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1 Introduction

In this paper a search and bargaining model of the emergence of localised factor markets is presented. As the model draws heavily on the search theoretic literature of the labour market it deals mainly with the conditions of localised labour markets. In the concluding sections the applicability to other factor markets will be discussed.

A general interest in the analysis of localised factor markets is derived from the fact that in general equilibrium theory the assumption of a uniform geographic distribution of resources implies that all economic activity boils down to Robinson Crusoe economies. Under the assumptions of the Arrow-Debreu model each economic agent would produce for his or her own consumption (Scotchmer/Thisse 1992). All economic activities would be uniformly distributed over geographic space. As long as there are not some goods or resources that are immobile or untradeable in a physical sense each pint in geographic space cold be the basis o an autarkic economy where goods re produced on an arbitrarily small scale. To avoid this extreme result the number of firms is assumed to be fixed in models of a production economy or the analysis is restricted to exchange economies without firms. Just to assume that there is a non-uniform distribution of principally immobile resources seems to be a weak basis of an explanation of interregional specialisation and trade.

In this paper we address the question whether there are economic reasons for factor supplies being available only in certain locations although they are mobile in principle. if there are such reasons substance could be given to models of interregional (or international) specialisation and trade which are based on a non-uniform distribution of resources by just assuming that factors of production are immobile.[1]

Besides in international trade theory which is based on the assumption that there is a non-uniform distribution of resources there are growth theoretic models which analyse the consequences of immobile resources on the relative growth performance and the trade structures of individual regions. For example in the model of Walz (1993) the existence of an immobile factor of production which is considered as land or the subset of the labour force that is immobile leads to the incomplete geographical concentration of final goods production.

More specifically there are models studying the consequences of „Marshallian factor market externalities" for the dynamics of industrial

1 The extreme assumption of perfect intersectoral factor mobility and complete immobility between sectors is constituent for orthodox models of international trade.

localisation (David/Rosenbloom 1990). These factor market externalities are defined as „pecuniary externalities that tend to reduce the prices at which primary inputs can be purchased as more and more of those inputs come to be assembled at the locale in question." The positive pecuniary externality associated with increasing local labour market size is held to be due to the an insurance or „risk pooling" effect of an increasing number of both workers and employers. This claim is derived from the assumption that random productivity or demand shocks are firm specific, i.e. it is assumed that these shocks are not correlated whether the firms belong to the same industry or not. In such a case the presence of a large number of employers at a given location reduces the magnitude of the temporal variations in aggregate labour demand expected at a specific location. The smaller variance in earnings that workers would experience would make the larger labour market more attractive to risk averse potential workers choosing their residential location. The lower search costs per worker and the advantages of the „risk pooling" resulting from a large number of firms with uncertain but uncorrelated labour demand lead to a relatively low supply price of labour. In the David and Rosenbloom article all this is taken as a premise without providing a microeconomic explanation of its genesis. The arguments presented above had been used to specify a net immigration function.

A partial equilibrium analysis of the microeconomics of this model is found in Krugman's (1991) model of „labour market pooling". In his model uncertain labour demand, labour demand being uncorrelated across firms, makes workers migrate to locations with a higher number of firms. Once workers have decided on the location they are unable to change the location of labour supply reacting to short run variations of labour demand. Firms are assumed to be unable to split up production and choose different locations with a smaller scale of production . As a consequence firms will tend to choose locations with a larger work force. It is the interaction of demand or productivity uncertainty and increasing returns to scale which creates labour market pooling and industry localisation.

The search-and-bargaining model that will be presented below captures well what in the model of Rotemberg and Saloner (1990) is taken to be a central precondition of interregional specialisation, namely the competition of firms for the services of workers.

Close to the search and bargaining model of localised labour markets developed here is the early search theoretic model of David (1973). The search process of a risk neutral worker is described as taking a moneyvalued ball from an urn. Upon paying an „entry fee“ the searcher learns the particular probability distribution to which the dollar values therein conform. After choosing an „urn“ the worker has to decide on a specified number of balls to be drawn in sequence replacing each before extracting the next and recording its value. the searcher will then be allowed to retrieve any one ball contained in the random sample. For each picking of a ball „sampling charges“ have to be incurred. it is assumed that the ball with the highest dollar value will be chosen. The sampling process is governed by the rule that the sample should not be increased beyond the point at which the marginal improvement in the expected maximum of future draws becomes less than the incremental sampling cost. Simplifying the model it is assumed that the urns do not differ by the mean dollar value of the balls contained but by higher moments of the distribution which are indicated on the labels of the urns. In addition, it is supposed that the entry fee is the same for all urns and that the sampling cost schedules are uniform, tool As a result, the only reason for selection among the urns consists of the inter-urn variations of the expected extreme value due to differences in the dispersion and skewness characterising the underlying population distributions. If these distributions are symmetric the expected maximum value, gross or net of uniform expenditures for entry and sampling, will be greatest for he urn where the underlying population variance happens to bee greatest. Proceeding to a model of migration „urns" are identified as local labour markets, „balls" are to be considered as job offers. The „entry fee" which has to be incurred before learning the sampling opportunities of a peculiar local labour market represents the pecuniary and psychic cost of migration which is taken to be a prerequisite to start searching on local labour market. Assuming that the potential migrant is living in the dull uniformity of the countryside he or she would find it attractive to emigrate to seek fortune in a location where the relative variance of the prevailing distribution of job offers is greatest. Net migration would then happen to locations where levels of average real earnings are not necessarily highest. One implication of David's model is that workers might stay in larger localised factor markets even though there are other locations with higher average wage rates

Much in the spirit of the model of David, Maier (1987) has tried to exploit the job search literature with respect to the explanation of localised labour markets. Emphasizing the general importance of search processes for the explanation of migration and localised factor markets he comes up with rather negative results on the usefulness of the search theoretic literature. His findings rather suggest that information channnels are of overwhelming importance for deriving labour market pooling from assuming incomplete information of workers.

Finally, there is the model on an agglomeration economy of Helsley and Strange (1990) who extend the standard monocentric model of a residential land market to include a labour market with heterogeneous workers and firms as well as imperfect information. Agents deciding on their residential location choose a city knowing the number but not the characteristics of the other agents. Workers do not know job requirements of firms and firms do not know the skills of the workers. The agglomerative force results from the workers' and firms' expectations that better matches can be realised in larger cities. It is shown that the expected quality of the matches increases with city size. In equilibrium the agglomerative tendency is balanced by the negative consequences for firms' profits of increased spatial competition.

The model we present here does not, by contrast, depend on the restrictive assumption that productivity shocks are firm specific. It appears to be more appropriate to suppose that output variations are region or industry specific. The higher the level of regional specialisation the stronger would be the coincidence between regional and sectoral output volatility. The model of the search process that is used here does not require the restrictive assumption that workers have to incur the costs of a residential relocation (the „entry fees“ in the model of David) before they can start their search process or, more specifically, before they can obtain information on the distribution on job offers of a local labour market. That is, the results of the paper do not depend on the existence of (high) costs of acquiring information on the characteristics of local labour markets and are not driven by the differences of the variance of job opportunities between different local labour markets, given identical average wage prospects for different localities.

Workers are assumed to be identical; there are no differences in skills. Hence the agglomerative economies do not arise from the expectation of qualitatively improved matches depending upon the size of the local labour market.

2 Model description

The basic assumption of the model is that information of workers regarding the location of vacant jobs and their characteristics (compensation, non-pecuniary characteristics, job security) is imperfect. Job-related information has to be acquired and evaluated before a worker can or is willing to become employed. As in most of the literature on job search, this process is considered to be costly and sequential (cf. e.g. Mortensen 1986). The worker's decision problem under these conditions involves a choice of a strategy for „shopping" and the selection of a criterion that determines when job opportunities are „acceptable". As the job search is modelled according to the sequential „stopping approach" borrowed from statistical decision theory (DeGroot 1970), the worker is regarded as sampling job offers one at a time and deciding on the basis of the sample obtained to date whether or not to stop the search process. As will be seen, the sample size is a random variable whose distribution is i.a. determined by the stopping rule. In order to take account of the fact that search requires time, search costs should be interpreted as a flow per unit of search time, a net deduction from the value of time, which could otherwise be spent on some other activity, plus the financial costs associated with search. Time requirements of search depend on job availability, i.e. the frequency with which job offers arise. Finally, future costs and returns of search need to be discounted.

Before we discuss in detail what guides the search process we have to develop how the characteristics of the job offer are determined. In particular we are interested in how the wage offer comes about. In most of the literature on job search it is assumed that wage offers are made as "take-it-or-leave-it offers". We assume instead that the compensation for work is the result of a bargaining agreement between the employer and the worker on how to divide the "value of a match" (Wolinsky 1995). The value of a match is identical to the discounted present value of the (monetary) surplus that is created by establishing an employment relationship, supposedly with an infinite time horizon. This surplus is divided by a noncooperative bargaining process (Rubinstein 1982, Binmore 1994). The substitution of the assumption that only employers can make binding commitments is motivated by the argument of Diamond (1971) saying that if only employers can commit to wage offers and search costs are positive, the wage level should be equal to the subsistence level. This would result from the fact that if a worker accepted a wage offer greater or equal to the "value of not working" the employer could decrease the wage by slightly less than the search cost without running the risk of being deserted by the worker. If the workers were identical with respect to their labour-leisure choice the distribution function the worker draws from can only be degenerate. Moreover, to assume that employers are able to make wage commitments implies that they do not behave in a subgame perfect way. If employers stick to wage offers when accepted by workers in the course of settling the details of a labour contract they are not strictly profit maximising.

Assuming that there are many employers and many workers such that we can exclude coalition formation on either side of the market, the bargaining game is played by bilaterally between a potential employer and a potential worker. The monetary value of the surplus bargained over is denoted by m. All costs and benefits are counted in monetary terms. It is assumed that the agents have access to credit markets in which they can insure against income fluctuations at actuarially fair rates. This allows us to consider all agents as risk-neutral. The stream of future net returns which can in principle be interpreted as von Neumann-Morgenstern "utilities" can then be taken to be streams of net incomes. The bargaining process takes place over discrete time periods of length Δ and will be labelled by t, t=0,1,2.... In each period one of the parties is selected randomly, with probability 0.5 and independently of previous selections, to propose a division of the value of the employment relationship. The other party responds immediately by accepting the offer or rejecting it. If the offer is accepted, it is implemented and the game ends.

Outside options

Workers and employers do not only search from unmatched positions, like in the standard search theoretic literature, but look for alternative bargaining opportunities as part of an ongoing bargaining game as well. these alternative bargaining opportunities are called "outside options". When an outside option has been encountered the agent is able to immediately identify its value and to decide whether to adopt it or not. Adoption of such an opportunity ends the ongoing bargaining process and initiates another one, i. e. each bargaining party can only engage in one project at a time.

Job availability and the uncertainties inherent in the job search process are accounted for by introducing q(n,Δ) as the probability distribution over the number of offers n received per period of length Δ. To reflect the restriction that time is required to find a job and that bargaining opportunities are found sequentially, the distribution is assumed to be Poisson

$$q(n,D) = e^{-lD}(lD)^n / n!. \tag{1}$$

with λ denoting the arrival rate of bargaining opportunities. The inverse of the offer arrival rate is the expected length of time between two arrivals of bargaining opportunities.

With probability $\lambda'_i\Delta$ will party i of the bargaining game encounter an outside opportunity. Let N_i denote the number of workers in the market and N_j the number of employers. That is N_j will be smaller than N_i. The arrival rate of the workers depends on the relative numbers of market participants in the following way: $\lambda'_j\Delta$ being the probability that an employer encounters a bargaining opportunity in period t, the total number of meetings is $\lambda'_i \Delta N_j$. For the arrival rate of the workers we then obtain

$$\lambda'_i = \frac{N_j}{N_i} \lambda'_j . \tag{2}$$

In a stationary environment with an unchanged number of market participants and an unchanged job availability the arrival rates well be constant over time. (Net) search costs per time period are assumed to be fixed and constant. b_i is the value per time unit of using the time for an alternative to working. k_i is the individual search cost per unit of time. That is, total net costs of search per period are equal to $(b_i-k_i)\Delta$.

The monetary values of the outside options for party i are realisations of identically and independently distributed random variables with a cumulative distribution function $G_i(\cdot)$ which is continuously differentiable and has its support on $[0,M_i]$ where $M_i \geq m$.

Order of events

Suppose that the process has arrived at period t without the parties having agreed to a division of the surplus or having adopted an outside option. At the beginning of that period a chance move allocates the right to make a proposal. The proposer then makes an offer to which the other party responds with acceptance or rejection. The acceptance implies immediate implementation of the proposal and the end of the game. Upon rejection the bargaining parties move on to the search stage of period t. Doing so they have to incur the search costs $k\Delta$ and then may encounter an alternative bargaining opportunity. If the value of the outside option is larger than the value of the match that is currently bargained over it will be adopted. If both parties do not adopt their outside option they well proceed into the bargaining stage of period t+1.

The bargaining process ends at some stage t after each party has obtained a certain sum x and has incurred a stream of search costs. The agents are assumed to maximise expected utility. Party i's present value of a stream of returns (x_0, x_1, ..., x_t,...) is given by $\sum_{t=1}^{\infty} \delta_i^t(\Delta) x_t$ where $\delta_i^t(\Delta)$denotes agent i's discount factor in period t. Under the above assumptions on access to the credit market the discount factors should be identical for all i. Switching later to a continuous time representation we shall write $\delta(\Delta) = e^{-r\Delta}$ with r denoting the interest rate.

The distribution function $G_i(\cdot)$, the value of "leisure" b_i and the search costs k_i are mutual knowledge of the players. A strategy of the search-and-bargaining game comprises a sequence of decisions on which proposal to make (if she or he is randomly chosen as a proposer), a decision on which proposal to accept (if the rival was chosen to make a proposal) and whether or not to adopt an outside option (if such has been encountered after the rejection of a proposal).

3 Equilibrium Analysis

In this section the equilibrium of the search-and-bargaining game is discussed. To begin with the bargaining game is ignored and the search component is studied in isolation.

3.1 Optimal Search

After each draw from the distribution function $G_i(\cdot)$ the searcher has a choice: She or he can keep what has been obtained or incur the net search costs (b_i-k_i) and take another draw from the distribution function $G_i(\cdot)$. The searcher obtains a profit which consists of the opportunity that is eventually accepted minus the costs of the entire search history. It has been shown that an optimal search rule exists under rather mild conditions (DeGroot 1970; Kohn and Shavell 1974, Lippmann and McCall 1976, 1981 and McCall 1970). The profit depends on the actual draws the searcher gets from $G_i(\cdot)$

and on the decisions to accept or reject particular opportunities.[1] The optimal rule must maximise the expected net return of the searcher. If V_i^* denotes the expected value of a searcher following an optimal strategy, she or he should never accept an opportunity that has a value less than V_i^*. The timing is assumed to be such that search costs have to be incurred immediately. Benefits of the search activity accrue in the next period and have to be discounted.

Let $W_i(m,\gamma)$ represent the given present value of stopping the search process, accepting the best opportunity (m,γ) encountered to date. m denotes the joint return of the cooperation between the employer and the worker, the gross product of employing one more worker, γ the layoff rate, i. e. the probability that the worker is laid off at the end of the period. The acceptance of the offer implies that the worker will work for one period for a wage w(m) which is a function of m as the wage is the result of a search and bargaining process which will be explained below. W_i is assumed to be a continuous, strictly increasing function m with $W_i(0,\gamma) = 0$.

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1 It is assumed that the searcher can make only one observation at a time. For models allowing for several simultaneous observations cf. Morgan (1983,1986) and Morgan and Manning (1985).

The value of the optimal search strategy V_i^* is conditional on the searchers information set Ω. Maximising wealth, the worker continues search, given a best available job offer (m,γ) to date if and only if $V_i^*(\Omega) > W_i(x,\gamma)$, with x denoting the random best offer realised. Since the analogous acceptance rule applies for the next period, we have as a general expression for the value of search

$$V_i(\Omega) = (b_i - k_i)\Delta + \delta(\Delta)E\{\max[V_i(\Omega+\Delta), W_i(x,\gamma) | \Omega(t) = \Omega]\}. \tag{3}$$

In expression (3) x is the random best offer realised during the next period of length Δ and Ω(t+Δ) is the information set which the worker will have in the next period. the first term on the right hand side indicates the net costs of search. The second term represents the expected present value of tomorrow's optimal stopping decision which is made once the next period's best offer and information is known, conditional on the information available today.

Here it is assumed that the future sequence of draws is identically and independently distributed and that the distribution is known for all periods. In other words, the information set remains constant over all t and the agent learns nothing. As a result, the value of continued search is a constant through time. Summarising, we have the following expression for the value of search:

$$V_i = (b_i - k_i)\Delta + \delta(\Delta)\left[\sum_1^{\infty} q(n,\Delta)\int_0^{M_i} \max\left[V_i, W_i(x,\gamma)\right]dG_i(x,\gamma;n) + q(0,\Delta)V_i\right], or$$

$$(1-\delta(\Delta))V_i = (b_i - k_i)\Delta + \delta(\Delta)\left[\sum_1^{\infty} q(n,\Delta)\int_0^{M_i} \max\left[0, W_i(x,\gamma) - V_i\right]dG_i(x,\gamma;n)\right] \quad (4)$$

The equation has a unique solution for the value of search V_i, provided that the mean of the distribution function G_i is finite (Kohn and Shavell 1974). The worker's optimal search strategy satisfies the reservation property, and the reservation value m*, is the unique solution to W(m*,γ) = V. The reservation property says that the worker's wealth maximising search strategy has the property that it is optimal to accept an opportunity when the highest valued opportunity in any period is equal to or in excess of a critical number called the reservation value m*. The value of accepting a job, and more specifically, whether the layoff rate as any influence on the reservation value depends crucially on assumptions about market participation immediately after the ending of an employment relationship (Wright 1987). We start by assuming that workers *cannot* sample a new offer in the same period in which a separation between the employer and the worker has occurred. In this case the layoff rate does not influence the reservation wage (Burdett and Mortensen 1980, Hey and Mavromaras 1981, Ioannides 1981). For the analytical purpose of this paper it is at the same time the most interesting case as the results on the emergence of localised labour markets do not depend on the layoff rate having an influence on the reservation wage. If the worker has to wait for the next period to search for another employment we have as the value of accepting a job offer

$$
\begin{aligned}
W_i(m,\gamma) = w(m)\Delta + \delta(\Delta)\gamma\left[(b_i - k_i)\Delta + \delta(\Delta)V_i^*\right] \\
+\delta(\Delta)(1-\gamma)\max\left[W_i(m,\gamma),(b_i - k_i)\Delta + \delta(\Delta)V_i^*\right]
\end{aligned}
\tag{5}
$$

Accepting a job means that in the immediately following period the worker receives the wage offered w which is the result of bargaining over a specific m. In the subsequent period he or she will loose the job with probability γ, dispose of the value of the alternative to working and have the discounted expected benefit of search in the third period. In case that there is no employer-initiated separation in the second period the worker can either stay on in the employment relationship or quit and search in the third period. If the last option were optimal, i.e. $W_i(m,\gamma) < (b_i-k_i)+\delta(\Delta)V_i^*$, it would never have been optimal to have accepted the job in the first place. That is, (5) implies that

$$W_i(m,\gamma) = w(m)\Delta + \gamma\delta(\Delta)(b_i - k_i)\Delta + \gamma[\delta(\Delta)]^2 V_i^* + (1-\gamma)\delta(\Delta)W_i(m,\gamma), or$$

$$W_i(m,\gamma) = \frac{w(m)\Delta + \gamma\delta(\Delta)(b_i - k_i)\Delta + \gamma[\delta(\Delta)]^2 V_i^*}{1-(1-\gamma)\delta(\Delta)} \tag{6}$$

A sufficient condition for an offer to be acceptable is that

$$W_i(x,\gamma) \geq (b_i - k_i)\Delta + \delta(\Delta)V_i^* .$$

For a given layoff rate the reservation value m* follows from the equation

$$W_i(m^*,\gamma) = (b_i - k_i)\Delta + \delta(\Delta)V_i^* . \tag{7}$$

Any job offer (m,γ) for which $m \geq m^*$ is acceptable then. Using (7) it follows from (6) that

$$w(m^*)\Delta = (1-\delta(\Delta))(b_i - k_i)\Delta + (1-\delta(\Delta))\delta(\Delta)V_i^* \tag{8}$$

Equation (8) shows that the wage implied by the reservation value m* is independent of the layoff rate. Given a wage offer that equals exactly the reservation wage, the agent will be indifferent between accepting and working or rejecting and remaining unemployed. Therefore the probability of a future layoff is of no consequence, as long as a future layoff leaves the worker in the same state with respect to his search opportunities he would be in had he rejected the offer in the first place.

Given the definition of a best job offer above and the Poisson offer arrival rate specification in (2), equation (4) simplifies considerably in the continuous time version which corresponds to the limiting case of an infinitesimal period length. Specifically, the assumption of the Poisson process implies that the probability of a single offer arrival per period of length Δ is approximately equal to λΔ while the probability of more than one arrival is approximately zero when the period is small. Formally, we replace equation (4) by

$$V_i = (b_i - k_i)\Delta + e^{-r\Delta}\left\{[1 - \lambda_i\Delta + \lambda_i\Delta F(x,\gamma)]V_i + \lambda_i\Delta \int_x^{M_i} W_i(y)dF(y,\gamma)\right\}, \quad (9)$$

with $e^{-r\Delta}$ denoting the discounting operator. $\lambda\Delta[1\text{-}F(x,\gamma)]$ is the probability that a searcher will accept an offer in an interval Δ as it is the probability that the researcher will encounter an opportunity times the probability that this opportunity will be from the upper tail of the distribution F. With the complementary probability the searcher will reject the offer and start searching again. Approximating $e^{-r\Delta}$ by $(1\text{-}r\Delta)$ and discarding all terms involving Δ^2, we obtain after simplifiction:

$$V_i(\lambda_i, x) = \frac{\lambda_i \int_x^{M_i} W_i(y) dF(y, \lambda_i) + b_i - k_i}{r + \lambda_i [1 - F(x, \lambda_i)]} \tag{10}$$

Excluding again that it might be optimal to remain unemployed forever we have the equivalent expression

$$rV_i^* = (b_i - k_i) + \lambda_i \int_0^{M_i} [W_i(x, \gamma) - V_i^*] dF(x, \gamma). \tag{11}$$

As V represents the searcher's "wealth" when searching, rV is an "imputed income" derived from that wealth per time period. Equation (11) indicates that this imputed income is equal to the value of time not spent working net of search costs plus the expected capital gain attributable to search. This expected capital gain, in turn, is equal to the expected difference between the net present value of accepting a job and the wealth imputed to search. Searching optimally, the reservation value m* is implicitely determined from equating the value of search and the value of accepting a job.

$$V_i^*(m^*, \gamma) = W_i(m^*, \gamma). \tag{12}$$

Proceeding from equation (6) and letting Δ recede to zero we obtain for the reservation wage of the searching worker:

$$w(m^*) = rV_1^* - \frac{\gamma}{1+r} [b - k + V_1^*] \tag{13}$$

with the worker's value of searching optimally being denoted by V_1^*. Let V_2^* be the employer's value of searching optimally. If the sum of the worker's and the employer's valuation exceed the surplus m that is obtained from initiating an employment relationship $(V_1^* + V_2^* > m)$ the parties will not attempt to reach an agreement and will just keep on searching optimally. Clearly, no party will accept a match that results in less than the value of search V_i^*, i = 1,2. If $V_1^* + V_2^* > m$ there is no solution that gives both sides more than V_i^*.

If $V_1^* + V_2^* \leq m$ there exists a perfect equilibrium in which the parties reach an agreement.The equilibrium is charcterised by values for the bargining payoffs W_i and reservation values of the search process x_i^* (i = 1,2) such that $V_1^* \leq m - W_2$ and $V_2^* \leq m - W_1$. As the bargaining surplus and the bargaining payoffs must be non-negative we can write in compact notation:

$$V_1^* \leq m - W_2 \leq W_1 \leq m - V_2^* \tag{14}$$

If the length of a single period Δ is sufficiently small, the perfect equilibrium is unique.

Taking account of the fact that the distribution function F(m,γ) is known and defining Q(m) as the distribution function [1-F(m,γ)] for given values of the layoff rate, the equilibrium values are obtained from the following four equations:

$$m - W_k = \left(1-\lambda_i Q\left(x_i^*\right)\Delta\right)\left(1-\lambda_k Q\left(x_k^*\right)\Delta\right)\delta(\Delta)\frac{1}{2}\left[W_i^* + m - W_k\right]$$
$$+\left[-\lambda_i \int_{x_i^*}^{M_i} W_i(x)dQ(x) + b_i - k_i\right]\Delta \qquad i \neq k = 1,2 \quad (15)$$
$$+\delta(\Delta)\lambda_k Q\left(x_k^*\right)\Delta\left[1-\lambda_i Q\left(x_i^*\right)\Delta\right]V_i^*$$

$$W\left(x_i^*\right) = \left[1-\lambda_k Q\left(x^*\right)\Delta\right]\delta(\Delta)\frac{1}{2}\left(W_i^* + m - W_k^*\right) + \delta(\Delta)\lambda_k Q\left(x^*\right)\Delta V_i^* \qquad (16)$$

Equations (15) are the basic equations of the bargaining solution. Equations (16) are the first order conditions for an optimal reservation value derived from equations (15). The right hand side of (15) shows the expected payoff to party i in the subgame that starts immediately after a proposal was rejected. The first term on the r.h.s. indicates the expected value of both parties not finding a better match and agreeing to an equal split of the bargaining surplus.[1] The second term gives the (negative) sum of the expected value of finding a better match after having incurred the net costs

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[1] On the division of the surplus of a noncooperative bargaining game cf. Shaked and Sutton (1984). On the equivalence of the result with the cooperative Nash bargaining solution cf. Binmore et al. (1986).

of search. The third term is equal to the discounted expected value of party k of finding a better match and deserting party i, forcing the latter to search again optimally from an unmatched position. Equations (16) establish that, given W_i and W_k the choice of the x_i^* maximise the expected payoff.[1] A direct application of Brouwer's fixed point theorem ensures that if $V_i^* + V_k^* < m$, the system (15) - (16) has a solution satisfying condition (14) (cf. Appendix of Wolinsky (1987)). If the length of the bargaining period is sufficiently small it can be shown that the perfect search and bargaining equilibrium is unique.

3.2 *Solution based on strategic bargaining*

The size of the W_i depends on the length of the bargining period Δ. Δ is assumed to be small, or, more specifically, we let Δ recede to zero and view the limiting equilibrium outcome as the solution of the bargining game. Solving equations (15) and (16) and taking the limits we get

$$\begin{aligned} W_i &= m - W_k \\ &= \frac{1}{2}\left[m + \frac{(r+\lambda_i Q(m))V_i^{**}(\overline{m}) + \lambda_k Q(m)V_i^* - (r+\lambda_k Q(m))V_k^{**}(\overline{m}) - \lambda_i Q(m)V_k^*}{(r+\lambda_i Q(m)+\lambda_k Q(m))} \right] \end{aligned} \tag{17}$$

---

[1] The intuition behind equations (15) on the worker's side derives from the above result that the reservation wage must be equal to the imputed income on the value of accepting a job. The value of accepting a job corresponds to the worker's bargaining payoff.

This equation can be transformed to the easily interpretable expression

$$W_i = m - W_k = \frac{1}{2}(m + d_i - d_k) = d_i + \frac{1}{2}(m - d_i - d_k). \tag{18}$$

In equation (18) the payoff of the search-and-bargaining game is expressed as the sum of the conflict payoff of player i and the equal split of the difference between the bargaining surplus and the conflict payoffs of the individual players, denoted by d_i and d_k. These conflict payoffs can be expressed as a weighted average of the values of search in an unmatched position V_j^* and in an ongoing bargaining relationship V_j^{**} (j = i,k). The value of search in an unmatched position is determined according to equations (8) or (10), respectively. The value of search in an ongoing bargaining process differs from that value in that the reservation value for the "gross joint payoff" of forming the employment relationship $\overline{m}$ must be at least as high as the reservation value of search from the unmatched position. Otherwise the wage bargaining wouldn't have been initiated. From equation (17) we have the following disagreement payoffs:

$$d_i = \frac{(r + \lambda_i Q(m))V_i^{**}(\overline{m}) + \lambda_k Q(m)V_i^*}{(r + \lambda_i Q(m) + \lambda_k Q(m))} \tag{19}$$

$$d_k = \frac{\left(r + \lambda_k Q(m)\right)V_k^{**}(\overline{m}) + \lambda_i Q(m)V_k^*}{\left(r + \lambda_i Q(m) + \lambda_k Q(m)\right)} \tag{20}$$

From these equations we get the weighted averages

$$d_j = \alpha_j V_j^{**} + \left(1 - \alpha_j\right)V_j^* \text{ with j = i,k} \tag{21}$$

and

$$\alpha_j = \frac{r + \lambda_j Q(m)}{r + \lambda_j Q(m) + \lambda_l Q(m)} \text{ with } j \neq l = \text{i,k.} \tag{22}$$

The weights denote the relative probabilities of not continuing the bargaining relationship and searching from a matched or an unmatched position, respectively.

Given that the bargaining surplus is divided according to the Binmore Rubinstein bargining model which under the conditions of the model presented here coincides with the cooperative Nash bargaining solution, existence of a schedule [W_1(m), W_2(m)] which satisfies (16) follows for the steady state of the labour market from a contraction map theorem of Blackwell (1965) (cf. also chapter 5 of Bertsekas 1987). The steady state of the labour market is defined by all unmatched agents having a constant arrival rate, all agents choosing ththe reservation value of their search policies optimally and thesteady state numbers of workkers and employers being consistent with the initial conditions, i. e. $N_1 - N_2 = N_1^0 - N_2^0$, with N_1^0 denoting the initial number of workers and N_2^0 denoting the initial number of employers. Given this model of wage determination we are able to show how localised factor markets may arise and what determines their size.

4 Geograpical Dimension of Localised Labour Market

So far we have only looked at one point market. It is we shown that the existence of a positive probability that the worker may loose the job alone may lead to a labour market pooling under the conditions set out in section 3. In contrast to the models of David (1973) and Maier (1987) we assume that search does not require the job searcher to migrate to a prospective job location before being able to search there. Rather we ignore that communication costs which are associatied with job search and depend on the residential location of the job searcher relative to the prospective job location.[1] Even if search costs are related to this distance a major part of

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[1] For the same reason a direct application of the search theoretic models of spatial competition (e.g. Wolinsky (1983) and Kopp (1994)) to the job search context appears to be inadequate. In the models of spatial competition, due to the assumption of "mill pricing", the price searching consumers have to visit suppliers of the consumer good and incur the transportation costs. Here it is assumed that the search process does not require transportation, or rather that the associated costs are negligible compared to the (prospective) returns.

them is normally borne by the prospective employer. Moreover, this assumption takes account of the decreased and decreasing communication costs. However, the distance between the residential location of the job searcher and the job locations is such that it is impossible to commute between the residential location and the work place. That is, the acceptance of a job necessitates a residential relocation. We consider these costs to be substantial. To begin with, they are treated as fixed, i. e. the distance dependend transportation costs are assumed to be small compared to transaction costs on the housing market and other costs of adapting to a new location

To keep things simple and without any loss of generality we assume that there are two locations which are identical with the exception of different numbers of employers and workers. We distinguish the locations as location one, with only one employer and location n with N employers. It is assumed that employers do not react to the migration decisions of the workers. That is, the number of employers in each location is taken to be exogenously given.

We now consider a jobless worker residing in a third location deciding to migrate location one or two. As migration costs are assumed to be fixed the distance between the current residential location of the potential migrant and the location of the job is of no importance for the migration decision. As we assumed tht search costs are independent of distance-related costs of communication, search after being laid off does not refer only the the potential employers of one location but to all remaining N employers in both locations.[1] This avoids the result of the above cited migration models that job search is always related to just one location with the consequence of a strong spatial labour market segmentation.

The decision where to migrate depends on where the worker encounters a higher value of accepting a job, as formalized in equation (6) above. To see how the migration costs influence this decision we abstract for a moment form the facht that in equilibrium wages will differ between the two locations. Searching optimally, the value of accepting a job offer w(m) (>w(m*)) in location two with only one employer is:

$$W_1^{(2)} = w(m)\Delta + \delta\gamma\left[(b_1 - k_1)\Delta + \delta\left(V_1^* + \bar{R}\right)\right] + \delta(1-\gamma)W_1^{(2)} \qquad (23)$$

With probability γ the worker will be laid off after a period of length Δ. Any other job she or he might find will be in location one. A layoff is therefore always associated with the costs of relocation R. The present value of the

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[1] We do not consider temporary layoffs, i. e. that the worker is reemployed immediately after an employer-initiated separation.

cost of migration is $\delta\gamma R$. If the job in location two continues (with probability $(1-\gamma)$) the migration costs occur with probability γ in the subsequent period etc.

If the worker accepts a job in location one, in which we have the same layoff probability, we obtain the following algrbraic expression for the value of accepting a job:

$$W_1^{(1)} = w(m) + \delta\gamma\left[(b_1 - k_1)\Delta + \delta\left(V_1^* - F(m^*)^{N-1}[1 - F(m')]R\right)\right] + \delta(1-\gamma)W_1^{(1)} \tag{24}$$

A worker who accepts a job in location one will also be laid off at the end of a working period with length Δ with probability γ. There are, however, N-1 employers left with whom she or he may initiate an employment relationship without having to change the residential location. Only if she or he is disappointed with all the N-1 job offers and agrees to the offer in location two he has reason to move and bear the migration costs. As both probabilities are smaller than one the value of accepting a job in location one will clearly be higher than accepting a job offer in location two with a lower number of, here only one, potential employers. The attractiveness of the agglomeration will be the higher the greater is the difference between the number of employers in the two locations. The fact of the possibility of being laid off alone, without any location specific differences in the layoff rates and without any dependence of the search behaviour from the layoff rate in the sense that the latter doesn't influence the choice of the reservation value, the labour market uncertainty with respect to job security induces a further concentration of jobs in one location.

This effect is reinforced by the fact that the prospect of (a higher probability of) having to migrate after being laid off in the smaller location will reduce the reservation value of the workforce there. As the disagreement payoffs of the employers are insensitive to the geographic structure, this implies a relatively stronger bargaining position of firms in the smaller location.

5 Conclusions

It has been shown that job insecurity can lead to a Marshallian "labour market pooling". The model proceeds from the assumption that workers searching for a job are confronted with job offers that are characterised by a wage offer and a positive probability of being laid off after a certain employment period. The searchers don't know ex ante which type of employer they meet but know the multivariate distribution of job productivities and layoff rates. Search acts are independent draws from this distribution function. Search is conducted subject to an optimal stopping rule that takes account of the job insecurity. The benefit of initiating an employment relationship is divided between the employer and the worker in a bargaining process. At each stage of the bargaining process that is characterised by disagreement the bargaining parties have the opportunity to search outside partners.

It is shown that even without any dependence of the reservation value determining the search behaviour on the layoff rate and without any dependence of search costs on the geographic structure of the job search there is a strong tendency for labour market pooling, that is a high attractiveness of locations with relatively high number of employers. This tendency might reinforced by the location decisions of firms who find it advantageous to locate near large (specialised) labour markets.

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