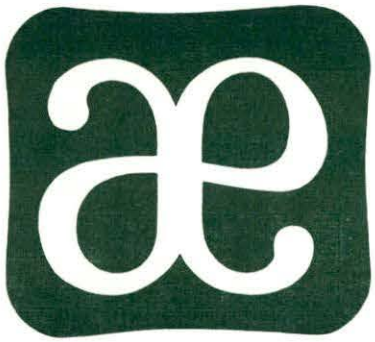

Agricultural Economics Report

Number 567
January, 1993

RETURNS TO EDUCATION: THE IMPACTS OF M.S.U. TRAINING ON WEST AFRICAN SCIENTISTS

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James Sterns
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"[My] concerns about the development of national agricultural research systems [include] the apparent presumption in some national systems that it is possible to do research in agricultural science without scientists"

Vernon Ruttan

INTRODUCTION

Michigan State University (MSU) has a long tradition of involvement with research, teaching and institution building in sub-Saharan Africa. Perhaps the most distinguishing characteristic of MSU's work is the development of domestic scientific capacity in African countries. MSU is a leading contributor to the development of African Ph.D. capacity, ranking first among all U.S. and Canadian Universities in the number of dissertations filed by African students (Kearl 1990).[2]

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[1]Research Assistant, Associate Professor, MSU and Research Assistant, World Bank, respectively. The authors would like to thank Richard Bernsten, Russ Freed, Robert Myers, Harold Riley and Lindon Robinson for comments on earlier versions of this paper. Research supported by the Bean/Cowpea CRSP and the MAES.

[2]The Department of Agricultural Economics at MSU is a strong participant in this training mission. During the Period 1985 to 1989, 21 M.Sc. and 6 Ph.D. degrees were awarded to African students. In the Fall term of 1990, there were 18 African graduate students enrolled in the department.

This paper quantifies the personal benefits of university education of West African researchers and administrators who have graduated from MSU since 1965. Education generally leads to higher salaries and personal benefits such as improved opportunities to earn outside income, or increased welfare through nonpecuniary amenities. This paper quantifies these benefits, using survey results and regression analysis. Coefficients from this analysis are then used to calculate a rate of return to investments in education. It would be of interest to know also the social benefits of enhanced research and education systems, however, quantifying the contributions of individual scientists to social objectives is difficult. Discussion of differences between personal and social benefits indicates that personal benefits provide a lower bound on social returns to investments in education of scientists, and hence that the ROR calculated in this paper is a lower bound to the social ROR to investments in training. The paper concludes with a discussion of implications and suggestions for further inquiry.

CURRENT TRENDS IN TRAINING

Current university training opportunities are low in Africa. Kearl reports that African universities have facilities to train only 139 students per 100,000 population. This can be compared to Asia/Middle East with 650 openings per 100,000 population and Latin America with 1,250 openings. Ninety percent of all African Ph.D. students are studying at universities outside of Africa. Today, a total of 100,000 Africans are studying abroad, of which 23,000 are at U.S. universities. Approximately one-third of these 23,000 students are enrolled in graduate programs (Kearl, 1990).

The Rockefeller Foundation has tracked 2,300 African graduate students in the United States. Within this group approximately 500 Ph.D.'s were awarded annually, of which 45 were in the agricultural sciences. Approximately fifty to sixty-five percent of these students were

sponsored by donors. Assuming that this group is representative of African graduate students in the U.S., an estimated 3,800 to 4,900 Africans are funded by donors (Kearl, 1990).

The estimated cost for the 1989-90 academic year for a Ph.D. student living on the MSU campus is $22,750 (See Appendix 1). Students accompanied by their families, or those doing field research, often require substantially larger budgets. Additional costs of overseas education include travel expense from Africa to MSU, and the relatively high tuition paid by out-of-state students.[3] In most cases these costs are borne by a combination of donor agencies, the student and his/her family, and Michigan taxpayers through implicit subsidies or explicitly through Departmental and other assistantships.

A rough estimate of the amount spent by sponsors and state governments in training of African graduate students is calculated by extrapolating the average cost of $22,705 to represent the cost today of one year of university training in the United States. From the range listed above, assume that in the U.S. about 4,400 African graduate students are currently being sponsored. Assuming annual costs of $22,750 per student, these sponsorships represent an annual investment of $100 million in education and training. Additional public funding for this training is provided by states since they subsidize approximately 56% of total operating costs of state universities. Even African students without donor funds enjoy the benefits from this funding. Estimating that there are 3200 African students without direct financial support, the indirect costs are $41 million,[4] implying a total cost for training of $141 million. Regardless of

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[3]Donor agencies affiliated with USAID projects budget as much as $25,000 to $30,000 annually for sponsoring a graduate student. This figure is considerably higher than the single student, "on-campus" expenses used to estimate the 1989-90 costs of $22,750 at MSU.

[4]If total annual costs are $22,750 and appropriations represent 56% of this cost, then each student costs the state, in appropriations $12,740. With 3,200 African students studying at U.S. universities, this implicit cost is calculated as ($12,740 * 3,200) = $41 million.

this estimate's crudeness, it indicates a need to ask, "What are the returns to an annual investment of this proportion?"

CONCEPTUAL ISSUES

The existing literature does not sufficiently document the economic returns to degree level training in agriculture, especially at the graduate level. Broder and Deprey (1981) and Preston et. al. (1988) examine private benefits to graduates in the U.S. employment market for former agricultural students, where private benefits are measured by increases in salary. In Preston's work, gender, education, year of job market entry, profit sharing, and personal emphasis on earnings were significant factors determining starting salaries. Significant factors affecting salaries received after some time in the labor market were starting salaries, on the job experience with the first job, profit sharing, communication skills, marital status, and place of residence. Broder (1985) finds positive correlations between monetary returns and higher levels of education for graduates in agricultural economics. Other work, conducted even earlier, focused on the sub-sector of agricultural economists with doctorate degrees that were working in academic positions (Broder, 1985). Although all of this literature was relevant, it could not be directly applied to African scientists who return to their home country after completing their training.

A SURVEY OF MSU GRADUATES

Survey Design

A survey was designed by the authors to measure the contribution of MSU, post-secondary education to the welfare of scientists who came from and returned to West Africa.

An attempt was made to identify both monetary and nonmonetary benefits that could be attributed to the attainment of a university degree(s).

The target population for the survey included all graduates of the MSU College of Agricultural and Natural Resources (CANR) who had come from and returned to West Africa. The survey instrument used to collect the desired data was a mail questionnaire, sent to every address available. Ninety-seven questionnaires were mailed during the first three weeks of September 1989. Notably, 92 percent of the 50 anglophone addresses and 47 percent of all addresses were Nigerian (Table 1).

A first draft of the questionnaire was pre-tested at MSU. Eighteen current African graduate students within the CANR were interviewed. Thirteen of these pre-test respondents were Ph.D. students and five were M.Sc. students. Each of these respondents was asked first to complete the questionnaire and then to critique it. Insights gained from both the questionnaire responses and feedback from pre-test respondents were used to upgrade the questionnaire into the final survey instrument.

The final draft included 10 sections and 48 questions. Aside from demographic information, the two main themes to the survey were the identification of a) monetary gains due to education and b) non-monetary gains due to education. Possible monetary gains that were considered were salary income, opportunities to earn secondary income through contracting, consulting, etc, and opportunities to earn per diem. Non-monetary benefits that were considered were changes in the level of family health care and nutrition, access to education for children, quality of housing, personal and work transport, and availability of leisure time and activities.

The questionnaire was designed to distinguish between changes due to training and changes due to other factors. Specific questions were asked to distinguish between improved

personal welfare that was or was not related to training. Respondents were asked to what degree the following factors increased their salaries: the length of time employed, cost of living adjustments, changes in job position and/or title, and graduate training. One factor affecting personal welfare which this survey did not attempt to measure was the criteria for selecting trainees. Some trainees may have been selected because of family ties, political connections, or other special circumstances. For these trainees, a certain standard of living may have always been assured. However, by comparing pre- and post-training income levels insights into the magnitude of benefits from training can be gained.

Summary of Survey Results

Thirty surveys were returned during the six month period which followed the September mailings. Three were returned unanswered since the address was no longer current or the respondent was deceased. One was returned with no indication of the nationality of the respondent. Efforts made to encourage a higher response rate included provision of addressed return envelopes and postage coupons for mailing. However, a low response rate is not surprising for a mail survey which involved two trans-Atlantic crossings and depended on the postal services of 13 countries. The response rates on a country by country basis are listed in Table 1.

Important demographic characteristics of the respondents in addition to nationality were gender (26 out of 27 were male) and the level of training received at MSU (4 B.Sc.,23 M.Sc., and 9 Ph.D. degrees). Nine of the respondents received two degrees from MSU. The most common fields of study were agricultural economics (9), agricultural education and extension (4), and food science (4). Years since graduation ranged from one to 23 years with a mean of 8.56 years.

The most prominent theme found in the responses is that the respondents unanimously felt that their training was beneficial to them. Twenty-four of the twenty-seven respondents indicated that these benefits were both pecuniary and nonpecuniary. Two of the remaining respondents felt that the benefits were only non-pecuniary while one felt that they were strictly pecuniary.

The nominal increase in respondents' salaries from pre-training levels averaged 341 percent. In no way does this figure represent the impact of training on earning potential since inflation, economic cycles, political climate, status of donor agencies, longevity of employment, and other factors will also affect reported salaries. This is most obvious when the nominal salaries of the respondents were converted to 1967 dollars. In real dollars, the average salaries actually decreased after training by 21 percent. This decrease in earnings after training can only be understood in the broader picture of African economies in the 1980's. As respondents incurred an average decline of 21% in salaries since completing their degrees, their respective countries incurred an average decline in Gross Domestic Product (GDP) of 43 percent.

Nineteen respondents stated that they have opportunities to earn income in addition to their salaries and thirteen of them marked that these opportunities increased after training. These opportunities included presenting papers at conferences (9 responses), personal enterprises (7), and consulting for private firms, their home government and donor agencies (13). Moreover, it is plausible to relate increased job responsibilities and occupational longevity directly to the educational process. There was a shift away from employment with government ministries towards employment at universities, plus an increase in the level of responsibility at the work site for all respondents. Eleven of the twenty-seven respondents now have University staff positions while six are at research institutes. However, one shift in employment which is known to exist (Wessen, 1988) that was not well documented by this survey is an employment

shift from the public to the private sector. The lack of corroboration of this shift is probably a function of the mail survey. Since MSU cannot keep a completely current list of addresses, graduates who have left the public sector (government/ university employment) and did not update their addresses with MSU may not have received the questionnaire. Also, those in the private sector who did receive the mailing may have a lower response rate (this will be discussed further momentarily).

United States graduate education also increases nonmonetary benefits. Seventeen of the twenty-seven respondents with children indicated that their ability to provide for their children's education had changed. Seventeen of the twenty-seven stated that their ability to provide for their family's health care had improved. The majority of the respondents noted increased family consumption of meats, dairy products, and fruits and vegetables. Twenty indicated improved housing conditions. Specific improvements included larger, cleaner, more secure and better located housing with improved access to services like electricity, running water and telephones. Respondents were also asked about how access to leisure activities and leisure time had changed after their return from MSU, however, no clear pattern of increases/decreases in access and time was discernible.

ECONOMETRIC ANALYSIS OF SURVEY DATA

Methodology

Of the twenty-seven returned questionnaires, only eighteen had complete income data with both current and pre-training salaries. Because of the small number of cases, results from this analysis should be considered to be preliminary. However, attempts have been made at identifying possible trends and correlations drawn from analyzing the data.

The eighteen cases with income data were from seven countries, although ten of the eighteen were Nigerian (Table 1). All but one of the 18 cases in this sub-group were male. The highest degree earned by each of the 18 respondents within this sub-group was one B.Sc., twelve M.Sc., and five Ph.D. degrees.

The SAS mainframe program was used to do this analysis. All salary, GDP, and cost data were converted to U.S. dollars at the mean exchange rates for the year in which the salary, cost or GDP figure was quoted. After converting the data to these nominal dollars, all figures were deflated to 1967 equivalent values.[5]

Annual salaries (deflated, as above) earned prior to training ranged from $110 to $4,160 and the arithmetic mean for them is $2,440. Ex-post salaries currently being earned range in value from $270 to $12,100 with a mean of $1,930. The average elapsed time since completion of graduate studies at MSU was 7.5 years.

A multiple regression model isolated the contribution of education to current annual salaries. The dependent variable was the natural logarithm of the current salary as quoted on the questionnaire. Independent variables included years since graduating, dummy variables for both the highest degree earned while at MSU and the alumnus' nationality, interactions between the degree and nationality variables and the interaction between the time since graduation and the country's GDP.

It is expected that both education variables (M.Sc. and Ph.D.) will contribute positively to current salary. The nationality variable allows for differences in basic salary levels between Nigeria and francophone West African countries. Because Nigeria's oil-based economy suffered from recession in the 1980's, leading to structural adjustments, it is expected that salary levels in Nigeria will be below those in francophone countries. The interaction between nationality and

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[5]See Appendix 2.

education allows the returns to education to differ between Nigeria and francophone countries. Inclusion of these interaction terms means that the coefficient on the education variables represent the salary effects of education in West African countries, while the effects in Nigeria are represented by the coefficients on the education variables plus the coefficients on the education* nationality interaction variables. It is expected that because of economic problems in Nigeria, the value of education will be less than in other West African countries.

A variable measuring time since graduation is included, since it is expected that individuals with more seniority (longer time since graduation) will achieve a higher salary level. Hence the coefficient on this variable is expected to be positive. An interaction term between years since graduation and nationality allows for different effects of seniority in Nigeria and francophone countries. Again, because of problems with the economy, it is expected that seniority commands less of a salary premium in Nigeria. Finally, a variable measuring the increase in gross domestic product (GDP) since the scientist began training is an attempt to capture other effects of the national economic environments on salaries.

Results

Regression results showed an excellent goodness of fit with an $\bar{R}^2$ of 0.99 and an F-statistic of 651, which rejects the null hypothesis of no meaningful regression at the 0.01 percent level (Table 2). All variables are significant at the 5 percent level except for the interaction term between the Ph.D. education variable and nationality; this variable is significant at the 7 percent level. All variables have the expected signs with the exception of the nationality variable; the positive coefficient on this variable indicates that other things being equal, base salary levels in Nigeria may be higher than francophone West African countries (this positive

effect is largely offset by the negative effects of zero or negative real growth in the Nigerian economy.)

The coefficients on the education variables appear to be similar in size; however, due to the nonlinear (semi-log) fashion in which these variables enter the regression equation, the coefficients indicate that a Ph.D. contributes more than does an M.Sc. to salary. The interaction terms between education and nationality are negative for both the M.Sc. and the Ph.D. The effects of education in Nigeria are measured by adding the coefficient on the M.Sc. (Ph.D.) variable to the coefficient on the M.Sc.* nationality (Ph.D.* nationality) interaction term. For both the M.Sc. and the Ph.D. the effect of education is positive in Nigeria, although much smaller than in the francophone countries. In Nigeria, the increase in salary due to a Ph.D. degree is not substantially different from that due to an M.Sc. degree.

Is Small Sample Size a Problem?

The regression results presented above are based on 18 observations, which is an acceptable but small sample. Three problems generally associated with small samples are multicollinearity, imprecise parameter estimates, and low power of hypothesis tests.

Multicollinearity can arise because the small sample may not have adequate variation in the independent variables. If this is the case, then within the sample some variables may behave similarly to each other or to a constant, leading to high correlations among these variables (and the constant term if one is included), and difficulty in interpreting parameter estimates. For example, multicollinearity can cause an F-test to reject the joint hypothesis that a group of regression coefficients are all equal to zero, while a t-test of the hypothesis that a single coefficient equals zero would be accepted for every coefficient in the group. Contradictory inference results of this type make it extremely difficult to determine the significance of any

particular variable, such as education. Fortunately, collinearity diagnostics do not suggest the presence of multicollinearity in the survey data (this is in part due to the categorical nature of independent variables such as education or nationality). We do not observe problems with inference: t- and F-tests performed on the regression estimates exhibit consistent results, generally showing statistical significance of the estimated parameters.

Imprecise parameter estimates can also arise in small samples. The standard errors of OLS estimators are inversely related to the number of observations in the sample, so that small samples lead to large standard errors and imprecisely measured parameters. This would lead to problems with hypothesis testing and prediction based on parameters. For example, rates of return calculated from imprecise parameters would be imprecise themselves, with large standard errors, leading to difficulties in interpretation. Fortunately all parameter estimates presented in this paper have small standard errors (e.g. as shown by t-ratios), suggesting that calculated rates of return are not subject to large errors caused by inaccurate parameter estimates.

Finally, small sample sizes can also lead to low power of hypothesis tests, particularly when multicollinearity of imprecisely measured parameter estimates are present. Low power indicates a high probability of making a type II error; that is, of accepting the null hypothesis when it is false. For the inference presented in this paper, a type II error would translate into accepting the hypothesis that education has no effect on salary when in fact it does. However, empirical results reject the null hypotheses that education has no effect and so concerns about type II errors are not a serious issue (presumably because we have precise parameter estimates). When the null hypothesis is accepted, the concern is about type I errors; that is, rejecting the null hypothesis when it is true. But the probability that this happens is governed by the choice of significance level, which can be made independently of sample size. For example, with a 5 percent significance level a type I error would be made in 1 out of 20 hypothesis tests which

reject the null hypothesis (on average), and this error rate would be the same whether the sample size was 18 or 1,800.

Thus we conclude that our sample does not suffer from the problems which can cause small samples to be uninformative, and the estimated parameters accurately reflect the information in our sample.

Selection Bias from a Mail Survey

Selection bias occurs in mail surveys when certain groups of individuals return the survey and other groups do not. For example, in a survey about the effect of education on income, those individuals who believe that their income is lower than average may choose not to respond to the survey because they do not want to divulge their income status. Similarly, those individuals who chose to leave a government institution (which may have helped sponsor their education) for a more lucrative job in the private sector may choose not to respond because they are embarrassed about leaving their sponsoring institutions. These kinds of non-responses may occur despite guarantees of and adherence to strict confidentiality.

Selection bias leads to problems with statistical inference or with the robustness of results. If characteristics of the target population are normally distributed, as is often the case, and if only particular groups within the population report, then it is likely that regressions and statistical inference based on assumptions of normality will be inappropriate. On the other hand, if the responding groups constitute a distinct subpopulation with normally distributed characteristics, then regression may be meaningful for this subpopulation but will be hard to generalize to the entire population.

Examination of responses shows that all of our respondents were employed in the public/university sector, with no respondents employed by the private sector (Table 3). Hence we conclude that our sample may be valid for the group of scientists employed in the public sector, although generalizations made to a larger population may not be supported.

If the regression is to provide meaningful results for those scientists employed in the public/university sector, then it is important that the regression errors satisfy the assumption that they are distributed normally.

Judge et. al., (1985) suggest use of the Shapiro-Wilk statistic (Shapiro and Wilk, 1965) for tests of normality. The statistic has a range of (0,1) with 1 representing normality and lower values of the statistic representing departures from normality. For the errors from the training regression presented in Table 2, the value of the test statistic is 0.96. The probability of obtaining a lower value from an underlying normal distribution is 0.70, so that the hypothesis of normally distributed errors cannot be rejected at any reasonable significance level.

Hence we conclude that the sample used in this analysis does provide relevant information about the effects of education on scientists' salaries in the public sector. The mail survey does lead to selection bias which limits our conclusions to those scientists employed in the university/public sector, but does not lead to problems with regression as applied to this group. It is expected that the effects of education would be stronger on those scientists employed in the private sector (e.g. by consulting firms), although we have no data in our sample to confirm this.

Quantifying the Impacts of Education

The regression results can be used to quantify the increase in salaries caused by education. Using the sample means and regression coefficients, the model is capable of predicting current salaries of researchers as well as what salaries would have been if the scientists had never received additional education. The base salary, assuming no graduate training, is US$ 111 for francophones and US$ 304 for Nigerians. The difference between current and base salaries is the net personal gain in annual earnings from attaining a graduate degree. This jump in earnings is more evident for the francophone scientists with a net gain of

$2,290 for completing a masters degree and a net gain of $4,260 for completing a Ph.D. degree (Table 4).

A rate of return to training can be calculated using the cost and benefit data. Table 5 illustrates the incremental benefit streams with and without the inclusion of non-monetary benefits. The benefit streams were generated using the regression described above to predict ex-ante and ex-post salaries. The average increase in salary was calculated for both masters and doctoral students and projected over a period of 30 years. The Benefit II stream shown in Table 5 includes non-monetary benefits as well. Non-monetary benefits are quantified based on respondents' estimates of the percent of total benefits of training which is non-monetary. The average estimate was 38%.

Costs include only tuition, fees, living costs and state appropriations. Additional costs not included are: travel to and from training institutions, replacement of professionals while they are in training, psychic costs such as separation from family, and opportunity cost of salary not earned by students during the training period.[6] Benefits include only the private returns to the individual. Returns to society in the form of enhanced research and educational systems are not included in the benefit stream. The rate of return to training based on benefits derived purely from increased income is 22 percent. When non-monetary benefits are included the rate of return rises to 31 percent.

IMPLICATIONS FOR RETURNS TO PUBLIC INVESTMENT IN TRAINING

Thus far this paper has focused on the private returns to human capital acquisition by individuals who have gone through an advanced degree program. However, many donors are

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[6]It is possible that donor stipends for students while in the U.S. may actually have been greater than the foregone salaries. If this is the case, then net income (stipends less foregone salary) would be a benefit that is not included in the stream.

interested in the social benefits rather than private benefits. Estimation of private returns to education provides two pieces of information relevant to discussions of public returns.

First, the private returns provide a realistic lower bound on the range of possible public returns to increments in scientist training. Economic theory indicates that workers will not be paid in excess of their product. In the case of public research the end product is social benefit. Most public research agencies are expected to generate social benefits which exceed their costs, including salary costs, reinforcing the idea that the social benefits of educating and employing scientists are at least as great as the private benefits.

Second, because research scientists are an integral part of public agricultural research, it would be expected that social returns to investments in the employment of trained scientists are comparable to social rates of return to investments in the larger research program. This implies that the benefits of education and consequent employment of scientists in public research would equal the private benefits of education plus the additional social benefits generated by the scientists' research. In a rate of return framework, the social ROR to education and employment equals the private ROR to training multiplied by one plus the social ROR to public agricultural research. For example, if the private ROR to training were 21 percent and the social ROR to research were 33 percent, then the social ROR to training and employment would be 28 percent. These calculations would have to be altered to account for the social rate of return in different careers: a scientist working for a private (or ineffective public) firm may generate low social ROR's from this work.

The magnitude of social RORs to investments in public research depends on the particular research programs under examination. The large number of ROR studies for Asia, Latin America and the developed world indicate consistently large, positive RORs to agricultural research. However, the paucity of ROR studies in Africa and the apparent stagnation in

African agricultural productivity suggest a need for circumspection when applying these results to African agricultural research (Daniels, et al.). High turnover in West African research institutions (Wessen, 1988) also limits the applicability of approximating social returns to education and employment from research ROR studies. Thus it is appropriate to conclude that the estimated private RORs of 22-31 percent calculated in this paper provide reasonable lower bounds on the social rate of return to training, but that greater precision is not possible with the survey data.

CONCLUSIONS

Significant amounts of money and time are being invested in the U.S. training of African technicians and scientists. Eighty-four universities were identified as being involved in a some way in this type of activity (Kearl, 1990). Many USAID projects world-wide have included university training of host nationals as part of a project's objectives. The question of benefits and returns then is a relevant one well beyond MSU's campus. Data concerning the returns, both to the individual and to society, from this investment are lacking and difficult to attain.

This study indicates a positive return to investments in graduate education. Using a regression analysis, a private rate of return to graduate training was calculated to be between 22 and 31 percent. The sample used to generate results consists of scientists employed in the public sector, and hence considerable care must be exercised in generalizing these results to scientists employed by the private sector. However, since private-sector salaries generally exceed those in the public sector, it is expected that personal returns will be higher for those scientists employed by the private sector. Education has positive impacts on measures of individual welfare such as health, education of children, work conditions, etc. Social benefits and rates of return are expected to be at least as large as private benefits.

There is a need in Africa for improved monitoring and evaluation of returned graduates. Such efforts could be coordinated between foreign and domestic educational institutions. The information garnered from these efforts is needed to evaluate the cost effectiveness of training programs.

Table 1. Survey Mailing Rates and Response Rates By Country.

COUNTRY	# OF SURVEYS MAILED	# OF SURVEYS RETURNED	# OF RETURNS WITH INCOME DATA
Benin	1	0	0
Burkina Faso	5	1	1
Cameroon	7	3	1
Cote D'Ivoire	3	1	0
The Gambia	1	1	1
Ghana	3	0	0
Mauritania	4	1	1
Niger	4	2	1
Nigeria	46	11	10
Republic of Mali	5	1	0
Senegal	17	5	3
Togo	1	0	0
Totals	97	26	18

Source: Survey of MSU alumni from West Africa, Sept. 1989.

Table 2. Regression Analysis of Salary after Training [a/b/]

Variables	Parameter Estimates[c/] (Standard Error)
Years Since Graduation	0.77 (0.17)
Nationality Nigerian	5.34 (0.58)
Highest Degree: Masters	3.09 (1.09)
Highest Degree: Doctorate	3.51 (1.32)
Interaction Between Masters & Nationality	-2.99 (1.13)
Interaction Between Doctorate & Nationality	-2.78 (1.37)
Rate of Increase in GDP Since Entering Training at MSU	5.34 (1.65)
Interaction Between Nationality and Time Since Graduation	-0.74 (0.18)

[a/] The dependent variable is the log of post training salary.

[b/] The F statistic is 651.271 with a probability > F of 0.0001; $\bar{R}^2 = 0.998$

[c/] All variables are significant at the 5 percent significance level.

Table 3. Place of Employment, Before and After Training.

EMPLOYER	BEFORE TRAINING	AFTER TRAINING
Government Ministry	16	11
Government Research Institute	7	7
University/Student	2	0
University/Faculty-Staff	2	8
Donor Agency	1	2
Private Sector	0	0

Table 4. Predicted Annual Salaries for 3 Levels of Training (In 1967 U.S. $)

Survey Strata	Predicted Without Training	Pred. Current Salaries With Training	Mean Current Salary
Francophone-MSc	110	2400	3910
Nigerian-MSc	320	350	360
Francophone-PhD	130	4390	4390
Nigerian-PhD	280	580	630

Table 5. Aggregated Costs and Predicted Benefits of Training Based on West African Survey Data

Year	Costs	Benefits I Increased Income Only	Benefits II Including Non-Monetary	Incremental Benefit Stream I	Incremental Benefit Stream II
1981	4445	0	0	-4445	-4445
1982	6346	0	0	-6346	-6346
1983	9427	0	0	-9427	-9427
1984	12228	2290	3690	-9938	-8538
1985	16475	2290	3690	-14185	-12785
1986	8419	9160	14760	741	6341
1987	3337	11450	18450	8113	15113
1988	0	18000	29010	18000	29010
1989-2013	0	18000	29010	18000	29010
2014	0	15710	25320	15710	25320
2015	0	15710	25320	15710	25320
2016	0	8840	14250	8840	14250
2017	0	6550	10560	6550	10560
2018	0	0	0	0	0

APPENDIX 1 - ANNUAL COSTS OF A UNIVERSITY DEGREE

Training costs fall into two broad categories: those incurred by states via funding of public universities and those incurred by the student and/or sponsor.

MSU is a publicly funded land grant institution and currently receives about 56% of its operating budget from the people of Michigan (by way of legislative allocation of state taxes). Table A3 outlines the funding trends of the past twenty-five years. Appropriations are funds supplied by the State. Other funding comes form federal reimbursements for overhead costs of managing federal grants, interest on trust funds, application fees, and transcript sales. Any analysis of the costs of training needs to include the state appropriations since it subsidizes the costs of an education at MSU.

Students and their sponsors are directly responsible for the payment of tuition, fees and living costs. Tables A1 and A2 outline tuition and the estimates of living costs for university students for the past twenty years. The estimates in table A2 were made by the Financial Aid Office at MSU and include the costs for tuition and fees.

A general total cost figure for university training can be calculated from the three tables. For the academic year 1989-90, total annual costs (explicit and implicit) of educating an out-of-state graduate student at MSU was approximately $22,750. This figure is calculated as follows:

a) From Table A1, costs of tuition and fees for four terms with 9 credits per term is $6,449. This calculation is (36 * $168.25) + (4 * $98).

b) From Table A3, it is implied that tuition and fees represent 37.4% of total funding. This can imply a crude estimate for total operating costs (those costs met by tuition and fees as well as those met by appropriations) for one graduate student of $17,230. This calculation is ($6,449/.3743).

c) From the MSU Financial Aid Office, the cost of living estimate for 1989-90 is $11,970. Subtracting out tuition and fees, an estimate for other living costs is $5,521. This calculation is ($11,970 - $6,449).

d) Summing estimated student living costs and estimated university operating costs, a total cost figure is estimated to be $22,750. This calculation is ($5,521 + $17,230).

Using tables A1 - A3 and survey responses, cost data were estimated for the 27 respondents in the survey (discussed on page 3). The following is an example of how the cost figures were determined:

a) From the completed survey, it is noted that the respondent (code # 140) was at MSU for seven quarters (fall term 1985 through spring term 1987), and that he completed a M.Sc. degree.

b) Assuming that the respondent was enrolled all seven quarters and that the respondent completed roughly the number of required credits for a M.Sc. (48), then the respondent averaged seven credits per term.

c) From Table A1, in-state tuition and fees for seven credits for four quarters in 1985-86 are $1,808.

d) From Table A3, it is noted that 32.14% of general funds are from tuition and 60.92% are from appropriations. This implies that appropriations are worth $3,427. This calculation is ((1808/.3214)*.6092).

e) From Table A2, a per term cost of living estimate for 1985-86 is $1,965. This implies a four term cost of living estimate of $7,860.

f) Summing estimated living costs and estimated state appropriations, a total cost figure for this respondent in 1985-86 is estimated to be $11,287.

g) This process would be continued for the three quarters in 1986-87 during which the respondent was also enrolled. A total cost figure would sum the two annual costs.

Table A1. Graduate Student Tuition and Fees for Michigan State University in Nominal Dollars per Credit Hour

Year	In-State	Out-Of-State	Fees
1967-68	12.88-17.00 per block	31.67-41.67 per block	
68-69	16.22-22.67 per block	33.44-43.00 per block	
69-70	13.00	31.00	
70-71	15.00	34.00	
71-72	15.00	34.00	
72-73	16.00	35.00	
73-74	17.00	37.00	
74-75	17.00	38.00	
75-76	22.00	43.00	
76-77	26.00	49.00	10
77-78	28.00	49.00	10
78-79	29.50	52.50	10
79-80	32.50	57.50	12
80-81	37.50	63.00	13
81-82	43.50	82.00	13
82-83	50.00	82.00	13
83-84	55.00	94.00	13
84-85	60.00	104.00	13
85-86	61.00	117.00	25
86-87	66.00	126.00	25
87-88	73.00	135.50	110
88-89	82.75	150.00	95
89-90	90.00	168.25	98

Source: MSU Office of Planning and Budgets

Table A2. Estimated 10 Month/3-Term Cost[1] of Living at MSU in Nominal US $

Year	In-State		Out-of-State	
	Single	Married	Single	Married
1967-68	1830	3300	2655	4185
68-69	na	na	na	na
69-70	2250	3855	3050	4830
70-71	2610	4855	3420	5660
71-72	2850	4800	3700	5790
72-73	2950	4900	3700	5900
73-74	3050	5100	4050	6000
74-75	3150	5145	4150	6090
75-76	3280	5245	4225	6190
76-77	3580	5545	4525	6490
77-78	3780	5745	4895	6850
78-79[2]	4050	6105	5200	7255
79-80	4320	6510	5550	7740
80-81	4695	6930	5865	8100
81-82	4905	7290	5940	8325
82-83	5115	7440	6270	8610
83-84	5895	7995	6750	9315
84-85	5595	8175	7005	9585
85-86	5895	9795	7650	11550
86-87	6195	10260	8220	12285
87-88	6960	11240	9030	13310
88-89	7335	11735	9585	13985

[1]Cost estimates include tuition, books, room, board, medical, and personal/recreation. Source: MSU Financial Aid Office. [2]1978-79 and on, estimates are for graduate students.

Table A3. General Fund Budgets by Component.

Year	Appropriation	%Budget	T & F*	%Budget	Other	Total
1964-65	31,384,333	72.05%	10,372,040	23.81%	1,800,949	43,557,322
1965-66	38,571,731	74.21%	11,532,040	22.19%	1,869,949	51,973,720
1966-67	44,180,272	72.57%	14,868,328	24.42%	1,832,369	60,880,969
1967-68	45,004,168	67.66%	18,954,698	28.50%	2,554,389	66,513,255
1968-69	48,949,219	65.29%	23,236,228	31.00%	2,780,949	74,966,396
1969-70	54,086,462	63.48%	27,272,028	32.01%	3,837,302	85,195,792
1970-71	59,932,124	63.45%	29,880,362	31.63%	4,645,949	94,458,435
1971-72	65,318,000	64.51%	30,209,000	29.84%	5,720,000	101,247,000
1972-73	70,839,000	66.13%	30,361,000	28.34%	5,925,000	107,125,000
1973-74	77,325,100	66.77%	31,450,900	27.16%	7,030,000	115,806,000
1974-75	85,665,800	67.12%	33,301,200	26.09%	8,668,000	127,635,000
1975-76	88,635,893	64.02%	41,057,607	29.65%	8,764,000	138,457,500
1976-77	89,752,925	62.07%	44,198,875	30.57%	10,640,000	144,591,800
1977-78	99,382,900	62.33%	48,038,100	30.13%	12,030,000	159,451,000
1978-79	109,614,225	63.14%	51,577,560	29.71%	12,426,000	173,617,785
1979-80	120,208,275	63.76%	55,840,886	29.62%	12,486,000	188,535,161
1980-81	123,850,646	60.78%	64,452,786	31.63%	15,478,800	203,782,232
1981-82	125,442,994	58.54%	70,964,700	33.12%	17,861,000	214,268,694
1982-83	122,067,641	56.59%	75,701,571	35.09%	17,939,393	215,708,605
1983-84	139,054,593	57.75%	80,008,083	33.23%	21,722,284	240,784,960
1984-85	151,906,696	58.33%	83,514,936	32.07%	25,024,858	260,446,490
1985-86	168,082,837	60.92%	88,682,122	32.14%	19,145,000	275,909,959
1986-87	186,660,017	60.88%	95,963,000	31.30%	24,000,983	306,624,000
1987-88	196,496,000	58.76%	116,463,000	34.83%	21,450,000	334,409,000
1988-89	204,925,000	57.84%	127,600,000	36.02%	21,761,000	354,286,000
1989-90	211,152,000	56.17%	140,696,000	37.43%	24,050,000	375,898,000

NOTE: When prior year forward funding is incorporated as a revenue item, it is reflected within the "Other" column.
*T & F stands for tuition and fees.

APPENDIX 2 - DEFLATION PROCEDURE

Ideally, income data would have been deflated using each country's consumer price index and then converted with a real exchange rate to U.S. dollars. Regrettably, deflators and real exchange rates for many developing countries do not exist or are of questionable reliability. The authors justify converting salaries to U.S. dollars (using the nominal exchange rate) and then using the U.S. deflator with the following example.

Given that a donor agency wishes to invest X dollars, the "no risk" choice would be to invest in guaranteed U.S. government securities at Y% return. It is this return that is the baseline return to which all other project rate of returns can be compared.

A second option is to invest the money each year in short term savings in the U.S. and then spend a portion of the money on annual income support payments to developing countries. (Note, this money is annually at the nominal rate.) Thus workers in the chosen developing countries enjoy the personal benefit of increased income, though societal gains are limited.

A third option is to spend the money on U.S. training of researchers from developing countries. Assuming that salaries increase due to training, then the personal benefits to the researchers are the same as the income support option listed above. Yet, the training is likely to have benefits to society well beyond the increased personal returns.

With both the second and third options, the benefit stream involves increased personal earnings. If the income support in the second option exactly equaled the gains in income from training in the third option, then, conceptually, the U.S. deflator is an acceptable substitute for country specific deflators.

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