

Job Search, Migration, and Metropolitan Growth

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JOB SEARCH, MIGRATION, AND METROPOLITAN GROWTH

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Preface

Interest in human settlement systems and policies has been a critical part of urban-related work at IIASA since its inception. Recently this interest has given rise to a concentrated research effort focusing on migration dynamics and settlement patterns. Four sub-tasks form the core of this research effort:

- I. the study of spatial population dynamics;
- II. the definition and elaboration of a new research area called demometrics and its application to migration analysis and spatial population forecasting;
- III. the analysis and design of migration and settlement policy;
- VI. a comparative study of national migration and settlement patterns and policies.

This paper, the second in the demometrics series, argues the need for an alternative formulation of urban labor market dynamics. It reviews recent theories of job search and job creation, and examines their implications for internal migration.

Related papers in the demometrics series, and other publications of the migration and settlement study, are listed on the back page of this report.

Andrei Rogers

December 1976

Abstract

While most current empirical urban-growth models emphasize the role of urban labor market dynamics, there has been little discussion of alternative theories of labor market behaviour. A review of theories of job search by labor force members and job creation by firms is undertaken. This reveals that current urban-growth models are based on, at best, an overly-simplified view of labor market processes. A better treatment of long-distance job search and the relationship between search and migration is seen as a high priority in future work. Without such work, a true test of industry versus household-initiated regional development is not possible.

JOB SEARCH, MIGRATION, AND METROPOLITAN GROWTH

INTRODUCTION

One of the main controversies today in urban and regional economics is over the causes of regional growth in a market economy. Hirsch (1973) has typified the two polar approaches in this debate as the household-initiated and the industry-initiated theories of urbanization and growth. Supporters of the first approach suggest that it is the locational behaviour and preferences of households which, through their roles as consumers of goods and services and as suppliers of labour, determine the evolving spatial pattern of growth and development within a nation. Supporters of the second approach argue that industry decides where future growth will take place and that in making such decisions firms are relatively insensitive to the locational choices and preferences of households. It is not difficult to accept that the evolving pattern of urbanization within a nation is likely responsive in some degree to both kinds of initiative. The main question is the following. Can we identify empirically the relative roles that household-initiated and industry-initiated sources have played in shaping recent national urbanizational patterns ?

This is a very important public policy question. Increasingly, governments in many countries have been trying, for various reasons, to affect both the magnitude and spatial pattern of human settlements within their country. The policies that they would need to effect these changes must be related to a view of what is causing this spatial pattern of industries and households. If it is mainly household preferences which lie at the heart of the urbanization pattern, successful policies must be directed toward affecting these. If it is the behaviour of firms which is mainly responsible, a different prescription is in order.

Most of the empirical models of urban economic growth characterize this debate in a very simple manner¹. They see the locational preferences and decisions of households as being represented solely by local population growth (or decline). They then ask whether the local growth in employment is the cause or the consequence of this population growth. Some of these empirical models have involved the estimation and interpretation of a simultaneous equation system wherein job and population growth are both endogenously related to each other². Mixed findings have been obtained.

Although several models have been empirically tested, there has been virtually no treatment of the theoretical basis for such models. Each empirical researcher has used a different structural model with virtually no rationale for the choice of variables, linkages among variables, or time lags used. More importantly, if one attempts to build a theory under these models, one will generally be forced to rely on a notion of migration and job search behaviour with which few social scientists would feel comfortable. The principal problem here is that, in constructing empirical models, researchers have taken too narrow a view of the notion of household-initiated urbanization. This can be shown in turn to lead to the inferior notion of migration and job search just alluded to.

This essay is intended to flesh out these arguments. The spatial pattern of urbanization will be formulated here as the outcome of a process of urban labour market dynamics. Two classes of actors are identified in this discussion; firms and labour force members. The ensuing material considers three questions. How do labour force members express their locational preference in their search for better jobs? How do firms in a given local labour market make their hiring and investment decisions? How does the interplay between these two sets of actors translate itself into a theory or model of urban economic growth? Further, when answers to these questions explicitly

¹Refer to reviews by Miron (1971) and Muth (1975; Chapter 2).

²Examples include Muth (1971), Greenwood (1973); Kain and Niedercorn (1963), and Alperovich et al. (1975).

consider a spatial dimension, the role of labour migration in long-distance job search and local labour market dynamics becomes important.

The stress here on migration behaviour has its basis in recent demographic patterns in developed countries. In such countries, the age-specific fertility and mortality rates are relatively homogeneous from one urban area to the next. Cities with higher (or lower) than average population growth must generally be explained in terms of the only other component of change; migration. However, many researchers from Sjaastad (1962) onward, have viewed migration as an economic response to local and external labour market conditions. An emphasis on the connection between urban population growth and labour market considerations is thus understandable.

To provide a framework for discussing job search and migration behaviour, the model of David (1974) is examined in Section 1. It is perhaps the best formal attempt yet to develop a micro-economic model of job search and migration. This model can be shown to provide a theoretical basis for the labour supply (or population) growth equation of a typical empirical aggregative urban model. Some major questions are raised about this model and its relevance to current conditions. These questions are shown to be tied in part to the restricted view which David takes of how household-initiated urbanization might take place. Some alternative and broader perspectives on job search behaviour are then offered in Section 2.

A complementary model of job creation behaviour is considered in Section 3. This model is designed to emphasize the information which might be used by a firm in making its hiring and investment decisions. The model of Mortensen (1970) is used as a starting point for the development of a more general model. Finally, issues in the linking of job search and job hiring models are discussed. It is shown that models such as those of David and of Mortensen can be linked to provide a full model of urban labour market dynamics. Moreover, this coupling of

theoretical models can be seen as one basis for a typical current empirical model. However, the failure of these theoretical models to consider a broader notion of household-initiated urbanization makes both the empirical models and themselves deficient.

DAVID'S MODEL OF JOB SEARCH AND MIGRATION: A CRITIQUE

David uses an analogy to what he refers to as the prospective migrant's decision problem. This section begins with an outline of that analogy and the parallels drawn. Subsequently, consideration is given to the assumptions made and the restrictions this places on migration and job search behaviour. Here, the empirical relevance of some assumptions is also questioned. For ease of presentation, the assumptions are considered in two sets; the prospective migrant's state of knowledge and his method of wage sampling. Following this is a discussion of David's main findings and the significance these place on his various assumptions. Finally, attention is turned to the problems of tying David's model to a more general model of urban economic growth.

The analogy used by David may be described as follows.

...it is best to commence with an analogy of the kind calculated to put statisticians at their ease. A man has been presented with a set of labeled urns, each containing many balls. Every ball has a dollar value inscribed upon it, but the value of any ball can only be obtained after it is withdrawn from the urn. Upon the label of each urn appear the parameters of the particular probability distribution to which the values of the balls therein conform. Also written upon every label is the fixed "entry fee" that must be paid just for the right to put one's hand in the urn, and, further, a schedule of "sampling charges" describing the (dollar) costs of withdrawing different numbers of balls therefrom. Were our friend able to inventory the contents of all the urns and choose a single ball on the basis of full knowledge, he would prefer the one with the highest value--although he might decide that the whole game had not been worth the candle. This, however, is not even a practicality. He is, instead, required to choose an action strategy composed of two elements: He

must designate (1) the single urn from which (2) a specified number of balls are to be drawn, say, in sequence, replacing each before extracting the next and recording its value. He will then be allowed, without further expense, to retrieve any ball--and obviously he will want it to be the highest valued--among those comprising the (random) sample. How should he proceed in making this strategy decision? If given a fixed budget, how should he divide it between purchasing "entry" and sampling? And how large a sum should he be willing to spend in this game? [David; 1974, p.24.]

The parallels drawn by him to the migration decision problem of an individual are clear.

In place of "urns" we should then quickly substitute local labor markets: rural districts, towns, cities, or even different countries. And instead of "balls," read job offers. For simplicity's sake a traditional Japanese arrangement may be imagined to prevail--permanent job tenure; the value of a job offer thus becomes the present value of an annual wage annuity received over the remainder of the worker's earning life. To what does "sampling" correspond here? Obviously to local job search, an activity which is presumed to be distinct from employment (job tenure) and can be conducted only at some (scheduled) expense to the individual concerned. Since the contemplated search is to be carried on within the local confines of a single local market, we must suppose that migration thither is a prerequisite for its conduct. Hence the fixed "entry fee" that appeared (along with the schedule of sampling charges) on each urn's label now represents the pure pecuniary and psychic costs of the migration activity necessary to effect entry into the respective local labor markets from some standard-origin place in the system--the "null urn" initially inhabited by the prospective migrant. [David; 1974, p. 30.]

The Prospective Migrant's State of Knowledge

The prospective migrant is assumed to be in some local labour market in space. From this point, he observes other labour markets elsewhere in space at which he might be employed. For each labour market, including his own, he knows the probability

distribution of wage offers³. That is, different firms in the same labour market offer different wages for the same employee. The prospective migrant does not know beforehand which firm offers what wage or even if a firm has an opening for which he might be suited⁴. He does know only the probability that any given wage offer will turn up next. To find a specific wage offer, the job seeker must 'sample' firms.

The prospective migrant is assumed to be able to attach specific values to every job offer. Presumably each city, or local labour market, offers a bundle of net amenities to the migrant who would choose to live or work there. These, in part, would reflect elements entering into the job seeker's locational preferences such as climate and residential environment. Within David's model, it can be assumed that these are all valued by the migrant and included in the 'wage offer' associated with a job opening in a particular local labour market⁵.

The Method of Sampling

David envisages the process of sampling in the following way. The job seeker searches within a local labour market by collecting a set of 'n' wage offers⁶. How many firms will have

³How does the job seeker form his estimates of the probability distribution of wage offers in a particular local labour market? David does not consider this question. He does not suggest whether these probabilities are exact or subjectively estimated. Further, he does not consider these probabilities to be changing over time either because of changes in local labour market conditions or because of the changing perceptions of job seekers.

⁴He thus has no information by which to orient or make systematic his search among firms within a given local labour market. The implied randomness of local search is in sharp contrast to his detailed knowledge about the general distribution of wage offers in different local labour markets and his rational search among these markets.

⁵To the extent that the migrant is uncertain about how well his locational preferences might be satisfied in a given urban area, such an approach is over-simplifying his problem.

⁶To what extent can wage offers be accumulated? As David (1974; page 70) admits, there are broad classes of job seekers who face offers which are only of the "take it or leave it" variety. Even for those fortunate enough to get an offer with a non-trivial life, the time is usually so short that the job seeker is hard-pressed to collect more than one or two additional offers. Most job seekers face a decision situation in which job alternatives are too few in number to make David's model useful.

to be sampled to come up with these 'n' offers is dependent on the frequency of occurrence of job vacancies among firms. From this sample, the job seeker is assumed to choose the highest offer⁷.

How does the job seeker 'sample' firms? David has assumed that the job seeker must migrate to sample firms in any but his own present local labour market⁸. This implies that sampling requires a physical contact with the firm. In empirical labour market research, this most closely corresponds to the 'gate application' strategy which has been found to be commonly used; especially by certain categories of workers⁹. There are, however, also other search methods which do not require migration or physical presence to sample distant labour markets. Letters of inquiry, written responses to regionally-advertised job openings, telephone contact, and national or regional job placement agencies all provide well-recognized substitutes for gate applications.

⁷David's notion of choosing from a fixed sample is subject to some criticism. Other researchers would argue that uncertainty about the cost of generating an additional wage offer makes this a problem in sequential sampling. After each individual offer, they would argue that the job seeker should and does weigh the costs of continuing the search against the marginal expected gain in a subsequent wage offer.

⁸Since the job seeker must migrate to sample firms in other labour market areas, David views each local labour market as distinct geographically. In fact, more than this is assumed. The usual concept of a labour market area is a fairly dense cluster of work-sites surrounded by a net of residence sites lying within some maximum commuting range. The maximum commuting range is partly defined by the daily journey-to-work cost relative to wages and partly by commuting time relative to total daily disposable time. In practice such a commuting threshold is usually much smaller than the search range of a job seeker. That is, the job seeker is willing to search sporadically further afield than he is willing to commute on a daily basis. Thus, David assumes both that local labour markets are non-overlapping in spatial terms and that they are further separated by more than the maximum range of local job search. Broad-scale urban conurbations with interlinked labour market commuting or search areas cannot be handled under these assumptions. The model is relevant only for a widely separated network of compact cities and these are increasingly fewer in number with the passing of time.

⁹David (1974; page 69) himself draws support from the findings of Reynolds (1951; pp. 214, 215, 240). Similar arguments with respect to young job seekers in particular have also been made by Stephenson (1976; page 108).

David does not consider these alternative strategies for long-distance job search. This is a critical oversight. In his model, households can express their locational preferences only by the actual act of migrating.

David also does not consider the distinction between migration and long-distance search travel. Migration, according to census takers is a change in the place of permanent residence from one pre-defined area to another. It usually involves a movement of household effects and dependents as well as the job seeker himself. David presumes that such movement is a prerequisite to job search. However, it is possible for a job seeker to be physically present for search purposes without having to move his household effects and family first. Thus, in addition to being able to search distant markets without having to be physically present, the job seeker also has a choice between migration and search travel if he wants to be physically present. Indeed, such search travel may be a more efficient strategy under a wide set of conditions. Migration need only occur, if, in the process of search travel, the job seeker finds and accepts a distant job opening.

At first glance, this may seem a moot point. After all, one could rename this a 'search travel', rather than a migration, model and the problem could thus be simply avoided. Our interest here is primarily in terms of migration and urban growth however and not search behaviour on its own. To examine migration with this model, it must be extended to include the possibility of both migration prior to search (as assumed by David) and migration subsequent to a successful long-distance search. His model is incomplete, in failing to specify the conditions under which these alternative search strategies are each optimal.

Further, David presumes an 'intensive' sampling strategy in two senses of the word. First, job seekers are assumed to be searching full-time for job offers. During the search period, they must be otherwise unemployed. This does not permit, for example, part-time search where a job seeker retains a job while searching for a better position. David supports this argument

by suggesting that a large proportion of workers undertake such intensive search. At the same time, there is no evidence presented about the proportion of total job quits associated with subsequent search unemployment. A more general search model would permit a choice between intensive and part-time search and emphasize the determinants of such choices.

The sampling strategy is also intensive in that only one local labour market is sampled. David does not consider a strategy in which the job seeker samples, either simultaneously or sequentially, a series of markets. He would undoubtedly justify his approach on the assumptions that (i) prior migration is necessary and (ii) migration costs are too high to make extensive spatial sampling economic. However, the possibility of sampling several markets in a short period of time exists; especially when sampling is not strictly of the gate application kind. David's simplistic view of search behaviour thus leads him to disregard another important aspect of a sampling strategy.

In conclusion, David considers a very restricted kind of search behaviour. No search occurs without prior unemployment thus eliminating part-time search. No local market search occurs without physical presence thus disregarding other sampling methods. Finally, no change of location is permitted without corresponding migration thus eliminating long-distance search travel.

Conclusions from Model

Given these assumptions, however flawed they might be, David is able to derive some interesting mathematical results. Perhaps the most important is an emphasis on the variance of the wage-offer distribution (denote it by σ_i^2 for local labour market 'i'). This variance is important in two respects. First, since the prospective migrant is making a decision under uncertainty, some notion of rational risk-taking behaviour must be specified. David assumes that some degree of risk-aversion is rational so that the individual is not indifferent to the variance of the wage distribution. Other things being equal, the risk-averse individual would choose to migrate to the local labour market having the

lowest σ_i^2 . Secondly, the variance is important because it helps to define the expected maximum offer in a random sample of size 'n'. The larger the variance, other things equal, the greater the expected maximum offer. Thus an increase in the variance of wage distribution has an undetermined effect. On the one hand, it increases the expected maximum offer while, on the other, it increases the risk of having to accept a low wage.

Another contribution of David is to make the decision to migrate and the decision as to how long (or hard) to optimally search simultaneous. His model permits the prospective migrant to consider, in effect, the expected duration of search unemployment as one aspect in his choice of where to locate. This represents one of the first attempts in the formal theory of migration to give consideration to the duration of unemployment¹⁰.

A simple version of David's model serves to illustrate both of the points raised so far. Consider a prospective migrant who currently resides and works in labour market 'a'. As shown in (1), the present value of an earnings stream at 'a' for this worker is Y_a where y_a is the (fixed) annual income and R is the present value of a dollar flow of income over the worker's remaining work-life. R reflects the discount rate and the individual's work-life horizon. Alternatively, the worker could choose to migrate to 'b' (the only other labour market in this example) and search for 'n' wage offers. As indicated in (2), his annual wage would be the maximum of these. His discounted earnings stream here, Y_b , is similar to that at 'a' except that initial search costs, S , are subtracted out. This is shown in (3). The expected search costs in (4) include a fixed component (s_0) corresponding to the migration cost and a local search cost which varies with the number of offers required, or equivalently with the time required for local search at 'b'.¹¹ Further, the

¹⁰Although the Todaro models, as are seen shortly, also do treat the probability of being unemployed in a time period, they are not formal microeconomic models.

¹¹Let 'p' be the probability that a firm has a vacancy. The expected number of firms a job seeker must visit to obtain 'n' offers is $N = n/p$. Therefore, the expected search cost is $S = s_0 + (ps_2)N$ where s_2 is the marginal search cost per firm. From (4), it is seen that s_1 reflects both the cost of search per firm and the likelihood of getting an offer.

utility, W_i , placed by an individual on these discounted earnings streams is, in (5), subject to diminishing marginal utility. Finally, the prospective migrants' decision problem is to select a local market (a or b) and, if 'b', to choose an optimal level of search. In (6), this is done to maximize the expected value of W_i . This completes the formal statement of the model.

To make this model operational, a few additional assumptions and derivations are required. First, since y_a is deterministic (i.e., known), $E(W_a) = (Ry_a)^\gamma$. On the other hand, y_{bmax} is a stochastic variable. David argues that a good second-order approximation is the following. $E(W_b) = R\bar{y}_{bmax} (1 - \delta\rho_Y) - S$ where $\bar{y}_{bmax} = E(\bar{y}_{bmax})$, $\rho_Y = \sigma_Y^2 / \bar{y}_{bmax}$, $\sigma_Y^2 = E(y_{bmax} - \bar{y}_{bmax})^2$, and $\delta = [\gamma(1 - \gamma)]/2$. Equation (6) then reduces to (7). To evaluate \bar{y}_{bmax} and σ_Y^2 , the mean and variance of the extreme value of a

FORMAL STATEMENT OF DAVID'S MODEL: TWO LOCAL LABOUR MARKETS

$$Y_a = Ry_a \tag{1}$$

$$y_{bmax} = \max [y_{b_1}, y_{b_2}, \dots, y_{b_n}] \tag{2}$$

$$Y_b = Ry_{bmax} - S \tag{3}$$

$$S = s_0 + s_1 n \tag{4}$$

$$W_i = Y_i^\gamma \quad 0 < \gamma < 1 \quad i = a, b \tag{5}$$

$$\max_{i,n} E(W_i) \tag{6}$$

sample, it is necessary to invoke some particular probability distribution for wage offers. David assumes wage offers are $N(\bar{y}_b, \sigma^2)$. In that case \bar{y}_{bmax} and σ_Y^2 are approximated by (8) and (9) where A and B are constants.

Equations (7) to (10) form a complete statement of the migrant's decision problem. They can be solved both for the worker's choice of labour market areas and, if 'b' is

chosen, the optimal level of sampling. Alternatively, of course, W_b could be solved explicitly for an optimal n and the optimized value, W_b^* , could be used to solve separately the problem $\max[W_a, W_b^*]$.

Several comments are in order here. First, the model can not be analytically solved for the optimal sample size, n . Although the economic interpretation of an optimized expression for $E(W_b)$ is clear enough (i.e., the marginal cost of increasing sample size, s_1 , should be equal to the marginal gains from search), the solution is tractable only at a numerical level. Secondly, the model can be easily extended to include search within labour market 'a' as well. Thus, the worker would choose among three strategies; retaining his current job, searching in 'a' and searching in 'b'. Finally, the model is readily extended to cover more than two local labour markets.

The final set of results in David's paper rests on additional assumptions. David assumes that the expected value of a wage offer is everywhere the same. Further, he assumes that all labour markets can be arranged according to their distance (or migration cost) from a given market. Let $\hat{\sigma}^2(d)$ be the wage variance of the labour market with the highest variance at distance 'd'. It is assumed that $\hat{\sigma}^2(d)$ is a continuous and increasing function of 'd'.

SIMPLIFIED VERSION OF DAVID'S MODEL: TWO LOCAL LABOUR MARKETS

$$\max[Ry_a, R\bar{y}_{b\max} - \delta\sigma_y^2 - S] \quad (7)$$

subject to:

$$\bar{y}_{b\max} = \bar{y}_b + B\sigma n^\beta \quad 0 < \beta < 1 \quad B > 0 \quad (8)$$

$$\sigma_y^2 = A\sigma^2 n^{-\alpha} \quad \alpha > 0 \quad A > 0 \quad (9)$$

$$S = s_0 + s_1 n \quad s_0, s_1 > 0 \quad (10)$$

In this special case, it is possible to show that there is some optimal migration distance, d^* . As d increases, so does $\hat{\sigma}^2(d)$.

Initially $\bar{y}_n(d)$, the mean of a sample of n wage offers received in the market with the largest variance at d , also increases but at a decreasing rate. Given a particular wage expectation--variance preference trade-off, d^* can then be defined.

It is difficult to imagine a spatial system of labour markets with such a structure of variances; particularly if the probability distributions underlying them are objective. David comments on this at several points. However, if one adopts the view that the wage offer distributions are subjectively based, it may be quite reasonable to assume that prospective migrants would attach higher variances to further, and less well-known, markets.

Individual Migration and Aggregate Urban Growth

To get some perspective on the kinds of aggregative urban economic growth models for which theoretical underpinnings are being sought, consider the following typical example. Let $M(t)$ be the aggregate flow of in-migrants into a local labour market less the aggregate flow of out-migrants between 't-1' and 't'. Let $N(t)$ and $L(t)$ be the number of job openings and the labour force present at time 't'. Thus, $N(t) - L(t)$ is the excess of job openings over labour supply (i.e., the net level of job vacancies) if positive. If negative, $N(t) - L(t)$ is the excess of labour supply over job openings or the net level of local unemployment.

A simple and commonly-used model of migration which reflects the 'push-pull' hypothesis is the following.

$$M(t) = \alpha_0 + \alpha_1 [N(t-1) - L(t-1)] \quad \alpha_1 > 0 \quad (11)$$

In general, an excess demand for labour is thus seen to lead to a net inflow of migrants while an excess supply leads to a net outflow¹². Is this aggregate behaviour consistent with David's

¹²Some researchers such as Cordey-Hayes (1975) have suggested that the behaviour of in- and out-migrants should be modelled separately. Nonetheless, (11) is widely used as for example by Bell (1967). Other researchers suggest that local wages are an important determinant of migration. However, (11) can be viewed as a reduced form of this if relative wages in turn are responsive to the local excess demand for labour.

model of individual choice? In his model, supply aspects of local labour market conditions are ignored. The prospective migrant considers only the labour demand aspects; the wage offer distribution and the probability of getting an offer from a sampled firm. The wage offer distribution may change over time in response to local market conditions. As a consequence, the shortage or surplus of labour may force changes in local wage rates which in turn affect the propensity of a job seeker to search there. David's model, being concerned only with the supply side, does not assert how these wage changes would come about. A complementary model of wage setting by the firm is required to assess such a process.

The probability of getting an offer from a given firm is, however, more directly affected by local labour market conditions. This probability is affected by the level of local job vacancies. With fewer vacancies, for example, the job seeker expects to have to search more firms to get his 'n' offers. This raises his search costs and makes the local labour market in question less attractive as a place to migrate to and search. Thus, a low (high) level of job vacancies discourages (encourages) potential in-migrants.

To be correct, this argument relies on a notion of total vacancies while (11) is based on vacancies net of unemployment. The empirical relationship between these two is quite strong generally. An increase in total vacancies is almost always accompanied by a reduction in unemployment. Similarly an increase in unemployment, when due to a decreasing demand for labour, is almost always accompanied by a reduction in vacancies.

Does David's model indicate anything about the behaviour of out-migrants? The model presented in equations (1) to (5) presumes that the job seeker at 'a' is employed. It is not difficult to extend this model to consider him as unemployed. David's analysis suggests that an unemployed job seeker at 'a' will be more likely ceteris paribus than his employed counterpart to migrate elsewhere in search of a better job. Because the unemployed job seeker will have to incur search costs whether he is at 'a' or 'b', he is more likely to be affected by the differences between the wage offer distributions of the two

markets than is an employed worker. Thus, David's model provides a basis for the push hypothesis in (11) that increased local unemployment leads to increased out-migration¹³.

Thus, David's model can provide a general basis for (11). Under this interpretation however, (11) can be criticized for the same things that David's model is. In particular, it implicitly assumes that the flows of in-migrants and out-migrants consist mainly of unemployed job seekers. If not, why should the condition of the local labour market matter to a prospective migrant?

¹³This discussion has been intuitive. It has been broadly suggested that David's model of the individual's migration decision could be aggregated for all individuals to produce a form such as (11). The exact proof of this is actually some way off. Two main problems emerge if one attempts to aggregate over such individual decisions. First, are there differences among individuals which make simple aggregation difficult? Secondly, is there a congruence between the time frames used in (11) and on David's model?

Consider the first of these. David's analysis would suggest for example, that aggregation must take account of different age groups. Workers in different age groups will, of course, have different values of R (the present value of a lifetime stream of one unit of currency). Further, workers in different age groups might be expected to face different wage offer distributions reflecting their level of experience and training requirements. Finally, they also may have varying degrees of risk aversion. It is commonly argued, for instance, that young workers are more prone to risk taking than older ones. All of these arguments suggest that in aggregation, people in different age groups may have different values for the parameters of David's model. Similarly, other kinds of homogeneous groupings of the population may be required in aggregation each with its own set of parameter values.

The second problem is the congruence of time frames. Most empirical urban economic models are based on annual data. However, empirical work on labour market behaviour suggests that most employment is of relatively short duration; on the order of one to two months according to the U.S. estimates of Barron (1975). To aggregate David's model over collections of individuals is thus not enough. Some attention must also be paid to the problems of aggregating in a temporal sense as well. This is important, for example, where current migration decisions depend on recent past labour market conditions. To relate migration to local market conditions a month or two ago is one thing. To argue, in a temporally-aggregated model such as (11) that migration depends on last year's conditions is something completely different. No attempt has been made so far to reconcile these two time frames.

Here is the major contribution of David's model. By clarifying the assumption of migration prior to search, the fault with (11) is made clear. While it may be true that local labour market conditions encourage job seekers to search within (or outside) the market, it is not true that this need imply migration. The fault with (11) and with similar kinds of empirical migration equations are that they suggest an over-simplified view of the job search process.

ALTERNATIVE PERSPECTIVES ON JOB SEARCH

Given these criticisms of David's approach, it is instructive to ask how alternative models of job seeker behaviour might be formulated. The long-run purpose in asking this question is to develop some models of individual behaviour which are more consistent with the range of search strategies open to individuals and which could then be aggregated to yield new empirical migration equations to replace (11). Like all long-run purposes, there is much to be done before this can be achieved. The immediate purpose of this section is to examine some of the current approaches to job search theory to see what the major issues are in the design of models of job seeker behaviour.

Two broad sets of issues are identified. One has to do with the general setting within which job search behaviour is examined. The other treats questions about the choices open to the job seeker and his optimal choice under different assumptions about rationality. This section is concluded with an assessment of the directions in which job search and migration models should be headed.

The Problem Setting

The 'problem setting' includes a grab-bag of different aspects. One of these is the number of different ways in which researchers have tended to treat space including the number of (and separation among) local labour markets. Another concerns the different assumptions by researchers about the knowledge (or degree of uncertainty) possessed by job seekers. A final

aspect considered is the different ways in which the probability of finding a job offer in a unit of time is handled. These are now considered in more detail.

The Spatial Setting

In the treatment of a spatial setting, David's model is the most ambitious job-search model to date. The only other spatial models, in any sense, have been those of Todaro (1969) and Zarembka (1970a and 1972). Those are concerned with rural-urban migration and assume only two corresponding labour market areas. David's model, by contrast, allows for any number of local (rural or urban) labour markets.

Does the multi-market aspect of David's model generate any new insights? The answer is negative because of two critical assumptions made by him. By assuming spatially distinct labour market and search areas, he is unable to consider relevant phenomena such as interarea job commuting or search. His spatial setting in this regard is more reminiscent of a nineteenth century urban system than of a contemporary one. Further, by assuming a distance-dependent maximum wage variance, he has created an unrealistic urban settlement system. Although his model may be used numerically in interesting applied analyses, it is doubtful that the multi-market aspect is helpful in a theoretical model. Pushing this attack further, it is not clear that any useful theoretical insights can be formed which would not be available in a two (or at most a three) market model. Although future theoretical models should be restricted to such small urban systems, this argument of course does not deny the usefulness of a large-scale multi-market approach in empirical models.

An additional issue here is whether local labour markets should be treated as area-less points in space. Schneider (1975) considers a model which explicitly analyzes areal form in studying search in an urban market. This model emphasizes search by physical contact and the necessity of moving along paths between firms being searched. How relevant this approach is to aggregate urban labour market models is an open question. Schneider's model does not consider the use of other search tools such as

telephones, letter writing, and job vacancies which alleviate the need for purely physical spatial search. The gains from considering simple point markets seem, in conclusion, to outweigh the restrictive complexity of the areal market models developed so far.

Uncertainty and Search

In David's model it has been assumed that the job seeker is uncertain only about the wage offer, if any, of a particular firm. It has also been assumed that he knows the mean and variance of the (Normal) wage distribution in each labour market. Further, the worker is assumed to know that any wage offer can be kept open until he finishes collecting his sample. Finally, it is assumed that the job seeker can assess all the additional elements intrinsic to a given job opening (e.g. work environment and job stability) and include these in an overall 'wage' measure. Are these realistic assumptions for a broad sector of workers in a contemporary society? Alchian (1970) and others have attacked the assumption that the parameters of the wage distribution are known. They perceive the employed labour force member to be cognizant only of the wage rate he himself has received in the past and is currently receiving. A less-than-average change in this rate, relative to past changes, will cause the worker to quit and search for work elsewhere in the perhaps mistaken belief that his firm is not being competitive. Such behaviour, because the worker is uninformed about average market wages, leads to a 'wage illusion' in which the worker accepts a certain wage rate without knowing how large it is relative to other wages. Parsons (1973) in an empirical study of quit rates finds no support for such a wage illusion. His findings are consistent with the idea that workers are broadly aware of average wages. Thus, although they may not know much about the other parameters of a wage distribution, they are at least generally aware of its expected value.

As indicated earlier, it seems unreasonable that a wage offer can be kept open until a large ($n > 3$) sample is collected.

Several researchers, including McCall (1970), have constructed models which relax this assumption. They find the optimal strategy is a sequential one in which, after each wage offer, the job seeker weighs the relative cost of finding an additional offer against the expected gain which that new offer would represent. A sequential strategy has been shown by McCall and others to lead to a 'reservation wage'. The individual would choose, under this strategy, to stop searching with the first offer exceeding this reservation wage. The reservation wage approach has not yet been integrated into a model of migration behaviour.

There is, however, a more fundamental issue here. Both the fixed-sample and the reservation wage strategies emphasize the dispersion of wages in a local labour market as the prime source of uncertainty underlying the job-seeker's problem. Is such a dispersion the essential source of uncertainty underlying migration behaviour¹⁴? Some researchers, particularly Todaro (1969) and Zarembka (1970 and 1972), emphasize the uncertainty of job finding alone. In their models, they assume that all jobs carry the same wage thereby eliminating wage dispersion. The prospective migrant has a known and fixed probability of finding a job in any period of time and this constitutes the only uncertainty facing him. Such an approach is quite attractive because it makes the informational requirements for a migration decision much smaller. What emphasis should be placed on job finding versus wage dispersion is still an open empirical question¹⁵.

As a final issue here, one might ask how the job seeker weighs one important intrinsic element of a given job; its expected duration. David has assumed that the job seeker believes that a job opening will last the rest of his lifetime. This,

¹⁴The basic search theory models have often been criticized for their reliance on wage dispersion. In addition to empirical doubts, Rothschild (1972; p. 1288), and others have questioned the theoretical basis of such dispersion.

¹⁵As an example of the fragmented evidence available, Stephenson (1976; p. 110) suggests that about 90% of young U.S. job-seekers accept the first job offered to them.

however, is a polar case. More generally, the worker believes a job will have a finite life although he may be unsure about how long this will be¹⁶.

A job may terminate for several main reasons; retirement, quitting, and layoff. The retirement effect has already been considered in David's model in terms of the discounted stream factor R . No presently-available search model considers future 'voluntary' quits (for the purpose of taking, or searching for, a better job) in the job-seekers current decision problem. A simple discounted earnings stream approach, such as that of David, understates the true expected earnings stream by ignoring the expected income gain from future search. This could call for a drastically different choice from the one dictated by David's model. Layoffs or 'involuntary' quits (i.e., not quitting to search for or take up a better job) are not generally considered in the literature either. These too may have a significant effect on the prospective migrant's decision by making a simple discounted earnings stream overstate the expected true stream of earnings.

To incorporate the possibility of these last two kinds of job termination, more information is required by the prospective migrant. He needs to have some idea about the probability of layoff in each of the local labour markets. In addition, for each labour market, he needs to evaluate the likelihood that future search will become profitable. The latter might include, for example, an expectation about temporal shifts in the wage distribution of a local market relative to current conditions. It is unclear as yet just what sources the prospective migrant tends to use in estimating such information.

A small example illustrates the role of uncertainty about layoff on the prospective migrant's choice. Suppose that a job seeker is considering searching some particular local labour market. Assume that he knows the only wage, w , which can be

¹⁶Stephenson (1976; p. 109) also presents evidence suggesting that, among young U.S. job seekers, the older the job seeker the longer he expects his next job to last.

obtained there. Further, assume he knows the probability, p , of finding a job opening and the probability, q , of being laid off involuntarily during a period.

Given that the job seeker is unemployed at the outset ($t = 0$), can we find the probability, e_t , that he is employed at time 't'? Let u_t be the probability that he is unemployed and $Y_t = [u \ e]_t$,¹⁷. The earlier assumptions define a Markov model of the form

$$Y_t = Y_{t-1} A \quad \text{where } A = \begin{bmatrix} (1-p) & p \\ q & (1-q) \end{bmatrix} \quad (12)$$

From this,

$$Y_t = Y_0 A^t \quad (13)$$

As Howard (1971; pp. 63-64) indicates, A^t has a closed form solution.

$$A^t = \begin{bmatrix} \frac{q}{p+q} & \frac{p}{p+q} \\ \frac{q}{p+q} & \frac{p}{p+q} \end{bmatrix} + (1 - p - q)^t \begin{bmatrix} \frac{p}{p+q} & -\frac{p}{p+q} \\ -\frac{q}{p+q} & \frac{q}{p+q} \end{bmatrix}$$

Given the prior assumption that $u_0 = 1$, it is now easily seen that

$$e_t = \frac{p}{p+q} \left[1 - (1 - p - q)^t \right] \quad (14)$$

The expected value of the discounted flow of future earnings can now be calculated. Assume a discount rate of 'r' and that there are no unemployment benefits. The expected discounted earnings stream, U , is given by

¹⁷Noting, of course, that $u_t + e_t = 1$.

$$U = \sum_{t=1}^T \frac{e_t W}{(1+n)^t} \quad (15)$$

Substituting from (14) and letting the worker's time horizon, T , be large, one gets as an approximation

$$U = \frac{(1+n)}{(p+q+n)} \frac{p}{n} w \quad (16)$$

Equation (16) can be expressed in a number of ways. Let us assume that the worker has a fixed level of U , say U_0 , in mind. Re-arranging (16) in this case yields

$$q = -n + \left[\left(\frac{1+n}{n} \right) \frac{w}{U_0} - 1 \right] p \quad (17)$$

This equation ties together the three local market variables; q , p , and w . Given that the job seeker wants to maximize U , (17) indicates indifference curves among these three variables¹⁸. For example, the job seeker is indifferent to a higher quit rate provided that it is accompanied by a higher wage or higher job-finding probability.

The Probability of Job Finding

Whatever the emphasis on wage dispersion, some attention must be focussed on uncertainty in the search for job openings. This, we may summarize by thinking of the probability that a job seeker will locate any opening either while searching a firm or during a given time period. How would one measure this probability? What are its determinants?

¹⁸Note that the coefficient of 'p' in (17) is positive. From (16),

$$\frac{w}{nU_0} = \frac{p+q+n}{p} \left[\frac{1}{1+n} \right] > \frac{1}{1+n}$$

There are several ways in which one could measure the probability of getting a job offer during a period. These may be broadly classified according to how one would view the hiring behaviour of firms. One possibility is that firms maintain waiting lists of acceptable job applicants. The firm would make available a job opening only to the first person on this list and the person's name would be dropped from the list, subsequently, regardless of whether he accepts or rejects the offer. An opposite view of the hiring process would be that no waiting lists are maintained. In this case, a job opening is offered to the next applicant who appears. These two alternative views of the hiring process result in different kinds of job-finding probability measures.

Let us look more carefully at the 'waiting list' or queueing model of job hiring. Suppose that a job-seeker randomly visits N firms during a period of which n on average find him an acceptable applicant. Then, $p_1 = n/N$ is the probability that a firm will make him a job offer at some time. This offer may come immediately but, generally, may come substantially after the application. The probability $p(t)$ that he gets an offer during a time interval ' t ' is dependent on p_1 , on the magnitudes of the waiting lists of firms, and on the rate of occurrence of job vacancies. In general, $p(t)$ will be near zero when the job seeker initially begins searching but will increase, at least to some level, with his duration of search. No application of this approach has been found in the job search literature although this queueing model seems to be a realistic representation of many job search problems.

The alternative view of the hiring process in which no waiting lists are maintained, might be referred to as the 'bingo' model. Here there are at least two different measures of the probability of finding a job. One is the measure used, for example, by David and by Barrow (1975). During a small interval of time, only a certain proportion of firms, say p_1 , have one or more job openings of a type suitable to the particular job seeker¹⁹.

¹⁹ Barrow assumes, more strictly, that no firm has more than one vacancy (of a given type) at a given time.

If a job seeker happens to find a firm with such a vacancy, this position is assumed to be offered to him. Thus, in the David-Barrow view, the job seeker who engages in random search has a probability p_1 of getting an offer from a firm. Further, if it takes $m > 1$ time periods to search one firm, the probability of getting an offer in a unit time is $p = p_1/m$.

An alternative definition of this probability in the bingo model has been suggested by Todaro (1969). He imagines a labour market where all new job openings are filled within one period of time and that these positions are filled randomly from among the ranks of a large stock of unemployed²⁰. Given O_t openings in the local labour market at time 't' and U_t unemployed job seekers, the probability that a job seeker will get an offer is $p(t) = O_t/U_t$.

These two definitions of the job-finding probability in a bingo model share certain features. They are both objectively determined by conditions in the local labour market. They both see the hiring of workers as a kind of random choice among the unemployed job seekers. They both require that the job seeker have some idea of the rate of job creation by firms in a given local labour market. Finally, neither sees the duration of an individual's search as affecting 'p'²¹. In fact, if the general labour market conditions remain constant so does 'p'.

²⁰This is in contrast to the David-Barrow model where an opening is filled in a period only if an appropriate applicant appears.

²¹Some objections to the basic assumptions of the bingo model raise questions about the effect of search duration on 'p'. Several researchers, including Zarembka (1972; pp. 54-58), have suggested that job search involves skills which must be learned. They see the sampling of firms not as a purely random process but as one in which the job seeker becomes increasingly adept at discovering firms with vacancies. Thus, the individual job seeker has his own 'p' which increases with search duration.

An alternative argument has been developed by Salop (1972) to suggest that job seekers are relatively good at picking out high-wage and likely employers. In systematic searching, the job seeker will search these firms first and will only subsequently search low-wage, less-likely employers. In this contrasting view, 'p' will decrease with the duration of search. It is improbable that search learning and systematic search effects exactly cancel each other out but the net effect on 'p' of search duration is an empirical issue if one accepts the bingo model as a realistic approximation.

Are there any reasons for preferring either a queueing or a bingo model? In terms of realism, the bingo model seems to suffer somewhat. Firms, to varying degrees, may find it helpful to maintain waiting lists of acceptable job seekers especially where such workers infrequently approach the firm. By maintaining such lists, the firm should be able to fill its openings more quickly (and at a relatively small increase in administrative costs) than by hiring according to a bingo model.

Secondly, the queueing model makes more realistic information demands on the part of the job seeker. How would the job-seeker get the information required to estimate 'p' in the bingo model? Newspaper and other reports about the expansion of economic activity in a local labour market might be a common source. The job-hunting experiences of friends who have recently searched in that market might be another frequently-used source. It is doubtful in either case that the job seeker could get enough information to have more than a very vague estimate of p.

In a queueing model, there are two kinds of information which the individual must acquire. First, he must know p_1 ; the probability of being a successful applicant. Then, he must have some idea of the expected time until he comes to the top of a waiting list. To estimate p_1 , he must rely on his own past experiences in job search since this is his only guide to his intrinsic qualities as generally perceived by firms. To estimate waiting times, he might reasonably rely on the personnel officers of the firm who might say, for example, "you are an acceptable applicant. At current turnover and expansion rates, we would be able to hire you in six to twelve weeks". As his search gets underway, the job seeker thus has a built-in process by which to estimate and update $p(t)$ with his market experiences.

Finally, the queueing model has an advantage in terms of its relatively subjective nature. The David-Barrow and Todaro approaches assume that 'p' is objective and known before the job seeker makes his migration decision. The queueing model, however, suggests that 'p' is subjective. The migrant may enter a labour market with some notion about 'p' that undergoes changes

with his own job search experiences. In this case, 'p', or more generally, its time distribution, may be changed according to Bayes theorem, for instance, in which a prior estimate of 'p' is combined with search (sample) information to yield a posterior estimate of 'p'.

The Choice Problem

In this subsection, the specifics of the choice problem facing the job seeker are discussed. What are the choice alternatives? Initially a general discussion of these questions is undertaken here. Subsequently, a simple model illustrating some of the issues raised is presented.

To this point, simple models of job search have been presented. The job-seeker looks at different local labour markets, makes a choice among them, migrates, and then searches for work. His choice was merely where (if at all) to migrate and how long to search. Several objections are possible about this paradigm. As indicated earlier, several researchers might criticize the notion that migration and unemployment prior to search is the only strategy open to the job seeker. The choice alternatives should be expanded to include long-distance search travel with migration only consequent to successful job finding.

Other researchers, such as Mortensen (1970), have emphasized the choice between full and part time search. They see the possibility, in other words, of employed workers undertaking limited search for new work while maintaining their present jobs. The presence of such part-time search in reality is quite extensive and can not be ignored. In fact, several researchers, such as Alchian (1970; p. 29), are quick to point out that full-time search is justifiable only if it enables more efficient and productive search. Therefore, David's view that search begins only with unemployment restricts the alternatives open to the job seeker in reality. He typically can engage in limited search while maintaining a job, change jobs and move to a part-time basis with more extensive search activity, or quit to search full-time. A more realistic model of the job seeker would make intensity-of-search part of his choice problem.

Finally, in treating the problem of rational choice, most researchers have assumed that the job seeker maximizes the expected value of his discounted future earnings stream. This implies risk neutrality. David is one of the few to consider risk aversion as a basis for rational decision-making under uncertainty. Just what the gains are in moving from simple risk neutrality to other rationality assumptions is an open question. While David's model, for example, places an emphasis on the variance of the wage distribution, it is unclear that a job-seeker would even have enough information about this to behave properly. Unless alternative models of rationality can be developed which generate realistic data requirements on the part of job seekers, there would be little to gain from considering them here.

Consider the following model, as an example of what can be done, with the first issue raised; the choice of search strategies. Imagine two local labour markets, 'a' and 'b', in which there are fixed wages, y_a and y_b , and fixed probabilities of job-finding, p_a and p_b , respectively. The cost of migration from 'a' to 'b' is c_m , the cost of a round-trip search trip is c_s , and the discount rate is r . Of course, $c_m > c_s$. Finally, assume risk neutrality on the part of the job seeker.

There are three actors whose decisions might be evaluated. The employed worker at 'a' considering quitting to search at 'b', the unemployed job-seeker at 'a' considering which market to search, and the unemployed job-seeker at 'b' considering a similar question²². Here, attention is focussed on the first two although the third can be handled in a similar manner.

Several earnings streams can be calculated. The person presently working at 'a' (or 'b') has a discounted stream of U_e^a (or U_e^b) where, from (16)

$$U_e^i = y_i/r \quad i \in (a,b) \quad (18)$$

Here, work life horizons have been ignored again. The unemployed job seeker at 'a' (or 'b') has a similar discounted earnings stream,

²²Given the structure of the assumptions, there is no incentive for the employed person at 'b' to want a job at 'a'. This actor is therefore ignored.

U_u^i , where

$$U_u^i = \frac{(1+r)p_i}{(p_i+r)r} y_i \quad i \in (a,b) \quad (19)$$

Given that a person makes a migration or search decision so as to maximize U , equations (18) and (19) can be used to identify an optimal choice. For the moment, disregard direct costs of search and migration (c_s and c_m). The minimum conditions for an employed person at 'a' to seek work at 'b' is $U_u^b > U_e^a$ or²³

$$\frac{y_b}{y_a} > \frac{1+r/p_b}{1+r} \quad (20)$$

This asserts a simple relationship among the relative wage rate at 'b', the likelihood of finding a job there, and the discount rate. The similar minimum conditions for an unemployed worker to search at 'b' is $U_u^b > U_u^a$ or

$$\frac{y_b}{y_a} > \frac{1+r/p_b}{1+r/p_a} \quad (21)$$

This is similar to (20) except insofar as it also includes p_a .

What about the choice of search strategy? If a job seeker at 'a' migrates to 'b' and then searches, his direct search cost, S_m , is an immediate outlay

$$S_m = c_m \quad (22)$$

If he undertakes search travel first and migrates only if a job

²³This is a minimum condition because the existence of non-zero c_m and c_s will generally require a larger y_b/y_a ratio.

is found, the expected search cost, S_m , when properly discounted is

$$\begin{aligned}
 S_s &= c_s + p_b c_m + p_b \left(\frac{1-p_b}{1+r} \right) c_m + p_b \left(\frac{1-p_b}{1+r} \right)^2 c_m + \dots \\
 &= c_s + \frac{(1+r)}{(r+p_b)} p_b c_m
 \end{aligned}
 \tag{23}$$

The advantage of this second strategy is that it allows the job seeker to defer c_m until a job is found. The disadvantage is the initial outlay c_s required. The job seeker will choose the smaller of (22) and (23). He will undertake prior search if $S_s < S_m$ or

$$\frac{c_m}{c_s} > \frac{(r + p_b)}{(1 - p_b)r}
 \tag{24}$$

and prior migration otherwise. Optimal choices for varying combinations of c_m/c_s and p_b and a given value of 'r' are illustrated in Figure 1.

The decision problem facing the job seeker at 'a' is thus separable into two parts. First, how should 'b' be searched by a job-seeker at 'a'. His optimal decision is to incur a search cost, S_* , where

$$S_* = \min(S_s, S_m)
 \tag{25}$$

Based on this, the second problem is to decide whether to search 'b' at all. The

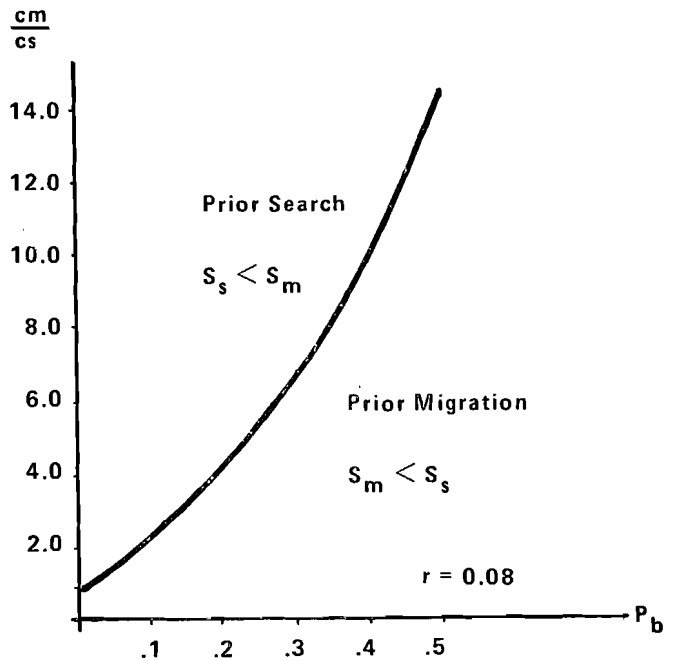


Figure 1: Optimal Job Finding Strategy

job seeker will do this if

$$U_u^b - S_* > U_i^a \quad i \in (u, e) \quad (26)$$

depending, of course, on his current employment status. Thus, it is possible to develop relatively simple models which make endogenous interesting aspects of the job seeker's decision problem not considered by David.

Priorities in Future Modelling of Job Search and Migration

Throughout this section, several issues have been raised about alternative ways to model or represent job search behaviour. In concluding this section, the most important of these need to be re-identified and suggestions made about future modelling.

The most important controversy in job search theory is over the relative roles of wage versus job-finding uncertainty. Most models, including that of David, assign a central role to the dispersion of wages within a labour market in the job search process. Is it reasonable to assume however that wage dispersion is so important to prospective in-migrants? Even if it is, are not the informational requirements of a model such as David's too excessive on the migrant's part to be realistic? Finally, is it realistic to think of the wage sampling that inevitably accompanies wage dispersion as a common experience of job seekers. For all these arguments, Todaro's model of wage rates which are fixed within each labour market but vary from one local market to the next seems to be an attractive alternative. His emphasis on uncertainty about finding a job seems preferable because it is more in agreement with everyday experience as well as being simpler.

The second important controversy surrounds the treatment of search behaviour over long distances. David's model is the only one to consider this and his emphasis on migration and unemployment as prior conditions for searching are objectionable.

Some work must be done toward the modelling of long-distance search behaviour without prior migration. Even though certain areas are very attractive places to live or work, many prospective migrants are unwilling to take the chance of giving up a current livelihood, moving lock, stock, and barrel, and hoping for a new job upon arrival. Many of these same prospective migrants however are willing to engage actively from a distance in trying to find job openings in these areas. The impact of this behaviour is not lost on firms in these favoured areas who observe constant flows of applicants or applications for job openings. The model described in this paper is only a first small step toward a better treatment of the alternative search strategies open to such prospective migrants.

COMPLEMENTARY PERSPECTIVES ON JOB CREATION

There have been very few attempts to integrate a model of firm behaviour with a model of job search. However, to construct a dynamic model of the urban labour market, some account has to be taken of the job creation and wage setting behaviour of firms. The most ambitious attempt here has been that of Mortenson (1970). Therefore, this section is initiated with a review of Mortensen's model. A critique of this approach is presented next which emphasizes the time lags induced by capital construction as the primary source of uncertainty facing the firm. Some aspects of rational firm behaviour under this source of uncertainty are investigated. Finally, an assessment of the value of a model based on this concept for the study of aggregate urban growth and migration is made.

Mortensen's Model

Formal Statement of Mortensen's Model of Firm Hiring Behaviour

Maximize:

$$V_i = \sum_{t=1}^{\infty} R_i(t)/(1+r)^t \quad (27)$$

Subject to:

$$R_i(t) = p_i Q_i(t) - w_i(t) N_i(t) \quad (28)$$

$$Q_i(t) = h_i(N_i(t)) \quad (29)$$

$$\dot{N}_i(t)/N_i(t) = v(w_i(t)/\bar{w}(t), U(t)) \quad (30)$$

As part of a broad labour market model, Mortensen considers the following model of a typical firm 'i'. This firm faces a perfectly elastic demand for output at an f.o.b. price p_i which may vary from one firm to the next²⁴. The firm produces an output $Q_i(t)$ at time 't' using its labour supply, $N_i(t)$, as the only input. This production relationship, which may be unique for each firm, is expressed mathematically in equation (29). Finally, the firm is free to set its own wage rate, $w_i(t)$. From this, the net revenue earned by the firm, $R_i(t)$, can be calculated as in (28). The firm is assumed to maximize the discounted flow of these net revenues over time as indicated in (27).

The linkage with the behaviour of job seekers enters through (30)²⁵. The firm's wage rate offer is seen in relation to an average market wage, $\bar{w}(t)$. The larger $w_i(t)$ is relative to $\bar{w}(t)$, the more attractive the firm is to job seekers. However, because job seekers are assumed to be unaware of the exact offer of each firm, there is a limited response by workers to the firm's wage offer in the short run. The best the firm can hope to do is to draw a larger proportion of job searchers who approach the firm during a time period. This number of searchers will in turn depend, at least partly, on the aggregate number of unemployed, $U(t)$, searching in the local labour market. Equation (30) asserts that the relative change in a firm's labour supply over time is tied to these two determinants. It is noted in concluding that

²⁴This is a slight simplification of Mortensen's original model which permits p_i to vary over time.

²⁵ $\dot{N}_i(t) = N_i(t+1) - N_i(t)$.

nothing is being said about the firm's labour supply in the long-run. A higher-than-average wage, if maintained in a market with a constant number of unemployed, could lead to an infinitely large labour supply for the firm.

The problem facing the firm is to choose an optimal time path for its wage offers, $w_i(t)$. This will be based on expectations about future average wages, $\bar{w}(t)$, and about unemployment levels in the local market, $U(t)$. In attempting to increase net revenues by increasing its labour supply, the firm will be broadly constrained by the costs of increasing its labour supply too rapidly²⁶.

A Critique of Mortensen's Approach

A major shortcoming of Mortensen's approach is that in one sense it is concerned with the long-run. In it, the firm faces no demand constraints. It can sell any level of output, within a broad range, at the same price, p_i . Moreover, the firm is able to hire and put to use any amount of labour, again within a broad range, that would be forthcoming at its chosen wage rate. Presumably, there are other inputs to the production process, such as fixed capital, but marginal units of these can be put into place immediately as the supply of labour changes. In short, Mortensen has constructed a long run model of the firm constrained in the short-run by its labour supply. He totally ignores other demand or input supply constraints which might arise in the short run.

This is a critical oversight in view of the short-run nature of the job search process. In Mortensen's model, unemployment exists solely because of wage 'shopping' by the unemployed. However, the firm may also contribute to unemployment in the short-run by being unable to hire willing job seekers. This could occur either because the firm faces output demand constraints or because it has limited supplies of required complementary inputs such as fixed capital. A more complete model of the short-run would begin to consider the firm under multiple kinds of constraints.

²⁶The firm may also be constrained if there are decreasing returns to scale in the production function (29).

In the remainder of this paper, one particular kind of constraint is considered; the supply of fixed capital. The firm at any point in time is seen to have an 'inherited' capital stock which it seeks to couple efficiently with labour in a production process. This inherited capital stock is seen to be determined effectively by a past investment decision. If, in making that prior investment decision, the firm had knowledge of its future available labour supply, it would behave according to Mortensen's model. However, uncertainty about the future labour supply may lead to situations in which the firm over or underbuilds a fixed capital stock in relation to the labour supply which materializes. In these cases, the firm may be either labour or capital constrained with different implications for its behaviour in the labour market.

A second criticism of Mortensen's model should be noted. Although he develops a complete model of labour market dynamics including the job search process, he considers only a single labour market in which the aggregate labour supply is growing at a constant rate. Although he does consider part-time search by employed workers, the flow of acceptable job seekers (or applicants) to a given firm is partly determined by the stock of local unemployed job seekers. If one is to extend Mortensen's model to a multi-market environment or to one which is open in that migration is permitted, the specification of (30) will have to be altered. Instead of the number of locally unemployed, one of the determinants of the firm's available labour supply should be the flow of job applicants. This, in turn, would depend on the available search channels and strategies for both local and long-distance search as well as on the number of job seekers in various local labour markets. It is at this point that integration of job search and job creation models will occur.

A final criticism of Mortensen's model is its emphasis on wage dispersion. It has already been argued that job search models designed to explain inter-area migration might better de-emphasize wage dispersion and emphasize job finding probabilities. If that intuitively-asserted and yet-to-be-empirically-shown argument is accepted, it suggests that the model of the firm should

have a different emphasis. Less importance should be attached to firm wage-setting and more to other determinants of the firm's demand for labour. This is an additional reason for developing the theme of the occasionally capital-constrained firm in this paper. It is consistent with a de-emphasis on wage dispersion in job search models.

Job Creation by Firms under Labour Supply Uncertainty

In order to investigate some characteristics of a model in which firms are uncertain about the future labour supply, it is necessary to make several assumptions. These will be kept broadly in spirit with those of Mortensen and will be expanded to get around the criticisms raised above.

Let us begin by assuming that the firm 'i' operates in competitive markets. It can sell any output it produces at a fixed f.o.b. price, p , as assumed by Mortensen. Further, it can purchase any amount of fixed capital at a fixed rental rate, ' r ', corresponding to the normal rate of return on capital. Finally, it can also purchase labour at a fixed wage rate, ' w '. There is a maximum labour supply, $L_i(t)$, available to firm 'i' at time (t) at this wage. The firm may choose to use only part of this supply (at the same wage) but cannot exceed $L_i(t)$ under any circumstances. This is in distinction to Mortensen's model where the firm can effectively vary $L_i(t)$ by changing its wage offer. The firm is thus seen to view wage changes on its own part as ineffective in altering its labour supply.

Further, assume that the firm has constant returns to scale in its production process which involves fixed capital and labour. Variable returns were allowed for by Mortensen but this merely added a complicating constraint to the labour demand relationship. Using a constant-returns-to-scale model helps to make clear the exact role of anticipatory behaviour by firms in the labour market. Subsequent empirical and theoretical models can make more realistic assertions and add another layer of complexity.

The firm now has, because of constant returns to scale and fixed prices, certain fixed optimal ratios. Suppose the firm knows beforehand what $L_i(t)$ will be. Investment can be undertaken

to ensure that the optimal level of job openings ($\tilde{N}_i(t)$), the optimal capital stock ($\tilde{K}_i(t)$), and the optimal output level ($\tilde{Q}_i(t)$), satisfy the following

$$\tilde{K}_i(t) = k_i \tilde{N}_i(t) \quad (31)$$

$$\tilde{Q}_i(t) = q_i \tilde{N}_i(t) \quad (32)$$

$$\tilde{N}_i(t) = L_i(t) \quad (33)$$

The constants k_i and q_i reflect the firm's production technology and the ratio w/r . Further, the firm earns a maximum 'excess' profit, $\tilde{\pi}_i(t)$, given by²⁷

$$\tilde{\pi}_i(t) = p_i \tilde{Q}_i(t) - r \tilde{K}_i(t) - w \tilde{N}_i(t) \quad (34)$$

The maximum excess profits per job opening are thus

$$(\tilde{\pi}/N)_i = p_i q_i - r k_i - w \quad (35)$$

Thus, the firm's optimal excess profits per job is independent of its scale of output and time in this model. Excess profits are limited, in aggregate, only by the availability of labour.

To complete this model, add the following assumptions. Assume that one time period is required to put fixed capital into place²⁸. In other words, at time 't-1' the firm must decide on $\tilde{K}_i(t)$ and make a corresponding investment, $I_i(t-1)$. The fixed capital stock is assumed to depreciate at a fixed rate, d . Therefore the identity follows that

$$K_i(t) = (1-d)K_i(t-1) + I_i(t-1) \quad (36)$$

²⁷These are excess in the sense that 'normal' profits $r\tilde{K}_i(t)$ have been deducted.

²⁸The lag of one period is arbitrary. The estimate is that up to three years is required to put new fixed capital in place depending on the scale and nature of the new facilities.

These assumptions make the firm's actual level of profits at 't' dependent on its ability to estimate at 't-1' what the maximum labour force at time 't' will be. Only by doing this can the firm undertake the investment required to obtain the optimal capital stock at 't'.

The firm generally will not know how much labour will be forthcoming when it makes its investment decision although it may be able to specify the likelihood of alternative labour force realizations. For this reason, the firm's profit level may be thought to be subject to a stochastic component. It is assumed that the firm seeks to minimize the loss arising from its uncertainty.

The discussion so far lays the ground for three main questions. What do we mean by $L_i(t)$; the 'maximum' labour force available to firm 'i' at time 't'? How does the firm project the likelihood function for alternative realizations of $L_i(t)$ at time 't-1'? What level of capital investment does the firm undertake given its knowledge of this likelihood function? For simplicity, these questions are perhaps best approached in reverse order.

Optimal Capital Investment

Under the above assumptions, how would the firm decide on its future capital stock requirements and its corresponding level of job openings. The optimal investment choice is going to depend on the likelihood function of different labour force realizations and on the different costs of over and undershooting the realized labour force. Further, the cost of overshooting in particular is itself dependent on the technological ability of the firm to substitute abundant capital for scarce labour in the short run.

An important conclusion is that the optimal capital stock, $\tilde{K}_i(t)$, may be substantially different from the capital stock, $\hat{K}_i(t)$ appropriate to the expected value of the labour force, $\hat{L}_i(t)$ (where $\hat{K}_i(t) = k_i \hat{L}_i(t)$).²⁹ Generally, the costs of undershooting one unit are the foregone excess profits that could have been earned if the number of job openings had been one

²⁹ $\hat{L}_i(t) = \int_0^{\infty} Z g_{t-1}(Z) dZ$ where $g_{t-1}(Z)$ is the likelihood function at 't-1' for $L_i(t)$ being realized at Z .

larger. The cost of overshooting the labour supply by one unit is roughly the rental cost of the unused or inefficiently used capital stock. The first of these is the larger if and only if the optimal excess profit per unit labour $(\tilde{\Pi}/N)_i$ is larger than the normal rate of return on capital, n . Thus, a firm which minimizes the expected value of its over- and under-shooting costs will tend, where the probability distribution of $L_i(t)$ is symmetrical about $\hat{L}_i(t)$ to have $\tilde{K}_i(t) > \hat{K}_i(t)$ when $(\tilde{\Pi}/N)_i > n$ and vice versa. This is an exact description when no short-run substitution exists between labour and capital. Permitting such substitution increases the likelihood that $\tilde{K}_i(t) > \hat{K}_i(t)$ by lowering the costs of overshooting. Thus, how the firm comes to decide on the value of $\tilde{K}_i(t)$ under uncertainty depends on more than merely expectations about the future labour supply.

This argument can be stated in mathematical form³⁰. Assume that the firm has a Leontief production function with a fixed capital-labour rate of ' k_i ' and a fixed output-labour ratio ' q_i '. Given that a labour force $L_i(t)$ is available at 't', the employable capital stock is $k_i L_i(t)$. If the firm has a capital stock, $K_i(t)$, which exceeds this, the firm's loss, λ , due to uncertainty in the period is the rental on the unused capital.

$$\lambda = r[K_i(t) - k_i L_i(t)] \quad \text{if } K_i(t) \geq k_i L_i(t) \quad (37)$$

If the firm has an insufficient capital stock, the capital stock constrains the level of job openings to $(1/k_i)K_i(t)$ and the level of output to $(q_i/k_i)K_i(t)$. The firm's uncertainty loss now is the foregone profits that could have been earned on the unused labour.

$$\lambda = (\tilde{\Pi}/N)_i [L_i(t) - (1/k_i)K_i(t)] \quad (38)$$

³⁰Raiffa and Schlaifer (1961; Chapter 6) discuss the properties of Linear Loss Functions of which the present model is a special case.

The expected value of the firm's loss is thus

$$\begin{aligned} \hat{l} = & \int_0^{N_i(t)} r[K_i(t) - k_i Z] g_{t-1}(Z) dZ \\ & + \int_{N_i(t)}^{\infty} (\tilde{\Pi}/N)_i [Z - (1/k_i)K_i(t)] g_{t-1}(Z) dZ \end{aligned} \quad (39)$$

Minimizing this with respect to $K_i(t)$, or equivalently $N_i(t)$, yields the first-order condition that

$$G_{t-1}(\tilde{N}_i(t)) = \frac{rk_i}{p_i q_i^{-w}} \quad (40)$$

where

$$G_{t-1}(x) = \int_x^{\infty} g_{t-1}(Z) dZ \quad (41)$$

Thus, the firm optimally chooses that level of job openings (or capital stock) such that the probability of a labour force realization exceeding it is equal to the ratio of normal profits to total (normal plus excess) profits. As a corollary, if the excess profits are equal to the normal profits and the $g_{t-1}(\cdot)$ distribution is symmetric, the firm would choose to set $\tilde{N}_i(t) = \hat{L}_i(t)$.

To carry this example further, suppose that $g_{t-1}(\cdot)$ is a normal distribution with mean $\hat{L}_i(t)$ and variance $\sigma_i^2(t)$. The optimal level of job openings for any ratio of rk_i to $p_i q_i^{-w}$ is displayed in Figure 2. In mathematical terms, $\hat{N}_i(t)$ can be expressed as follows

$$\hat{N}_i(t) = \hat{L}_i(t) + \sigma_j(t) \cdot u(rk_i/p_i q_i^{-w}) \quad (42)$$

where $u(\cdot)$ is the monotonically increasing function displayed in Figure 2. If it is further assumed that $\sigma_i(t)$ is proportional to $\hat{L}_i(t)$, then

$$\tilde{N}_i(t) = \alpha_i \hat{L}_i(t) \tag{43}$$

where

$$\alpha_i = 1 + V_\ell \cdot U(rk_i / p_i q_i^{-w}) \tag{44}$$

and

$$V_\ell = \sigma_i(t) / \hat{L}_i(t) \tag{45}$$

Thus, the optimal level of job openings here is proportional to the expected labour force under these additional assumptions.

Leaving this example, it is noted that, for several reasons, a firm may deliberately choose to have a $K_i(t)$ which is not equal to $\tilde{K}_i(t)$ (or $k_i \tilde{N}_i(t)$). One reason is that $\tilde{K}_i(t) < (1-d)K_i(t-1)$. In this case, the firm faces a corner solution where it chooses to have no gross investment. Because demolition of the capital

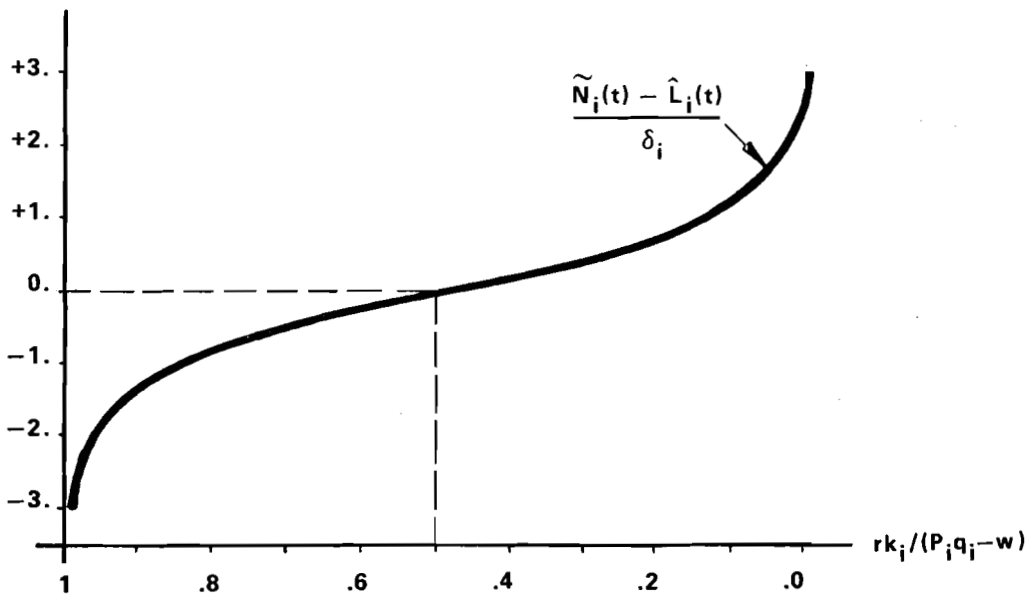


Figure 2: Optimal Capital Investment and Job Creation

stock is assumed to be expensive, the firm finds it optimal to set $K_i(t) = (1-d)K_i(t-1)$ and wait for depreciation to bring the capital stock eventually to its optimal lower level. A second reason is related to this first. Although $\tilde{K}_i(t)$ may be larger than $(1-d)K_i(t-1)$, the firm might observe that in two (or more) time periods ahead, $\tilde{K}_i(t+1) < (1-d)\tilde{K}_i(t)$. In these cases, the labour force might, for instance, be expected to fluctuate over time. The firm will find it optimal to take some account of the permanency of the labour supply with the consequence that the single-period optimized $\tilde{K}_i(t)$ may be replaced by a lower longer-run optimum³¹. A third reason might have to do with decreasing returns to scale in the investment process itself. Although it has here been assumed that each monetary unit of investment yields the same unit increment in capital stock, some researchers have shown that a relaxation of their assumptions to include decreasing returns would generate a partial adjustment investment model³².

$$I_i(t-1) = \varepsilon_1 [\tilde{K}_i(t) - (1-\delta)K_i(t-1)] \quad 0 < \varepsilon_1 < 1 \quad (46)$$

The firm finds it advantageous to undertake only a portion of the aggregate gross investment required to achieve the optimal stock because of the diseconomies of rapid capital stock growth.

Projecting the Labour Supply Likelihood Function

To this point, the implications of labour supply uncertainty for the level of investment have been traced. Let us now examine how the firm forms, at 't-1', its anticipations about the shape of the probability distribution, $g_{t-1}(\cdot)$, underlying $L_i(t)$.

The likelihood function may be thought of in either subjective or objective terms. Because we are principally interested in the behaviour of the firm, it is more useful to inquire about the likelihood function as perceived (subjectively) by the firm. Given the difficulty of formulating such a function, it might be expected

³¹An analogous argument for the demand (rather than labour) constrained firm is found in Birch and Siebert (1976).

³²Grossman (1972) has developed this partial adjustment model under this assumption.

that a firm would rely on a simple model. Therefore, it is assumed here that $g_{t-1}(\cdot)$ is a subjective likelihood function describable at most by two parameters, the mean and variance. How might the firm go about estimating these two terms?

First, how might the firm estimate the expected value of next period's maximum labour supply $\hat{L}_i(t)$. The expected future labour supply could be related to the recent size of or growth in labour force. For example, $\hat{L}_i(t)$ might be an extrapolation of $L_i(t-1)$ or an extrapolation of the growth over two previous periods.

$$\hat{L}_i(t) = Z_{i\ell} L_i(t-1) \quad \text{where } g_{i\ell} > 0 \quad (47)$$

$$\hat{L}_i(t) = L_i(t-1) + g_i (L_i(t-1) - L_i(t-2)) \quad (48)$$

These two alternative hypotheses make current capital investment and job creation dependent on the previous level(s) of labour force supply. An alternative hypothesis is that firms expect the labour supply to be able to expand job openings at a constant rate. A simple model of this form is

$$\hat{L}_i(t) = Z_{in} N_j(t-1) \quad (49)$$

In this model, the growth of jobs would be, in effect, independent of the actual labour supply. These two kinds of models, where either labour force or job openings grow at a constant rate, are the most commonly used in the literature³³.

This approach is quite mechanical, however, in that the firm is presumed to exogenously specify the growth rates, $Z_{i\ell}$, Z_{in} , or g_i . There is no process described whereby firms come to

³³As one example of (41), Mortensen (1970) constructs a labour market model in which the urban labour force grows at a constant rate. Further this rate is known by firms. As an example of (49), Todaro (1969) assumes that employment grows at an exogenously-given rate.

form such anticipations. Further, such expectations are not seen to be modified through time as the firm's experiences in the labour market evolve. Alternative approaches which make anticipations endogenous are, however, quite rare in the literature.

A useful way to approach alternative perspectives is to inquire about the information channels through which a firm might expect to learn how many workers might be forthcoming. The firm in its search for information about the local labour market may rely on two kinds of sources; intra-firm and extra-firm. Extra-firm sources, such as labour force surveys, censuses, tax assessment data, building permit records, and other data usually give indications of the aggregate growth of the local labour market. Included in this data may be short-term forecasts of the urban area's development. The firm recognizes however that the connection between aggregate growth and the future labour supply forthcoming to the firm is not mechanical or automatic. The firm must additionally use intra-firm sources to evaluate the past relationship between aggregate labour market growth and the firm's ease in attracting new labour. For a variety of reasons specific to the firm and its geographical setting, the firm may be finding it increasingly easier or more difficult to attract a certain quality of labour given a rate of aggregate labour market growth.

Instead of using a combination of intra and extra firm data sources, the firm may choose to use strictly internal information channels. It may watch the quit rate of employees, the average amount of time required to fill a vacant job opening, the rate of off-the-street job applications, and the current inventory of job applications for example. With such information at hand, the firm would extrapolate in estimating how long it would take to fill the job openings created by an expansion of productive facilities.

In either case, the firm is attempting to estimate and respond to local labour market conditions. If, using extra-firm channels, it perceives an increase in the labour supply relative

to demand it will be profitable for the firm to increase investment. Similarly, an increase in aggregate unemployment will lead to an increase in the rate of off-the-street job applications and in the inventory of recent applicants while decreasing the amount of time required to fill a vacant position. To the extent that higher unemployment makes job search more competitive and less fruitful, it also discourages employed workers from quitting to search for better work³⁴. Thus, intra-firm and extra-firm channels both emphasize labour market fluidity or tightness.

In the discussion on job search behaviour, an emphasis has been placed on the process by which searchers sample firms for job vacancies. It seems appropriate here to emphasize the role that this sampling plays in the investment decisions of firms. Therefore, let us assume that the firm uses the flow of 'acceptable' job applicants as its only gauge of the potential labour supply available to it. This is similar to Mortensen's approach except that this flow need no longer be strictly related to the level of local unemployment.

Labour market conditions may change over the period between the investment decision and the point at which the fixed capital becomes productive. The firm must, at time $t-1$ use the then-current flow of applicants as a proxy for the same flow at ' t '. This poses some risks for the firm in that an investment decision based on the flow at ' $t-1$ ' may turn out, as indicated in the previous subsection, to be quite inappropriate at ' t '.

The concept of an 'acceptable' applicant requires clarification. So far, job openings and labour force members have been treated as broadly homogeneous. There are, however, many peculiarities about a job opening at a particular firm such as hours of work, location, employment stability, work environment, and advancement opportunities. As argued earlier, even if all firms offer an identical wage, a particular job seeker may be willing or unwilling to accept a position with a given firm. Similarly, a firm may view different applicants in different ways; age, skills, sex, education, past employment record, work attitude, and initiative are among the attributes

³⁴Empirically, this has been illustrated by Holt (1970, p. 60) for the U.S.A.

considered³⁵. The hypothesis is forwarded that the number of 'acceptable' applicants, $E_i(t)$, to firm 'i' at time 't' is proportional to the total number of applicants, $A_i(t)$, in the same period.

$$E_i(t) = \beta_i(t) \cdot A_i(t) \quad 0 < \beta_i(t) < 1 \quad (50)$$

The proportion $\beta_i(t)$ can vary from one firm to the next³⁶.

The firm must now fix at 't-1' a level of job openings, $N_i(t)$, to be maintained at 't'. The actual level of employment, however, is $N_i^\Delta(t)$ where

$$N_i^\Delta(t) = \min[L_i(t), N_i(t)] \quad (51)$$

Thus, $N_i^\Delta(t)$ depends on whether the firm is capital-constrained or labour-constrained. At 't-1', the firm has an expectation about the future labour supply forthcoming to it. This supply is made up of two components; the new hirings and the remaining employees from the previous time period. The stock of retained employees is expected to decline because of quits. Quits are effected by workers for several reasons as indicated earlier although one main reason is search for a better job³⁷. The firm expects a certain quit rate, $\hat{\gamma}_i(t)$, equal to the actual quit

³⁵ Similar arguments about the uniqueness of job openings and job seekers and the difficulty of matching the two have been made by Toikka (1974, p. 63).

³⁶ Both Mortensen and Mirman and Porter (1974) assume that the firm can alter its flow of acceptable applicants by varying its wage rate relative to other firms. This possibility is excluded here by the assumption of a fixed wage rate.

³⁷ Mortensen, among others, suggests that quits to search are negatively related to the level of unemployment. This is consistent with the job search behaviour described earlier because a lower level of unemployment generally implies a greater stock of job vacancies and a shorter expected unemployment duration.

rate at 't-1', $\gamma_i(t-1)$. The expected level of new hirings is the expected flow of acceptable applicants, $\hat{E}_i(t)$. It is assumed that $\hat{E}_i(t) = E_i(t-1)$. Thus, the firm expects a labour force at time 't' of

$$\begin{aligned}\hat{L}_i(t) &= [1 - \hat{\gamma}_i(t)]N_i^\Delta(t-1) + \hat{E}_i(t) \\ &= [1 - \hat{\gamma}_i(t-1)]N_i^\Delta(t-1) + E_i(t-1)\end{aligned}\tag{52}$$

The actual labour force realized, by contrast, is

$$L_i(t) = [1 - \gamma_i(t)]N_i^\Delta(t-1) + E_i(t)\tag{53}$$

The discrepancy between expectation and realization occurs because of changes in the quit rate and in the flow of acceptable applicants³⁸. When one thinks of the density function $g_{t-1}(L_i(t))$ of labour supply realizations, it is uncertainty about these two which underlies it.

How does a firm go about projecting the entire function $g_{t-1}(\cdot)$? As argued earlier, 'g' is perhaps best treated as a simple function. While some arguments may be made for having the firm estimate 'g' on the basis of a sample of its prior quit rates and applicant flows, this would seem to be unrealistic. A firm likely works simply with an expected value and some related variance estimate. As assumed earlier, the firm might simply treat the standard deviation of $L_i(t)$ as proportional to $\hat{L}_i(t)$. Under this assumption (52) dictates the entire shape of $g_{t-1}(\cdot)$.

The Firm's Labour Supply

The preceding discussion has served to classify what we mean by the maximum labour supply available to a firm. In the short-run world of this theory, a limited number of acceptable job

³⁸The discrepancy between the realization of a labour force supply and the level of job openings makes necessary the distinguishing of an 'acceptable' applicant from an accepted one. Even if an applicant is acceptable to the firm and the firm acceptable to him, the lack of job openings may make a firm unable to take him on.

seekers will approach the firm in search of work. Even though in the longer run a large number of workers might be willing to work for a given firm, it takes time for these workers to find the firm. Therefore, in the short-run, the firm is quite constrained in its growth by the number of unemployed persons, the patterns of job search, and more generally by the ignorance of labour force members about alternative job openings.

Can the firm affect the size of its available labour supply? In reality, it can and it has at least two strategies for doing this. One is to raise its wage offer relative to other firms competing for labour in the same labour supply area. Most job search models emphasize this alternative. The second would be to alter its work environment so as to make it more acceptable to job seekers or to lower its standards as to what constitutes an acceptable job-seeker. Both of these strategies essentially involve increasing $\beta_i(t)$. In this sense, the firm has some freedom to select $\beta_i(t)$. In doing so, it weighs the profits gained from a larger labour supply against the extra costs (wages or overhead) which this entails.

Aggregate Urban Job Creation and Labour Market Models

In this subsection, let us consider the implications of both the Mortensen model and the new framework described above for empirical models of urban job creation. The Mortensen model is quite consistent with that of David and the pair are shown to constitute a unified basis for a full labour market model. The alternative view of job creation behaviour described in this paper is more consistent with the alternative perspectives on job search behaviour. However, any attempt to link these two latter kinds of models is shown to present a major unresolved problem.

How have aggregative-empirical models of job creation been formulated? The most common approach is to assume that the number of job openings in a local area is determined by the level of 'exports' of goods or services to other areas, $X(t)$.

$$N(t) = \psi(t) \cdot X(t) \tag{54}$$

Sometimes $X(t)$ is related to the Gross National Product of the relevant nation. Sometimes $\psi(t)$, the proportional factor, is related to the local supply of fixed capital or to the mix between industries geared to export production versus those oriented to satisfying local demands. In any case, the level of job openings is seen to be exogenous with respect to local labour market conditions. When such models are part of a full labour market model, a uni-directional causal structure is posited. Changes in exogenous conditions alter the level of job openings which in turn affects the flow of job seekers. No role for household-initiated urbanization is possible here.

The only other common empirical model is that similar to Muth (1971). Here, the growth in total job openings (or employment) is related to the growth of the local labour force as well as other factors. If $L(t)$ is the total labour force in an area, then

$$N(t) - N(t-1) = \eta_0 [L(t) - L(t-1)] \quad (55)$$

would be a simple version of this. Such a model makes the level of job openings dependent on the growth of the labour force alone. Changes in the level of job openings are not seen as a response to such local labour market conditions as wages or unemployment however.

Mortensen suggests, indirectly, that (55) is incorrect under his interpretation of the labour market. He envisages a closed labour market with a stock of unemployed, $U(t-1)$, at time 't-1'. He further assumes that the number of firms in the local labour market is large but fixed. Given that each firm selects its relative wage rate, (30) can be summed over all firms to yield, as a special case, the following aggregate form.

$$N(t) - N(t-1) = \eta_1 U(t-1) \quad (56)$$

The constant η_1 reflects both the intensity of search by job seekers and the distribution of wage offers among firms. Here, (56) differs from (55) in that job creation is linked to the

degree of disequilibrium in the labour market rather than to the growth of the labour supply. If one accepts Mortensen's notions, (56) is superior to (55) because it more closely represents the process by which job hiring decisions are undertaken.

Although Mortensen considers only a single urban labour market, one assumption made by him provides the unifying link with David's model. Mortensen has assumed that his labour market is closed. That is, job seekers who search in the local market are assumed to reside there. Therefore, $U(t) = L(t) - N(t)$,³⁹. This is equivalent to David's notion of migration as a prerequisite for search.

The two models are easily combined. Assume that the local labour force has a rate of natural increase which is fixed at g_ℓ . Further, assume that (11) is an appropriate, if simplified aggregation of David's model. This yields a complete labour market model of the following form.

$$L(t) = [1 + g_\ell]L(t-1) + M(t) \quad (57)$$

$$M(t) = \alpha_0 + \alpha_1[N(t-1) - L(t-1)] \quad (58)$$

$$U(t) = L(t) - N(t) \quad (59)$$

$$N(t) = N(t-1) + \eta_1 U(t-1) \quad (60)$$

It is recognized that α_0 , α_1 , and α_2 are responsive to 'hidden' variables such as the distribution of wages within the local market and conditions in other local labour markets. However, this system of equations does provide a relatively simple model of urban labour market dynamics which emphasizes a particular concept of the search process.

³⁹Note that in Mortensen's model, a job opening is created for each willing applicant. Thus, there is an exact correspondence between openings and employment. This is a distinction from the job creation model derived in this paper.

Mortensen's model shares the faults found in David's model as well. In particular, it ignores the possibility of long-distance search travel. The number of job seekers looking in a given labour market for work can be substantially different from the number of unemployed currently residing there. Therefore the flow of acceptable job seekers need not be $\eta_1 U(t-1)$ or any function of $U(t-1)$. Equations (58) and (60) force too restrictive a view of the job search and hiring process. They thus limit the means by which household-initiated urbanization can occur.

The alternative approaches to job search and job creation modelling discussed in this paper are as yet incomplete. However, some progress toward an aggregate model is possible. Suppose, as did Mortenson, that there are a fixed number, m , of firms in a given local labour market at every point in time. Then (43), (52), and (50) can be aggregated from the firm to the local market level. This yields

$$N(t) = \bar{\alpha}(t) \hat{L}(t) \quad (61)$$

$$\hat{L}(t) = [1 - \bar{\gamma}(t-1)] N^\Delta(t-1) + E(t-1) \quad (62)$$

$$E(t-1) = \bar{\beta}(t) A(t-1) \quad (63)$$

where

$$\begin{aligned} N(t) &= \sum_{i=1}^m N_i(t) & \hat{L}(t) &= \sum_{i=1}^m \hat{L}_i(t) & E(t) &= \sum_{i=1}^m E_i(t) \\ A(t) &= \sum_{i=1}^m A_i(t) & N^\Delta(t) &= \sum_{i=1}^m N_i^\Delta(t) \end{aligned} \quad (64)$$

$$\begin{aligned} \bar{\alpha}(t) &= \frac{1}{\hat{L}(t)} \sum_{i=1}^m \alpha_i(t) \hat{L}_i(t) & \bar{\gamma}(t) &= \frac{1}{N^\Delta(t)} \sum_{i=1}^m \gamma_i(t) N_i^\Delta(t) \\ \bar{\beta}(t) &= \frac{1}{A(t-1)} \sum_{i=1}^m \beta_i(t) A_i(t-1) \end{aligned} \quad (65)$$

Here, $\bar{\alpha}(t)$ may vary with the ratio of excess to normal profits and $\bar{\gamma}(t)$ may vary with the profitability of search. As a first approximation however, the system (61)-(63) is a simple but telling model of aggregate job creation behaviour in three variables. The level of job openings is determined by the anticipated labour supply. This is tied to the quit rate and the flow of acceptable applicants. Finally, the flow of acceptable applicants is tied to the total flow of job applications during a period.

The major source of incompleteness at this stage comes in the specification of this latter variable, $E(t)$. What determines the flow of job applications? The answer must come from a full model of job search behaviour. The analysis in section 2 of this paper is intended to lay the groundwork for that model. Since a job application can take many forms ranging from a gate application to a written enquiry, a full job search model must consider many sampling or application strategies each with its own array of costs and expected benefits. So far, only a partial analysis has been undertaken of the conditions under which a prospective job-seeker would (i) decide to undertake search, (ii) decide how to carry out search, and (iii) decide where to search.

CONCLUDING COMMENT

The development of a better model of job search is no trivial exercise. If one is to put the household versus industry-initiated urbanization controversy to a true test, a more thorough treatment of job search behaviour is required. When a firm is trying to decide where to locate or to expand, it will take account of more than just the local supply of labour. It will also usually consider the likelihood that the required workers can be attracted there if not available locally. How will it measure this? One source might be the flow of job applications to the firm if it is already in the area. Another might be the case of similar firms already in the area in attracting workers. This in fact would often seem to be more important to firms than the available local labour in place already. However, it is the

households again, who through their locational preferences are shaping the spatial pattern of industry here. As long as simple models such as (57)-(60) are used to test the household-initiated urbanization hypothesis, they will fail to consider this perhaps more important impact of household preferences. The time has come for a deeper treatment of labour market processes. It is hoped that this paper will help to spur and direct that research effort.

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