facility type	*Mean*	*Median*	*SD*	*Max*	*Min*
Hospital	2.0	1.63	1.58	12.2	0.1**
Health Centre	1.9	1.70	1.28	9.3	<1**

**P<0.05, **P<0.01*

Length of Visit and Cost of Visit

The average number of minutes spent by the patient in receiving ART services was 8.46 minutes, with a range of less than one to 60 minutes per visit. As depicted in Table 3, the time spent with patients was similar at health centers (8.3 minutes) and hospitals (8.9 minutes) ($p<0.05$). The length of visit

with a doctor and a senior nurse was also similar, at an average of 8.7 minutes. Health officers spent on average 7.6 minutes with a patient ($p<0.05$) (Table 3).

The overall mean cost per visit was 2 ETB, with a range of 0 to 12 ETB (less than 0.5 USD). This variation could be attributed to two factors: the amount of salary paid and the amount of time spent during the visit. As shown in Table 4, the highest visit cost was recorded when a patient visited a physician/doctor (3.02 ETB), while visits with a nurse had the lowest cost (1.90 ETB) at a statistical significance level of $p<0.05$. Health officers and nurses had similar costs per visit (2.0 ETB for health officers).

The labor cost per visit further varies with the type of the services provided: initiation, follow-up and referral. The highest unit cost was estimated for patients on initiation (2.32 ETB), and the lowest was for patients with continuing/follow-up visits (1.95 ETB) ($p<0.05$). The cost of a visit at hospitals averaged 2.04 ETB, which is slightly higher than the average cost at health centers (1.91 ETB) ($p<0.01$).

Table 4. *Cost of Visit Spent by Different Professional Categories*

Cost of visit by professional type			
Health professional type	*Mean*	*SD*	*Median*
Doctor	3.02	0.91	3.2**
Health Officer	2.0	1.54	1.4**
Nurses	1.9	1.36	1.9
Total	1.96	1.39	1.7

**p<0.01

Econometric Model Result

An ordinary least square technique (OLS) model was employed to estimate the relationship between the logarithmically transformed dependent variables (log of cost per length of visit) and the independent variables (type of health professional, type of health facility and type of ART activity). A summary of the model results for the dependent variable labor cost per visit is provided in Table 5. R^2 for the model was found to be 0.02, showing that the model explains little of the variation in the cost per visit. The insignificant result from the Cook-Weisburg test (Figure 1) indicates no heteroskadasticy. The second model was estimated using the log of the length of visit as the dependent variable. As shown in Table 3, the coefficients of the second model are similar to the first model on the labor cost per visit. This clearly suggests that much of the difference in the cost per visit is due to the length of the visit rather than the salary of the health care professional.

Table 5. *Summary Result of Modeling Log of Length of Visit and Log of Length of V*isit

Model One (log of cost per visit)			
Variables	**Coefficient**	**S.E.**	**p-value**
Professional	0.15	0.08	0.04
Facility	0.01	0.05	0.67
Type of visit	-0.01	0.2	0.91
Constant	0.35	0.41	0.721
R^2=0.01, N=664, F(3,660)=0.25, Prob>F, 0.8643			
Model Two (log of length of visit)			
Professional	0.15	0.08	0.076
Facility	0.01	0.05	0.83
Type of visit	-0.01	0.2	0.65
Constant	1.94	0.41	0.00**
*R^2=0.02, N=664, F(3,660)=0.23, Prob>F, 0.754,**p<0.01*			

Figure 1. *Cook-Weisberg test for Heteroskedasticity for Log Length of Visit*

Breusch-Pagan/Cook-Weisberg test for Heteroskedasticity for Model Log Length of Visit
Ho: Constant variance
Variables: resid
Chi^2(1)=0.23
Prob>Chi^2=0.6351

The interpretation of the econometric models followed the approaches suggested by Halvorsen and Palmquist (1980). In line with these authors, the simielasticity for regressor with qualitative variables was analyzed by taking the antilog (to base e) of the estimated dummy coefficient, subtracting 1, and multiplying by 100 (Halvorsen and Palmquist 1980). The results obtained from the estimated model indicate that the median length of visit for doctors (D=1) is 16% higher than that of nurses and health officers when controlling for health facility type and type of visit (p=0.076). The same analysis shows that the median cost per visit to hospitals (D=1) was 1 percent higher than to health centers (p=0.67).The analysis indicates that the length of visit for a follow up/continuing visit (D=1) would be 1% lower than that of an initiation visit (p-value=0.65). Similar results were obtained for both the length of the visit and cost of visit dependent variables. As shown in Table 5, the model also shows that the median cost per visit for doctors (D=1) is 15% longer than that for nurses and health officers (p=0.04). According to the OLS model results, there are minimal differences in the length of a visit to hospitals (D=1) compared with a health center (p=0.83).

Discussion

The study found a 15% lower length of visit and labor cost per visit for ART patients treated by nurses and health officers than physicians. The findings from the econometric model support the recent debate on task shifting (Anonymous 2008, O'Malley et al. 2014, Zacharia et al. 2009) health care delivery to the least costly health worker capable of reliably performing this task. This micro-economic analysis strengthens recent findings on anti-retroviral task-shifting in Namibia and Botswana which highlighted the relevance of task shifting in improving access, service quality and skills enhancement (Monyatsi et al. 2011, O'Malley et al. 2014).

The finding of the study also support recent momentum in the initiation of task shifting by the WHO (2008). Unlike the variable of the type of health professional, no statistically significant difference was detected in the effect of the type of health facility (hospitals and health centers) and type of patient examined (initiation, follow-up) on the length of visit and cost per visit. This suggests that efficiency gains are due to task shifting and not to either decentralization or different types of patients being sorted to different service providers. Studies by Zacharia et al. (2009) also qualitatively indicated lower estimated costs of pre-service education of non-physician clinicians, especially lower level health professionals. Furthermore, task-shifting was considered a cost-effective measure to maximize output (Babigumira et al. 2009, Buttorff et al. 2012) but cost saving should not be achieved at the expense of the quality of service provision. The health economics literature has also cautioned that the economic benefits generated by any intervention should not compromise the quality of care (Zacharia et al. 2009). However, a government report draws attention to the fact that services provided through a task-shifting approach are not necessarily inferior to a physician-led, team-based approach to providing ART services, provided necessary measures are taken assure quality (Ethiopia Ministry of Health - HAPCO nd).

Conclusions

The length of visits for ART patients varied little with the tier of the health facility (hospital and health center). However, the estimated labor cost of a visit (wage rate * time spent) was less at the surveyed public health facilities than at private facilities. This is possibly due to the fact that staff at public health facilities in Ethiopia earn less than at private facilities and that the former have far more ART patients due to economies of scale. Considering the limited resource setting at public health facilities in Ethiopia, this study highlighted a significantly lower length of visit and labor cost of a visit to nurses and health officers. Since task-shifting to less specialized health-care workers yields economic benefits, the expansion of ART task-shifting should be considered by all concerned stakeholders, but should not undermine patients' benefits and public health outcomes. Moreover, the econometric models were tested for

proper functional form, outliers, residual normality, homoskedasticity, multicollinearity, and found to be well-fit, which adds credibility to the findings (Figures 2, 3, 4 and 5).

Figure 2. *Power Transformation for Cost per Length of Visit*

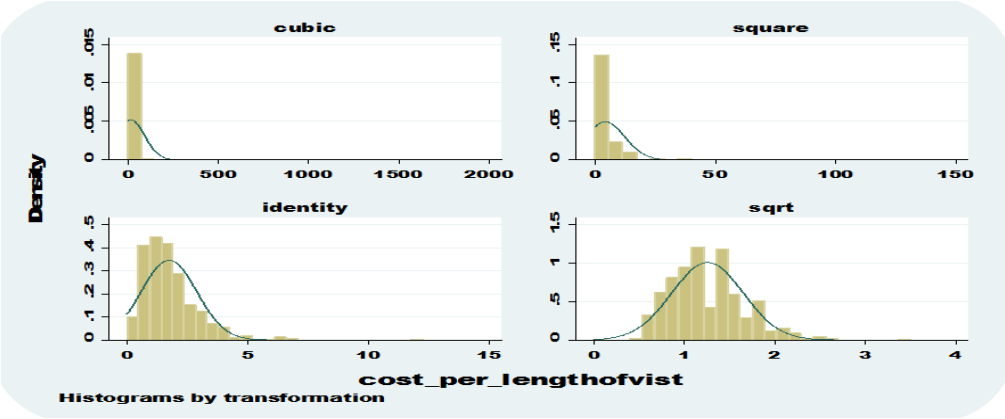


Figure 3. *Power Transformation for Length of Visit*

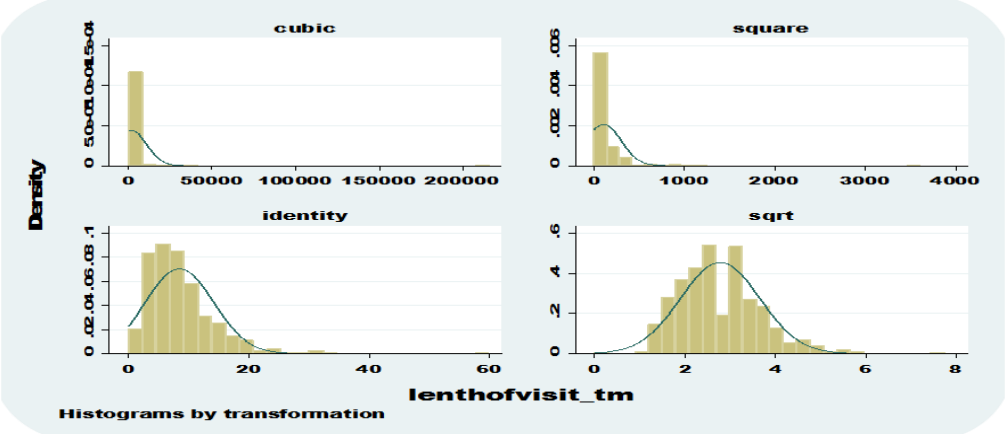
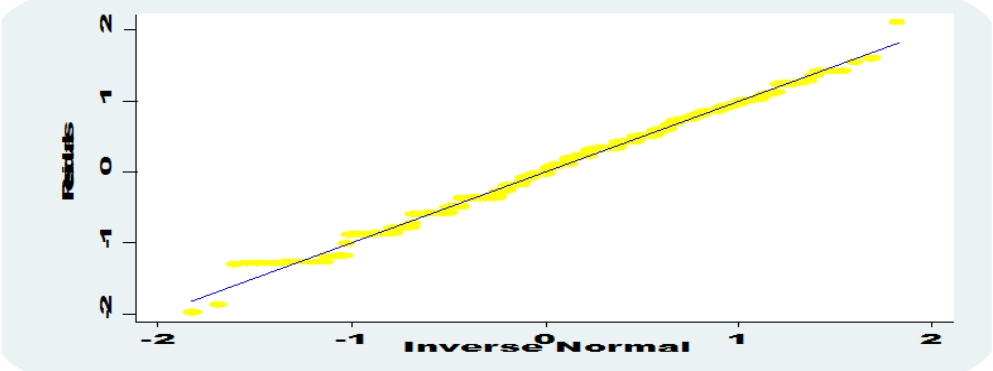


Figure 4. *Testing the Normality of the Residuals***.**
Testing the Normality of the Residuals, Cost per Length of Visit (a)



Testing the Normality of the Residuals, Length of Visit (b)

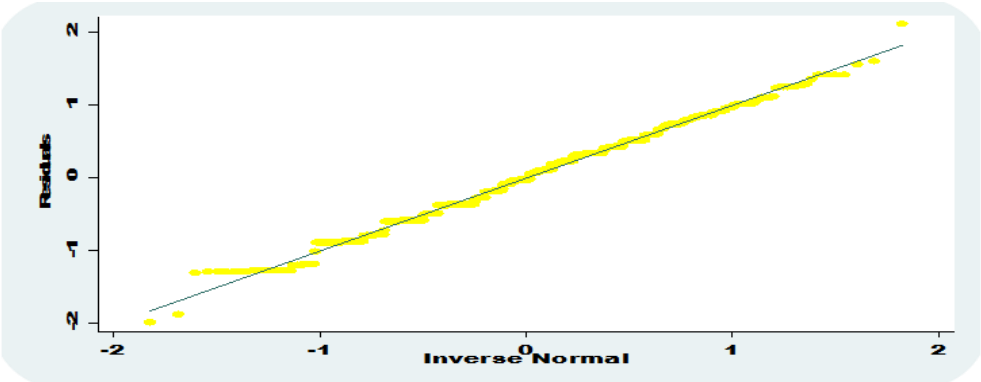
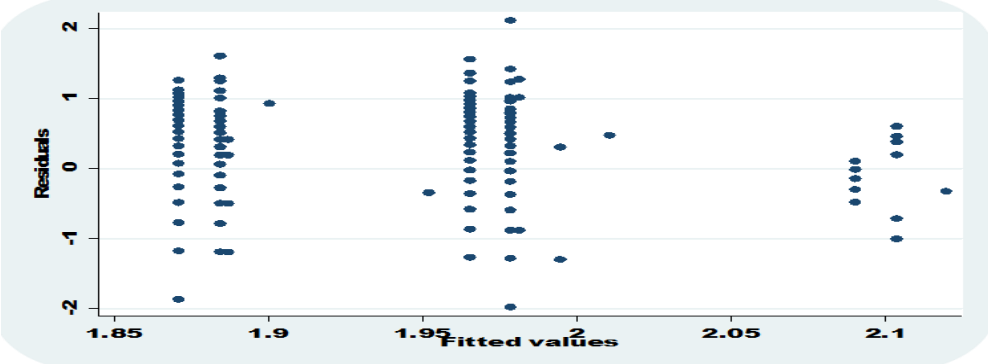


Figure 5. *Multicollinearity Test using Graph for Length of Visit*



Due to the dearth of evidence on the health facilities, the model analyzed the statistically different relationship between (length of visit and cost per length of visit) using only three variables (the level of health professional, type of health facility and type of patient examined). Further in-depth research that considers other determinant variables such as the quality of care should be conducted in order to determine their impact on the cost difference. The impact of ART task shifting on the broader public health domain is also an important topic for future research in limited resource setting countries like Ethiopia.

The limited availability of data constrained this study in capturing other determining factors in the model. The models were limited to supply-side independent variables, without considering other variables such as patients' socio-demographic characteristics, the quality of care, distance from the health facility and treatment success indicators, which are also likely to affect the length of visit and cost per visit. The cost analysis emphasized only the labor visit cost, without considering other types of variable costs such as medical supplies and other related items. Despite this constraint, we believe that, this is the first study to analyze the economic significance of ART task shifting through applying a micro-econometric modeling exercise in the context of limited resource setting countries.

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Competing Interest

The authors have declared that no competing interests exist.

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