PN-ABB-867
60007

WORKING PAPER No. 3

ANALYZING CONDITIONS OF SERVICE FOR AGRICULTURAL RESEARCHERS: AN EXPERIMENT USING EARNINGS FUNCTIONS

isnar

International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, Netherlands on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting governments of developing countries to strengthen their agricultural research. It is a non-profit autonomous agency, international in character, and non-political in management, staffing and operations.

Of the thirteen centers in the CGIAR network, ISNAR is the only one which focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on organization, planning, manpower development, staff requirements, financial and infrastructure requirements, and related matters, thus complementing the activities of other assistance agencies. Additionally, ISNAR has an active training and communications program which cooperates with national agricultural research programs in developing countries.

ISNAR also plays an active role in assisting these national programs to establish links with both the international agricultural research centers and donors.

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Citation:

International Service for National Agricultural Research. Analyzing Conditions of Service for Agricultural Researchers: An Experiment Using Earnings Functions. 1985. The Hague, Netherlands.

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July 1985

isnar

International Service for National Agricultural Research

ISNAR WORKING PAPERS

The ISNAR working papers series is a flexible instrument for sharing analysis and information about relevant organization and management problems of the agricultural research systems in developing countries.

In the course of its activities - direct assistance to national agricultural research systems, training, and research - ISNAR generates a broad range of information and materials which eventually become the formal products of its publications program. The working papers series enhances this program in several important ways:

1. These papers are intended to be a rapid means of presenting the results of work and experiences that are still in progress, but are already producing results that could be of use to others;

2. They are intended to be an effective vehicle for widening the discussion of continuing work, thereby increasing the quality of the final products; critical comment is welcomed;

3. The series provides an outlet for diffusing materials and information that because of their limited coverage, do not meet the requirements of general audience publication.

The series is intended mainly for the diffusion of materials produced by ISNAR staff, but it is also available for the publication of documents produced by other institutions, should they wish to take advantage of the opportunity.

ACKNOWLEDGEMENTS

The opinions expressed in this document are the sole responsibility of the authors.

This paper represents an attempt to develop a methodology for analyzing conditions of service using administrative data or data from surveys carried out as part of ISNAR reviews of national agricultural research systems.

We would like to acknowledge the constructive comments received from colleagues and the assistance of those staff members who first generated the data used in the paper.

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I. INTRODUCTION

One of the critical functions of a national agricultural research system is to develop, retain, and motivate a body of competent scientific professionals. Without denying the possible existence of individual scientists for whom the "mystique" of research is its own reward, the present paper is based on the belief that the reward structure for agricultural researchers is basic to the system's ability to attract, retain, and motivate its scientific labor force.

In many of its system reviews, ISNAR has discovered that the government was considering a revision of the salaries for researchers, more often than not in the face of loss of its high-level human resources to other sectors. The oft-proposed solution of paying "higher" salaries to researchers involves, however, questions of both the level and the structure of salaries. ISNAR also requires a way of projecting the cost implications of any recommended increase, whether it be across the board or in favor of particular groups in scarce supply.

The present paper is a first step in developing a tool for the analysis of salary structure in agricultural research systems. The proposed method can be used as a standard part of ISNAR system reviews or for providing insights into the reward structure as a special project to study conditions of service in a particular country. The paper recognizes that to be useful a tool must be relatively simple to use:

a. It must not impose a large problem of data collection.

b. The time needed to carry out the analysis must be short.

c. The results must be understandable by the users.

d. They must lend insights into real problems of the system.

The earnings function approach proposed in this paper responds to these exigencies within a theoretical framework which is scientifically satisfying.

This paper has an introduction and four sections. Section II below describes the use of earnings functions and their associated income profiles. Section III describes the data sources for the three country analyses and the way in which the data were analyzed in three separate country studies: one from Africa (Zimbabwe); one from Asia (Thailand); and one from Latin America (Dominican Republic). Section IV attempts to relate the reward structure, as described by the earnings function, to the training efforts of the three cases studied. Section V closes with some comments on the usefulness of the earnings function as a way of linking the problem of the development of a body of professionals with the problem of retaining and motivating them.

It is not possible to argue that the three cases reported here represent the African, Latin American, and Asian wage structures. However, as ISNAR expands the number of countries about which it has data, we may find it possible to relate reward structure to particular phases of development of a research system or to particular regions of the world.

II. THE HUMAN CAPITAL APPROACH AND THE EARNINGS FUNCTION

The human capital approach treats investment in human beings in the same way as investment in physical capital. Individuals or their sponsors incur the costs of education or training in anticipation of higher productivity of the worker as a result of the training. Human capital is usually acquired through formal education, concentrated early in an individual's life on a full-time basis, and through on-the-job training and experience acquired on a part-time basis. The acquisition of human capital involves real costs to the individual or his sponsors. This may be in the form of foregone income, reduced productivity during training, and direct tuition and training costs. However, the individual acquiring the increased level of skills will enjoy a higher level of productivity and often a correspondingly higher level of income.

Education as an investment has been shown to offer a rate of return on invested capital which is higher than that earned on physical capital when the discounted present value of the additional output resulting from the training is compared with the costs of providing that training. In developed countries, where labor markets are finely tuned, an individual's earnings may be taken as a measure of his productivity to employers, and competition among employers ensures that the employee can sell his services at a rate which reflects the amount of human capital he possesses and the cost of obtaining it.

In developing countries, the prediction of earnings from a multiple regression analysis of education and experience factors is instructive in summarizing labor market information and in identifying statistical regularities which suggest the principal determinants of earnings. The

earnings function used in this paper attempts to estimate the relationship between the earnings of individuals and the amount of human capital they possess. It studies the monthly income of a cross-section of researchers with different degrees of formal education, lengths of experience, and other employment characteristics. The magnitude and statistical significance of the association between earnings and the various personal and job characteristics factors is a powerful guide to the working of the reward structure.

The amount of human capital possessed by an individual is usually proxied by the number of years of formal schooling completed by an individual and by years of job experience. In our formulation we use a series of zero-one dummy variables representing the highest degree actually completed by the individual instead of a continuous years of schooling variable because most personnel files and surveys will record information about completed degrees but not likely record years of schooling. Experience is also a very important determinant of productivity, especially in scientific professions, and the way in which salary rises with experience is very important in determining the ability of a system to retain its experienced researchers. In addition to these two basic components of human capital, we require various control variables for other influences on the earnings of an individual. These may be of a personal nature (e.g., whether the researcher is male or female) or of an institutional nature (e.g. whether the researcher is in a University, research institute, or the ministry of agriculture; whether he is in or out of the capital city; or whether he occupies a position of authority).

Most systems in developing countries are strongly based on formal credentials and seniority. The dangers of rigid credentialism are the

price a system often pays to escape the inefficiency of nepotism and inequitable remuneration practices that would occur in the absence of formal criteria. However, a system must have a way of rewarding competence and dynamism and the earnings function can be used to analyze whether or not the system permits more rapid advancement to those who are more productive.

The earnings function (discussed in Annex 1) takes the final form:

$$\ln SALARY = a + b\ EDUC + c\ EXPER + d\ EXPERSQ + e\ OTHER + RESIDUAL$$

where:

ln SALARY = the natural log of monthly salary in local currency

EDUC = a dummy variable representing the highest degree attained OR in some formulations the actual number of years of schooling completed,

EXPER = experience as measured by the number of years of potential work experience since graduation,

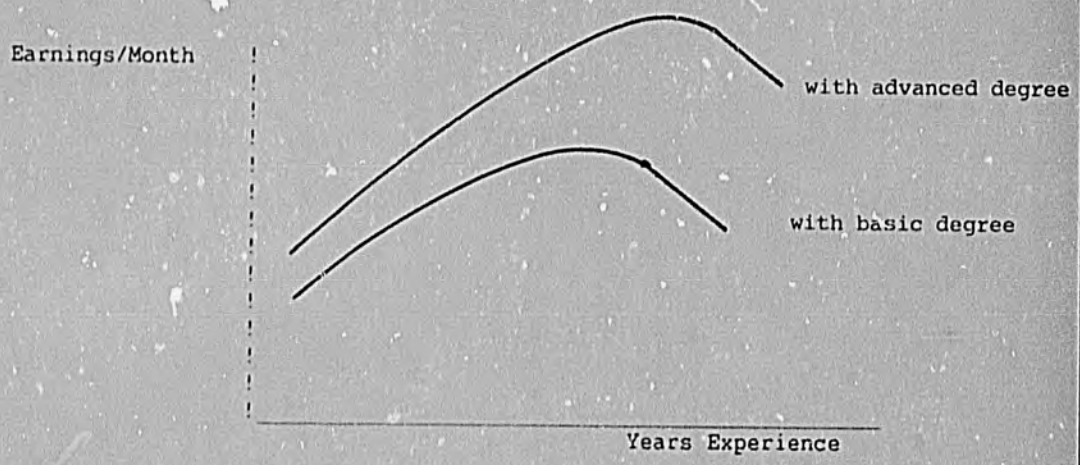
EXPERSQ = the square of the number of years of experience,

OTHER = an array of control variables representing personal or institutional factors, and

RESIDUAL = a residual representing a set of unobservable variables which are assumed on the average <u>not</u> to affect salary.

The results of the analysis can be represented in two-dimensional form as an income profile, with monthly salary on the vertical axis and years of experience on the horizontal axis. Higher levels of education (or OTHER characteristics) can be represented as upward or downward shifts in the height of the curve depicted in Figure 1 below:

Figure 1: The Income Profile



The shape of the Income Profile is our guide to the reward structure. It may be considered as a snapshot, at the time of the study, of the incomes of individuals with similar personal and job characteristics but different lengths of experience. Normally, the earnings profile will rise rapidly in the early years and reach a peak after 20 years of employment. The steep rise is useful in attracting individuals into the occupation (or establishment) where they acquire specific knowledge that increase their usefulness and tends to fix them in place. The salary structure will usually reward this increased level of skill.

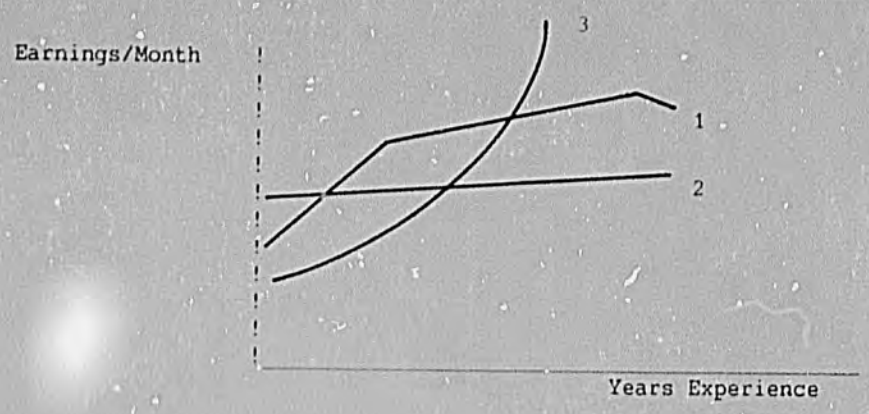
However, wages cannot rise indefinitely at compound annual rates without eventually pricing the owner of the skill out of the market. Therefore, we would expect that absolute wages will continue to rise with years of experience (a positive coefficient on EDUC), but the rate of increase will decline (a negative coefficient on EDUCSQ).

If earnings profiles are drawn separately for researchers with first degrees and researchers with higher degrees, we would normally expect the profile of the researcher with the higher degree to rise more steeply and reach its peak later in the individual's career. This is to be expected because a higher level of formal education may increase the individual's ability to profit from experience and maintain his productivity later in life.

The tendency for the curve to turn downward towards the end of a person's career is understandable when we consider that the curve is drawn in cross-section. A worker in mid-career (at the peak) is continuing to receive training opportunities in anticipation of high productivity over the remaining years of his career. The worker coming towards the end of his career has relatively fewer years over which additional training can provide benefits; thus there is a tendency for workers to receive less training late in their careers than earlier. This is reflected in lower relative earnings towards the end of their careers.

It was stated that the degree of incentive provided by a reward system was a question of the level and structure of salaries. In Figure 2 we present three representative shapes of the income profile, which have different implications for recruitment and retention of scientists.

Figure 2: Representative Shapes of Various Income Profiles



Curve 1 shows a "normal" shape of the income profile with a steep rise of salary in the early years of the individual's career and then a flattening of the curve in middle career. This curve is quite typical of "professional" occupations in which recent graduates (e.g. engineering) have the most advanced techniques and command high starting salaries. However, if the rate at which their skills or knowledge becomes obsolete is high, they may quickly reach their plateau. The rapid rise in the early years is useful to attract them to the employer and, insofar as the skills they acquire on the job are not marketable elsewhere, they will remain after their plateau has been reached. It is worth noting that all labor market conditions may differ widely among disciplines and that different reward structures may be needed within the same institution.

Curve 2 is "flat". Its height determines whether or not employment with a given employer is attractive. However, its flatness offers no incentive for an employee to seek continuous employment with that employer. Generally, employers offering flat income profiles face a

large supply of workers able to perform the job, there are low start-up costs for a new worker learning the job, and the work is organized in a way that does not require continuity of personnel. While an employer might try to hire and reward agricultural field supervisors in this way, he would not try to hire his scientists in this fashion.

Curve 3 is rising continuously with time. It is the salary structure which places the highest premium on retention of its personnel. Because of the way the curve rises with time it can be an expensive structure and can create large gaps between beginning employees and employees with long service. It is a structure which may be found in a "protected" public administration. The point of entry to the system is found at the bottom of the scale and the entire structure is thereafter insulated from the outside job market. Promotion is within the organization and while there may be some outward mobility (if wages are not comparable to those earned outside), entry is usually restricted to the lower levels.

In the following sections we attempt to estimate earnings functions for our three case studies. We wish to describe the reward structure of the system in terms of the shape of the income profile and then see if this allows us to say something about the appropriateness of the structure in the light of the staffing situation of the system.

III. THE USE OF ADMINISTRATIVE DATA FOR POLICY ANALYSIS: THREE CASE STUDIES

One of the advantages of the proposed methodology is that it requires only moderate effort to collect data for the analysis. Most civil

services collect very detailed information about their employees and their families. Thus one can usually count on finding information about the age, sex, family composition, education, position, function, and salary of researchers. For this reason, we have asserted that it is possible to use administrative data, which is collected regularly as part of the civil service administration, in order to undertake analyses of wage policy. However, it is rare to find that administrative data records the productivity of the employee in the form of some measure of scientific output (number of publications, etc) or systematic evaluation of his performance by his supervisors. Insofar as an individual's salary or rate of promotion depends on scientific output or performance, we would hopefully have some measure of this in his personnel file. The personnel information, on the other hand, is usually very rich in family information which can be useful in analyzing such characteristics as geographic mobility (a problem in systems where it is hard to attract scientists to up-country stations).

ISNAR has experimented successfully with a Human Resource Inventory questionnaire in several countries. The advantage to ISNAR of using such a questionnaire (see Annex 3) lies in its standardization of information across countries and its coverage of all information of a personal or professional nature important in analyzing conditions of service. Results with the surveys have been very good where it has been administered directly by the researcher or followed up closely by someone familiar with the system. This ensures that questions are properly answered and that there is no missing information. The ISNAR questionnaire covers all the personal and institutional information required for estimating the earnings function as well as a measure of

research productivity (publications) which is often missing from the administrative data. It also allows us to probe more deeply into training needs perceived by the researchers and thus serves as an input into analyses of human resource needs.

Separate files were created for each country studied. Data on the individual researchers were coded so that information could be cross-tabulated by the personal and institutional characteristics associated with each individual. The data were processed on a 64K microcomputer using STATPAK, a statistical analysis program for CP/M systems, and therefore, the study is one that could easily be carried out in the field during a review of a national agricultural research system.

A. Dominican Republic

The Division of Agricultural Research (DIA) in the Ministry of Agriculture agreed to undertake a special survey of its employees using a questionnaire proposed by ISNAR. This survey provided information on the age, sex, education, work experience, official position, and scientific output of the individual scientists attached to DIA. Some of the questionnaires were incomplete, and could not be used in the analysis. However, their absence did not introduce any serious bias into the results. The information supplied by the DIA came from all five stations under their jurisdiction.

We estimated the earnings function for researchers in the DIA of the Dominican Republic using several different combinations of personal and institutional characteristics. The results of these estimations are

presented in Table 1 below, and the corresponding earnings profile are presented in Figure 3.

Table 1: Earnings Functions for Dominican Republic

Variable	Equation 1 (n = 72)	Equation 2 (n = 72)	Equation 3 (n = 72)	Equation 4 (n = 72)
CONSTANT	6.02 (81.23*)	6.09 (108.6)	5.6 (26.92)*	5.9 (59.89)*
EXPER	0.03146 (2.379)*	0.026 (1.97)*	0.015 (1.147)*	0.047 (2.67)*
EXPERSQ	-0.00047 (0.00067)	-0.00026 (0.397)	-0.00035 (0.55)	-0.00099 (1.09)
LICENCIADO	-0.038 (0.505)	-0.1218 (2.10)*	-0.207 (1.26)	+0.553 (0.551)
INGENIERO	0.093 (1.57)	..	-0.085 (0.518)	+0.198 (2.54)*
MS	0.261 (3.387)*	0.186 (3.09)*	0.088 (0.509)	0.36 (3.548)*
SHORTCOURSE	..	0.18 (1.09)	-0.067 (0.284)	..
NONUNIV	..	-0.08 (1.43)	-0.14 (0.917)	..
DIRECTOR	0.498 (7.43)*	0.534 (7.05)*	0.505 (6.98)*	..
ENCARGADO	..	0.036 (0.815)	0.055 (1.28)	..
FEMALE	-0.151 (3.15)*	-0.14 (2.89)*	-0.10 (2.26)*	-0.188 (2.91)*
AGE	..	..	+0.018 (3.21)	..
$\bar{R}^2$	0.67	0.67	0.72	0.40

Note: The figures in parentheses are 't' statistics; all 't' statistics significant at the 97.5% level are marked with an asterisk.

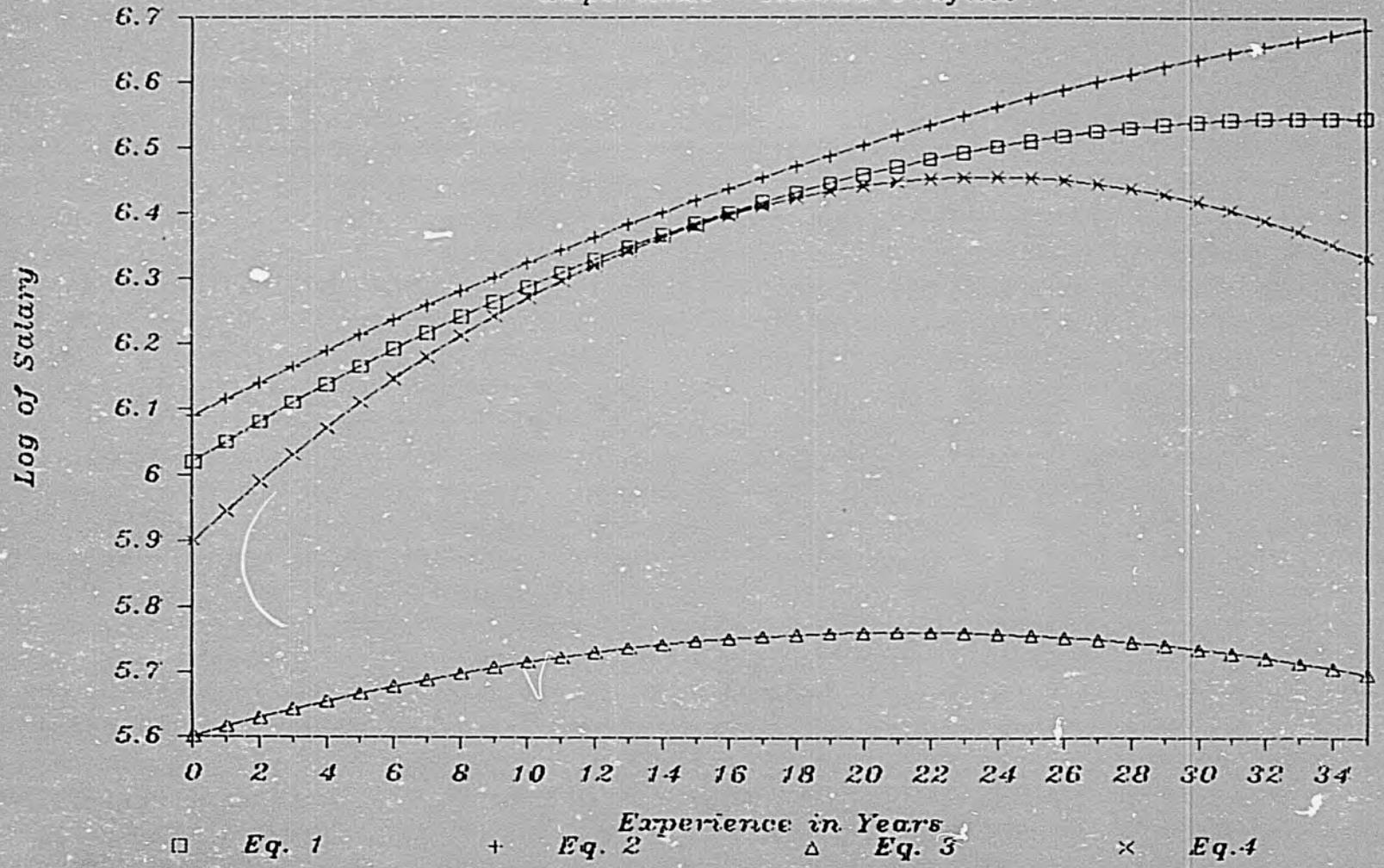
$\bar{R}^2$ is a corrected R^2 which allows us to compare estimating equations with different numbers of independent variables.

Descriptive Statistics on key variables are found in Annex 2.

Figure 3

DOMINICAN REPUBLIC

Experience – Income Profiles



In Equation 1 we estimated the earnings function across the entire sample of researchers using as explanatory variables EXPER and EXPERSQ, dummy variables representing the type of diploma received by the individual (licenciatura, ingeniero, maestria), a dummy (or Zero-One) variable indicating whether or not the individual was DIRECTOR of some institute or program, and finally, whether or not the respondent was FEMALE. Essentially the same equation was run in the case of Equation 4, omitting the DIRECTOR variable. Equations 2 and 3 introduce a number of variables which control for other job characteristics such as type of position held or educational experience received.

The earnings function is well-behaved in the sense that it has the expected shape and explains a high proportion of the variance in salaries among individuals in terms of the independent variables used in the equations. Based on the results of our estimating equations, we can make several observations about the reward structure:

1. The positive and significant coefficient on the experience variables in Equations 1, 2, and 4 show salary rising between 3% and 4% per year of experience. In Equation 3, the inclusion of a separate age variable, which is highly correlated with experience, explains the reduced significance of the experience variable.

2. The negative coefficients on EXPERSQ have the expected sign in terms of the human capital model, but their low magnitude and statistical insignificance lead us to believe that the salary structure has not yet evolved to the "peaked" structure of a mature system.

3. The ingeniero agronomo degree is the minimum training required to become an agricultural researcher. While the licenciatura in science or social sciences represents the same period of studies as the ingeniero degree, it appears to be associated in general with lower salaries than those received by people with ingeniero diplomas.

4. The masters degree has a strongly positive impact on salary (between 18 and 36%) and its effect is statistically significant as shown in Equations 1, 2, and 4.

5. The variable "SHORTCOURSE" measured participation in some form of non-degree (usually short-term) training after completing formal training. It does not have a significant effect on income and may underline the fact that, however useful they may be, short courses do not seem to improve one's income.

6. The DIRECTOR variable is strongly positive and highly significant wherever it has been included in the estimate. In Equations 1,2, and 3, however, where the Director and M.S. variables both appear, the estimated return to the M.S. degree falls. This indicates that there is a correlation between advanced degrees and the holding of administrative positions which should be investigated further. On the other hand, the variable "ENCARGADO", which was used to classify people who described themselves as being "in charge of" a section or program, does not appear to be associated with higher incomes. Both the magnitude of the coefficient and its statistical significance are small.

7. Finally, female researchers appear to earn less than their male counterparts as shown by the large negative coefficients on the FEMALE variable which are always statistically significant.

We will return to this case when we try to draw some lessons across the three examples. However, Equations 2 and 3 would lead us immediately to investigate carefully a) the relationship between nomination to positions of authority and the level of formal training; b) the apparently low impact of length of service on salaries; and c) the causes of the male-female differential.

B. Zimbabwe

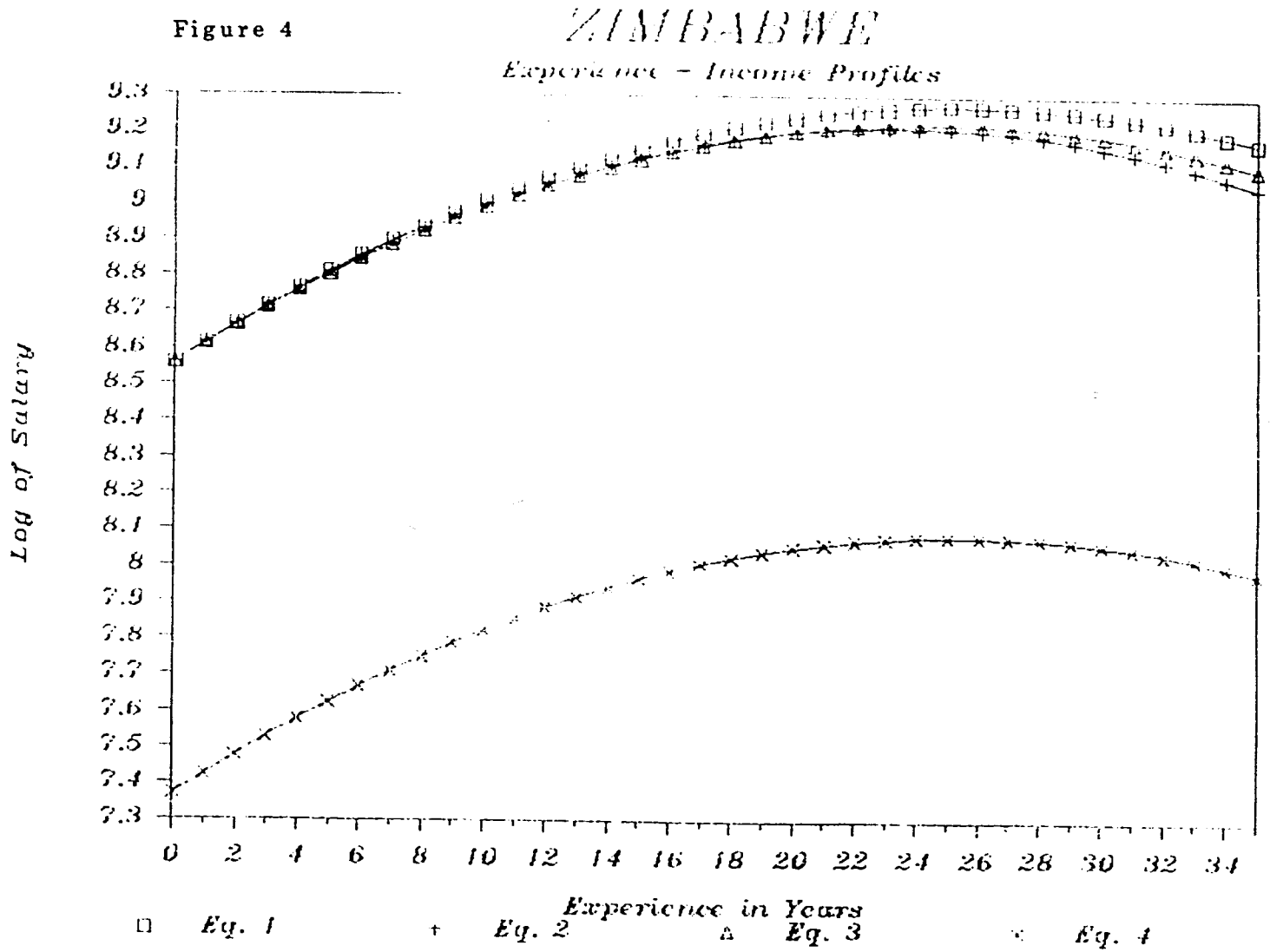
The data used in the Zimbabwe analysis came from a Human Resource Inventory survey prepared by ISNAR (see: A Training Plan for the Department of Research and Specialist Sciences, Zimbabwe, 1985 to 1988). The natural logarithm of salary was estimated as a function of EXPER, EXPERSQ, university degree dummy variables, the position held by the researcher, and sex. Again the earnings function is well-behaved, the amount of variance explained is high, and the coefficients on the principal variables are of the expected magnitude and are statistically significant. They are summarized below in Table 2, and the earnings profiles are shown in Figure 4.

Table 2: Earnings Functions for Zimbabwe

Variable	Equation 1 (n = 174)	Equation 2 (n = 174)	Equation 3 (n = 174)	Equation 4 (n = 174)
CONSTANT	8.56 (196.6)*	8.56 (146.5)*	8.56 (148.5)*	7.37 (63.8)*
EXPER	0.056 (9.27)*	0.056 (9.20)*	0.054 (8.91)*	0.056 (10.66)*
EXPERSQ	-0.0011 (6.27)*	-0.0012 (6.22)*	-0.0011 (5.57)*	-0.0011 (6.80)*
BS	0.279 (7.08)*	0.283 (7.06)*	0.278 (7.02)*	..
MS	0.426 (8.88)*	0.428 (8.90)*	0.413 (8.69)*	..
PhD	0.630 (7.29)*	0.635 (7.39)*	0.664 (7.61)*	..
YRSCHOOL	..	..	..	0.0847* (13.63)
DIRECTOR	..	..	0.428 (2.46)*	..
PRO/CRO	..	..	-0.199 (1.24)	..
LOCATION	0.016 (0.484)	..	..	..
FEMALE	..	0.0048 (0.10)	..	0.028 (0.69)
$\bar{R}^2$	0.58	0.58	0.60	0.67

See notes to Table 1.

Figure 4


ZIMBABWE
Experience - Income Profiles
Log of Salary
9.3
9.2
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9
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8
7.9
7.8
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7.6
7.5
7.4
7.3
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Experience in Years
Eq. 1
Eq. 2
Eq. 3
Eq. 4

We note the following results:

1. The large coefficient on EXPER is indicative of an income profile which is steeply sloped and provides rapid increases in salaries in the early years.

2. The negative coefficient on EXPERSQ is also highly significant and indicates a "normal" pattern of earnings function with diminishing increases as experience is accumulated.

3. Comparing the coefficients on the BS, MS and PhD variables, we find that the estimating equations reflect what one would believe to be the case: a PhD earns more than a master's who in turn earns more than a bachelor's. All coefficients are highly significant.

4. In Equation 4, where we used Years of Schooling rather than degree dummies, the return to a year of schooling is high and statistically significant. It is also worth noting that the earnings profile has the same shape as the ones estimated using dummy variables for the education variable.

5. The DIRECTOR variable shows up as highly positive and significant, without taking away explanatory power from the education variables.

6. The coefficient on the gender variable, FEMALE, is neither large in magnitude nor statistically significant, indicating that there is no evidence of discrimination against the women in the system.

7. Finally, in Equation 1, in which LOCATION was used, there do not seem to be any special advantages accruing to those located in the capital, Harare.

From the earnings function we would be led to examine more closely the rapid rise in salaries in the early years of one's career and the ability of the system to maintain a steeply sloped earnings profile over the long run. The system appears to reward as expected the earning of successively higher credentials.

C. Thailand

Agricultural research within the Department of Agriculture (DOA) in Thailand has a much longer history without major disruption than the other cases studied. It is also a much larger system, with a larger proportion of female scientists (38%) and a more stable pyramid of qualifications. In this respect, the Thai salary structure might approach a "stable" model to which systems might gravitate in the long run as their human resource pattern approaches the desired balance between BS, MS, and PhD scientists that it wants.

In 1983 the Department of Agriculture requested ISNAR's help in undertaking a study of the conditions of service for researchers which was potentially to serve as a pilot study for an investigation into conditions of service in the civil service in general. The present analysis has benefited from the availability of data collected for that study but is not formally part of it. The data used in the estimations were collected by clerks of the Department of Agriculture from personnel files maintained by the Department. It is worth noting that the files contain much more information than was extracted for purposes of the analysis, and it would be possible to design a much more refined analysis of the wage structure using only data from the administrative files. (Many systems in Latin America and Asia maintain computerized records that are potentially accessible for policy analysis.)

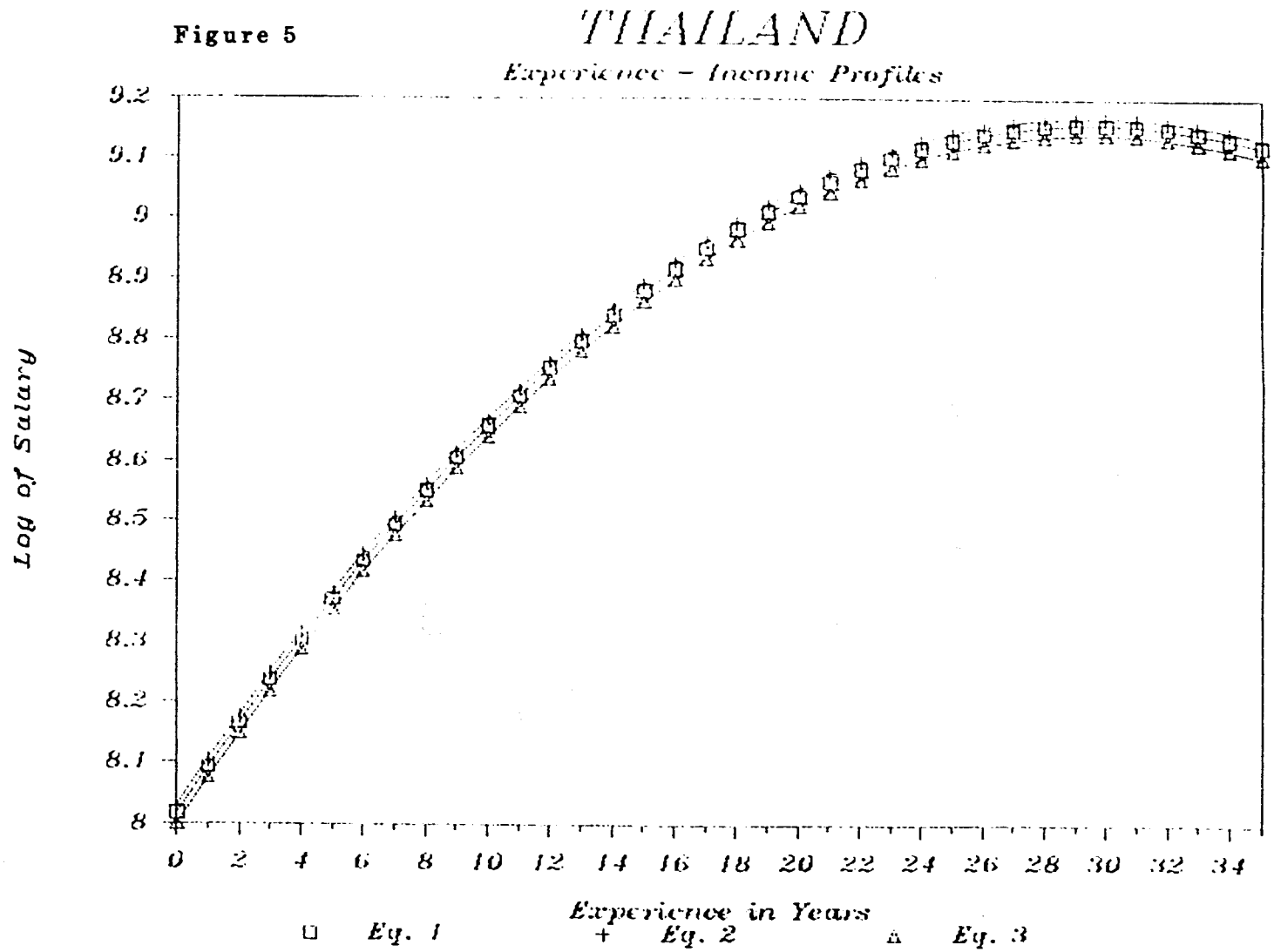
The large number of researchers in the Thai Department of Agriculture allows us to estimate earnings functions at a more disaggregated level than is possible in smaller systems. In Equation 1 of Table 3 we present the results of the basic human capital model, in which the log of monthly salary is estimated as a function of EXPER, EXPERSQ, and EDUC. In Equations 2 and 3 we add variables controlling for SEX and LOCATION. The experience-income profiles corresponding to these equations appear in Figure 5.

Table 3: Earnings Functions for Total Thai Sample

Variable	Equation 1 (n = 882)	Equation 2 (n = 882)	Equation 3 (n = 882)
CONSTANT	8.017 (436.01)*	8.03 (413.56)*	8.00 (390.06)*
EXPER	0.077 (24.72)*	0.077 (24.70)*	0.077 (24.84)*
EXPERSQ	-0.0013 (11.05)*	-0.0013 (10.93)*	-0.0013 (11.19)*
MS	0.054 (4.41)*	0.052 (4.23)*	0.045 (3.63)*
PhD	0.222 (5.68)*	0.227 (5.82)*	0.221 (5.71)*
SEX	-	-0.023 (2.13)	-0.016 (1.49)
BANGKOK	-	-	0.048 (4.10)*
$\bar{R}^2$	0.762	0.763	0.767

See notes to Table 1.

Figure 5


THAILAND
Experience – Income Profiles
Log of Salary
9.2
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9
8.9
8.8
8.7
8.6
8.5
8.4
8.3
8.2
8.1
8
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Experience in Years
Eq. 1
Eq. 2
Eq. 3

We observe:

1. The earnings functions are all well-behaved and exhibit a relatively steep slope in the early years and a peak coming between 25 and 26 years of experience.

2. The earning of a master's degree appears to be associated with a salary between 5 and 6% higher than the average for all researchers while the PhD is associated with a 22% gain, as demonstrated by the positive and significant coefficients on the degree dummies in Equation 1.

3. When the SEX dummy is added to the estimating equation (Equation 2) we find that males appear to earn about 2% less than females.

4. However, when the LOCATION dummy is included, as in Equation 3, the significance of the SEX dummy falls, leading us to believe that the reason for the apparently lower salaries for males is the concentration of women in Bangkok, where salaries are between 4 and 5% higher than the average.

In Equations 1-3 we estimated the earnings function across the total sample of Thai researchers, using dummy variables for sex, degree level, and location. When presented in this way, the influence of these variables on the earnings profile is represented by a parallel shift, upward or downward, in the curve. However, because the sample is so large, we are able to estimate earnings functions at a much finer level of disaggregation and still obtain statistically significant results. In

Equations 4-6 we estimate separate earnings functions for researchers with bachelor's (BS), master's (MS) and doctoral (PhD) degrees. In Equations 7-10 we further disaggregate in a way which permits comparisons between men and women at the bachelor's and master's levels. By disaggregating in this way, we can test to see if sex and degree levels affect not only the level but also the shape of the earnings profile.

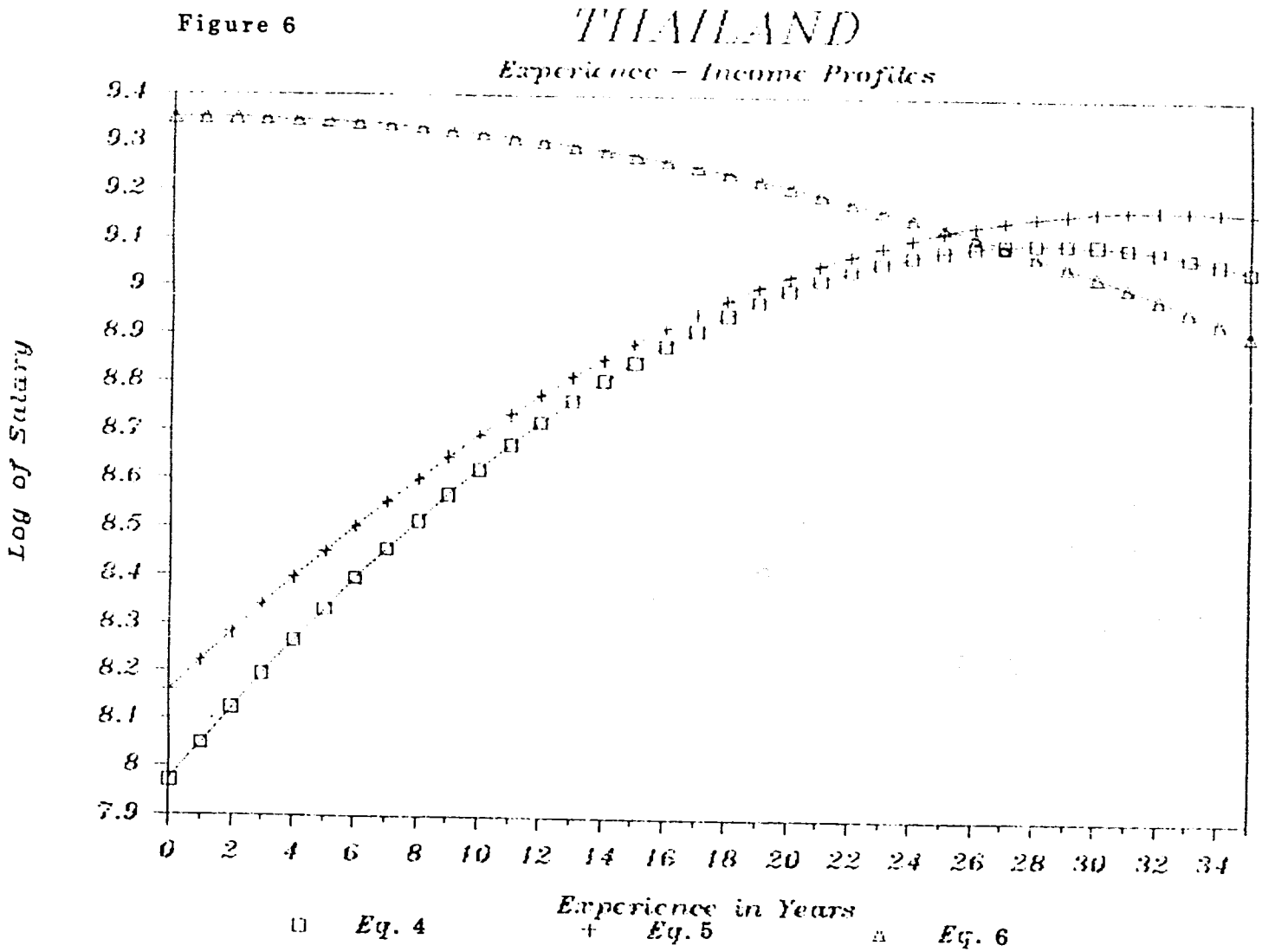
In Equations 4-6 we have broken the total sample into three separate samples by level of highest degree earned. The log of monthly salary is estimated as a function of EXPER, EXPERSQ, SEX, and LOCATION. The results are presented in Table 4, followed by the corresponding earnings profiles in Figure 6.

Table 4: Earnings Functions for Thai Researchers by Degree Level

Variable	Equation 4 BS (n = 624)	Equation 5 MS (n = 239)	Equation 6 PhD (n = 18)
CONSTANT	7.97 (332.65)*	8.16 (184.15)*	9.35 (4.83)*
EXPER	0.079 (22.10)*	0.063 (9.90)*	0.00078 (0.0043)
EXPERSQ	-0.00138 (9.86)*	-0.00098 (4.16)*	-0.00038 (0.09)
SEX	-0.022 (1.60)	+0.0049 (0.28)	-0.126 (0.079)
LOCATION	0.0564 (4.04)*	0.03 (1.31)	-0.159 (1.10)
R^2	0.742	0.717	0.129

See notes to Table 1.

Figure 6


THAILAND
Experience – Income Profiles
Log of Salary
9.4
9.3
9.2
9.1
9
8.9
8.8
8.7
8.6
8.5
8.4
8.3
8.2
8.1
8
7.9
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
Experience in Years
Eq. 4
Eq. 5
Eq. 6

We observe:

1. The shape of the income profile is very similar for the BS and MS scientists. One might have expected that earning an advanced degree would steepen the slope of the earnings function and permit a more rapid advancement through the system. This does not appear to be the case.

2. There is no significant difference in salaries of men and women as demonstrated by the low magnitude and statistical insignificance of the sex dummy.

3. For scientists with only a BS degree, there appears to be a statistically significant salary advantage (of the magnitude of 5-6%) to holding a job in Bangkok. However, the locational advantage does not appear to be significant at the MS and PhD levels, perhaps because scientists with these degrees working out of the capital have been posted up-country to positions of authority.

4. Although we present the equation for the PhD sample, the number of observations (18) was so small that there is little statistical significance to the coefficients.

In Equations 7-10, we carry the analysis to one further degree of disaggregation by creating separate samples for men and women at the BS and MS levels. The results of the estimations, in which the log of salary is a function of EXPER, EXPERSQ, and LOCATION, are presented in Table 5, with the corresponding earnings profiles in Figure 7.

Table 5: Earnings Functions for Thai Researchers by Sex and Degree

Variable	Equation 7 BS Men (n = 369)	Equation 8 BS Women (n = 255)	Equation 9 MS Men (n = 115)	Equation 10 MS Women (n = 124)
CONSTANT	7.987 (256.09)*	7.88 (252.52)*	8.12 (124.83)*	8.22 (135.11)*
YE	0.073 (15.16)*	0.104 (17.11)*	0.074 (8.33)*	0.037 (3.57)*
YE^2	-0.00115 (6.51)*	-0.0024 (8.95)*	-0.0013 (4.48)*	+0.00009 (0.21)
LOCATION	0.068 (3.47)*	0.0335 (1.89)	-0.007 (-0.25)	0.104 (2.87)*
$\bar{R}^2$	0.692	0.837	0.696	0.753

See notes to Table 1.

We observe:

1. At the level of the B.S., the earnings of men seem to peak later in their careers than those of women, indicating perhaps slightly better promotion prospects for men in years past.

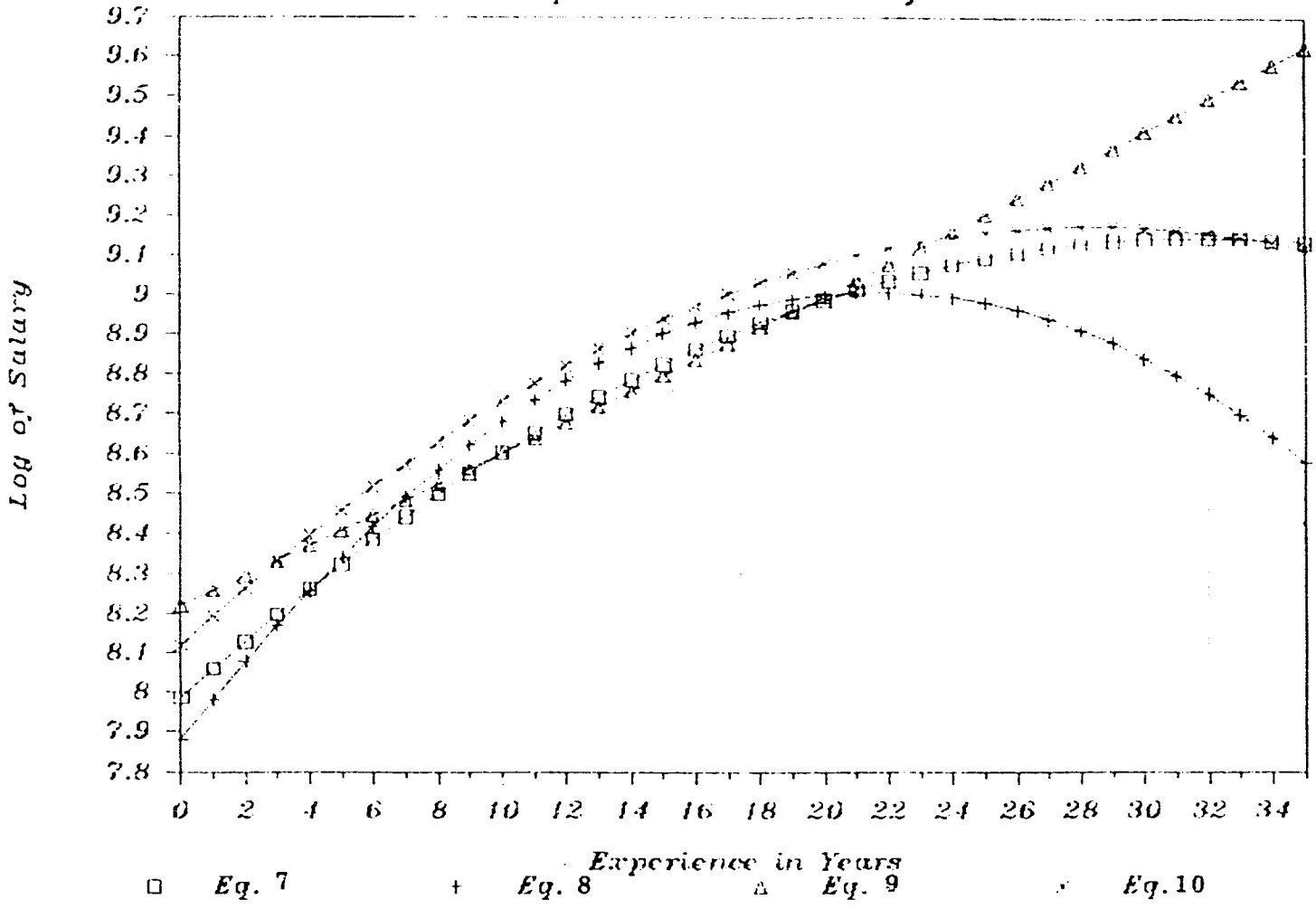
2. At the level of the B.S. men seem to benefit more than women from a Bangkok posting as shown by the higher and more significant coefficient on the LOCATION dummy in the male equation than in the female equation.

3. We observe again the similarity between the earnings profiles of male scientists with the B.S. and male scientists with the M.S. This is consistent with the impression that there is automatic promotion through the system.

Figure 7

THAILAND

Experience – Income Profiles



4. We note that for women, however, the earnings profile is quite different between the BS and MS samples. The earning of a Masters degree appears to have the effect of straightening out the earnings profile. Instead of peaking early in the career, the earnings profile of women MS scientists continues to rise with time (as shown by the insignificant coefficient on EXPERSQ). In an in-depth analysis, we would investigate several possible explanations. First, this phenomenon might result from the fact that the earnings profile for women MS scientists is reliable only over the rising portion during the first ten years because there are not enough observations of women MS scientists with long experience to describe a peaked function. Second, there may be important personal characteristics which separate BS and MS women scientists, either in the permanence of their attachment to the job or in their access to higher education and promotion.

The preceding analysis does not pretend to be an exhaustive analysis of the conditions of service in the Thai Department of Agriculture. It simply attempts to demonstrate that one can use readily available administrative data to identify important aspects of the conditions of service which merit in-depth examination.

From the high percentage of the salaries explained by the human capital variables in the Thai case we can see that the reward system is systematically related to length of service and formal education. Since this is the longest-established system included in our study the staffing patterns and reward structure may have stabilized to their long-run levels. The system is well-designed to reduce turnover of

trained staff, but it may also imply restriction of entry at the lower levels. The government has paid for the advanced training of its scientists and adopted a wage structure which encourages them to remain. However, as a market demand for trained agriculturalists grows outside the government, and possibly a supply of trained people becomes available outside the government, as well, the DOA may consider the desirability of paying premium salaries to MS and PhD scientists recruited directly and reducing its own expenditure on training.

IV. STAFF DEVELOPMENT AND THE EARNINGS FUNCTION

An analysis of the returns to the individual of earning an advanced degree is a useful way of predicting whether or not the system will be able to retain for research the scientists who have been trained by the government or donors. In the three systems studied the earnings function gives evidence that there are high returns to earning master's and PhD degrees.

In most of the systems the earning of an advanced degree is associated with increased salary but both the higher degree and higher salary are often accompanied by appointment to some administrative function. It is normal for a system to promote its most qualified people into senior positions, and perhaps all we can say is that a major effort will be required in training to create the critical mass needed in order to have PhD scientists active in full-time research. When that time arrives, the systems will have to look at reward structures which encourage people to remain in research when the rapid advancement offered by administrative functions is closed off to them. The earnings function can be a useful tool in such analyses.

The shape of the earnings function may change over time with the phase of development of the national system. At an early stage of development, in which scientists with advanced degrees are relatively scarce, it may be advantageous to have a steeply sloped earnings function to attract such scarce people. However, as more people with advanced training become available in the country, the earnings functions may become flatter and still permit the system to hire and retain the people it needs. As ISNAR accumulates cases of countries at different levels of development, we will be able to relate the shape of the earnings function to the state of development of human resources in the country and have a way of making cross-country comparisons in discussing reward structures.

V. CONCLUDING OBSERVATIONS

The purpose of this paper was to test a methodology for analyzing readily available administrative data (or data collected by a relatively simple questionnaire) to generate insights into the character and appropriateness of a system's reward structure. The human capital model, based on the earnings function, offers a means by which we can approach the question of conditions of service in a national system. It does not preclude the need to study the institutional processes directly, but it allows us to test various hypotheses about the way in which conditions of service operate. From the cases presented here it is evident that patterns differ greatly among countries. By undertaking such analyses across a range of countries, ISNAR will begin to build up patterns which may be applicable to particular regions of the world or alternatively to systems at different stages in their development. Through the analysis

of the return to advanced training and the way in which this return is gained, we will be able to relate the reward structure to human resource development plans.

The present document is a working paper for critical comment and suggestions for improvement. The simple earnings functions estimated here can eventually be improved through the addition of other explanatory variables or through a more sophisticated path analysis model which separates the effects of position and formal education in the determination of salary. We believe, however, that even in its present form we have demonstrated that the method permits a potentially powerful analysis of reward structures with a relatively small investment in data collection and analysis time, once the most appropriate general form of the model has been developed.

ANNEX I

The Earnings Function Approach and its Interpretation

The standard human capital earnings function is a multiple regression procedure in which the natural logarithm of earnings is expressed as a linear function of the number of years of schooling; years of labor market experience; the square of years of experience; and a number of earnings-related personal or job characteristics such as occupation, sex, and location.

The human capital approach considers that an individual's productivity and earnings are enhanced by investment in education and the regression coefficient relating the natural logarithm of earnings and years of schooling may be interpreted as the rate of return on education. This logarithmic form of the earnings function is developed by Addison and Siebert in both the simple form below and in a mathematical appendix with extensions of the model.

Let us define the rate of return on the first year of education, r_1, as

$$r_1 = \frac{Y_1 - X_0}{X_0}$$

where Y_1 is the income a person would earn after completing one year of education and X_0 is the assumedly lower income he would earn without that education.

This may also be expressed as:

$$Y_1 = X_0 \ (1 + r_1)$$

where income in Year 1 is the initial income increased by the rate of return on his investment of foregone earnings of X_0 while undergoing training.

In similar fashion, the rate of return on the second education may be expressed as:

$$r_2 = \frac{Y_2 - Y_1}{Y_1}$$

such that

$$Y_2 = Y_1 \ (1 + r_2) = X_0 \ (1 + r_1) \ (1 + r_2)$$

After 'S' years of schooling, earnings will be

$$Y_S = X_0 \ (1 + r_1) \ . \ (1 + r_2) \ldots (1 + r_s)$$

On the assumption that $r_1 = r_2 = r_s$ and that $(1 + r)$ can be approximated as e^r

$$Y_S = X_0 e^{rS} \qquad \underline{\text{or}}$$

$$\ln Y_S = \ln X_0 + rS$$

In this basic earnings function, earnings at time 'S' are a function of the initial (without education) salary (X_0), the rate of return on schooling (r), and the amount of schooling (S).

Earnings are also related to experience and on-the-job training. Therefore, most formulations of the human capital model include a variable for years of experience and its square to account for a non-linearity in the relationship. Extensions of the model add a number of personal or job characteristics which are believed to have an effect on earnings.

ANNEX 2

Descriptive Statistics of Key Variables

1. Dominican Republic: Survey of DIA Scientists 1983

	Unit	Mean	S.D.	Min	Max
Log Salary		6.27	2.80	5.79	6.91
Years Experience		6.44	5.03	1	21
Years Experience^2		66.83	98.13	1	441
Age		32.87	4.84	23	44

2. Zimbabwe: Survey of DRSS Scientists 1984

	Unit	Mean	S.D.	Min	Max
Log Salary		9.07	0.333	8.19	9.91
Years Experience		8.68	9.37	1	41
Years Experience^2		163.4	315.33	1	1,681
Age		34.93	10.04	21	63
Years Education		16.18	2.39	11	22

3. Thailand: Administrative Data from DOA 1983

Total Thai Sample

	Mean	S.D.	Min	Max
Log Salary	8.70	0.32	7.76	9.56
Years Experience	11.48	5.97	1	37
Years Experience^2	167.52	157.76	1	1,3659
Age	36.2	6.10	23	59

Thai Women

	Mean	S.D.	Min	Max
Log Salary	8.6876	0.303	7.76	9.39
Years Experience	10.7601	5.42274	1	24
Years Experience	145.186	125.309	1	576
Age	35.3881	5.63396	23	50

Thai Men

	Mean	S.D.	Min	Max
Log Salary	8.71	0.338	7.92	9.56
Years Experience	12.002	6.30084	1	37
Years Experience^2	183.748	175.624	1	1,369
Age	36.8591	6.36094	24	59

ANNEX 3

HUMAN RESOURCE INVENTORY AND ANALYSIS

A. Background Information

Family Name/Surname: _____

Given Names: _____

Date of Birth: _____

Sex: Male _____ Female _____

Marital Status: Single ____ Married _____ Widowed _____
Divorced _____ Separated _____

Spouse's Occupation: _____
Spouse's Employer: _____

Number of dependent children living with you: _____

B. Education (begin with highest degree obtained)

1. University

Name of University	Location City/Country	Years Attended From	Years Attended To	Degree Obtained and Year	Specialization
1.					
2.					
3.					
4.					

2. Short Courses (less than 9 months)

Name of Institution	Location City/Country	Dates From	Dates To	Title or Objective of Course
1.				
2.				
3.				
4.				
5.				

C. Employment

1. Current Employer: _____

2. Date of Initial Hire: _____

3. Current Job Title _____

4. a. Type of Work Performed: _____
   b. Indicate the percentage of your time devoted to:

Research	_____
Administration	_____
Training	_____
Extension	_____
Travel/Conferences, etc.	_____
TOTAL	100%

5. If there is a formal scheme of service in your institute, please indicate: Grade _____ Step _____

6. Remuneration Structure:

   a. Current base salary _____
   b. Other allowances _____
   c. Value of housing provided or allowance _____
   d. Premiums for function or specialization _____

7. Position at entry:
   Title _____
   Grade _____ Step: _____
   Base salary at entry: _____

8. Other work experience: Please list period of professional employment outside of your current institute or ministry or periods of leave without pay.

Name of Employer	Location	Dates of Employment From	To	Type of Work	Salary + Allowance
1.					
2.					
3.					
4.					
5.					
6.					
7.					

9. Current Research: Please list all the current projects you are currently undertaking, whether your role is that of "principal researcher" or "collaborator", and the percentage of your time that the project takes.

Description of Project	Principal or Collaborator	Percentage of Time
1.		
2.		
3.		
4.		
5.		
6.		

(attach additional pages if necessary).

10. Publications: Please list your publications, indicating the nature of publication (book, journal article, research report), the number of pages and year of publication. (Attach extra pages if necessary).

11. Please describe the nature of training that you feel you require in order to achieve your career objectives. Indicate if this training is of a short- or long-term nature and whether it is potentially available within country.

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