ALTERNATIVE MODELS OF APPRENTICE RECRUITMENT:
WITH SPECIAL REFERENCE TO THE BRITISH
ENGINEERING INDUSTRY

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Despite the continuing problem of shortages of skilled workers in most Western countries, very little is known about the key determinants of apprentice intake. Several research techniques have been employed to date. The interview method has been employed fairly successfully by Williams (1957), Leipmann (1962) and MacKay (1971). While providing invaluable insight into the recruitment process, these studies are not very effective in distinguishing between different models. In short, they are useful for suggesting hypotheses, but not in testing them.

Essentially there are two main rival models which seem likely to explain apprentice recruitment levels: recruitment for current production, and recruitment for future production.

The basic idea of the first approach is that apprentices can be treated as just another source of skilled labour as an input in current production. This enables the researcher to use the familiar framework of labour demand functions to explain apprentice intake. While this approach is blessed with tractability and seems to offer meaningful results initially, the investment dimension of apprentice intake decisions is conspicuously absent. Our more intricate tests reject this approach.

The second approach emphasises the investment motive underlying apprentice intake decisions, with the output contribution being deferred until some initial period of learning and training is completed. Two main frameworks can be used to analyse apprentice intake levels from an investment point of view. The simplest of these derives from the pre-Jorgenson investment function literature, notably the flexible accelerator model. Such a model stresses that apprentice intake levels are some function of future output levels. It will be shown that this model performs quite well. A more sophisticated investment approach to training decisions comes from the Becker (1964) formulation, which adds cost considerations to the investment decision as well as a more general perspective to the problem. It will be shown that this approach adds to our understanding of the actual behaviour of variations in apprentice levels.

The outline of the paper is as follows. In Section I we review the interview studies. In Section II the recruitment for current production model is introduced, noting the results of two empirical papers in this area. In Section III an investment model of apprentice recruitment is presented.
Section IV the results of testing these models for the British engineering industry are analysed. These results are aimed at explaining intake numbers of apprentices on a time series basis. Further support for these results is given in Section V where the analysis is in terms of stocks; stocks of apprentices (first to fifth year apprentices and not just new recruits) relative to stocks of craftsmen. Finally, in Section VI a brief evaluation is made of the training performance of the engineering industry since the early 1950s.

I Interview Studies

The seminal works using interview techniques are the monographs by Williams (1957) and Leipmann (1962). These studies provide a wealth of useful information relating to apprentice recruitment. Both authors express concern about the lack of purpose and co-ordination of industrial apprentice programmes in Britain as of the late 1950s. Wastage rates of apprentices seemed high. Firms were dissatisfied with the calibre of recruits. There were shortages of craftsmen and the quality of training was indifferent. The authors felt much of the training was merely a matter of distant observation by the apprentice rather than graduated instruction from selected craftsmen. Few craftsmen were rewarded with more than two hours pay per week for instruction, so there was little incentive for them to exceed this time.

The formation of Industrial Training Councils in several key industries made only a marginal difference to this picture. Direct intervention by the Government in training matters was minimal, save in the construction industry for a limited period (1944-1952). Thus external factors (government policy and industry training councils) had little influence in the 1950s. Firms seemed to treat the training process lackadaisically, which appears to invalidate the use of sophisticated neoclassical decision rules. While this negative information is helpful in narrowing down the range of applicable models, the interview studies fail to identify exactly what rules of thumb might have been in vogue. This is surprising, given the objectives of the studies. Nevertheless, one can glean the elements of some alternative simple rules of thumb from the Williams-Leipmann studies.

One simple rule of thumb is the determination of apprentice intake by a fixed apprentice-craftsmen ratio. This is consistent with a simple replacement demand model in the context of no growth in craftsmen requirements. Apprentices are needed for the sole purpose of replacing craftsmen who leave the industry. As we argue later, there is some empirical support for this model for the 1950s, though not the 1960s or 1970s. A fixed apprentice-craftsmen ratio is also
consistent with a craft union imposed rule, designed to control the supply of craftsmen into a particular industry and ultimately ensure job security and a particular wage level. Quite often these rules were quite elaborate, varying with the size of the firm and the particular craft within a given industry. The interview studies note that craft union sourced rules were phased out in most industries in the 1940s and early 1950s. Only in the printing industry did the practice continue in overt form. Yet even in the printing industry the rule was relaxed from time to time, necessitating an analysis of such circumstances.

Another simple model which can be deciphered from the interview studies is recruitment for current production. Williams notes that many firms in the engineering, printing and other industries tried to draw out the apprenticeship period as long as possible so as to avoid paying craftsmen wage rates. Similarly, Leipmann notes that construction employers tried to prolong the initial probation period because it did not entail day release. These observations suggest an interest by firms in the current output contribution of apprentices rather than their future skill potential. However, as far as new recruits are concerned, this argument only applies to the construction industry.

Finally, the aforementioned observations are also consistent with a simple investment model, akin to the well-known payback period method used to evaluate physical investment projects. Williams' interviews reveal that the first two years of apprenticeship are a net loss to the firm, the third year is a break-even period and the last two years represent a net gain. Thus it takes the full five years of apprenticeship for the firm to fully recoup its investment outlay, notably the net loss in the first two years. This investment outlay results from the costs of supervision, day release and wasted materials. Our reading of Williams suggests that firms used the length of the apprenticeship (five years) as the cut-off payback time period in making investment decisions. Williams herself does not express firms' recruitment behaviour in these terms, though her discussion certainly comes very close to this. If a firm felt it was not breaking even over the five year period, it would cut back its apprentice intake or perhaps try to extend the training period. Such an investment criterion could have philosophical roots of the nature "apprentices should pay their own way". Alternatively, the criterion could derive its rationality from investing in a milieu of extreme uncertainty, where poaching was rampant. More simply, it could be just another rule of thumb which is not much more arbitrary to those used in more traditional (physical) investment areas.
Notwithstanding, a number of authors, including McCormick and Manley (1967), have interpreted the other interview study by Leipmann as conveying a much shorter, two year period, as the period needed to recoup investment outlays. In Leipmann's (1962, p.81) words, apprentices become "productive" after two years' experience ... and "profitable" to the firm within the first half of their term. The ambiguity of this research technique becomes apparent when Leipmann notes, as an aside, that several informants distinguished between the time when an apprentice begins to pay his way and the time when he becomes an asset. Although nothing is definite, it makes sense to interpret Leipmann in a similar vein to Williams, with apprentices "paying their way" after two years and "becoming an asset" after five years.

Our emphasis of a five rather than a two year payback criterion is more in keeping with the hostility shown by employers to reforming the length of apprenticeships. Tampering with this training period would uproot a possibly well-established rule of thumb for training investment decisions. It is interesting to note that more recent data for the early 1970s, shown in Table 1, confirms our description that first and second year apprentices are a net loss to the firm, whereas third year apprentices represent a break-even situation for the firm. The figures in Table 1 suggest a further reason for an uncertainty dominated investment criterion (viz the payback method); namely the large variability of the output contribution of early stage apprentices.

The common thread amongst the above alternative rules of thumb is that they are fairly crude and sub-optimal in various ways. The fixed apprentice to craftsmen ratio based on replacement needs is insensitive to dynamic changes in craftsmen requirements. This imposes costs on the industry in the form of shortages when craftsmen requirements increase and surpluses when requirements decrease. The method of relating apprentice intake to current production needs neglects the investment nature of training apprentices. As we noted, however, this criticism is directed more at the construction industry rather than the engineering industry. Finally, the use of a five year investment payback period neglects the stream of benefits from fully trained apprentices staying on in the firm. This would result in sub-optimal investment. The lack of foresight which characterises these recruitment methods is also uncovered by MacKay (1971) in a study of the engineering industry over the 1959-1966 period. Not only were most manpower forecasts confined to the ensuing twelve months and therefore short-term in nature, it was not uncommon to find firms which had no formal system at all of selecting apprentice levels. The whole process seemed haphazard.
II. Apprentice Recruitment for Current Production

A small number of scholars has attempted to directly estimate labour demand functions for apprentices. In this regard, apprentices are viewed as just another current input, though less efficient than craftsmen, in providing skilled labour services. The costs of training are usually not explicitly treated in these models, though some of the opportunity cost of using trainees, such as higher wastage rates for example, would be allowed for when considering the productivity of the trainee.

One of the more elaborate models using this approach is Lindley (1975). Essentially he uses a short-run, cost-minimising model of the firm's decision to hire skilled labour inputs. Two main sources of skilled labour are considered, namely craftsmen and new apprentices. These are assumed not to be substitutable with unskilled labour. The problem facing the firm is to choose that mix of craftsmen and new apprentices which minimises skilled labour costs. To expedite the analysis it is postulated that the relationship between craftsmen (LC) and new apprentices (LA) and the skilled labour services they provide (LS) can be represented by a Cobb-Douglas specification, viz:

\[ LS = D \cdot (LC)^a \cdot (LA)^b \]  
(1)

Skilled labour costs are given by:

\[ z = W_c (LC) + W_a (LA) \]  
(2)

Equation (1) is substituted into a standard Cobb-Douglas production function. The familiar first-order conditions of minimising costs (i.e. \( z \)) subject to the Cobb-Douglas production function constraint can then be found. From this the optimal intake of apprentices takes the form:

\[ \log (LA) = x_0 + x_1 \log (Q) + x_2 \log \left( \frac{W_a}{W_c} \right) \]  
(3)

where \( Q \) is the rate of output.

Equation (3) is modified by Lindley (1975) to allow for transaction costs. An unemployment variable is added on the grounds that certain transaction costs are likely to be related to such a variable. For instance, when unemployment of craftsmen is high, the search and recruitment costs of hiring craftsmen is lower than the costs of selecting and training greater numbers of apprentices. Additionally, a lagged dependent variable is added as a more
general way of allowing for lags in the response of apprentice recruitment to changes in the explanatory variables.

The modified equation (3) is applied to the British engineering industry for the 1951-71 period. Lindley's results are quite good, with the relative wage, output, unemployment and lagged dependent variables having the expected signs; usually at acceptable levels of significance. Using a different specification, Briscoe (1976) more or less repeats these results for the British construction industry for the 1955-75 period. Industry output and unemployment levels again feature as leading determinants of the demand for apprentice intake, though the overall explanatory power of the model is less than in engineering.

There seem to be two main empirical weaknesses in these two studies of the recruitment for current production model. One is the use of a lagged dependent variable to capture lagged responses. While this approach provides some quick insight into the likely presence of lags, there is a danger in relying on such a method. It is possible that the variable connotes serial correlation rather than lags, in which case its presence is a worry. In any case, it is likely that different explanatory variables have different lag lengths, so the Koyck approach is too restrictive.

The other empirical reservation concerns the use of the relative wage variable. The hub of the recruitment for current production approach is the substitutability between new apprentices and craftsmen; a feature which requires a significant negative coefficient for \( x_2 \) in equation (3). However, instead of an apprentice wage series, Lindley (1975) uses wages of young workers (under 21 years) across all engineering occupations from the Employment Gazette October survey. He is unaware of the annual Time Rates of Wages and Hours publication (H.M.O.) which does provide apprentice wage data in its appendix, conveniently as a percentage of the craftsmen rate. The latter series is subject to less variation than the Gazette series, so use of the Gazette series is likely to impart moderate errors of measurement in time series analysis.

Briscoe (1976) is more wary of the Gazette wage data (but equally unaware of the alternative Time Rates series) and chooses instead to allow for apprentice-craftsmen substitution by including the level of craftsmen as an explanatory variable in the apprentice intake demand equation. Apart from the problem of including a dependent variable (craftsmen) in an ordinary least squares specification, the sign of craftsmen variable in the apprentice demand equation is persistently positive. This is inconsistent with the Cobb-Douglas specification on which the estimation is based. Briscoe tries to rationalise the results by suggesting that apprentices and craftsmen may be complements in
the short run, but substitutes in the long run. Such a dichotomy is still inconsistent with the Cobb-Douglas specification and in any case his results (1976, p.19) show that the complementary relationship persists in the long run.

Apart from these empirical difficulties with the recruitment for current production model, there are also theoretical reservations. Although Lindley (1975) does discuss the stock-flow distinction in general terms, one is left with an uneasy feeling about equation (I). This arises because "craftsmen" is inherently a stock concept whereas the intake of new apprentices is inherently a flow concept, so the relationship between them is likely to be complex. More fundamentally, does it make sense to treat new apprentices and craftsmen as substitutes in contributing toward current production? Craftsmen, after all, are time-dated products of apprenticeships, save for a small amount of upgrading of semi-skilled workers. For instance, an increase in apprentice intake in one year results in an increased stock of craftsmen four or five years later, unless deliberate steps are taken to the contrary. The notion of permanent substitution between the two types of skilled labour is not easily perceived. Drastic cutbacks in apprentice intake would eventually spell genocide for craftsmen, though admittedly these are long run matters.

Moreover, the increasing trend towards off-the-job technical instruction shunts attention to the role of future rather than current production as the key to explaining apprentice recruitment. Prior to the 1964 Industrial Training Act only about 20 per cent of first year apprentices in engineering received day-release for technical instruction. In the wake of the 1964 Act, off-the-job instruction has become the norm for first year trainees. Another factor enhancing the investment motive is the obligation on the firm to employ the boy for the four or five years of his apprenticeship.

In summary, the recruitment for current production model appears to provide a reasonable explanation of apprentice intake changes in the engineering industry over the 1951-71 period as shown in the Lindley (1975) paper. The results in the construction industry are more doubtful, especially regarding the substitution coefficient. In both studies there seem to be potential empirical difficulties concerning the measurement of apprentice-wage rates and the specification of the lag structure. While these reservations may not be sufficient to undo the Lindley results for the engineering industry, one is left with an uneasy feeling about the theoretical status of the model. For reasons outlined in the last few paragraphs, the recruitment of apprentices for future output has more intrinsic appeal.
III The Investment Motive for Apprentice Recruitment

As in the physical investment literature, there are a variety of approaches to modelling an investment decision. On one hand, there is a band of models which more or less correspond to what we can call the pre-Jorgenson investment approach. Within this band the flexible accelerator model is the best known, with investment postulated to be a function of future output. Underlying this model is the belief that output is the most important determinant of input requirements and that relative input prices are not particularly important. Sometimes other influences of investment, such as cash flow, are included, though in all cases the list of investment determinants is often described as ad hoc, that is, devoid of an explicit optimising framework.

At the other theoretical extreme in modelling investment decisions is the Jorgenson approach, where the optimising framework (profit maximisation) is made very clear. In the investment in training discipline, the Becker (1964) formulation corresponds closest to the Jorgenson approach.

In this section we begin by outlining the flexible accelerator model in an apprentice investment context. It is in this light that we interpret some econometric evidence by Lindley (1975), which appears to be the only econometric study which directly explains training levels using an investment motive framework. Next we outline the Becker neoclassical approach to apprentice investment and draw a number of arguments from such. Finally, some use is made of more recent neoclassical investment models which incorporate transaction costs into the optimising process.

The flexible accelerator model provides a useful first approximation to the apprentice investment decision. We can borrow the concepts of an "optimal craftsmen-output ratio" (as a guide to the desired level of craftsmen) and a flexible accelerator (as a guide to the adjustment time path of investment in apprentices in response to disequilibrium levels of craftsmen). Thus we have:

\[ LC_t^* = aQ_t \]  

\[ LC_t - LC_{t-1} = (1-b)(LC_t^* - LC_{t-1}) \]

Equation (5) implies that there are investment goods "on the shelf" which can be purchased in the current period. In our context this requires unemployed craftsmen to draw upon, which will be valid in some but not all years. However, it is obvious that equation (5) does not allow for the gestation period of apprenticeship; it will be \( t+n \) years before the stock of craftsmen can be augmented by increasing apprentice intake. A further complication arises
because later-year apprentices become economically productive before qualifying as craftsmen, so changes in LA are desired even though LC may be unchanged.
Thus equation (5) needs to be replaced by a more complex, less-defined relation between apprentice intake and disequilibrium in craftsmen needs. Thus we have:

\[ LA_t = f(LC_t - LC_{t-1}) \]  \hspace{1cm} (6)

or alternatively,

\[ LA_t = g(\sum_{t=1}^{n} Q_t) \]  \hspace{1cm} (7)

Equation (7) is a more specific variant of (6) and embodies the hypothesis that future output is the key determinant of future craftsmen employment and hence current apprentice intake. Instead of a flexible accelerator approach, we can interpret equation (7) as a delivery lag modeled arising from the gestation training period. Unlike some physical investment models which have also perceived the investment-output nexus in terms of delivery lags (such as Maccini (1973)), there is no need for us to include the delivery lead time as another decision variable for the firm; for apprenticeships the lead time between ordering an investment good (intake of apprentice) and the delivery of the investment good (emerging as a craftsman) is institutionally determined.

Although Lindley (1975) does not present his work explicitly in terms of a flexible accelerator model, it is convenient for us to present his results as such. Lindley considered the investment motive as an extension of his work on the recruitment for current production model. Thus he pioneered the application of econometrics in both the recruitment for current production and recruitment for future production models. Notwithstanding, his formal emphasis is on the current production model, with the investment motive presented without full commitment and in a more ad hoc manner.

Reflecting this tenuous foundation, the unemployment variable in his current production model is simply reinterpreted to depict the profitability of apprentice investment or as a proxy to internal cash flow which is also sometimes used to explain physical investment. In a more definitive move, Lindley (1975) replaces the current output variable by a measure related to future output, namely gross fixed capital formation in engineering. This variable is included as an expectational variable rather than a productive input.

Certainly Lindley’s regression results are improved by reformulating
the output variable. However, the superiority of the future production approach over the current production approach is based on a marginal difference in goodness of fit. Moreover, the reformulation creates more of a hybrid model than a pure investment model because the current production dimension continues via the relative wage variable.

The apprentice investment decision model given by equation (6) or (7) can be refined in two respects. One way is to draw upon Becker styled neoclassical training investment theory. The other way is to allow for internal adjustment costs in allocating craftsmen between production and training activities. Both of these refinements add considerable insight into the recruitment process.

Becker's (1964) model is based on the distinction between specific training (which raises the marginal productivity of the trainee within the confines of that particular firm, but has no effect on the trainee's productivity outside that firm) and general training (which raises the productivity of the trainee across all firms). The equilibrium condition of a firm providing specific training in a competitive market is given by (Becker 1964, p.20): 

$$MP^*_0 + G \left[ \sum_{t=1}^{m} \frac{(MP^*_t - W^*_t)(1 + i)^{-t}}{MP^*_0} \right] = W^*_0 + C^*_0$$

(8)

where $C^*_0$ is the cost of training given only in the initial period, $MP^*_0$ is the opportunity marginal output of trainees (which is more than the actual $MP^*_0$ because of time lost in instruction), $W^*_0$ is the wage paid to trainees in the initial period, and $W^*_t$ and $MP^*_t$ are the wage and marginal product of trainees in the post training period $t$. Thus $MP^*_t - W^*_t$ is the return to the firm in period $t$ from training given in the initial period, and $G$ is the present value of the return.

Becker argues that $MP^*$ equals $W^*_0$ so that in equilibrium $G$ equals $C^*_0$; that is, the return from training equals costs. Note that since $MP^*_0$ is less than $MP^*_0$, then $W^*_0$ is greater than $MP^*_0$.

The specific training formulation (8) is useful for interpreting our Table 1 and related discussion in Section I. There we see that in the initial two years of apprentice training, the trainee receives a wage rate in excess of his marginal product (expressed in comparable terms), whereas in the fourth and fifth years of apprenticeship, $MP^*_t$ is greater than $W^*_t$. This pattern is consistent with equation (8). Thus it seems that British engineering firms finance the initial two years of apprenticeship (with $MP^*_0$ less than $W^*_0$) and also collect the reward from such investment in the later stages of apprenticeship.
Equally, the data rules out a general training interpretation. As Becker's initial model shows (1964, pp.11-18), with general training the initial training is likely to be financed by the trainee himself, who also collects the reward at a later date. This would require \( W_0 < MP_0 \), which is refuted by the Section I evidence.

Nevertheless, while the specific training approach provides the only meaningful explanation for wage rates and training over the apprenticeship period, how do we explain the poaching problem in the post-apprenticeship period? Poaching should not be a problem if training is primarily specific, which raises an obvious anomaly. To reconcile this difficulty we can make use of Oatey's (1970) distinction between the generality of a particular skill (defined with respect to training) and the generality of the investment (in terms of the mobility potential of the trainee). Thus firms may invest in general skills if the trainee is relatively immobile. In part, the inertia of the trainee (for family, geographical or whatever reasons) will give rise to some degree of immobility. As well, the firm has a number of policy variables, both wage and non-wage instruments (such as vested private pension plans) which can have a similar effect.

In light of the poaching problem in the post-apprenticeship period, we can interpret the training process in British industry as involving essentially general skills, but that during the apprenticeship period the trainee is relatively immobile. This immobility may stem from moral and quasi-legal factors associated with the apprenticeship agreement, which is more or less an indenture. There is little transfer of trainees between firms during apprenticeship, though quite a few trainees give up apprenticeships altogether before completing their term. Most of the inter-firm poaching occurs immediately after the term is completed, though of course many apprentices continue on in the same firm after training. Expressed in this way, it could be that poaching problems of the early 1960s (and also of today) reflect a failure of firms to use the full range of policy instruments to control a labour turnover problem.

There are a number of fascinating problems amenable to the original Becker model and its modified successors, as the papers by Lees and Chippin (1970) and Ziderman (1978) suggest. In one way or another, these problems revolve around the questions of who does finance apprentice training investments (as we have discussed above) and who should finance such investments. In nearly all cases, the Becker model is useful in explaining a variety of labour market behaviour, such as the cyclical differences in the wage and employment behaviour of unskilled versus skilled workers. Most sought to confirm the implications
of the Becker neoclassical model. These are ostensibly indirect tests of the Becker model. As Phipps (1975) has noted, continuous time series data is not available in order to conduct a direct test of the Becker model.

While all the components of the full set of benefit and cost data related to equation (8) are obviously not available, it is clear that (8) differs from the flexible accelerator approach insofar as Becker's model allows for costs as well as benefits (as related to future output). An important component of training cost is the excess of the trainee's wage above his marginal product. Ceteris paribus, an increase in the wage rate of the trainee measured as a percentage of the craftsmen's rate raises the cost of training and we would expect a neoclassical orientated firm to cut back its training effort by reducing apprentice intake. Thus, by including the relative wage rate of the apprentice, we can capture at least part of the cost aspect in Becker's model. Equations (6) and (7) can be modified to include this relative wage rate variable.

With respect to equations (6) and (7), much of the corresponding physical investment literature has been concerned with finding both suitable variables to represent $Q_t$ and a suitable lag distribution to represent the $g(...)$ function. Surprisingly, current output is often used to explain current physical investment - much to the horror of Gould (1969) and other critics. Other studies, using expectational variables, such as orders outstanding, seem to be on safer ground.

Another (virtually ignored) difficulty with the demand variable is how to treat the time profile of future orders when making physical investment decisions. If the expected rise in product demand is thought to be short-lived (because it is due to a competitor having a strike, for instance), then increased physical investment is probably the worst strategy in meeting the extra orders. Other short-run options, such as increasing plant utilisation, working extra shifts or overtime and running down stocks seem much more sensible. Firms have only limited resources and it is possible that attempts to use physical investment as the main adjustment instrument in response to changes in product demand could divert inputs out of production activities and actually lower output in the short run. These issues are well known to economists studying inventory and other short-run decisions of the firm, but have only had a limited impact on the physical investment literature. The issue of short-run trade-offs between inputs is brought out clearly by the Eisner-Nadiri (1969) paper, as well as a number of papers dealing with internal adjustment costs (Lucas (1967) and Treadway (1969 and 1971)).

As is well known, the main problem with the Jorgenson model is the
weak theoretical link between the desired stock of capital obtained from a maximisation of network framework and the actual flow of investment per period. The internal cost literature, Eisner and Strotz (1963), Lucas (1967), Gould (1968), Treadway (1971), Schramm (1970) and Maccini (1973), has rectified this problem under special circumstances. However, as Locke Anderson (1974) notes, while the adjustment cost theory is used to justify distributed lag investment models, the validity of transaction cost theory is only tested indirectly, via the presence of lags. There are no known direct tests of transaction costs.

Is it true that an increased rate of investment has a detrimental effect on the rate of output in the short-run? Locke Anderson (1974) argues that to test this theory one would need to empirically include investment in the production function.

Our paper is able to take one small step in redressing our ignorance about internal adjustment costs. The distinction between external and internal adjustment costs is as follows. External adjustment costs embrace market effects, so that a move by firms to hire an above average number of workers (equipment) might increase the wage rate (price of equipment). Thus an attempt by many (rather than one small firm say) firms to add quickly to their stocks of inputs is likely to increase costs. In contrast, internal adjustment costs arise because the intake of additional labour or capital inputs requires resources which could have been used to produce output. An example often cited is the case of a firm which has personnel and training departments which are adequate for the normal replacement of quits and retirements (Breaching (1975, p.41)). Let us now consider what would happen if the firm wanted to increase its stock of labour. As a result, more capital and labour has to be devoted to these departments. With given resources of labour and capital, this means less resources available for production, which must therefore fall.

As it turns out, it is this example from Breaching for which we can provide some evidence. An attempt by engineering firms to increase the intake of apprentices would require craftsmen to spend relatively more time on supervising training compared to producing goods. Production must be foregone if apprentice intake is increased; at least this is the short-run effect.

Equally, in this particular case, there is no initial compensating effect coming from the output of first year apprentices because their marginal product is close to zero. Thus if there is a short-run increase in product demand, it would not make sense to increase apprentice intake as an immediate response. To do so would entail lost production from craftsmen as their training duties are increased to gain more of another input (apprentices) whose output contribution is negligible. Indeed, a useful strategy by the firm would be to reallocate craftsmen from training to production duties. This would be
cheaper than the search costs of finding, selecting and briefing new (fully trained) craftsmen recruits from the open market (if any are available) to meet the additional production needs. The reallocation of currently employed craftsmen from training to production duties is easily achieved by simply reducing, at least temporarily, apprentice intake.

This discussion leads to the surprising conclusion that the immediate response of firms to excess product demand is to decrease apprentice intake. At the same time, we have added another reason why the employment of skilled workers may be insensitive to cyclical changes, quite apart from Becker type considerations.

Thus we see why special attention needs to be given to the time profile of orders. The productivity of trainees is very much a function of time. Trainees with more than two years experience can make a reasonable contribution to output, so if the firm expects a substantial rise in output over the next couple of years, it is rational to increase apprentice intake. However, as we have just seen, if the firm is absorbed with increasing output quickly over the next six or twelve months, it is irrational to increase apprentice intake. Although data on the time profile of orders are not usually available, we can approximate such in our context. Data are available on orders outstanding in the engineering industry from 1954 onwards. Following Eckstein and Fromm (1968) we can convert this into an excess product demand variable, order backlog, by dividing by the rate of production; i.e., backlog equals orders outstanding at the end of period divided by production during period $t$. Since the order books represent between six to twelve months' production, we can take this data as indicative of imminent future sales (although a small fraction of the orders could extend over several years); that is, expected sales over the next twelve months. For longer term expectations, we can use the variable in Lindley (1975), namely gross fixed capital expenditure in the engineering industry. This variable is included as an indicator of long-term expectations. Thus we can specify equation (7) more elaborately as:

$$L A_t = x_0 + x_1 R W_t + x_2 B a c k l o g_t + x_3 L O N G_t$$  \hspace{1cm} (7)$$

where $L A_t$ is apprentice intake in period $t$, $R W_t$ is the wage rate of the apprentice relative to that of craftsmen as of May in period $t$, $B a c k l o g_t$ represents backlog of outstanding orders for the product in period $t$, and $L O N G_t$ is an expectational variable depicting expected output in the long run (which is correlated to gross fixed capital formation).
Thus we see that apprentice recruitment is a function of the relative wage rate (via the Becker model) and two components of the time profile of orders geared to future output; namely the short run (BACKLOG) and the long run (LONG). The variable BACKLOG represents the short run effects of disequilibrium in the product market. Following our discussion, we would expect $x_2$ to be negative. However, this is essentially the immediate response to excess product demand. We would not expect excess product demand in a particular period to permanently reduce apprentice intake levels, so to allow for the transitory nature of this effect we should include a lagged value of BACKLOG in the regressions (which should be positive). It is possible that the wage effects on apprentice intake operate with a lag, so this possibility must also be tested.

While equations (7) or (7a) are promising routes to explaining intake levels, there is an alternative. In contrast to physical investment, there is a well developed "second-hand" market for the stock of craftsmen. This permits us to use a direct measure (in terms of comparing unemployment with vacancies) of disequilibrium in the craftsmen market, as implied by equation (6). If there is an imbalance in the craftsmen market, this can be expected to flow onto the demand for apprentices. Alternatively, disequilibrium in the craftsmen market can be included as an additional influence in equation (7a). If there is a surplus of craftsmen in the market, this will lower the need to take in apprentices, ceteris paribus. Thus our basic model for explaining apprentice recruitment is:

$$LA_t = x_0 + x_1RW_t + x_2BACKLOG_t + x_3BACKLOG_{t-1} + x_4DIS_t + x_5LONG_t$$  \[(7b)\]

where $DIS_t$ is unemployment of skilled workers minus vacancies of skilled workers all divided by the stock of craftsmen as of the beginning of period $t$.

Equation (7b) forms the basis of our empirical tests in the next section.

**IV. Empirical Tests of Apprentice Recruitment**

In this section we conduct time series analyses using the ordinary least squares regression method to explain apprentice intake variations in the British engineering industry. Most of the tests relate to the 1963-78 period because this corresponds to the availability of craftsmen stock data which formed a small part of the tests reported here, though a larger component of the tests in Section V. Some of the tests cover the 1954-78 period, which corresponds to the availability of the BACKLOG time series data. Data sources
are given in the Appendix.

Equation (7b) has been estimated in log linear form, with the basic results shown in Table 2. Overall, the performance of the investment model is satisfactory, with the best fitting result shown as the second equation in Table 2. The (unadjusted) value of the $R$-squared is 0.89 and the Durbin-Watson statistic is 2.05. The five key explanatory variables are significant at the five per cent level and have the appropriate signs. Earlier regressions led to three other variables being rejected on the basis of the $t$-statistic test; these results are also included in Table 2.

To test the robustness of the results, variables were dropped in various combinations and the time period was altered slightly. These results are shown in Tables 2 and 3. It can be seen that the strength of the model mainly comes from the relative wage variable ($RW$) and the short-run product disequilibrium variables ($BACKLOG_t$ and $BACKLOG_{t-1}$). If either of these two elements is absent, the results become quite weak.

The relative wage variable indicates that a ten per cent rise in the relative wage of apprentices, *ceteris paribus*, lowers the intake of apprentices by twelve per cent in the best fitting equation. In absolute numbers, twelve per cent represents about 2500 apprentices. Thus the emphasis on costs of training by Becker seems vindicated.

The coefficient on $BACKLOG_t$ is minus 1.82, which means that a ten per cent increase in order backlog (in months) results in an eighteen per cent cutback in apprentice recruitment. This represents about 3500 apprentices. To a large extent this effect is temporary, with a reversal in the next period as shown by the positive coefficient on $BACKLOG_{t-1}$. These results are consistent with our arguments concerning internal adjustment costs. In the short-run, a firm's cost minimising strategy in coping with excess product demand involves a cutback in apprentice intake.

The long-term expectations variable ($LONG$) is also significant in the preferred equation, though its contribution is less robust. The coefficient of 0.75 indicates that a ten per cent increase in gross fixed capital formation is associated with a 7.5 per cent increase in apprentice recruitment. As expected, there is a positive relationship between expected future output and apprentice intake.

The labour market disequilibrium variable ($DIS$) invariably has the expected negative sign; that is, an excess supply of craftsmen results in a cutback in apprentice intake. However, the relationship is not as statistically strong as other key variables, with fairly low $t$-values. The relationship becomes stronger in some periods when the variable $LONG$ is omitted, suggesting that $DIS$ and $LONG$ may be alternative rather than supplementary ways of accounting
for long-term apprentice needs. However, even this pattern was not consistent. The relationship was also stronger when equation (7b) was estimated in semi-log form (with the dependent variable measured in thousands of apprentices and the explanatory variables continuing to be measured in logs).

It should be noted that the DIS variable is defined to operate in the 1955-1971 period, but not the 1972-78 period. The reason for this are the E.I.T.B.'s counter-cyclical activities in the 1972-78 period. When DIS is allowed to operate over the 1972-78 period as well, its coefficient becomes even less significant.

It is not easy to explain the failure of firms to respond with force to craftsmen market disequilibrium. It could be that LONG is sufficient to account for long-term expectations and that DIS adds little to this effect. On the other hand, it could be that DIS is mainly useful for explaining short-run behaviour of firms, in which case apprentice intake variations have little to contribute to short-run changes in the stock of craftsmen.

Neither the TIME nor the ROSLA variable shown in Table 2 was significant and were quickly dropped from the equations. The ROSLA variable had been included to allow for a possible short-run supply constraint caused by an increase in the school leaving age in 1973. Namely, ROSLA seems to have lowered apprentice supply by about ten per cent, as given by the coefficient in Table 2, but this was insignificant.

LC, the stock of craftsmen, was included in equation (7b) as a means of testing a particular theory of "replacement investment"; that is, apprentice investment for the purpose of replacing craftsmen as they leave the industry. As in the physical investment literature, apprentice investment would be related to a lagged value of the craftsmen stock variable if the geometric mortality distribution is an adequate description of the replacement process. There is no evidence for this theory of replacement here, with the coefficient of the lagged stock variable not significant. On the otherhand, the process of retirement may be better modelled by the "one toss shay" (alias echo) model of replacement, though unfortunately this requires apprentice intake data going back to the last century.

As we have noted, the basic results are reasonably stable with respect to variations in the time period and dropping of selected variables from the equation. This stability is formally confirmed with a Chow test over the 1955-65, 1966-78 and 1955-78 periods, with the F-statistic insignificant at the five per cent level. The period split was based on the effective introduction of the 1964 Industrial Training Act. Finally, similar results (shown in Table 3) occur when a different data source, the E.I.T.B. series rather than the Gazette series, is used.
It is interesting to consider comparable tests for the recruitment for current production model. These are shown in Table 4. Emphasis has been given to the effect of current production rather than lagged production variables. When lagged adjustment is recognised, the basis of the current production model becomes suspect, as Lindley (1975) discusses. In particular, the assumption that current output equals desired output is less tenable when costs of adjustment and product market disequilibrium are allowed for. These objections are additional to those raised in Section II.

When focus is put on the explanatory power of current production, it is obvious from Table 4 that the relationship is weak. Quite often the coefficient on current production is negative, implying that an increase in current output decreases apprentice recruitment. Over some time periods (1963-78 for example) the model seems to perform satisfactorily, but this is not maintained over other time periods (such as 1955-78). Even in the 1963-78 period, when its performance is better, the use of a polynomial distributed lag version suggests that some of the Koyck lag version results may be illusory (viz indicating serial correlation rather than lagged adjustment, especially for the wage variable).

Moreover, closer inspection of the polynomial lag structure for the output variable indicates no contribution from current production, with lagged output representing the real force.

These somewhat negative statements about the current production model are consistent with our investment model results. Certainly the latter has much greater explanatory power (higher $R^2$-squared), though the proper specification of the current production model is admittedly a narrow and restrictive one. Perhaps the most telling result against the current production model comes from the excess product demand variable (BACKLOG) in Tables 2 and 3. The empirical results with this variable imply that new, first year apprentices have negative utility when firms are trying to meet short-run production goals quickly.

V Empirical Tests Explaining the Ratio of the Stock of Apprentices to the Stock of Craftsmen

Whereas the empirical tests reported in Section IV relate to the flow of new apprentice recruits, now we seek to explain the stock of apprentices (which include later stage apprentices as well as new recruits) relative to the stock of craftsmen. This exercise is useful in a number of ways. First, if certain variables affect the flow of apprentice recruits, then the same variables should also affect the stock of apprentices, though perhaps in a pattern which should reflect the flow-stock relationship. For example, if the relative wage
rate has a negative effect on the flow of apprentices in the current year and the effect is permanent (there are no offsetting lagged changes), this will affect the stock of apprentices in the following way. In the first year of a relative wage rate increase the stock of apprentices will fall (ceteris paribus). In the second year the stock of apprentices will fall even further because the reduced flow of recruits is permanently lower. This process continues until the stock of apprentices is "turned over" once; that is, four or five years. A simple unlagged effect of the relative wage rate on the flow of apprentice recruits leads to a distributed lag effect on the stock of apprentices, spread over a five-year period with approximately equal weights in each year. Thus if the relative wage influence in the flow equation is spurious, this would show up in the apprentice stock equation in the form of a no lag or inappropriate lag relationship. Another virtue of examining the stock ratio is our ability to control the behaviour of craftsmen and therefore make more secure statements about the relative behaviour of apprentices, viz-a-viz, craftsmen. For instance, is the response of craftsmen employment to excess product demand any different to that from apprentice intake?

It should be noted that the data underlying our equations of the relative stock of apprentices to craftsmen is not the same as the flow data used in the previous section, though they should not differ markedly. Moreover, the flow and stock data are not quite synchronised by time of year. Thus, for these two reasons, we would not expect an exact correspondence between the flow and stock results, quite apart from the fact that the stock equation is in ratio form and capable of a least-squares independent behaviour compared to the flow equation.

Our basic testing equation takes the form:

\[
\text{LOG(RATIO)}_t = y_0 + y_1 \text{DIS}_t + y_2 \text{ROSIA} + y_3 (\log \text{LONG}_t - \log \text{LONG}_{t-1}) + y_4 \text{LOG(BACKLOG)}_t + y_5 \text{LOG(BACKLOG)}_{t-1} + y_6 \text{PDL}(\text{LOG RW})
\]

where RATIO\_t is the ratio of the stock of apprentices to the stock of craftsmen in period t, DIS\_t is the craftsmen disequilibrium variable at the beginning of period t, ROSIA\_t is dummy variable (1973 equals one) to allow for a school leaving supply constraint, LONG\_t is gross fixed capital formation in period t which is included as indicating long-term output expectations, BACKLOG\_t is an excess product demand variable, and PDL(\text{LOG RW}) is a polynomial distributed lag (quadratic over five annual periods) on the log of the relative wage variable, RW.
The first difference of LONG is included rather than just \( \text{LONG}_t \) because it is hypothesised that changes in long-run output should have no permanent effect on the ratio of the stocks of apprentices to craftsmen. This reflects our basic position that there can be no intrinsic substitution between the two inputs. We have already explained our case for expecting a distributed lag effect with the relative wage variable.

The results of fitting equation (9) to the engineering industry are given in Table 5. As in the Table 2 intake equation, the supply constraint does not seem to be binding in 1973, with an insignificant ROSLA coefficient. The poor performance of the craftsmen disequilibrium variable \( \text{DIS} \) in the intake equations is even more pronounced in the Table 5 stock equations. The coefficient on the change in the LONG variable is about what we would expect based on the intake equation. That is, an intake coefficient of 0.8 on LONG (from Tables 2 and 3) corresponds to a stock effect of about 0.2 (since new recruits account for about a quarter to a fifth of the stock of apprentices). However, it is not significant. This suggests only a mild tendency to build up apprentice levels ahead of craftsmen levels. In turn this implies a certain degree of hoarding of craftsmen, i.e. recruiting well ahead of actual needs and slowly releasing craftsmen when requirements fall.

Without doubt the relative wage dominates the explanation of changes in the stock ratio. There seems to be a high degree of consistency between the flow and stock equations. The wage effect in the flow equation is unlagged, whereas a polynomial distributed lag pattern is evident in the stock equation. This lag structure is well determined, being impervious to changes in the lag length and degree of the polynomial. The individual components of the lag structure had high t-values and had fairly similar coefficients. The sum of the lagged wage coefficients is about 1.0, which also corresponds to our results in Tables 2 and 3.

The product disequilibrium variable \( \text{BACKLOG} \) displays less force in the stock equation compared to the flow equation. The current impact of a change in BACKLOG is negative in the Table 5 stock regression and is usually significant at the five per cent level. Moreover, the magnitude of the coefficient is about a quarter to a fifth of the coefficient in the intake equation. Thus there is a high degree of consistency between the flow and stock equation to this point. However, when we trace the effect of changes in BACKLOG beyond the current period, the flow and stock results diverge. In the stock equation the lagged effect of BACKLOG is either negative or close to zero, whereas in the flow equations it is positive. In fact, polynomial distributed lag estimates on BACKLOG in the stock equation (9) revealed a very unstable situation, highly sensitive to lag length, degree of polynomial and period of estimation. Within
these unstable results, the current coefficient of BACKLOG continued to be negative.

Two interpretations about the lagged BACKLOG effect on RATIO are possible. First, the unstable lagged response to changes in BACKLOG contradicts the observed pattern in the Tables 2 and 3 recruitment equations, so the lagged BACKLOG variable is spurious in the intake model. Note, however, that this makes little difference to our results, concerning the sign and significance of the other variables, including the unlagged BACKLOG variable in the intake model. Secondly, the intake model could remain satisfactory, in toto, and the stock equation could exert its own mode of behaviour, which contrasts with the wage variable effects. Thus, when the relative wage rate changed, only the apprentice intake numbers were changed. Firms made little adjustment to the stock of existing apprentices (second year to fifth year categories) nor to the stock of craftsmen when relative wage rates changed. In contrast, part of the response to excess product demand could involve some stock adjustments. Some firms could accelerate training schedules for existing later stage apprentices. In other cases firms might suspend formal training on apprentices, possibly reclassifying them (maybe at the apprentice's initiative) to a semi-skilled status. Additionally, the stock of craftsmen can also be increased over time, reinforcing the tendency for the coefficient on the lagged BACKLOG variable to be negative. With a variety of different options open to the firm in terms of changing training programmes and craftsmen recruitment, some instability in lagged BACKLOG responses is likely. Additional observations might clarify this issue.

On the whole, however, there does seem to be a fairly consistent pattern between the flow equations (in Tables 2 and 3) and the stock equation (in Table 5). The consistency stands out with respect to the DIS, ROSLA, RW and BACKLOG \( t \) variables, but is ambiguous with respect to LONG and BACKLOG \( t-1 \).


The training performance of British industry attracted considerable criticism in the pre-1965 period, perhaps enough to motivate the introduction of the 1964 Industrial Training Act. The lack of sophisticated managerial techniques used to choose recruitment levels is well documented in the interview studies summarised in Section I. Yet while the quality of training was suspect, much of the outcry about insufficient numbers being trained seems exaggerated. During the 1956–64 period, the typical excess demand for craftsmen, that is, vacancies minus unemployment and then expressed as a fraction of the stock of
craftsmen, was about 0.01. For one or two years and in some industries, the fraction was slightly higher, to which one can add further slight variations due to errors of measurement (the figures coming from the Gazette vis-a-vis the national census). The fact remains that the quantitative shortfall of craftsmen was not a social crisis and per se did not create an overwhelming justification for the 1964 Act. Notwithstanding, the equity between firms (against excessive poaching) and the quality of training arguments may have provided sufficient justification for the 1964 Act.

In comparing the 1955-65 and 1966-78 periods, the outstanding differences are the presence of the training levy-grant system operating under the 1964 Industrial Training Act and the shortages-surplus of craftsmen contrast. When judging the quantitative training performance of the engineering industry, we should be alert to the possibility that the depressed state of the economy in the post-1965 period undid the stimulus from the 1964 Act. Nevertheless, two years after the Act became effective and before pronounced craftsman surpluses had appeared, there was no upsurge in apprentice intake. In contrast to Woodward (1975), Lindley (1975) does control for other demand influences when evaluating the effect of the 1964 Act. He hypothesises that the Act manifests itself through the relative wage variable, by altering the cost of training. No effect was evident.

Rather than a simple quantitative effect, the 1964 Act may have had a more subtle impact, via firms' attitude to training. As Lloyd Ulmann (1968) suggests, the Act could have had a shock effect, making firms more "training conscious". This implies a dramatic change in the recruitment process. How can one test for this phenomenon? The Chow test is ideally suited for examining dramatic changes in the structure of our investment model in the aftermath of the 1964 Act. These changes should affect the demand variables (LONG, DIS) as well as the cost of training variable (RW). In fact, we have already carried out this Chow test in Section IV (using the Table 3 regressions). There is no evidence of structural change in the model as a whole, nor in any sub-set of the model. The coefficient on the LONG variable, for example, seems to have increased in the more recent period. However, a Chow subset test (by adding a variable DUMMY*LONG, where DUMMY equals one in 1966-78 and zero otherwise) rejected this hypothesis (the coefficient on DUMMY*LONG is positive, small and insignificant, with a t-value of 1.5). In summary, there is no evidence that the 1964 Act spawned a new era of "training consciousness", making firms more sensitive to demand stimuli; notwithstanding the effect on the quality of training.

The failure of the 1964 Act to alter the parameters of our investment model does create an enigma. In theory, the grant-levy system should encourage
more training. The levy (initially 2.5 per cent of payroll in engineering) can be viewed as a fixed cost, whereas the grant (financed by the levy) is a positive function of recruitment levels. Perhaps some firms (especially the larger ones) perceived the levy more as a variable cost (rising with training effort) rather than a fixed cost. The fact that the new training arrangements are industry financed (though less so after the 1973 amendments to the Act), explains the failure of firms to respond in any dramatic sense. An alternative explanation is that the 1964 Act was so successful in lifting the quality of training, it thereby generated labour-saving (apprentice-saving) effects. In turn these apprentice-saving tendencies counterbalanced the positive stimulus of the grant-levy system (when the levy is perceived as a fixed cost); which explains the apparently neutral effects of the 1964 Act. Other explanations are invited.

VII Conclusions

Emphasis has been given to an investment model of the recruitment process. Special attention is paid to the time profile of future product demand. In light of the gestation period before apprentices make a noticeable contribution to output, expected long-run product demand is a key positive explanatory variable of recruitment levels. In contrast, expected short-run increases in product demand reduce apprentice recruitment, for reasons associated with internal adjustment costs. Excess product demand in the short-run cannot be removed quickly by greater numbers of first year apprentices. Instead, firms switch craftsmen from training to production duties, with a concomitant reduction in apprentice recruitment. The costs of training, as emphasised in Becker type neoclassical models of training, are inversely related to intake levels.

The above model is supported by the empirical evidence presented in this paper. Indeed, the model seems to be fairly robust with respect to specification and time period estimated.

By way of hypotheses rejected, there is little support for the main rival model, the recruitment for current production model. Within the investment model, firms are unresponsive to labour market (craftsmen) disequilibrium, which suggests that firms do not project these imbalances beyond the short-run. Apart from raising the general quality of training, there is no evidence that the 1964 Act has had a major quantitative impact on the training process.
<table>
<thead>
<tr>
<th>Stage of Apprenticeship</th>
<th>Range of Output Contribution by Apprentice$^1$</th>
<th>Simple Average of Marginal Output Contribution$^1$</th>
<th>Wage Rate$^2$</th>
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<tr>
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<td>35%</td>
</tr>
<tr>
<td>2</td>
<td>0 to 60%</td>
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<td>42.5%</td>
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<tr>
<td>3</td>
<td>25 to 85%</td>
<td>55%</td>
<td>57.5%</td>
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Notes:  
1. Output contribution relative to the work of a skilled craftsman  
2. Expressed as a percentage of the craftsman wage rate  

Sources:  
2. Time Rates of Wages and Hours of Work, 1970 (H.M.O.)
Table 2: Empirical Tests of an Investment Model of Apprentice Intake: 1963-1978 (Log Linear Model)

<table>
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<tr>
<th>Constant</th>
<th>Time</th>
<th>DIS&lt;sub&gt;t&lt;/sub&gt;</th>
<th>Wage&lt;sub&gt;(RW)&lt;/sub&gt;</th>
<th>ROSLA</th>
<th>LONG&lt;sub&gt;t&lt;/sub&gt;</th>
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Notes: t-value or F-value in brackets
* denotes significant at 5% level
Table 3: Further Regression Results of Investment Model, Various Periods (Log Linear Except Last Regression which is Semi-log)

<table>
<thead>
<tr>
<th>Period</th>
<th>Data Source</th>
<th>Constant</th>
<th>$DIS_t$</th>
<th>$LONG_t$</th>
<th>$WAGE_{RW_t}$</th>
<th>BACKLOG $t$</th>
<th>BACKLOG $t-1$</th>
<th>$R^2$</th>
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<td>Gazette</td>
<td>-1.44</td>
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<td>(5.50)*</td>
<td>(2.41)*</td>
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<td>Gazette</td>
<td>-0.86</td>
<td>-2.79</td>
<td>0.67</td>
<td>-0.90</td>
<td>-1.54</td>
<td>0.97</td>
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<td>(2.79)*</td>
<td>(4.58)*</td>
<td>(5.76)*</td>
<td>(3.61)*</td>
<td>(14.0)*</td>
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<td>1966-1977</td>
<td>E.I.T.B.</td>
<td>-2.71</td>
<td>2.95</td>
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<td>-1.14</td>
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<td>(1.74)</td>
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<td>(5.14)*</td>
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<td>(1.63)</td>
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<td>(1.81)</td>
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<td>(4.05)*</td>
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<td>1955-1978</td>
<td>Gazette</td>
<td>-36.6</td>
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<td>9.9</td>
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<td>-23.2</td>
<td>15.0</td>
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<td>(semi-log)</td>
<td>(1.77)</td>
<td>(2.49)*</td>
<td>(2.65)*</td>
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<td>(3.65)*</td>
<td>(14.9)*</td>
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Notes: t-value or F-value in brackets
* denotes significant at the 5% level
Table 4: Recruitment for Current Production Model: Regression Results (N.B. Log-linear Model)

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<tr>
<th>Period</th>
<th>Constant</th>
<th>Wage (RW)</th>
<th>Q</th>
<th>Sum of Q Coefficient</th>
<th>Unemployment (U)</th>
<th>Lagged Dependent Variable</th>
<th>$R^2$</th>
<th>DW</th>
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<tr>
<td>1955-1978</td>
<td>3.29</td>
<td>-0.34</td>
<td>-0.07</td>
<td>0.01</td>
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<td>0.25</td>
<td>0.83</td>
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<td></td>
<td>(1.60)</td>
<td>(0.6)</td>
<td>(0.2)</td>
<td>(0.3)</td>
<td></td>
<td></td>
<td>(2.18)</td>
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<tr>
<td>1955-1974</td>
<td>-0.20</td>
<td>-0.48</td>
<td>0.28</td>
<td>0.62</td>
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<td>0.51</td>
<td>1.57</td>
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<tr>
<td></td>
<td>(0.1)</td>
<td>(1.19)</td>
<td>(0.8)</td>
<td>(3.28)*</td>
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<td></td>
<td>(6.90)*</td>
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<tr>
<td>1955-1974</td>
<td>1.29</td>
<td>-0.61</td>
<td>0.11</td>
<td>0.39</td>
<td></td>
<td></td>
<td>0.58</td>
<td>1.71</td>
</tr>
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<td></td>
<td>(0.6)</td>
<td>(1.47)</td>
<td>(0.3)</td>
<td>(1.70)</td>
<td></td>
<td></td>
<td>(7.52)*</td>
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<tr>
<td>1963-1978</td>
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<td>-1.71</td>
<td>2.17</td>
<td>0.74</td>
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<td></td>
<td>0.65</td>
<td>2.65</td>
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<tr>
<td></td>
<td>(2.61)*</td>
<td>(2.92)*</td>
<td>(2.94)*</td>
<td>(4.00)*</td>
<td></td>
<td></td>
<td>(7.42)*</td>
<td></td>
</tr>
<tr>
<td>1955-1978</td>
<td>3.54</td>
<td>-0.30</td>
<td>-0.16</td>
<td>-0.08</td>
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<td></td>
<td>0.64</td>
<td>1.79</td>
</tr>
<tr>
<td></td>
<td>(1.73)</td>
<td>(0.6)</td>
<td>(0.4)</td>
<td>(2.05)</td>
<td></td>
<td></td>
<td>(4.87)*</td>
<td></td>
</tr>
<tr>
<td>1963-1978</td>
<td>-10.50</td>
<td>-2.07</td>
<td>2.66</td>
<td>0.09</td>
<td></td>
<td></td>
<td>0.49</td>
<td>1.28</td>
</tr>
<tr>
<td></td>
<td>(1.99)</td>
<td>(2.42)*</td>
<td>(2.53)*</td>
<td>(1.69)</td>
<td></td>
<td></td>
<td>(1.95)</td>
<td></td>
</tr>
<tr>
<td>1963-1978</td>
<td>-5.78</td>
<td>-1.25</td>
<td>1.71</td>
<td>0.06</td>
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<td></td>
<td>0.26</td>
<td>0.88</td>
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<tr>
<td></td>
<td>(1.08)</td>
<td>(1.46)</td>
<td>(1.60)</td>
<td>(1.13)</td>
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<td></td>
<td>(1.42)</td>
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Notes: t-value in brackets
* denotes significant at the 5% level
Table 5: Determinants of the Stock Ratio of Apprentices to Craftsmen (Log-linear Model)

<table>
<thead>
<tr>
<th>Period</th>
<th>Data Source</th>
<th>DIS_t</th>
<th>ROSLA</th>
<th>LONG_t minus LONG_t-1</th>
<th>( \Sigma ) Wage Coefficients (EW)</th>
<th>BACKLOG_t</th>
<th>BACKLOG_t-1</th>
<th>Constant</th>
<th>( R^2 )</th>
<th>DW</th>
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</thead>
<tbody>
<tr>
<td>1963-1978</td>
<td>Gazette</td>
<td>-0.92  (0.6)</td>
<td>0.07  (0.97)</td>
<td>0.15</td>
<td>-1.07 (11.4)*</td>
<td>-0.28 (1.21)</td>
<td>-0.12 (0.6)</td>
<td>-1.74 (60.9)*</td>
<td>0.97 (32.7)*</td>
<td>1.96</td>
</tr>
<tr>
<td>1963-1978</td>
<td>Gazette</td>
<td>0.11   (0.7)</td>
<td>-1.10 (13.5)*</td>
<td>-0.37 (1.86)*</td>
<td>-0.05 (0.3)</td>
<td>-1.74 (66.7)*</td>
<td>0.97 (48.1)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1963-1978</td>
<td>Gazette</td>
<td>-1.08 (15.4)*</td>
<td>-0.33 (2.98)*</td>
<td>-1.74 (71.5)*</td>
<td>0.97 (79.9)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1963-1978</td>
<td>Gazette</td>
<td>-1.07 (15.0)*</td>
<td>-0.28 (1.84)*</td>
<td>-0.10 (0.6)</td>
<td>-1.74 (68.4)*</td>
<td>0.97 (60.4)*</td>
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<td></td>
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<tr>
<td>1966-1977</td>
<td>Gazette</td>
<td>-1.23 (15.5)*</td>
<td>-0.27 (2.05)*</td>
<td>-0.31 (1.80)</td>
<td>-1.68 (47.9)*</td>
<td>0.99 (85.2)*</td>
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<td></td>
<td></td>
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<tr>
<td>1966-1977</td>
<td>E.I.T.B.</td>
<td>-1.07 (12.6)*</td>
<td>-0.25 (1.78)</td>
<td>-0.11 (0.6)</td>
<td>-1.64 (43.9)*</td>
<td>0.98 (49.7)</td>
<td></td>
<td></td>
<td></td>
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</tr>
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Note: \( t \)-value in brackets
* denotes significant at the 5% level
## APPENDIX

### Data Sources

<table>
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<tr>
<th>Variable Code</th>
<th>Source</th>
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| 1. FRW        | wage rate of apprentice expressed as a percentage of the craftsman rate  
**Time Rates of Wages and Hours of Work (H.M.O.)** |
| 2. BACKLOG    | order backlog; orders outstanding at the end of the period divided by production  
**Monthly Digest of Statistics** |
| 3. Q          | current level of production in real terms  
**Monthly Digest of Statistics** |
| 4. LONG       | gross fixed capital formation in real terms  
**Monthly Digest of Statistics** |
| 5. LA         | apprentice intake: 1950-1974  
**Department of Employment Gazette**; spliced with **E.I.T.B.'s 1974-78 series** |
| 6. RATIO      | stock of apprentices relative to the stock of craftsmen; survey taken May each year since 1963  
**Department of Employment Gazette**; also **E.I.T.B. series as of April/May each year since 1966** |
| 7. DIS        | unemployment minus vacancies of craftsmen; all divided by the stock of craftsmen $LC_{t-1}$; stock figures between 1955-62 based on 1951-61 Census data interpolation (with stock changing very slowly at 0.5% p.a.); vacancy figures available back to 1956; for 1955 DIS based on unemployment behaviour alone  
**Department of Employment Gazette** |
| 8. U          | engineering industry unemployment level  
**Department of Employment Gazette** |
| 9. LC         | stock of craftsmen; as in RATIO; (No. 6) |
| 10. ROSLA     | 1 for 1973; -1 for 1974; 0 otherwise; (postponement version of ROSLA) |
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Oi, W. (1962) "Labour as a Quasi-Fixed Factor", *J.P.E.*, December


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<tr>
<td>1</td>
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<td>N.V. Lam</td>
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<td>Secondary Reserve Requirements, the Monetary Base and the Money Supply in Australia</td>
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<td>Pricing Behaviour in Australia: A Data Evaluation Study</td>
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<td>G. Lewis</td>
<td>A Strategy for Winning at Roulette</td>
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<td>4</td>
<td>V. B. Hall &amp; M. L. King</td>
<td><em>New Zealand Economic Papers</em>, 1976, 118-51.</td>
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<td>24</td>
<td>V. B. Hall</td>
<td><em>Economic Record</em>, Vol. 56, No. 152,</td>
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