A QUANTITATIVE ASSESSMENT OF THE UTILISATION OF ENGINEERING MANPOWER IN KENYA

By

Paul Bennell

Working Paper No. 381

INSTITUTE FOR DEVELOPMENT STUDIES
UNIVERSITY OF NAIROBI
P.O. BOX 30197
Nairobi, Kenya

May, 1981

A QUANTITATIVE ASSESSMENT OF THE UTILISATION OF ENGINEERING MANPOWER IN KENYA

ABSTRACT

This paper outlines the main empirical results of which have emerged from a preliminary analysis of data concerned with the pattern of utilization of engineering manpower in Kenya. It forms part of a wider research study into the formation of engineering labour markets from the early colonial period up until the late 1970s.

For expositional purposes, each of the three main occupational categories of engineering manpower-professional engineers, technicians and artisans - have been discussed separately. Four main aspects of utilisation have been delineated namely, overall stock, inter-and intra-sectoral employment distribution, utilisation of engineering knowledge and task analysis and remuneration structures.

This essentially quantitatative analysis of the pattern of engineering utilisation will be supplemented by more qualitatative research findings based on archival work, interview surveys of private and public sector employers and information collected from major training institutions.

A Quantitative Assessment of the Utilisation of Engineering Manpower in Kenya.

Introduction

The purpose of this paper is to summarize the results of one aspect of our study into the formation of engineering labour markets in Kenya. The wider theoretical and empirical objectives of this research have already been discussed elsewhere and we do not propose, therefore, to reconsider them here[1] Broadly speaking, however, the study is primarily concerned with analysing the relationship between the formal[2] provision of engineering manpower by the Kenyan State as this has evolved via the establishment of training institutions since the early 1950s and the subsequent utilization of this manpower within the economy as a whole. It can be viewed, therefore, as a contribution to the on-going debate which centres on the analysis of the relationship between education and training and economic growth and development.

The analysis of the relationship between engineering education/training and employment must be situated within a theoretical framework which transcends the highly technocratic and simplistic functionalist interpretations which have underpinned the great majority of manpower planning methodologies. This requires a detailed understanding of the economic, political and ideological "functions" of the general education system, and engineering training in particular. and the nature of their articulation with each other. This analysis cannot however be satisfactorily undertaken without, inter alia, a detailed knowledge of the pattern of utilisation of the main occupational categories of engineering manpower within the economy. In the absence of such data, manpower planners have invariably relied upon sets of assumptions which merely serve to reinforce implicit theoretical and ideological positions which are devoid of rigorous empirical justification.

The empirical research into the utilization of engineering manpower was undertaken between April 1980 and March 1981. In view of the paucity of existing sources of data we were obliged to conduct a number of sample surveys of both individuals possessing engineering qualifications and the employers of this manpower. Since we have not as yet had the opportunity to systematically analyze this data, it must be stressed that the results presented in this paper are highly preliminary and empirical in nature and are likely to be partially and perhaps even substantially, modified at a later date. We feel nonetheless that this is still a worthwhile exercise especially in view of the deliberations that are currently taking place on the establishment of a second (technically-oriented) university and also a Third Polytechnic at Eldoret.

Engineering labour markets in Kenya can be divided into three basic segments which largely correspond to the Anglophonic model of formal skill acquisition and certification. More specifically, training policies have been based on conceptions of engineering manpower (both in terms of level/quality and quantity) which relate to the perceived functional relationships between professional engineers, technicians and artisans in the various sectors of the economy i.e. the so-called 'engineering manpower pyramid'. We propose therefore to consider the pattern of utilisation of each of these main occupational categories in turn and then finally to briefly analyze the most important relationships between them. In this paper we shall concentrate mainly on the utilisation of engineers and technicians since we have not as yet been able to devote much time to the analysis of artisan utilization.

The analysis of each occupational category will be structured as follows; (1) determination of current stock and past and future trends (ii) present inter-and intra-sectoral distribution of employment (iii) the degree of utilisation of formally - acquired engineering skills coupled with a broad analysis of tasks undertaken once in employment and (iv) the structure of remuneration, job turnover and inter-sectoral mobility especially as these relate to developing our understanding of the pattern of utilisation.

1.1. The Present Stock of University - Trained Engineers.

According to the 1980 Annual Ennumeration of Employment in the Modern Sector conducted by the Central Bureau of Statistics (CBS) there were 4537 "architects, engineers and surveyors" in productive employment in Kenya. However, even when architects and surveyors are subtracted out, the resulting figure for engineers" is still likely to be a serious over-estimation of the number of University-trained engineers employed. This is because we know from our own surveys of private sector employers that many formally-trained engineering technicians occupy employment positions designated as being engineers of one sort or another. In the absence, therefore, of a comprehensive labour survey based on well-specified definitions of occupational categories according to formal educational qualifications we have attempted to estimate the present stock of university-trained engineers by summing (1) the past outputs of the Faculty of Engineering, Nairobi University which is the only domestic source of supply (ii) the annual number of foreign-trained engineering graduates who have returned to Kenya since the mid-1960s and (iii) the current number of non-citizen engineers all of whom are assumed to have university of equivalent academic qualifications.

The annual output of graduates from the Departments of Civil Electrical and Mechanical Engineering at Nairobi University from 1964 to 1979 are presented in Table 1.1 It can be seen that up until the early 1970s the numbers of Kenyan graduates were relatively small and or these at least 60-70% were Kenyan and British Asian students many of whom have since migrated permanently overseas (see below) By 1979, however, approximately 370 civil, 230 electrical and 290 mechanical engineers of Kenyan nationality had successfully graduated from Nairobi University, and, from the results of our tracer survey, are known to be employed in Kenya.

Ascertaining the current stock of foreign-trained engineers is considerably more difficult. The Ministry of Education started to build-up a comprehensive card index system for overseas students in 1965 but given the very large numbers of students involved coupled with the fact that the majority of them were privately sponsored (in particular Asians) and failed to register and be cleared by the Ministry as is formally required, this system quickly broke down. However, from the information that does exist we have attempted to estimate the total number of Kenyans who have studied engineering subjects at the tertiary education level at institutions overseas between 1960-1979. The results of this exercise are summarized in Table 2. It is interesting to note that engineering enrolments typically represent only a small proportion of the total number of Kenyan students studying overseas and that those in the U.K. and India have largely comprised of privately sponsored Asian students, many of whom have not returned to Kenya.[3]

In order to estimate just how many of the 1600 Kenyans who have undertaken engineering courses overseas during the last twenty years are now working as engineers in Kenya we have relied on three different sets of data. Firstly, from information obtained from public and private sector employers, ratios of local-foreign trained engineers were computed for each major sector and these were then multiplied by the number of University of Nairobi (i.e. local trained engineers) known from the tracer survey to be employed in each of these sectors. This yielded a total of 380 foreign-trained engineers - only 24% of 1600! Secondly, lists of civil, electrical and mechanical engineering students known to be studying overseas in the early 1970s were compiled from the records at the Ministry of Higher Education and these were distributed to over 250 'traced' engineers working in all sectors of the economy who were requested to write down the present or last known whereabouts of these foreign-trained engineers. The results of this tracer survey are presented in Table 3. While the number of replies was not particularly large, we know that engineers are concentrated in relatively few larger-scale establishments, the majority of which were covered by our respondents. Further, nearly all locally-trained engineers were traced on the basis of a similar number of respondents. Aggregating the three main categories of engineers, only 28% of the foreign-trained engineers in our sample were traced. If it is assumed that this is a representative figure for all periods since the early 1960s then no more than between 430-480 of the total of 1605 foreign-trained engineers are currently employed as engineers in Kenya[4].

The actual number of engineers who were 'discovered' during the course of our enquiries and surveys of public and private sector employers provide our third estimate although it must be pointed out that this was never intended to be a comprehensive survey of engineers. However we were also able to utilize unpublished data from the survey of scientists and engineers conducted by the National Council for science and Technology in 1975 from which numbers of foreign-trained engineers could be approximately determined[5] In addition, other foreign-trained engineers who had not been specifically located (and card-indexed) were extracted from the lists, of registered engineers published in the Government Gazette.[6] Pooling these various sources of information yields a total of approximately 430 foreign-trained engineers which again is of the same order of magnitude as the other two estimates. We can state therefore with some degree of certainty that there are between 400-500 foreign-ttrained engineers working in Kenya. But in the absence of more detailed data we have to assume that these engineers are distributed evenly among the three main engineering disciplines.

The number of expatriate engineers in Kenya was recorded by the immigration Department as being 757 in 1980[7]. A detailed breakdown according to engineering discipline and nationality could not however be furnished. Discipline breakdowns for 1978 were presented in the Humphrey Report on Post-Graduated Engineering Training (45% Civil, 15% electrical , 40% mechanical) and we have assumed therefore that these have remained largely unchanged in 1979. We have also decided to compute a separate (high) estimate of expatriate engineers which includes the 228 expatriate engineering technicians employed in Kenya since it is likely that this group possesses sufficient qualifications and experience and occupies 'engineers' employment positions for them to be regarded as being equivalent to university-trained engineers.

In Table 4 the total number of local and foreign-trained Kenyan engineers and expatriate engineers in each of the three major areas of engineering specialisation are presented. Comparing the 1979 figures with those given for 'professionally' trained (category A) engineers in the 1964 Manpower Survey[9] indicate that there have been markedly different increases in the numbers of each type of engineer employed during this fifteen year period:- civil 420% electrical 219% and mechanical 212%. Expressing these percentage increases in the stock of each type of engineering manpower as ratios of the percentage increase in real national output during the same period yields estimates of elasticities of demand. These are presented in Table 5 where it can be observed that that with respect to GDP measured in constant 1976 prices the elasticities of demand for civil, electrical and mechanical engineers between 1964-1978 were 2.88, 1.0 and 1.0 respectively. If we assume that the same pattern of demand continues then the implication of these results is that additional demand for civil and related engineers will be nearly 50% higher than the corresponding combined total for electrical and mechanical engineers (and related specializations).

In spite of the high degree of unreliability of manpower projections in the past, these elasticities of demand for university-trained engineering manpower can be used to derive at least tentative estimates of future manpower demand. The aggregate elasticity for all engineers is 1.5 which when multiplied by likely rates of real growth in GDP gives the annual rate of growth in demand for engineers. We are, of course, assuming that the previous pattern of demand for engineers will continue to prevail in the future but this is not too unrealistic if a relatively short time period of say ten years is adopted.[10] Two estimates (one 'high' and one 'low') of the average annual rate of real growth of GDP for the period 1980-1989 have been chosen. The results of this manpower projection exercise are presented in Table 6. Annual 'wastage' through retirement and deaths is likely to be negligible given the very young age profile of local engineers and has therefore been ommitted altogether. We have also assumed that the current stock of expatriate engineers will remain constant during the period as was the case during the 1970s. With real GDP growth rates of 2.5% and 5% per annum between 1980-1989 the incremental demand for university-trained engineers will be 2334 and 980 respectively (assuming an initial stock of 2200 at the end of 1979). Comparing these demand estimates with the total probable outputs of engineering graduates from Nairobi University during the same period of 2000-2300 plus returns from overseas training (say around 300-350 during this period) it is apparent that unless very high real rates of growth in GDP can be sustained, there is a strong likelihood of the emergence of a significant surplus of university-trained engineers which will result in either open unemployment and/or underemployment (in terms of being able to fully utilize professional engineering skills). In terms of development needs it is obvious that Kenya requires many more engineers but unless these needs can be translated into effective manpower demands there is a real possibility that any large-scale expansion of tertiary-level engineering training will merely exacerbate the existing tendencies towards over-production.[12]

1.2. The Inter and Intra - Sectoral Distribution of Engineers.

The sectoral distribution of university-trained engineers is of key importance in understanding the present utilisation of engineering manpower in Kenya. Unfortunately, however, there is an acute shortage of sufficiently detailed data on this subject. We have attempted therefore to ascertain the present employment whereabouts of all engineering graduates from Nairobi University between 1964-79. It would, of course, have been particularly interesting to undertake this exercise for all university trained engineers both citizen and non-citizen currently employed in Kenya but in view of the data problems already discussed in the previous section coupled with the inadequacy of the resources available to us (i.e me !) to trace such a large number of individual it was decided to concentrate solely on locally-trained engineers. Since this group comprise over two-thirds of Kenyan engineers it is not unreasonable to argue that their distribution among different sectors within the economy is representative of all Kenyan engineers.

The Engineering Faculty Tracer Study (EFTS) was started in July 1980. Two main sources of information were tapped in order to trace the present or last known whereabouts of graduate engineers. Firstly, lists of university-trained engineers were requested from all major employers in the public and private sectors and secondly 'traced' engineers were sent list of students who had graduated from Nairobi University at the same time as themselves. Some 110 engineers responded in this way. By March 1981 over 90% of graduates from all three engineering departments had been traced, the great majority of whom with a high degree of certainty. The remaining 10% proved particularly difficult to trace. Well over 50% of these were Asian Engineers who graduated during the 1960s. It seems likely that most of graduates are no longer living in Kenya. This assertion is based, firstly, on the predominantly Asian composition of the 26 graduates who are known to have migrated and, secondly, from the results of a tracer study of Nairobi University graduates 1961-70 conducted by Svein-Erik Rastad[13] which found that of the 78 non-African engineering graduates 23 had already migrated and 14 could not be traced (=47.4% of the total). If we assume that at least the same proportion of our untraced graduates have also left Kenya then the total 'brain drain' of engineers overseas amounts to approximately 60-65 (=7.5% of total output 1964-1979). Among African graduate engineers fro Nairobi University, however, out-migration has been minimal - less than 5 of tl this group were found to be working overseas. It is not clear whether this lack of integration into an already well-developed international market for engineers is due to the disinclination of locally-trained engineers to work overseas especially in view of the excellent opportunities for advancement within Kenya or whether it can be attributed to the low degree of negotiability in terms of their formal academic qualifications and/or overa on-the jobtraining and experience. Both sets of factors are likely to have been of importance during the 1970s. Future trends will clearly depend on developments in both international and local labour markets. North-South migration surged in the late 1960s wi a massive exodus of graduate manpower in particular doctors, scientists and engineers from South Asian to Europe and North America. Since then, however, this North-South migration has beer reduced to a trickle as a consequence of the present capitalist crisis in the metropoles. But the emergence of acute labour shortages in the booming Middle East oil economies has fuelled a new wave of international migration in particular of 'professional' manpower from Europe and non-oil producing Middle Eastern Countries(Jordan, Egypt, Sudan, Somalia) and of technicia and artisan labour from South Asia and the Far East. But apart from a few Asian engineers, Kenya engineering manpower has not been attracted to the Middle East. The likely extent of Kenyan engineering migration during the next decated will, therefore depend in the first instance on whether the demand for foreign skilled labour persists in the middle East and/or the western capitalist economies experience a repitition of the manpower shortages of the 1960s. Should either of these scenarios occur then it is likely that with the declining opportunities among an experienced cadre of engineers (especially civil) within Kenya, out migration could increase significantly Moreover, this will be facilitated by the increasing employment of Kenyan engineers by trans-national engineering consultancies (and corporations) who already have sizeable establishments in Kenya catering not only for the Kenyan market but also serve as regional headquarters for East and Central Africa and, in some cases, the Middle East as well.

While bearing in mind the possible significance of future brain drain of Kenyan engineers, we now propose to concentrate on the present pattern of employment within Kenya, relying principally on the results of EFTS as our main empilical base. The main results of the study are summarized in Table7. Each of the main engineering specializations will be discussed in turn but it is first necessary to briefly clarify the specification of the sectors delineated for the purposes of this research. Central Government is self-explanatory since it coversall engineers employed with government ministries. Parastatals include the Railways, Post and Telecommunications (both local and international), the Ports Authority, marketing boards and the East African Power and lighting Company (which legally speaking is a private company but will be treated as a defacto parastatal). Local government employees have also been included since they enjoy a large degree of autonomy from central government control. Engineering teachers and students while employees and sponsees of the central government or the university (a parastatal) have also been separately delineated. Within the private sector, the major division is between industrial and consultancy enterprises. Since we are particularly interested in assessing the extent to which African engineering graduates from the main training institutions have become entrepreneurs in their own right these have been treated as separate industrial and consultancy sectors. Transnational corporations (TNCS) and joint venture include all enterprises which are effectively owned and/or managed by foreign-owned Corporate entities with generally widespread operations overseas. 'Non-African industrial' is therefore an essentially residual category comprising of all non-African industrial enterprises both local and foreign-owned, which cannot be considered to be TNCs. The consultancy sector has been divided into African (employers and employers and employees) and non-African citizen and foreign.

Civil Engineers. Over 60% of civil engineering graduates from Nairobi University are employed in the central government and parastatal sectors. The three Ministries of Transport and Communication, Water Development and Works account for over 90% of engineers employed by Central Government (approximately 40% of the total). Engineering consultancies comprise the other major sector of employment with 24.2% of the total. And it is within this sector that Kenyan African engineers have been most successful in est establishing their own consultancies and effectively competing with foreign firms.[14] The industrial sector, on the other hand, only accounts for 50% of the total output of locally-trained civil engineering graduates. African industrial enterprises are non-existent and only a handful of graduates are employed in the construction industry which is a major sub-sector of the economy, employing just over 63,000 people in 1980.

Electrical Engineers. As with Civil engineers, the public sector employs over 60% of electrical engineering graduates from Nairobi University although parastatals comprise over 75% of this figure. EAPL is the single most important employers with 55 Nairobi-trained engineers. Relatively few electrical engineers are employed in the consultancy sector although 3 graduates have started their own firms. Approximately 20% of electrical graduates were traced in the industrial sector which while being a four-times larger representation from the corresponding percentage for civil engineers is still very low when it is considered that the private sector accounts for at least 60% of total employment in the modern sector in 1980.

Mechanical Engineers. The sectoral distribution of mechanical engineering graduates is markedly different from that of civil and electrical engineers in that private industrial employers comprise nearly 45% of the total output. However, mechanical graduate entrepreneurs are insignificant when compared with total employment in the non-African and TNC Sectors. As with electrical engineers, very few mechanical engineers are employed by consultancies which is indicative of the basic civil engineering orientation of this sector and the overwhelming dependence of the Kenyan economy on the direct importation by enterprises of foreign technology . In India, for example, the role of local mechanical engineering consultancies in selecting vetting and modifying foreign technology has been of considerable importance in the development of the industrial sector as a result of the enhancement of local innovative capacity.[15]

The Total Population of University-Trained Engineers.

To what extent is the sectoral distribution of locally trained engineers, summarised above, representative of the total population of engineers in Kenya? On the basis of our surveys of industrial and consultancy sectors in conjuction with the 1979 survey of manpower employed by the Civil Service we have imputed our own estimates of the broad sectoral distribution of all university-trained engineers in Kenya which are presented in Table 8. In addition, we have calculated similar estimates for "architects, engineers and surveyors" for 1980 from unpublished data obtained from the Central Bureau of Statistics Annual Ennumeration of Modern Sector Employment. Both sets of data indicate that higher proportions of expatriate engineers are employed in the consultancy and industrial sectors. The CBS Figure for central government appears to over-represent the number of engineers actually employed most probably because of aparticularly heavy concentration of surveyors in this sector, and under represent the consultancy sector since our research indicate that there are at least 450 and probably 500 engineers in this sector (=22.0-25.0% of the total). In view of the considerable overall over-estimation of engineers by the CBS coupled with the considerable inter-sectoral differences in the relative employment of achitects, engineers and surveyors we are strongly inclined therefore, to adopt our own estimates of the breakdown of all engineers. This data will be of particular value when combined with our preliminary analysis of the actual utilization of engineering skills in each of the main sectors (see 1.3. below).

Changes in the Inter-Sectoral Distribution of Engineers 1964-1979

Using a variety of sources of information such as civil service establishment lists, the membership records of the East African Institution of Engineers and annual reports of major parastatal organisations we have attempted to ascertain the inter-sectoral breakdown for each of the major engineering disciplines in 1964 and then compare this with the corresponding estimates already derived for 1979. It can be observed in Table 9 that only in the case of civil engineers has there been any dramatic change in the inter-sectoral distribution of employment. Even here it must be pointed out that this does not represent a major shift in demand for high-level engineering skill since an interview survey of 30 of the largest engineering consultancies in Kenya revealed that on average 70-80% of all on-going projects (measured in terms of total capital value) in the period 1979-80 were being undertaken for public-sector clients. Nevertheless the emergence of the consultancy sector and in particular the nature or its relationship with the public and private sectors is of key importance in understanding the utilisation of engineering manpower in Kenya.

The percentage of mechanical engineers employed in the private industrial sector actually fell slightly (from 57% to 59%) and for electrical engineers there has only been a marginal increase. Since most of these electrical and mechanical engineers are employed in the manufacturing sector we can estimate the elasticities of demand for these occupations by the manufacturing sector as a whole. Taking the percentage increase in manufacturing gross output, measured in constant prices, between 1964-1978 as our proxy for manpower demand, the elasticities of demand for electrical and mechanical engineers were 0.53 and 0.66 respectively. These estimates are relatively very low compared with those for other sectors in Kenya and they represent therefore, a direct challenge to the commonly held view that the industrialisation process is the primary source of demand for university-trained engineering manpower. The factors determining this low level of demand relate principally to the predominance of import-substituting industries which have relied on the direct importation of foreign technology which generally requires only a relatively small cadre of engineering manpower to maintain. University-trained engineers are heavily concentrated in no more than twenty manufacturing enterprises which utilize sufficiently sophisticated technology to warrant the employment of this level of engineering manpower. The extent of this concentration can be observed in Table 10 which shows the distribution of mechanical engineers from Nairobi University among different size categories of manufacturing and other industrial enterprises. Unpublished data from the survey of scientists and technicians conducted by the NCST in 1975 have also been analyzed to ascertain the pattern of employment of engineering graduates. Within the private sector. While this survey was heavily biased in favour of larger-scale enterprises and only 68 of the 150 returns contain sufficient information to be able to separate out engineering graduates from other scientists. It is nevertheless likely to be sufficiently accurate for the purpose of discerning the overall distribution of employment. The results of this analysis are presented in Table 11 which again reveals the same highly-concentrated distribution pattern.

1.3. An Inter-sectoral Analysis of the Employment Positions Occupied By university-Trained Engineers.

The purpose of this section is to analyze the degree of utilisation of the knowledge formally acquired by university-trained engineers and the tasks undertaken by them once in employment. This analysis is motivated by several inter-related sets of theoretical objectives. Firstly, it is necessary to assess the extent to which the conception of the engineer propogated by the engineering profession and supported by the Kenyan state (Via the enactment of registration legislation, its recruitment policies as a major employer of engineers and the structure and content of university training) corresponds to the tasks actually undertaken by engineers graduates once in employment. While the results of the tracer study indicate that nearly all engineering graduates from Nairobi university are employed as "engineers" of one description or another, we cannot automatically conclude from this that the nature of the tasks undertaken by them are necessarily identical. More specifically, we are concerned to establish the extent to which university-trained engineers are employed as engineers whose main activity centres on the application of the advanced technical knowledge acquired while at university and subsequent periods of formal and on the job training. The engineering profession's own definition of the engineer is particularly illuminating in this respect:

> "Aprofessional engineer is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably on research, designing, construction, manufacturing, superintending managing and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and judgement and the ability to supervise the technical and administrative work of others..........."[16]

The secondly objective of this part of the research will be to briefly consider the validity of certain fundamental hypotheses which have been derived in order to explain the nature of the relationship between education and training and the subsequent utilization of these skills in the employment sector. Human capital and rate-of-return theories

(HCT/RORT) assume that wages and salaries accurately reflect the relative productivity of each occupation which in turn is the outcome of the largely unfettered interaction of supply and demand. Formal education and training (either 'specific' or 'general') is conceived of therefore as imparting individuals with certain types of 'skills' which yield a rate of return over their productive working lives (discounted at an appropriate discount rate to reflect inter-temporal preference factors) which is directly attributable to the acquisition of these skills. Given this inextricable functional correspondence which is posited in the relationship between investment in skills and labour markets one should expect to find therefore a relatively high degree of utilization of these skills once in employment.

The manpower requirements approach (MRA) is based on the assertion that labour markets function too imperfectly to ensure the requisite amounts of manpower are produced by the educational sector. Using time-series and country-cross sectional data MRA theorists attempt to directly estimate the manpower requirements for each occupational category within any given economy. Hence, in spite of the important differences between HCT/RORT and MRA schools, the latter also implicitly assumes that if occupational requirements are correctly estimated, the utilisation of formally-acquired skills will be relatively high. Screening theories, on the other hand, argue that the relationship between the formal acquisition of skills and their subsequent utilization is generally weak since the main function of education is merely to screen out those individuals with innate ability and/or inculcate patterns of socialization and motivation required by employers.

The analysis of the relationship between formal skill acquisition and utilization for university-trained engineers is based on the data collected from postal questionnaires sent to all Nairobi-trained engineers. Respondent were requested to complete a section of the questionnaire concerned with identifying the main characteristics of their present employment. For the purposes of this preliminary analysis, we shall analyze the results two particular questions: (1) Approximately how much of the knowledge you learnt at university do you now utilize in your present job (expressed in percent) and (2) What percentage of your working day do you devote, on average, to the following tasks (i) Routine administration (of a non-technical nature) (ii) Managerial/ Supervisory duties (iii) original design work (new projects, R+D)(iv) Routine maintenance/repair activities (v) major maintenance/repair activities (vi) routine production activities.

The extent to which formally acquired engineering knowledge is utilised within the main sectors of employment already delineated is shown in Table 12. Extreme care must be exercised in interpreting these results since they are based on the subjective evaluations of each respondent. Moreover even where the degree of utilisation is very low (less than 25%) it cannot be automatically concluded that a university engineering education is unnecessary in order to satisfactorily undertake these jobs. Bearing in mind these important reservations, it can be observed that there are some interesting inter-discipline and inter-sectoral differences in the pattern of utilisation of university engineering skills. The overall median utilisation value for civil electricals and mechanical engineers is in the 25-49% region which is perhaps surprisingly low in view of the proclaimed shortage of engineers in the country. However the dispersion around this common median value is significantly different for each of the three disciplines. Just over 40% of civil engineers claim to utilize more than 50% of their university engineering knowledge whereas for electrical and mechanical engineers the laws corresponding figures are 31.7 and 22.0% respectively. Conversely 11.3% of civil engineers utilize less than 25% of their formally acquired knowledge whereas for electrical and mechanical engineers this rises to 31.7% and 30.0% respectively. And for mechanical engineers employed in the all-important TNC sector 43% of them report that they utilize less than 25% of their university knowledge. It would appear therefore that not only is the overall demand for university-trained engineers by the industrial sector much lower than is frequently asserted but also that where university trained engineers are employed they do not undertake tasks which require the utilisation of a significant proportion of the engineering knowledge they acquired at university. Consequently while their university education qualifies them for recruitment into relatively much higher paying jobs in the TNC sector (see 1.4 below), it cannot be convincingly argued that this high rate of return to their education is directly attributable to their formal acquisition of engineering skills as would be argued by human capital theorists.

The standard definition of the professional engineer quoted earliet is based on a conception of the engineer as a problem-solver and as someone who is engaged in tasks which are "predominantly intellectual" and "varied". Considerable emphasis is placed therefore on the amount and degree of sophistication of design work undertaken by the young engineer seeking registration. For the profession, to successfully design new engineering projects signifies that an engineer has undergone the training required to translate the theory acquired at university into applied practice. However in Table 13[17] it can be observed that only civil engineers spend a significant proportion of their time undertaking design design activities.[18] Given the variety of tasks civil engineers are engaged on coupled with a large design input, they are generally able to satisfy the requirements laid down for full registration. In Table7 it can be seen that between 40-60% of civil engineering graduates from Nairobi University who have more than three years of experience [illegible] who therefore satisfy the minimum eligibility requirements laid down by the Engineers Registration Board) are registered. However, in the case of electrical and mechanical graduates, at least 50% of whom spend less than 20% of their time engaged on design activities, this figures declines considerably, especially for those engineers employed in the TNC sector where only 25-30% of them are registered.

A closer analysis of Table 13 reveals that electrical and mechanical engineers are principally engaged in routine administration, managerial and supervisory tasks, the remainder of their time being devoted to routine and major maintenance and repair and production activities. In view of the generally low level of engineering knowledge required to satisfactorily undertake the latter tasks in the majority of industrial enterprises in Kenya, engineering graduates are therefore mainly employed as managers - cum technicians rather than as professional engineers per se. As a result, employers frequently face a high degree of substitutability, in the technical sense, in choosing between engineers and technician qualification holders. This enhances the importance of the value they attach to managerial (control) qualities of the two groups and, in particular, the extent to which these are seen to be correlated with the level of education attained and, at a more general level, the extent to which recruitment criteria strictly related to the prevailing structure of qualifications are important in legitimising the hierarchy of control which characterises the labour process. (This is essentially a screening function)

1.4. The Structure of Remuneration for University Trained Engineers

An analysis of the income determination process for engineers is not only interesting in its own right but may also yield a number of insights into the way in which engineering skills are utilized in the different sectors of the economy. However, in view of both the complexity and controversial nature of the now numerous theories of personal income determination, we propose only to briefly summarize our main emprical findings with respect to engineers and then, in a more theoretical vein, to consider the implications of these with regard to engineering labour markets in Kenya.

Human capital theory asserts that the principal determinants of personal income are the level of education attained and the amount of employment experience and on-the-job training. Income variations between individuals possessing the same skills and experience should therefore be minimal. Employers compete to recruit and then retain these individuals and while human capital theory does allow some discretion for employers to alter the salaries of their employees (depending mainly on the specific nature of the training process), they are perceived as being essentially "salary-takers" with the result therefore that there should be little dispersion of salaries between employers of each skill category of employees.

Opponents of human capital theory embrace a wide spectrum of highly divergent theoretical and ideological positions, some of which have already been reviewed in an earlier paper. The underlying core of these criticisms centres on the refutation of (1) the HCT logic that productivity and hence income can be directly related to acquisition of skills by each individual and (2) that labour markets are unified or homogeneous for each skill category. In reality, it is argued that there are a number of factors (such as race, class position, type of organisation/enterprise and sector) which play an important role in the income determination process and because their influence is exerted independently of the human capital variables this results in a multiple segmentation of labour markets. Furthermore, in the case of a seemingly homogeneous group of university-trained engineers, it has already been observed that, in Kenya, the composition of technical and non-technical tasks undertaken significantly differ both within and between the major employment sectors. There is little reason to suppose therefore that the human capital experience factor should be the only significant factor determining income variations.

Multivariate analysis has been widely employed as the principal method of testing the validity of human capital and segmentation theoretical propositions. We have not yet however been able to undertake a comprehensive computer analysis of the salaries data collected from our questionnaire respondents and have therefore, limited ourselves to computing simple regression equations using a programmable pocket calculator - which is still a very time-consuming exercise! Since all engineers have virtually identical formal educational backgrounds, this obviates the necessity of introducing years of education as a separate independent variable and means therefore that the relationship between nominal salary[19] and years of experience accounts for all measurable human capital variables. This relationship was tested using a simple linear equation of the form.

$$S = a + bE$$

where S = nominal salary and E = years of experience. For all civil, electrical and mechanical engineers in our questionnaire sample this yielded R^2 values of 0.30 0.22 and 0.30 respectively. Hence, despite the fact that we are dealing with a relatively highly specialised occupational group human capital theory is unable to account for between 70-80% of the observed variation in nominal salaries. It could be argued that years of experience is a poor proxy for the amount of general and specific training acquired by engineers once in employment but it is difficult to believe that variations among employers with respect to training are so great as to cause such a high dispersion of incomes. The data was disaggregated according to sector and the simple regressions recalculated. It can be observed from Tables 14, 15 and 16, and 17 that while this results in a significant improvement in the value of R^2 for many of the sectors. there is still considerable variation of engineers incomes within each sector that cannot be accounted for by the experience variable. The extent of inter-sectoral differences in engineers incomes can be gauged in Figure 1 where the sector-specific regression equations for all engineers have been plotted. The degree of sectoral segmentation would appear to so marked that it is more appropriate to consider university-trained engineers as belonging to one of at least five distinct labour markets, each characterised by a specific earnings function. And in view of the high concentration of engineers as employees within relatively few large-scale organisations it is probable that, even at the sectoral level, the income determination process will be influenced as much by factors internal rather than external to these organisations. It has been argued that the existence of internal labour markets among large oligopolistic enterprises means that salary and wage structures are not exogenously imposed according to external market forces but are subject to significant internal variation according to the organizational structure of the enterprise, managerial philosophy and objectives. etc Various studies have attempted to assess the influence of these factors by using such proxy variables as firm size, nationality and ability to pay.

Even taking account and controlling for experience, sectoral and internal labour market factors, there is still likely to be significant variations in engineer salaries which have still to be explained. In view of the significant differences in the pattern of tasks undertaken by engineers both within and between sectors these variations are likely to be an important factor in the income determination process. Typically, engineers occupy positions which span a wide range of the employment hierarchy within large-scale organisations.[20] Each position can be separated into its technical and non-technical (control) elements, and since the latter relate primarily to managerial and supervisory tasks these can be proxied by the number of people the engineer is directly responsible for in the production process. We propose to test the significance of these two factors using multivariate analysis. One possible regression equation is of the form:

$$S = a + bE + b_2R + b_3U + b_4S$$

where R = number of people responsible for and U is the percentage of university - knowledge utilized (a rough proxy for the technical content of the job) and S = sectoral dummy variable. This regression equation has not as yet been systematically tested but we have tried it for separate engineering disciplines in a few sectors. The results indicate that responsibility and utilisation are not significant at the 95% level and with one or two exceptions the inclusion of these variables do not lead to any substantial increase in R^2 values.

Engineer Job Turnover and Inter-Sectoral Mobility

The pattern of inter - job mobility also strong indicates that each sector should be regarded as a separate market in terms of task requirements and remuneration. A preliminary analysis of the job mobility of our questionnaire respondents reveals that the majority of moves are confined to employers within the same sector. Contrary to popular opinion, public to private sector job movements are relatively uncommon as can be observed in Tables 18, 19 and 20. Even among these engineers with more than three years experience who are allegedly the most prone to leave the public sector only 20.6% civil, 17.7% electrical and 12.3% of all mechanicals have migrated from the public to private sector at some stage of their careers. However civil, electrical and mechanical migrants do comprise a significant proportion of present public sector employment (see Table 20). The low incidence of public to private sector job movements is probably attributable to the extra incomes earned by public sector employees engaged in 'straddling' activities (although because of the sensitivity of this question it was ommitted from the questionnaire!) coupled with the fact that many private sector employers, particularly in the industrial sector, demand specific employment experience and requirements which civil servants do not generally possess. Furthermore for many engineers in the public sector their jobs are more satisfying from a professional point of view than many jobs in the private sector and this compensates to some extent for their lower remuneration and reduces the incidence of inter-sectoral movement.

Job turnover is relatively high among engineers with less than two years experience but, when expressed as number of jobs per year of experience, tends to fall thereafter (see Table 21). The reasons for this have yet to be analysed but are probably related to the fact that training is often highly enterprise/organisation specific which acts as a disincentive to move since the employee increasingly reaps the benefits of this training in terms of a higher income which cannot be obtained immediately elsewhere.

2.3 The Stock of Formally Qualified Engineering Technicians

Time series data on the stock of engineering technicians in Kenya is particularly lacking. This is due to the heterogeneity of the category technician in terms of formal qualifications and experience coupled with the highly divergent definitions adopted by employers and manpower and educational planners since independence. The three manpower surveys conducted in 1964, 1967 and 1972 based their ennumeration of technicians on markedly different selection criteria and also, because of the lack of specificity in relation to different types of educational qualifications, the technicians ennumerated embaced individuals with widely differing educational backgrounds. Out of the three surveys, the delineation of category B technical manpower (defined as "technical occupations which are filled by workers who work in direct support of and under the immediate supervision of professional persons and who usually require three years of progressive supervised post.- secondary training in a given technical field or a combination of formal training in a technical college plus supervised experience") in 1964 offers the most precise definition of technician manpower. According to this survey there were 888 engineering technicians employed in Kenya (527 African, 182 Asian and 229 European) although it seems likely that the African sub-total included many workers who had undergone only craft level training.

The other major source of time-series data is the Annual Ennumeration of wage employment conducted by the CBS. However broad occupational classifications were only included from 1968 onwards and technicians were subsumed into the relatively amorphous category of "technicians, foremen and supervisors". Even though manpower planners have had little idea just now many formally qualified technicians there are, they have nevertheless assumed that all "technicians, foremen and supervisors" should possess these qualifications which, given its relatively large size (approximately 20,000 throughout the 1970s) has provided a convenient justification for the continued rapid expansion of polytechnic enrolments. However according to the most recent data available presented in the 1972 manpower survey only 37% of production supervisors and foremen (who comprise at least 75% of the TFS category) had received any institutional training of any kind (either technician or just as, if not more, likely craft/artisan) and 60.3% of them only had primary school education. It seems unlikely therefore that no more that 10 - 15% of the supervisor and foremen category possessed technician level qualifications of any type.

And the results of our own survey of manufacturing enterprises conducted in June 1980 indicate that these has not been any marked increase in this percentage since 1972. This is symptomatic of the reliance placed on prolonged on the job training by the great majority of employers.

Since 1978 engineering technicians have been treated as a separate occupational category in the CBS survey. The total number of these technicians ennumerated in 1980 was 4083 which when compared to the stock of 4537 "architects, engineers and surveyors" also lends support to the view that technician training should be rapidly expanded since it is widely accepted that there should be at least 5 technicians to every engineer.

The CBS manpower data for technicians suffers from the same problems which have already been discussed in relation to university-trained engineers. In order therefore to obtain a more accurate and detailed assessment of the stock of engineering technicians we analysed the annual examination results for students attending the Kenya and Mombasa Polytechnics. Unfortunately examination records for the years 1960-1969 could not be obtained either from the institutions themselves or from the City + Guilds of the London institute which was the major examining board prior to the establishment of the East African (now Kenya) Examinations Council in the early 1970s. We had had to rely therefore on very fragmentary 'archival' material in making estimates for this period. It should be pointed out that during the 1960s well over 50% of the engineering students at the Kenya Polytechnic and the Mombasa Technical institute (which became Mombasa Polytechnic in 1974) completed craft rather than technician courses. And secondly, failure rates for the main technician courses (S1 - 3 of the Ordinary National Certificate) were very high up until the mid 1960s mainly because of the low educational level of the students recruited. Bearing these points in mind, we estimate that approximately 700 students successfully passed technician examinations in mechanical and electrical engineering during this period. The outputs for the period 1969-79 are presented in Table 22. The core engineering technician courses are divided into three parts, the first two of which extend over 7 terms (4 terms at the polytechnic and 3 with the sponsoring employer). Part III is a full-time course taking two terms. In addition there are ordinary diploma courses also of seven terms duration, recruitment for which is primarily composed of students direct from school. Higher National courses are in two parts which extend over seven terms (5 at Polytechnic and 2 with industry sponsor) and are generally considered to be equivalent to a university degree. It can be observed in Table 22 that approximately 2000 students successfully completed at least one part of these technician examinations which is a surprisingly low figure given that annual enrolments in the technician engineering subjects averaged approximately 1000 during this period and the educational calibre of the students was relatively high. This can be attributed to "drought" averaging approximately 30% and high examination failure rates generally averaging between 30-40% with the result that a large number of students are "repeaters". What is also particularly striking is the relatively very small output of full (Part III) engineering technicians - only 137 mechanical, 89 motor vehicle, 285 electrical and 100 building. Adding the 1960s and 1970s output gives a grand total of approximately 3400-3500 technicians of which no more than 60% can be considered to have attained full technician status or above if ordinary national diploma holders are also included in this definition. This represents approximately 0.35% of total wage employment.

2.2 Inter-sectoral distribution and demand for engineering technicians.

The inter-sectoral distribution of engineering technicians based on the CBS wage Employment Survey for 1980 is presented in Table 23. According to this data less than 15% of engineering technicians are actually employed in the industrial sector, the majority of them being distributed among the infrastructural (water, electricity, construction, communications and transport) and related consultancy and community service sectors. Approximately 2000 engineering technicians can be identified as public sector employees (1200 in the civil service and 800 in the parastatals) which represents 49% of the total.

Since the large majority of engineering technician students are employer - sponsored it is possible to analyse the sectoral pattern of the demand for technician training and, by obtaining data on inter-sectoral job movements of students once they have completed courses, this can be subsequently adjusted to give estimates of the actual inter-sectoral distribution of engineering technicians. In Tables 24, 25 and 26 we present inter-sectoral sponsorship data for building, electrical and mechanical engineering students attending Kenya Polytechnic in the 2nd term in 1975, 1977 and 1979.[22] Public sector students constitute over 75% of the total for building and electrical subjects and it would appear that this percentage has been steadily increasing since at least the mid-1970s. With regard to these technicians skills, therefore, the Polytechnics should be regarded primarily as public sector training institutions. For mechanical students, however, private sector sponsorship constitutes approximately 50% of the total although it should be noted that manufacturing sector training demand is less than 25% of the total and, in absolute terms, appears to be actually decreasing.

A technician tracer study was undertaken in order to ascertain in greater detail the pattern of demand for training (via sponsorship) and the subsequent job movements and turnover of technician graduates. Our sample comprised of a Kenya Polytechnic students who successfully completed Part III and HND courses in electrical and mechanical engineering from 1971/2 (which is the earliest year that comprehensive student records are available) to 1976. The total sample population was 174 which represents approximately 30% of the total output of these courses between 1969-1979. The methodology adopted was basically the same as for the university tracer survey; The major sponsors of technicians were requested to provide information on whether they were still employed by them. In addition, traced students were sent a list of the technicians in the sample and asked to identify their present or last known employer. A total of 40 students responded in this way. It is interesting to note that it was considerably more difficult to trace the present whereabouts of these technicians than was the case for university engineering graduates. This is probably due to the fact that the network of personal contacts among students who attend courses on a sandwich basis is not likely to be as extensive as that of university students who remain together throughout their three years degree course. The results of the technician tracer survey are presented in Tables 27 and 28.

The public sector employment (including also students) account for 54.5% of the total of 130 students traced although there is significant variations among the courses - 5.8% HND mechanical, 35.5 MET, 33.3% HND Electrical and 55.1% EET. Among private sector employers technician graduates are heavily concentrated in the TNC and joint venture sector. Only 3 technicians in the sample have started their own enterprises - 1 mechanical consultancy and 2 electical contractors. And 17% continue to remain within the technical education sector either as teachers, trainee teachers or students undertaking more advanced studies.

In Table 28 it can be observed that 53.8% of technicians have remained with their original sponsor after at least five years after completing their courses. Among the Part III technicians there is little variation in this percentage between courses and, more interestingly, public and private sector employers. With the exception of MET graduates, to private sector sponsees have remained within the private sector when changing employment. What is perhaps surprising is that public to private sector movement is relatively low especially in view of the much higher levels of technician remuneration prevailing in the ~~public~~ private sector (see section 2.4). While approximately 50% of technicians leave their original public sector sponsor slight less than half of these individuals take up jobs elsewhere in the public sector. Hence public sector employers only lose approximately 25% - 30% of their students/apprentices to the private sector (29% for all courses, 27% electricals, 33% mechanicals). However this source of 'poaching' constitutes 57% of the total of technicians sponsored by private sector employers in the sample.

Distribution of Technicians by Film Size

The percentage distribution of engineering technicians by firm-size measured in terms of total employment has been computed from unpublished CBS data for 1980 and is shown in Table 29. The 185 Private-sector establishments employing over 550 employees account for over 40% of the employment of engineering technicians which yields an average of 6.0 technicians per establishment. At the other extreme, there are 12074 establishments of 1-50 employees employing a total of only 473 engineering technicians (=0.04 technicians per establishment). The distribution within the manufacturing sector is shown in Table 30. Again here it can be observed that engineering technicians are heavily concentrated in relatively few larger-scale establishments with an even lower proportion employed in small-scale establishments compared with the private-sector distribution as a whole.

In order to obtain a more detailed understanding of the distribution of engineering technicians between and also within different firm size categories in the manufacturing sector we have utilized the data obtained from the the returns of our tracer questionnaire which was sent to a statified random sample of manufacturing enterprises. The results of this tracer exercise are summarized in Table 31. where it can be observed that (1) there is a high concentration of technicians according to enterprise size category (2) even with the largest firm-size category there is considerable variation in the pattern of distribution of technicians. In particular, relatively large numbers of technicians tend to be concentrated in usually no more than 2-3 enterprises in each product sector.

(3) The Utilisation of Engineering Technician Skills.

Technician questionnaire respondents were requested to answer the same two questions as engineers concerning utilisation of formally-acquired technical knowledge and task analysis. The utilisation percentage breakdown for full technicians (both Part III and ordinary Diploma) and higher diploma holders according to each major sector of employment are presented in Tables 32 + 33 It can be observed that our technician respondents claim a generally high utilisation of their technical knowledge, in particular those in the industrial sector, the majority of whom are employed by TNCs. This is in contrast to the much lower levels of utilization stated by university-trained electrical and mechanical engineers and would seem, therefore, to suggest that, in a purely technical sense, there is a much higher degree of correspondence between the content of technician training and the skill demands emanating from both public and private sector employers. It can also be seen that Higher National Diploma holders occupy an intermediate position between ordinary technicians and full engineers in terms of their perceived utililation of formally-acquired technical knowledge.

The technician task analysis is presented in Tables 34-35. Both ordinary and higher technicians are primarily concerned with managerial and supervisory duties directly related to plant maintenance, although, as expected, managerial content is generally higher for higher diploma holders. Involvement in design and routine production activities is relatively negligible for both groups. Considerable variation exists however in the distribution of managerial/supervisory and maintenance tasks among technicians. Comparing the task percentages in the lower and upper quartile columns reveals that there is a clear inverse relationship between these two types of tasks although, as many respondents themselves pointed out, they are often difficult to distinguish in everyday practice. This high dispersion is nevertheless indicative of the heterogeneity of the employment positions occupied by technicians. An analysis of job titles of technician qualification holders employed by some of the companies who responded to our tracer questionnaire also supports this contention. Of the 23 returns sampled the 90 individuals recorded as possessing technician qualifications occupied the following range of employment positions: works manager/manager 17.8% engineer/assistant engineer 13.3%, "technician " 32.2%, supervisor/foreman 34.4% /instructor 6.7% and electrian/mechanic etc. 6.7%. This variety of employment positions occupied by technicians is also reflected in the very high dispersion of technician salaries controlling for both experience (human capital) and sectoral (segmentation) variables which we shall now briefly consider.

4. The Structure of Remuneration for Engineering Technicians

Identical regression equations were computed for engineering technicians as for engineers. The results of this exercise are presented in Table 36 and Figures 2 and 3. It can be observed that years of experience explains only between 30-40% of the variations in nominal income among engineering technicians in each sector. As was the case for engineers, inter-sectoral nominal income differentials increase rapidly as years of experience increase. In other words, the effect of the sectoral segmentation variable is to cause both a shift and, more especially, a change in the slope of the earnings function. Interestingly however these inter-sectoral income differentials are, in percentage terms, not nearly as large as those that prevail among university - trained engineers. Furthermore it would not appear that among private sector employers, TNCs pay significantly higher salaries to their engineering technicians. Within the private sector, therefore, there is little intra-sectoral variation.

It is also interesting to compare the nominal salary functions for technicians with different levels of qualifications. While HND holders start off at salary levels considerably higher than ordinary technicians (O.T) the rate of increase in salary of the latter group is considerably higher so that after fifteen years or so the two salary curves intersect. It should be pointed out, however, that the degree of dispersion of HND salaries is much greater (r^2=0.14) than that of ordinary technician salaries(in fact the R^2 value is so low that we can conclude that no statistically significant relationship exists between years experience and nominal salaries for HND holders). What is even more striking is the comparatively much lower salaries paid to engineering technicians who are only partially qualified (i.e. have only passed either Parts I or II). Why should successfully passing the Part III examination make such an enormous difference to an individuals earning prospects? It will be recalled that only approximately 25-50% of students successfully complete the full technicians course but without additional information it is nor possible to say to what extent the superior technical knowledge acquired or alternatively their higher innate ability are responsible for the much higher salaries enjoyed by these individuals. But is seems somewhat implausible that the technical knowned acquired in just one year of additional formal training can have such enormous impart on remuneration. Finally it can be observed in

Figure 3 that nominal income differentials between electrical and mechanical technician engineers employed by TNC and in the private sector as a whole are relatively very small.

In view of the low R^2 values for the nominal salary-experience regression equations it again appears that measurable human variables account for no more than 50% of the variation in engineering technician nominal salaries - and this is after the data has been disaggregated according to sector. We propose therefore to extend the analysis to include ad additional firm segmentation variables and also incorporate the job characteristics data (such as variations in tasks, number of people directly responsible for, degree of knowledge utilisation) into the earnings function.

Job Turnover of Engineering Technicians.

Data on Job Turnover disaggregated according to years of experience

Data on Job Turnover disaggregated according to years of experience
for engineering technicians are presented in Tables 37 and 38. It can be observed that job turnover is very low for the majority of technicians, in particular those specialising in electrical engineering. Even for technicians with between 9-10 years employment experience 46% of them had only changed their job once, 25% more than once and 29% continued to remain with their original training sponsor. The reasons for this low turnover have not as yet been analysed but are probably the consequence of varying combinations of highly specific training programmes and high job satisfaction. And yet given that there is so much dispersion in technician salaries even within the private sector it is surprising that job turnover is not higher.

3.1 The Stock of Formally-Trained Engineering Artisans.

The formation of engineering skills among "skilled manual occupations" in Kenya is characterised by a combination of formal craft apprenticeship and informal on-the-job training. Given the overall research objectives of this study, we are primarily concerned with analyzing the first of these two modes of skill acquisition. However, our evaluation of official policies concerned with the institutionalisation of artisan training (via the establishment of formal craft training schemes requiring some form of attendance at industrial training centres) cannot be satisfactorily undertaken without some understanding of the overall pattern of skill formation among skilled engineering workers within the economy as a whole.

The reliance on on-the-job training by the majority of employers in Kenya coupled with the resulting low level of demand for formal sponsorship of craft apprentices makes it very difficult to meaningfully define and compute stock totals for what is an extremely heterogeneous group of manpower. A variety of definitions have been used by the three Manpower Surveys and the annual labour nnumeration conducted by the CBS with the result that these sources of data are of little value for time-series analysis. For example, the 1964, 1967 and 1972 Manpower Surveys recorded the total stock of skilled manual occupations as being 16376, 28704 and and 21341 respectively. Similarly, the CBS total for "skilled Workers" in 1972 of 101,900 fell dramatically to 63,400 in 1977 which clearly cannot be attributed to the actual deskilling of the labour force.

In order to try to clarify this extremely confused statistical picture concerning the numbers of skilled manual occupations we have relied on three sets of data namely (1) the annual number of craft, and in particular, engineering artisan apprentices between 1954-1977 (2) the total number of Government trade test passes (both grand totals and for engineering trades) and (3) 1980 CBS labour Ennumeration data. The results of this exercise are presented in Tables 39 and 40 . We have assumed that all apprentices and learners satisfactorily completed their training so that the enrolment figure between 1954-1977 can be treated as outputs between 1954-1979. Also we assume that each of these trainees has obtained at least one government trade test so that in order to obtain the total number of qualified but non-apprenticed artisans, these have been subtracted from the trade-test totals. In the absence of detailed information on trade tests however, we have also assumed that (1) all Grade I holders have also passed Grades II and III (this is the normal ruling laid down by DIT) and (2) all Grade II holders have a Grade III certificate. (3) each individual has passed trade tests in only one trade (a reasonable assumption and hence our estimates are likely to over-estimate the number of people with trade test certificates).

From Table 41 it can be observed that thereare approximately 9000 engineering artisans (broadly-defined) who have completed a formal apprenticeship which constitutes less than 20% of the likely total number of "engineering skilled workers' as ennumerated bt the CBS. In other words, among employers as a whole, apprentice training in its current form is only considered necessary for 1 in 5 of their skilled workers. From a costs point of view, the tra training levy offers some incentive to train but in many cases this is offset by the relatively high statutory rates of pay for apprentices laid down by the Government (and union rates once they have completed) compared to those paid to workers who have only received specific training on-the job.

3.2 Inter-Sectoral Distribution of Engineering Artisans

We did not attempt to undertake a systematic sample tracer survey of engineering artisans who have completed apprenticeships under the auspices of the Directorate of Industrial Training. We have however, been able to obtain employer sponsorship data from which the overall pattern of demand for formal artisan training can be ascertained. And this can be supplemented by data on job movements contained in the questionnaires received from some 65 craft apprentice-trained artisans (all of whom are employed in the private sector) which will allow us to roughly determine the actual distribution-at least between the private and public sectors.

Some idea of the overall pattern of employment of "engineering skilled workers" can be obtained from the 1980 CBS labour Ennumeration data. In Table 42 it can be seen that 53.2% of those workers are employed in the manufacturing sector (Three product sub-sectors, food, textiles[23] and fabricated metal products and machinery account for 80.2% of this figure) i, as with engineer and technician employment, "engineering skilled workers" are heavily concentrated in the largest establishments (Table 43).

3.3. The Utilization of Engineering Artisan Skills

The utilization and task analyses for engineering artisans are based on the data contained in the section of our questionnaire on characteristics of present employment. Artisans claim to utilize a very high percentage of their formally-acquired knowledge (see Table 45). While, therefore, the overall employer-demand for the present apprentice training is relatively low, where these artisans are employed there appears to be a high degree of correspondence between employer skill requirements and the training undertaken.

The task analysis breakdown is presented in Table 46 where it can be observed that artisans are engaged in routine and major maintenance andrepair activities involving, as expected a lower level of supervisory activity than technicians and engineers. One again, however, there is still considerable variation in the pattern of tasks undertaken by this sample of artisans thus indicating that they also occupy a widerange of of positions within the employment hierarchies of firms.

3.4. The Structure of Remuneration For Engineering Artisans

The results of the simple linear regression equations for nominal salary and years of experience are presented in Table 47 and Figure 4 on the basis of which the following tentative conclusions can be drawn: (1) The human capital experience variable accounts for between 10-50% of various in nominal remuneration within the private sector although more emphasis should be placed on the TNC R^2 values in view of the higher sample populations (2) Although salaries data for artisans employed in the public sector was not collected we have tentatively estimated probably regression lines based on the pre-and past-Waruhiu Commission Salary Scales for artisans employed in the Civil Service from which it can observe that private sector artisan nominal salaries are between 75% to 20% higher man in the public sector (depending on the number of years experience of the artisans) (3) TNC employers tend to pay considerably higher artisan salaries than other private employers especially for more experienced manpower (4) Salary differentials between electrical and mechanical artisans do not appear to be sizeable although the sample size for electrical artisans is not sufficiently large to be able to state this with a high degree of certainty.

The utilisation and responsibility variables were also included in the regression analysis and while neither produced coefficients which were significant at the 95% level the R^2 value increased considerably to 0.75. (The university - trained engineers employed by consultancies were the only other group where the inclusion of these two variables resulted in a much higher R^2 value.) It would seem therefore that; at least with respect to these variables (experience, degree of utilization, people responsibility for) there is some similarity in the wage and salary structures of private-sector employers of artisans and among engineering consultancies. But considerably more computational analysis needs to be undertaken before the complex nature of these earnings functions can be understood.

4.1. The Quantitatative Relationships Between Engineers Technicians and Artisans.

For manpower Planning Purposes, it is commonly asserted asserted that technical manpower should be produced so as to ensure the attainment of a manpower pyramid which is characterised by the 'correct' hierarchical composition of the various major categories of manpower. The case of engineering manpower, it is argued that there is an optimum quantitative relationship between engineers, technicians and artisans which, when expressed as ratios of one category to another, should be in the order of 1 engineer to 5-10 technicians to 10-20 (or more) artisans. It is then generally concluded that the manpower pyramid is heavy too and that the most important priority is, therefore, to expand training facilities for technicians and artisans. This, it is argued, is where the major manpower bottleneck arises in relation to ensuring the more efficient functionning of private and public enterprises and organisations and hastening the implementation of development projects. The point to stress, however, is that these statements which are made with such conviction and certainty are often based on the flimsiest empirical and theoretical knowledge of the actual manpower structure and effective manpower demands and needs. In the case, for example, of occupational ratios these are generally not determined on the basis of comprehensive surveys of stocks anc concrete employer demands but are merely assumed to be the most desirably although there is occassionally some attempt to at empirical justification by referring to manpower ratios prevailing in other developed economics. But a more detailed analysis of manpower structures even within these countries reveals that there it is often difficult to discern any uniform pattern.

Our study of the formation of engineering labour markets in Kenya is concerned to analyze the social political and economic forces which have staped the existing patterns of training and employment of each category of engineering manpower To merely subsume this key aspect of Kenyan political economy into pseudo-technocratic ratios is clearly unsatisfactory. ~~Indeed this is in itself symptomatic of the ideological and~~ theoretical premises of conventional manpower planning exercises which, given that this planning has had a very tangible effect on manpower development in Kenya, must themselves be carefully examined.

The purpose of this paper has been to furnish some of the data which is an essential prerequisite for the more theoretical aspects of our study outlined above. In simple quantitative terms we are now in position to derive the main features of the engineering manpower pyramid which provides a starting point for a discussion of the more qualitative and theoretical research we have undertaken which will be presented at a later date. In addition, the questionnaire data allow us to formulate testable theoretical propositions on the relationship between the training and utilisation of engineering manpower To what extent, for example, do educational qualifications serve to create formal boundaries of status and salary within the different types of engineering labour markets, in Kenya.. Comparing our very provisional engineer, technician and artisan salary-experience regression curves does indicate that this seems to be the case but with a number of very important reservations

Table 1: Kenyan and Non-Kenyan Engineering Graduates from Nairobi University 1964 - 1979.

DISCIP.	NAT.	NAT.	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
	Kenyan		4	3	14	15	11	12	8	16	14	14	23	42	42	54	52	57
CIVIL	Non-Kenyan		10	6	8	13	14	13	17	30	27	29	17	15	17	7	2	1
	Total		14	6	22	28	25	25	25	46	41	43	40	57	59	61	54	58
	Kenyan		4	3	3	5	6	8	7	-	6	12	20	32	19	40	35	31
ELECT	Non-Kenyan		3	8	9	5	9	12	6	-	17	7	5	10	7	6	1	0
	Total		7	11	12	10	15	20	13	-	23	19	25	42	26	46	36	31
	Kenyan		2	Na	4	9	5	8	4	-	11	11	41	40	36	40	35	47
MECH.	Non-Kenyan		3	Na	2	1	12	22	10	-	19	23	9	11	5	8	2	12
	Total		5	Na	6	10	17	30	14	-	30	34	50	51	41	48	37	49

TABLE 2: Estimates of Foreign - Trained Engineers By Country/Region 1960-1979

COUNTRY/REGION	A.V. STUD 1960-65	AV. NO STUDENTS 1966-74	TOTAL ENG STUDENTS GRD 1965-70	TOTAL ENG GRADUATES 1971 - 79	Eng/Total Ratios. 1960-65	Eng/Total Ratios. 65-74
UNITED KINGDOM	1200	n.a	130	300	10.5	12.5
U.S.A.	1000	2000	75	270	7.5	7.5
U.SS.R	400	350	40	100	8.0	16.0
INDIA/PAKISTAN	800	1000	120	270	15.0	15.0
EASTERN EUROPE	150	250	30	90	20.0	20.0
WEST GERMAY	50	150	15	80	30.0	30.0
REST OF WESTERN EUROPE	100	200	8	7	7.5	7.5
MIDDLE EAST/ REST AFRICA						
			418	1137		

Notes : (1 It has been assumed that on average a student takes five - years to complete his training overseas.

(ii) The output of Kenyan Engineering graduates from U.K. universities 1971 - 79 been estimated from data supplied by the University Statistical Records Office.

Sources: Ministry of Higher Education, Overseas Students Files, various.

TABLE 3 : Foreign - Trained Engineers Tracer Survey

SUBJECT	No. Replies	Number Traced	%
Civil	19	15/57	26.3
ELECTRICAL	26	10/36	27.7
MECHANICAL	31	12/39	30.7

Source: Foreign - Trained Engineers Tracer Survey. 1981.

TABLE 4 : Stock of University - Trained Engineers in Kenya 1964-1979.

DISCIPLINE*3 / YEAR	CIVILS			ELECTRICALS			MECHANICALS			Totals		
	K	Ex	Total	K	Ex	T	K	Ex	T	K	Ex	[illegible]
1964	64*1	136	200	65*1	149	214	74	206	341	203*1	491	[illegible]
1972	128	383	511	95	259	354	75	439	514	298	1081	[illegible]
1979 L	504	340	844	356	113	469	417	306	723	1277	759	[illegible]
*2 H	557	441	998	389	147	536	450	393	843	1396	982	[illegible]

*1 This also includes non - citizen Asians.

*2 High estimates include expatriate technicians and the upper estimate of overseas - trained students.

*3 Related specialization such as structural, telecommunications, chemical, textile engineering are also included within the appropriate discipline category.

Sources: Republic of Kenya, "High-Level Manpower: Requirements and Resources 1964-70", Ministry of Economic Planning and Finance, Nairobi, May 1965.
Republic of Kenya, "1972 High and middle level Manpower Survey" (unpublished)
Foreign and University of Nairobi Tracer Surveys.

Table 5: Demand Elasticities For University Trained Engineering Manpower

DISCIPLINE	$\frac{\Delta E}{E64}$	$\frac{\Delta GDP}{GDP\ 64}$	GDP Elasticity	$\frac{\Delta L}{L64}$	Employ Elasticity
CIVIL	335	116	2.88	57	5.8
ELECTRICAL	115	116	1.0	57	2.0
MECHANICAL	115	116	1.0	57	2.0
TOTAL	173	116	1.5	57	3.0

Sources: Annual Statistical Abstracts and Economic Surveys 1964 80 (various)

Table 6: Manpower Projections for University Trained Engineers

	1979 Stock	Incremental Demand 1980 89	Output 1980 89
	2200 2200	930 @ 2.5* GDP 2334 @ 5% GDP	2200–2800
Local trained	900	–	
Overseas trained	450	–	
Expatriates	950	–	

TABLE 7 : Present Employment of Engineering Graduates From Nairobi University, 1964 - 1979

DISCIPLINE	Central Government	Parastatals	African Industrial Entrepreneurs	Non-African Private	T N C + Joint Venture	African Consultant Entrepreneurs	African Consultant Employees	Other Citizen Consultancy	Foreign Consultancy	Teachers + Students	Migrated	Traced Total Reg.	Untraced	Traced % Total
CIVIL	166	56	0	10	9	9	13	22	52	10	12	359	36	91.1
% Traced	46.2	15.6	0	2.8	2.5	2.5	3.6	6.1	14.5	2.8	3.3	100	-	-
REGISTERED	51/118	27/47	0	5/10	4/9	8/9	10/11	15/18	24/39	2/8	0.0	144/265	3/36	-
%	43.2	62.8	0	50.0	44.4	88.9	90.9	83.3	61.5	25.0	0.0	54.3	8.3	-
ELECTRICAL	34	105	1	6	38	3	2	2	5	12	10	218	22	90.8
% Traced	15.6	48.2	0.45	2.7	17.4	1.4	0.9	0.9	2.3	5.5	4.6	100	-	
REGISTERED	11/22	16/87	0/1	2/5	8/27	2/3	0/2	1/2	1/5	2/9	0.0	43/164		-
%	50.0	18.3	0.0	40.0	29.6	66.6	0.0	150.0	20.0	22.2	0.0	26.2		-
MECHANICAL	70	53	3	22	95	1	2	2	1	18	4	271	21	92.8
% Traced	25.8	19.6		8.1	35.0			0.7	0.4	6.6	1.5	100	-	-
REGISTERED	14/48	23/39	0/2	9/18	16/60	1/1	0/1	1/2	0/1	5/13	0.0	69/186	3/21	-
%	29.2	60.0		50.0	26.7			50.0	0.0	38.5	0.0	37.1	14.3	-
TOTAL	270	214	4	38	142	13	17	26	57	40	26	848	79	91.5
% Traced	31.8	25.2	0.4	4.5	16.7	1.5	2.0	3.1	6.7	4.7	3.0	100	-	
REGISTERED	76/188	66/169	0/4	16/33	28/96	11/14	10/14	17/22	2/45	9/30	0.0	259/615		-
%	40.4	39.0		48.5	29.1			77.3	55.5	30.0	0.0	42.1		-

Table 8: Estimates of Sectoral Distribution of All University Trained Engineers in Kenya

SECTOR / ESTIMATE	Central Government	Parastatal	Consultancy	Other
UNTRACER	32.0	25.0	13.0	22.0
BENNELL TOTAL	23.0	23.0	25.0	29.0
CBS "Architects, Engineers & Surveyors" 1980	37.0	20.0	19.0	24.0

Table 9: Sectoral Distribution of Engineers (Kenyans & Non Citizens)

DISCIPLINE	YEAR	CENTRAL GOVERNMENT	PARASTATAL & LOCAL GOVT	CONSULTANCY SECTOR	PRIVATE
CIVIL	1964	100 -	120 (60) +	30–50 (15)	50 (25)
	1979	250	100(39)+	430 500(50)	75–125 (11)
ELECTRICAL + TELECOMMS	1964	240 -	260 (83)	10(3)	40 (13)
	1979	150	250 (75)+	50(9)	80 (15)
MECHANICAL CHEMICAL + RELATED	1964	110 -	130 (38)	10(3)	200 (59)
	1979	150	250(37)+	50(6)	450 (57)
Archs, Eng+Surv	CBS 1980	1704	na	851	na

Note: Figures in parantheses are percentages.
+ Total public sector percentage.

Table 10: Distribution of Nairobi University Mechanical Engineers By Firm Size.

	Number of Employees 0 – 200	200 – 500	500+	Total
Manufacturing	2	22	102	126
Other Industrial	5	15	8	28
Percentage	5.8	24.0	71.4	15.4

Source: Nairobi University Engineering Tracer Study.

Table 11: Distribution of Engineers Among Private Sector Enterprises 1975

No Engineers Per Enterprise	Number of Employees 0 – 20	21 – 50	51 – 100	101 – 200	201 – 500	500+
0	5	10	4	[illegible]	2	11
1	.	.	1	2	2	2
2	.	2	.	3	1	2
3	.	.	.	.	2	1
4	.	.	.	.	.	4
5	.	.	.	.	4	.
6 – 10	.	.	.	1	.	3
11 – 15	.	.	.	.	.	4
16 – 25	.	.	.	.	.	1
25+	.	.	.	.	.	3

Note: Figures show number of enterprises.

Source: National Council for Science and Technology, "1975 Survey of Scientists and Technicians", unpublished data.

Table 12: Utilization of Formally Acquired Engineering Knowledge By Sector

SECTOR \ % Utilisation	SUBJECT	0 – 24	25 – 49	50 – 74	75 – 100	Number Respondents
CIVIL SERVOCE	C	17.3	56.5	17.4	8.6	
	E	14.2	57.1	28.5	0.0	7
	M	33.3	33.3	33.3	0.0	12
PARASTATAL	C	11.0	55.5	33.0	0.0	
	E	31.4	42.8	20.0	5.7	35
	M	29.0	53.0	18.0	0.0	
NON-AFRICAN PRIVATE	C					
	E	50.0	50.0	0.0	0.0	2
	M	23.5	47.0	23.5	6.0	17
T N C	C	0.0	25.0	75.0	0.0	
	E	36.3	36.3	9.0	0.0	11
	M	43.0	43.0	16.0	0.0	44
CONSULTANCY	C	10.7	46.7	37.5	5.3	
	E	25.0	0.0	75.0	0.0	4
	M	0.0	25.0	75.0	0.0	4
UNIVERSITY/ POLYTECHNIC	C					
	E	0.0	100.0	0.0	0.0	1
	M	0.0	33.3	0.0	66.6	3
A L L	C	11.3	48.4	34.0	6.2	97
	E	31.7	43.3	26.7	5.0	60
	M	30.0	48.0	19.0	3.0	108

Source: University of Nairobi Questionnaire Respondents.

Table 13: Task Analysis of University - Trained Engineers.

		Lower Quartile	Median	Upper Quartile
Civils	Design	10 - 19	50 - 59	70 - 79
	Managerial etc	10 - 19	30 - 39	60 - 69
	Maintenance	0 - 9	0 - 9	0 - 9
	Production	0 - 9	0 - 9	0 - 9
Elect	Design 0	0 - 9	10 - 19	30 - 39
	Managerial etc	20 - 29	40 - 49	50 - 59
	Maintenance	0 - 9	10 - 19	40 - 49
	Production	0 - 9	0 - 9	0 - 9
Mechanical	Design	0 - 9	0 - 9	30 - 39
	Managerial etc	10 - 19	30 - 39	50 - 59
	Maintenance	0 - 9	20 - 29	40 - 49
	Production	0 - 9	10 - 19	20 - 29

Source: University of Nairobi Questionnaire Respondents.

Table 14: Relationship Between Nominal Salary and Years Experience For Civil Engineers.

SECTOR	Sample Size	Intercept Value	b Coefficient	R^2
CIVIL SERVICE	30	2495.6	156.20	0.43
PARASTATAL	11	4975.4	97.60	0.05
NON-AFRICAN INDUSTRIAL	2	na	na	na
T N C	4	na	na	na
LOCAL CONSULTANCY	26	4562.0	491.81	0.56
FOREIGN CONSULTANCY	32	4651.4	448.36	0.45
ALL PRIVATE SECTOR	64	4643.0	451.35	0.49
PUBLIC + PRIVATE	105	3774.4	403.8	0.30

Source: University of Nairobi Questionnaire Respondents

Table 15: Relationship Between Nominal Salary and Years Experience For Electrical Engineers

SECTOR	Sample Size	Intercept Value	b Coefficient	R^2
CIVIL SERVICE	9	3045.6	73.40	0.1
PARASTATAL	42	3396.6	268.0	0.31
NON-AFRICAN PRIVATE	4	na	na	na
T N C	8	na	na	na
LOCAL CONSULTANCY	2	na	na	na
FOREIGN CONSULTANCY	3	na	na	na
ALL PRIVATE SECTOR	17	3830.1	749.2	0.52
PUBLIC + PRIVATE	75	3463.5	365.0	0.22

Source: University of Nairobi Questionnaire Respondents

Table 16: Relationship Between Nominal Salary and Years Experience For Mechanical Engineers

SECTOR	Sample Size	Intercept Value	b Coefficient	R^2
CIVIL SERVICE	13	2358.3	26.64	0.01
PARASTATAL	16	2755.7	526.3	0.13
NON-AFRICAN INDUSTRIAL	22	4071.2	293.4	0.15
T N C	50	4341.15	674.7	0.51
LOCAL CONSULTANCY	2	na	na	na
FOREIGN CONSULTANCY	2	na	na	na
ALL PRIVATE SECTOR	73	4215.0	573.5	0.38
PUBLIC + PRIVATE	111	3485.6	562.0	0.30

Source: University of Nairobi Questionnaire Respondents

Table 17: Relationship Between Nominal Salary and Years Experience For All Engineers

SECTOR	Sample Size	Intercept Value	b Coefficient	R^2
CIVIL SERVICE	51	2678.7	123.56	0.22
PARASTATAL	71	3668.6	231.7	0.19
NON-AFRICAN INDUSTRIAL	30	4320.4	344.0	0.23
T N C	64	4370.2	593.4	0.44
LOCAL CONSULTANCY	64	4437.0	488.95	0.55
FOREIGN CONSULTANCY				
ALL PRIVATE SECTOR				
PUBLIC + PRIVATE		-	-	

Source: University of Nairobi Questionnaire Respondents

Table 18: Public to Private Sector Job Movements: An Engineers

DISCIPLINE	Number Public To Private	%	Number Private To Public	%
CIVIL	20/123	16.26	3/123	
ELECTRICAL	15/86	17.4	2/86	
MECHANICAL	12/120	10.0	7/120	
TOTAL				

Table 19: Public to Private Sector Job Movements For Engineers with more than Three Years Experience

DISCIPLINE	Number Public To Private	%	Number Private To Public	%
CIVIL	18/87	20.6	2/87	
ELECTRICAL	11/62	17.7	2/62	
MECHANICAL	11/53	12.3	4/89	
TOTAL				

Table 20: Public Sector Professional Migrants (with more than three Years Experience) Expressed As Percentage of Total Public Sector Employment

DISCIPLINE	Number Public To Private	%	Number Private To Public	%
CIVIL	18/42	42.8	2/42	
ELECTRICAL	11/52	21.1	2/52	
MECHANICAL	11/36	30.5	4/36	
TOTAL				

TABLE 21: JOB TURNOVER BY YEARS OF EXPERIENCE

Years Experience \ No of Job Changes		0	1	2	3	4	5
0 - 2	C	76.0	24.0	0.0	0.0	0.0	0.0
	M	61.0	40.0	0.0	0.0	0.0	0.0
	E	86.0	9.0	5.0	0.0	0.0	0.0
3 - 4	C	65.0	31.0	4.0	0.0	0.0	0.0
	M	46.0	42.0	10.0	2.0	0.0	0.0
	E	64.0	18.0	18.0	0.0	0.0	0.0
5 - 6	C	50.0	21.0	17.0	12.0	0.0	0.0
	M	63.0	25.0	11.0	3.0	0.0	0.0
	E	45.0	35.0	20.0	0.0	0.0	0.0
7 - 8	C	33.0	0.0	45.0	22.0	0.0	0.0
	M	10.0	40.0	50.0	0.0	0.0	0.0
	E	86.0	15.0	0.0	0.0	0.0	0.0
9 - 10	C	10.0	17.0	17.0	17.0	49.0	0.0
	M	20.0	80.0	0.0	0.0	0.0	0.0
	E	40.0	20.0	40.0	0.0	0.0	0.0
11 - 12	C	0.0	33.0	33.0	0.0	17.0	17.0
	M	0.0	0.0	100.0	0.0	0.0	0.0
	E	75.0	0.0	25.0	0.0	0.0	0.0
13 - 14	C	0.0	0.0	0.0	0.0	0.0	0.0
	M	0.0	0.0	0.0	0.0	0.0	0.0
	E	0.0	100.0	0.0	0.0	0.6	0.0
15 +	C	0.0	0.0	0.0	100.0	0.0	0.0
	M	0.0	0.0	0.0	100.0	0.0	0.0
	E	50.0	50.0	0.0	0.0	0.0	0.0

Table 22: Estimated Output of Technician Graduates From Kenya and Mombasa Polytechnics 1969-1979

MECHANICAL	
Mechanical Engineering Technician III+	137
Mechanical Engineering Technician I + II**	362
Other Mechanical Related Technicians I - III	57
Higher National Diploma Mechanical (full)	55
Ordinary Diploma in Mech. and Elect Engineering*	162
	773
MOTOR VEHICLE	
Motor Vehicle Technician III	89
Motor Vehicle Technicians I + II	248
	337
ELECTRICAL	
Electrical Install + Engin. Technicians III+	285
Electrical Install + Engin. Technicians I + II**	210
Higher National Diploma Electrical (full)	59
Other Electrical Technicians I - III	64
Ordinary Diploma in Electrical Engineering*	41
	659
BUILDING	
Ordinary Diplomas* in: Cartography	24
Land Surveying	70
Civil Engineering	105
Building + Civil Engineering	209
Water Engineering	91
Construction Technician I	270
Construction Technician II	100
Higher National Diplomas	43
	912
GRAND TOTAL	2681

Notes: * HND technician totals have been deducted from Ordinary Diploma total since the latter group constitute the main source of recruitment for HND courses.

+ Part III totals have been deducted from Part II totals.

** It is not possible to determine from examination records just how many students complete Part I examinations before proceeding to Part II. We have assumed that 50% of successful Part I students proceed to Part II and can therefore be eliminated.

Table 23: Distribution of Engineering Technicians by Main Economic Activity.

	Agric, Fishing Mining	Manu.	Elect + Water	Construct.	Retail Whole-sale etc	Trans + Com	Engin service	Community services
Number	159	444	939	385	111	612	714	719
%	3.9	10.9	23.0	9.4	2.7	15.0	17.5	17.6

Table 24: Pattern of Employer Sponsorship of Building Technicians at the Kenya Polytechnic 1975-79

SECTOR	2nd Term 1975			2nd Term 1977			2nd Term 1979		
	Number Students	% Total	No of Firms	Number Students	% Total	No of Firms	Number Students	% Total	No of Firms
Civil Service	200	63.7	10	163	74.4	6	218	82.3	7
Parastatals	47	15.0	6	8	3.6	2	3.	1.1	2
Manufacturing TNC	0.0	0.0	0.0	3	1.4	2	0.0	0.0	0.0
Manufacturing Other	2	0.6	2	4	1.8	2	0.0	0.0	0.0
Construction	35	11.1	30	30	13.6	29	11	4.1	5
Other	6	1.9	6	6	2.7	5	0.0	0.0	0.0
Consultancy	24	7.6	19	5	2.3	2	5	1.9	2
Private Unknown (i.e unspecified single sponsors	0.0	0.0	0.0	0.0	0.0	0.0	28	10.6	28
TOTALS	414	100	61	219	100	48	265	100	44
Public As % Totals	–	78.7	–		78.0		–	83.4	

Table 25: Pattern of Employer Sponsorship for Electrical and Related Technicians at the Kenya Polytechnic 1975-79

SECTOR	2nd Term 1975			2nd Term 1977			2nd Term 1979		
	Number Students	% Total	No of Firms	Number Students	% Total	No of Firms	Number Students	% Total	No of Firms
CIVIL SERVICE	70	28.2	10	87	37.5	10	101	44.3	11
Parastatal	113	45.6	8	82	35.3	6	81	35.5	6
Manufacturing TNC	24	9.6	11	25	10.8	9	16	7.0	5
Manufacturing Other	15	6.0	4	7	3.0	5	2	0.9	2
Construction	4	1.6	4	0.0	0.0	0.0	6	2.6	3
Other	20	8.0	18	5	2.1	3	3	1.3	3
Consultancy	2	0.8	2	2	0.9	1	2	0.9	1
Other Private Unspecified Single Sponsors	0	0	0	24	10.3	24	17	7.4	17
TOTALS	248	100	58	232	100	58	228	100	48
Public as % Total	-	73.2	-	-	72.8	-	-	79.8	-

Table 26: Pattern of Employer Sponsorship For Mechanical and Related Engineering Technicians at the Kenya Polytechnic, 1975-79

SECTOR	2nd Term 1975			2nd Term 1977			2nd Term 1979		
	Number Students	% Total	No of Firms	Number Students	% Total	No of Firms	Number Students	% Total	No of Firms
Civil Service	147	40.2	13	104	35.7	10	142	36.2	8
Parastatal	78	21.4	9	40	13.7	8	55	14.0	7
Manufacturing TNC	50	13.7	15	22	7.6	6	33	8.4	9
Manufacturing Other	46	12.6	26	28	9.6	5	26	6.6	6
Construction	3	0.8	2	0	0	0	7	1.8	2
Other	37	10.2	20	38	13.0	12	61	15.6	14
Consultancy	3	0.8	2	2	0.7	1	2	5.1	1
Other Private (ie Unspecified Single Sponsors	0	0	0	57	19.6	57	66	16.8	66
TOTALS	364	100	87	291	100	99	392	100	
Public as % Total	-	61.7	-	-	49.4	-	-	50.2	

TABLE 27: Employment By Sector of Graduate Technician Sample

COURSE \ SECTOR		CIVIL SERVICE + TSC	PARASTATALS + EAPL	OWN ENTER-PRISE	FOREIGN PRIVATE	TNCS + JOINT VENTURES	ENGINEER-ING CON-SULTANCIES	TEACHERS + FURTHER STUDIES	NON-KENYAN	TOTAL KENYAN TRACED	TOTAL UN-TRACED
HIGHER DIPLOMA MECHANICAL	NO.	0	1	1 (1)	2	10	1	2	2	17	
	%	0.0	5.8	5.8	11.6	58.8	5.8	11.6	-	100	
MET III	NO.	7	8	0	3	15	0	7	7	40	
	%	17.5	20.0	0.0	7.5	37.5	0.0	17.5	-	100	
HIGHER DIPLOMA ELECTRICAL	NO.	2	3	0	1	6	1	2	3	15	
	%	13.3	20.0	0.0	6.7	40.0	6.7	13.3	-	100	
EET III	NO.	6	26	2 (2)	3	14	0	6	1	58	
	%	10.3	44.8	3.4	5.2	24.1	0.0	10.3	-	100	
TOTAL	NO.	15	39	3 (3)	9	45	2	17	13	130	391
	%	11.5	30.0	2.3	6.9	34.6	1.5	13.0	-	100	

TABLE 28: Number and Percentage of Engineering Technicians still employed by sponsor and Pattern of Inter-Sectoral Job Movements

COURSE		PUBLIC SECTOR SPONSOR	PUBLIC SECTOR AS A WHOLE	PUBLIC SECTOR SPONSEES TO PRIVATE SECTOR	PRIVATE SECTOR SPONSOR	PRIVATE SECTOR SPONSEES TO PUBLIC SECTOR	% STILL WITH ORIGINAL SPONSOR
HIGHER DIPLOMA MECHANICAL	Nos	2/5	2/5	3/5	8/12	0/17	C/17
	%	40.0	40.0	60.0	66.7	0.0	58.8
MET III	Nos	11/22	16/22	6/22	9/18	6/18	20/40
	%	50.0	72.7	27.3	50.0	33.3	50.0
HIGHER DIPLOMA ELECTRICAL	Nos	3/9	7/9	2/9	6/6	0/6	9/15
	%	33.3	77.9	22.1	100.0	0.0	40.0
EET III	Nos	26/50	36/50	14/50	5/8	0/8	21/58
	%	52.0	72.0	28.0	50.0	0.0	50.0
TOTALS	Nos	42/86	61/86	25/86	28/44	6/44	/130
	%	48.8	70.9	29.1	63.6	13.6	53.8

Source: Kenya Polytechnic Technician Trader Survey.

Table 29 Employment Distribution of Engineering Technicians By Firm Size Within the Private Sector

No Employees	1 - 50	51-100	101-200	201-300	301-555	550+
Number	473	219	402	235	414	1118
%	16.5	7.6	14.0	8.2	14.5	39.1
No. Estabs.	12074	903	605	237	219	185
Av. Techs/Estab	0.04	0.24	0.66	1.0	1.9	6.0

Source : 1980 Labour Ennumeration, CBS, unpublished

Table 30 : Employment Distribution of Engineering Technicians By Firm Size within the manufacturing Sector

No Employees	1 - 50	51 - 100	101 - 200	201 - 300	301 - 555	550+
Number	18	46	88	57	85	150
%	4.0	10.3	19.8	12.8	19.1	33.8
No. Estabs	1448	215	152	59	50	47
Av. Techs/Estab.	0.01	0.21	0.58	1.0	1.7	3.19

Source: As Table 29.

Table 31 : Employment Distribution of Engineering Technicians Among Tracer Survey Firm Respondents

	FIRM SIZE (employees)	TOTAL NUMBER FIRMS	% POSTAL SAMPLED	% RETURNED	NUMBER OF TECHNICIANS PER FIRM 0	1	2	3	4	5	5	10	11-5	15-30	30-50	51+	NO TECHS SAMPLE	ESTIMATE TOTAL TECHS
	0 - 50	189	5		4	1												
	50- 100	1	20		4	1												
FOOD	100-200	24	20		2		1											
	200 - 500	12	50		1	1				1								
	500+	14	50		1			1	2		1				1	1		
	0 - 50	221	5		5	1												
	50 - 100	46	20		2	1												
TEXTILES	100 - 200	15	20		1	2												
	200 - 500	7	50															
	500+	11	50		1		1	1		1								
	0 - 50	356	5		4													
WOOD	50 - 100	52	20		3	1												
PRINTING	100 - 200	17	20		1	1				1								
+ PAPER	200 - 500	9	50			2												
	500+	3	50												1			
	0 - 50	89	5		5													
CHEMICALS,	51 - 100	28	20		5													
RUBBER	101 - 200	11	20		3		2											
PETROLEUM	201 - 500	7	50		1	2												
	500+	2	50				1					1						
	0 - 50	32	5															
NON-	51 - 100	15	20		2													
METALLIC	101 - 200	15	20			1	1											
	201 - 500	4	50		1			1										
	500+	2	50													1		

	FIRM SIZE (employees)	TOTAL NUMBER FIRMS	% POSTAL SAMPLED	% RETURNED	0	1	2	3	4	5	5-10	11-15	16-30	31- 50	51+	NO. TECHS SAMPLE	ESTIMATE TOTAL TECHS
METALLIC	0-50	180	5		4	2	1										
	51-100	58	20		2	1	1										
	101 - 200	23	20		2	2		1	1		1						
	201 - 500	14	50							3							
	500+	6	50		1					1	1			1			

Table 32: Percentage Utilization of the Formally Acquired knowledge of Engineering Technicians (Part III and Ordinary Diploma)

Utilisation (%) / Sector	0-25	26-50	51-75	75+
Civil Service	14.2	28.4	14.2	42.8
Parastatal	14.2	38.1	28.6	19.0
Industrial Private	9.5	21.4	33.3	35.7
Consultancy	0.0	0.0	0.0	0.0
Average	11.2	28.2	29.5	31.0

Table 33: Percentage Utilization of the Formally - Acquired Knowledge of HND engineering technicians.

Utilisation (%) / Sector	0 - 25	26 - 50	51 - 75	75+
Civil Service	n/a	n/a	n/a	n/a
Parastatals	n/a	n/a	n/a	n/a
Industrial Private	21.0	36.8	31.6	9.5
Consultancy	n/a	n/a	n/a	n/a
Average	n/a	n/a	n/a	n/a

Table 34: Task Analysis of The Employment Positions Occupied By Part III and Ordinary Diploma Engineering Technicians

TASK \ Interval	Lower Quartile	Median	Upper Quartile
Administration, Managerial, Supervising	10 - 19	20 - 29	50 - 59
Design	0 - 9	0 - 9	20 - 29
Maintenance	10 - 19	40 - 49	50 - 59
Production	0 - 9	0 - 9	30 - 39

Table 35: Task Analysis of the Employment Positions Occupied by Higher Diploma Engineering Technicians

TASK \ Interval	Lower Quartile	Median	Upper Quartile
Administration, Managerial, Supervising	30 - 39	40 - 49	60 - 69
Design	0 - 9	0 - 9	10 - 19
Maintenance	10 - 19	30 - 39	50 - 59
Production	0 - 9	0 - 9	10 - 19

Source: Engineering Technician Questionnaire Respondents.

Table 36: Relationship Between Nominal Salary and Years of Experience For Engineering Technicians, by subject and sector

Course / Sector		N	Intercept	b Coefficient	R^2
All P + III + Odip	Civil Service	11	1641	95.11	0.07
"	Parastatal	24	1231	231.1	0.44
"	T N C	23	1590.6	378.51	0.40
"	Private All	41	1527.8	410.8	0.35
All P + I + II	Private All	18	1103.6	166.8	0.33
All H N D	Private All	16	3591.7	282.82	0.14
Mech P+III+Odip	Parastatal	5			0.94
" " "	T N C	16	1204.54	464.4	0.49
" " "	Private All	27	1369.16	407.4	0.51
Elect P+III+Odip	Parastatal	18	1090.56	243.50	0.62
" " "	T N C	14	2004.83	365.5	0.19
" " "	Private All	16	1912.89	419.41	0.16

Source: Data contained in engineering technician questionnaires.

Table 37: Job Turnover By Years Experience Among Technician Tracer Sample

		0	1	2	3	4	5
4	MET	43.0 (3)	57.0 (4)	0.0	0.0	0.0	0.0
	HIM	29.0 (2)	44.0 (3)	29.0 (2)	0.0	0.0	0.0
	EET	90.0 (9)	0.0	10.0 (1)	0.0	0.0	0.0
	HDE	66.0	14.0	14.0	0.0	0.0	0.0
5	MET	75.0 (3)	0.0	25.0 (1)	0.0	0.0	0.0
	HIM	0.0	0.0	0.0	0.0	0.0	0.0
	EET	50.0 (4)	37.0 (3)	13.0 (1)	0.0	0.0	0.0
	HDE	0.0	0.0	0.0	0.0	0.0	0.0
6	MET	0.0	100.0 (2)	0.0	0.0	0.0	0.0
	HIM	0.0	100.0 (1)	0.0	0.0	0.0	0.0
	EET	57.0 (4)	43.0 (3)	0.0	0.0	0.0	0.0
	HDE	0.0	0.0	0.0	0.0	0.0	0.0
7	MET	0.0	0.0	0.0	0.0	0.0	0.0
	HIM	50.0 (1)	0.0	0.0	0.0	0.0	0.0
	EET	25.0 (1)	50.0 (2)	0.0	25.0 (1)	0.0	0.0
	HDE	0.0	0.0	0.0	0.0	0.0	0.0

Table 38: Job Turnover By Years Experience Among All Technician Questionnaire Respondents

		0	1	2	3	4	5
0 - 2	E	100.0 (2)	0.0	0.0	0.0	0.0	0.0
	M	100.0 (4)	0.0	0.0	0.0	0.0	0.0
3 - 4	E	100.0 (1)	0.0	0.0	0.0	0.0	0.0
	M	87.0 (13)	6.5 (1)	6.5 (1)	0.0	0.0	0.0
5 - 6	E	75.0 (6)	12.5 (1)	12.5 (1)	0.0	0.0	0.0
	M	54.0 (7)	23.0 (3)	23.0 (3)	0.0	0.0	0.0
7 - 8	E	75.0 (21)	7.0 (2)	18.0 (7)	0.0	0.0	0.0
	M	35.0 (8)	48.0 (11)	17.0 (4)	0.0	0.0	0.0
9 - 10	E	40.0 (6)	40.0 (6)	7.0 (1)	13.0 (2)	0.0	0.0
	M	15.0 (2)	54.0 (7)	8.0 (1)	15.0 (2)	8.0 (1)	0.0
11 +	E	54.0 (7)	46.0 (6)	0.0	0.0	0.0	0.0
	M	-	-	-	-	-	-

Table 39: Number of Craft Apprentices and Indentured learners 1954 - 1977.

Years	Type Trainee	Totals
1954-77	Engineering Apprentice	6393
1959-70	Engineering learners	2582
	Sub-Total	8,975
1954-60	Total Apprentices	1819
1961-77	Total Apprentices	7875
1959-70	Total learners	3611
	Grand Total	13,305

Notes: Engineering trainees include filters, turners, other machinists, sheet-metal workers, Plant and automotive mechanics, instrument

Source: As for Table 40

Table 41: Qualification Breakdown Among Engineering Skilled Workers

	Engineering	All
Formally Sponsored Trainees	8975 (18.3)	13305(14.0)
Non-Sponsored trade test passes	9213 (18.7)	24889(26.3)
Unqualified CBS"Skilled Worker"estimates	26108 (63.0)	46785(59.7)
Unqualified CBS"Production Supervisors & Foremen "estimates	4836	9673
	49136	94652

Sources: As for Table 40
Unqualified skilled worker estimates have been based on Unpublished CBS data giving total number of skilled and engineering workers in 1980 from whichapprentice and trade test totals have been substracted. In addition we have assumed on the basis of previous information that at least 50% production supervisors & foremen have no craft qualifications whatsoever and that 50% of these are engaged in engineering activities broadly defined.

Table 40: Total Number of Individuals Possessing Trade Test Certificates 1954-1979.

NO. Individuals with Trade Test:	Cumulative Total 1954-1979
Engineering I - III	3311
Engineering II-IIII	2948
Engineering III	11929
Sub-total	18,188
All Subjects I - III	5744
All Subjects II - III	5858
All Subjects III	26,592
Grand Total	38,194

Sources: Republic of Kenya/Kenya Colony, Annual Reports of the Ministry and Department of Labour 1955-1977. Kenya National Archive and, for passes since 1977, Unpublished records of the Directorate of Industrial Training.

Table 45. Degree of Utilisation of Formally Acquired Knowledge By Engineering Artisans.

Trade \ Utilisation%	0-25	26- 50	51 - 75	75
Mechanical & Electrical Engineering Artisans	7.7	23.1	28.2	41.0

Source: Artisan Questionnaire Respondents

Table 46 Task Analysis of Present Employment Positions Occupied by Engineering Artisans

Trade \ Interval	Lower Quartile	Media	Upper Quartile
Managerial etc	0 - 9	20-29	30-39
Design	0 - 9	0-9	10-19
Maintenance	30 - 39	60-69	80-89
Production	0 - 9	10-19	20-29

Source: Artisan Questionnaire Respondents.

Figure 1: Inter-Sectoral Linear Earning Functions.

TABLES 42 & 43 : Distribution of Engineering Skilled Workers by Major Sector and Firm Size.

	Agric, Mining Fishing	Manufac-ture	Electrical + Water	Const-ruction	Retail, Whole-sale etc.	Transport + Communi-cation	Consul-tancies	Community Services
Number	3339	23564	810	2991	4289	2310	515	6478
%	7.5	53.2	1.8	6.7	9.7	5.2	1.2	17.6

	0 - 50	51 - 100	101 - 200	201 - 300	301 - 550	550+	
TOTALS Private %	15.4	11.1	11.6	8.3	15.3	38.1	100
Manufac-turing %	8.6	7.1	10.4	8.6	12.9	52.4	100

Source: Central Bureau of Statistics, 1980 Annual Enumeration of Wage Employment in the Modern Sector, unpublished data.

Table 47. Relationship Between Nominal Salary and Years of Experience Among Formally-Trained Engineering Artisans

	Sector	N	Intercept	B.Coefficient	R^2
Mech	TNC	22	1142.2	190.2	0.53
		15	1246.0	71.25	0.17
Mech	Private All	37	1255.78	131.2	0.33
Elect	Private All	12	1656.9	81.49	0.10
All	TNC	31	1172.8	172.8	0.44
All	Private	59	1233.4	134.5	0.33

Figure 1: Inter-Sectoral Linear Earning Functions.

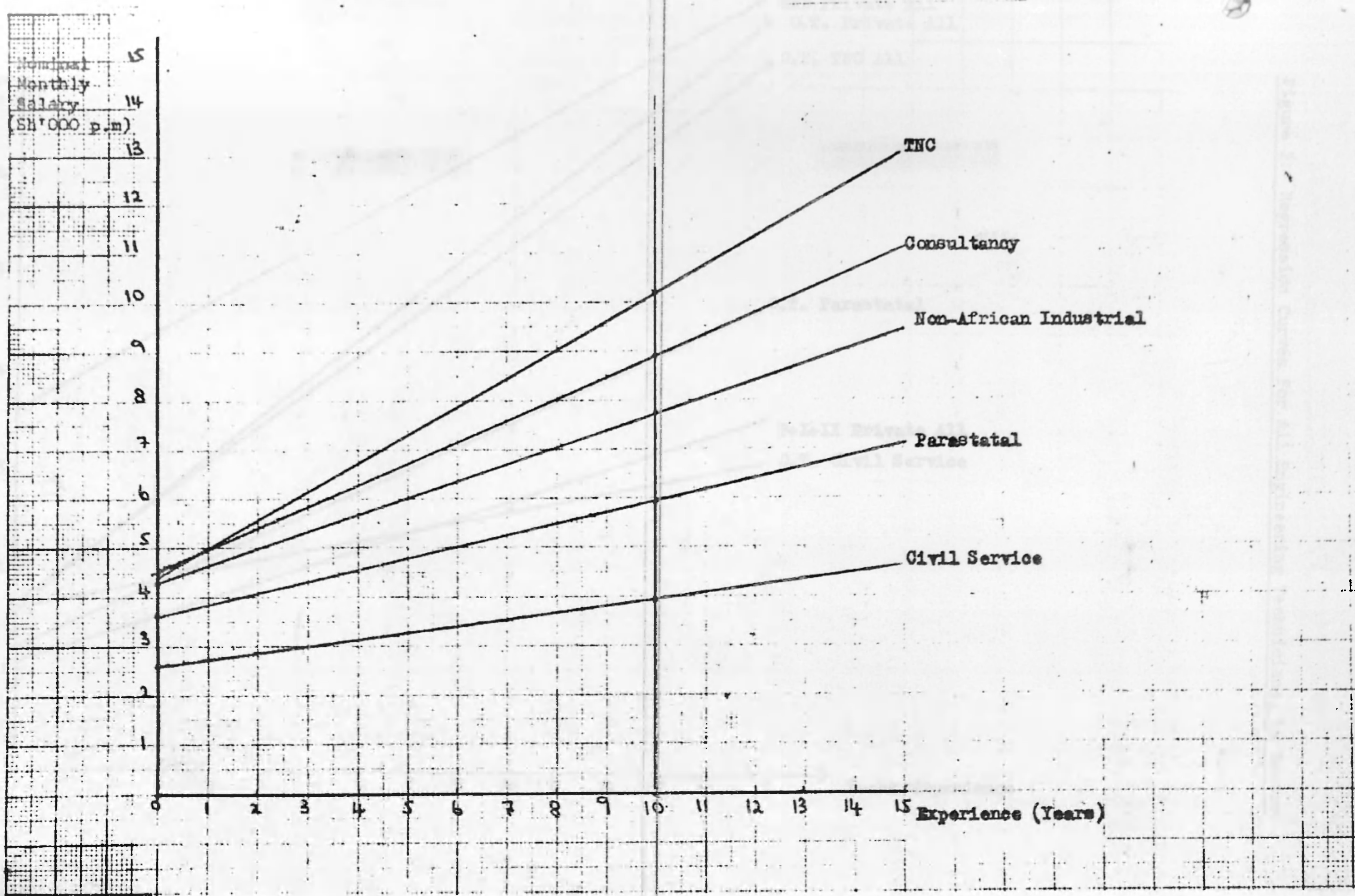


Figure 2: Regression Curves For All Engineering Technicians, by Sector

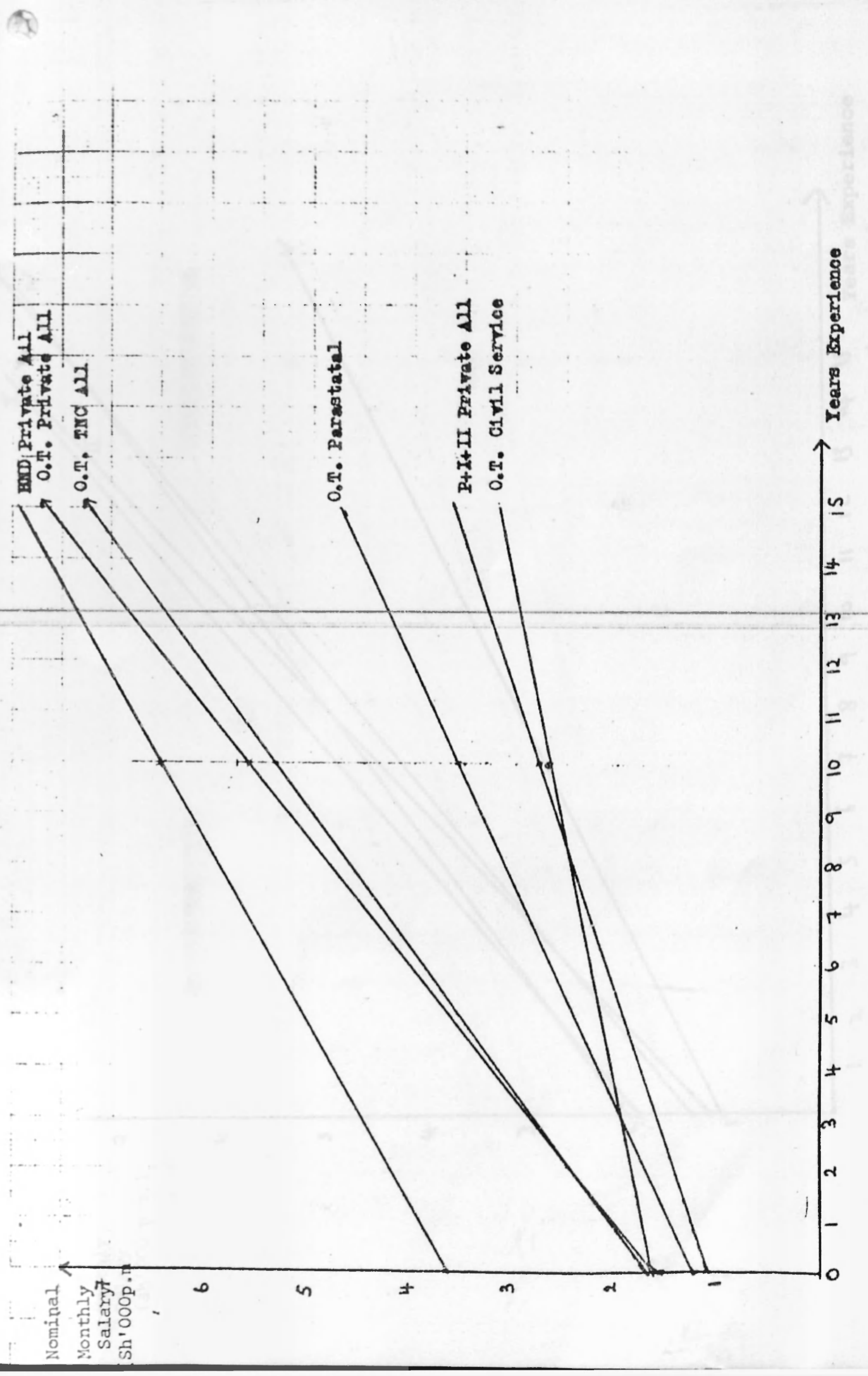
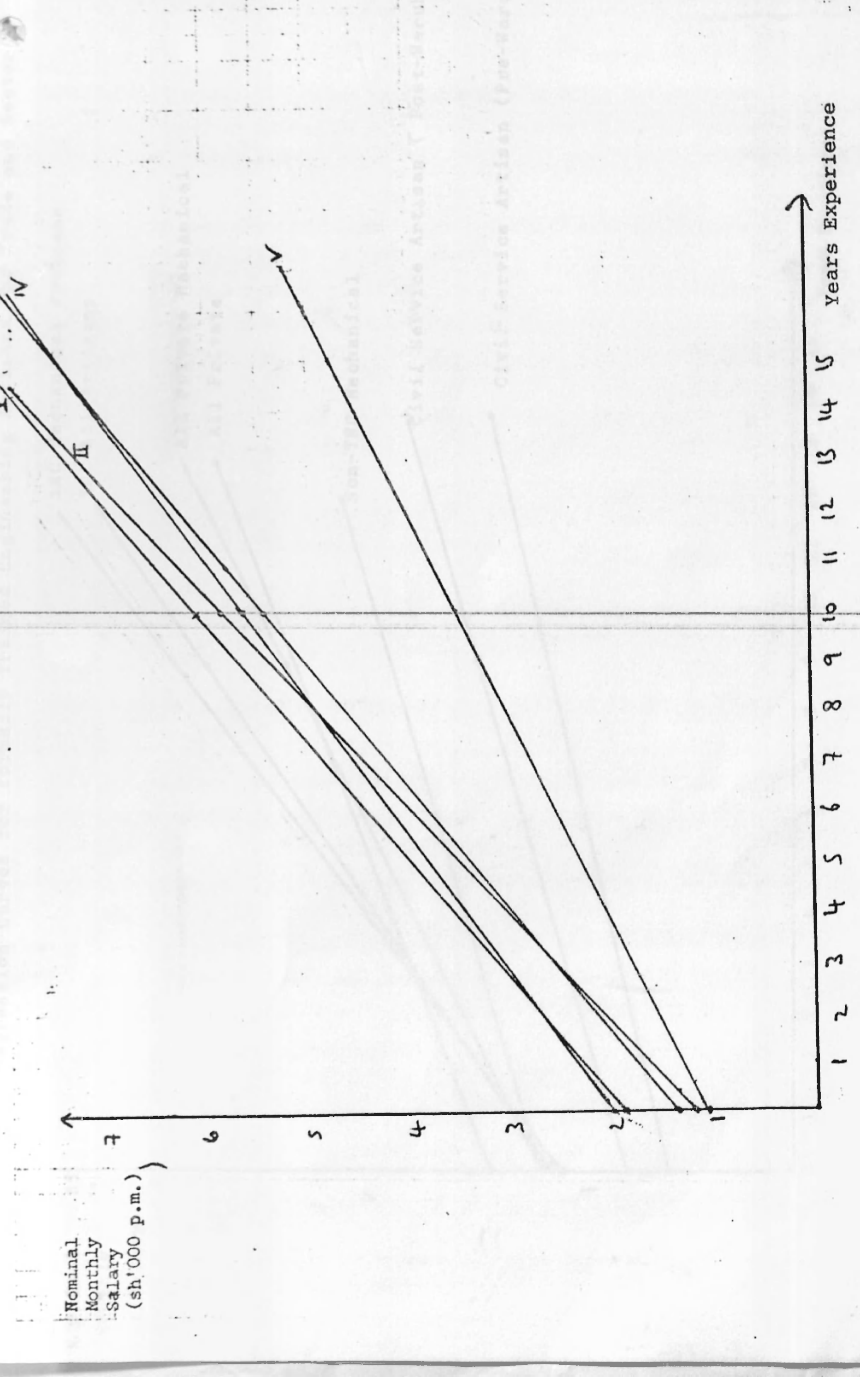
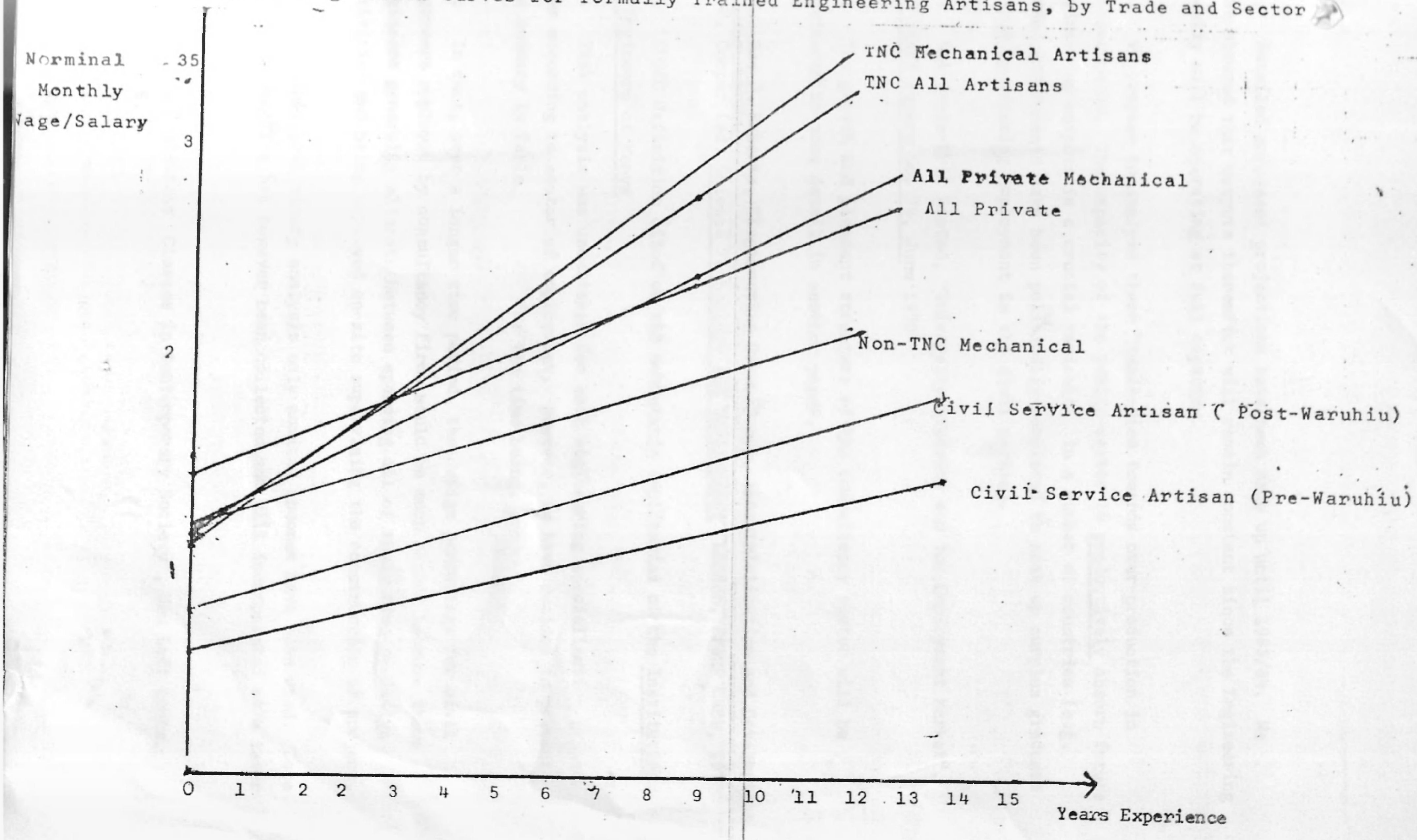


Figure 3: Regression Curves For Engineering Technicians, by Subject.



Fifure 4: Regression Curves for formally Trained Engineering Artisans, by Trade and Sector



11. Detailed enrolment projections have been made up until 1983/84. We have assumed that outputs thereafter will remain constant since the Engineering faculty will be operating at full capacity.

12. We propose to analyze these "tendencies towards over-production in another paper. The capacity of the public-sector to productively absorb future engineering outputs is a crucial variable. In a number of countries (e.g. Sudan) governments have been politically-completed to soak up surplus graduate output by offering employment in the civil service.

13. See Svein-Erik Rastad, "University Students and the Employment Market", IDS Staff Papers No. 74, June 1970

14. The growth and pleasant structure of the consultancy sector will be considered in some detail in another paper.

15. See J. Roberts, "Engineering Consultancy, Industrialization and Development in C. Cooper (ed) Science Technology and Development London, Frank Cass, 1973

16. EUSEC definition cited on the membership application of the Institution of Engineers of Kenya

17. Task analysis was undertaken for each engineering specialisation broken down according to sector of employment. However, we have decided to present the summary in Table for the time being.

18. In fact, over a longer time period, the design percentage for civil engineers employed by consultancy firms would be much higher because these engineers generally alterate between spending all of their time on design activities and being employed on-site supervising the construction of project.

19. For this preliminary analysis only nominal incomes have been used. Data on finger benefits has however been collected and will incorporated at a later date .

20. See N. Poulantzas Classes in Contemporary Society", New Left Books, London, 1976.

21. Telecommunications technicians are not included in this total for the simple reason that it was extremely difficult to compute the number of technicians in this skill category since they take a bewi Idering variety of different courses which often extend over long time periods. It is unlikely however, that there are more than 500 telecommunication technicians in Kenya which increases the grand total of engineering technicians to approximately 4000.

22. Unfortunately, detailed sponsorship records for students attending the Kenya Polytechnic have not been kept for the years prior to 1974.

23. The Figure for skilled engineering workers on the textile sector is undoubtedly a serious over-estimate.