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# EXTERNALITIES FROM LABOR MOBILITY

Laurence Ball

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1050 Massachusetts Avenue
Cambridge, MA 02138
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## ABSTRACT

This paper assumes that workers can move from a market with high unemployment to one with low unemployment at a cost. In principle, equilibrium mobility can be greater or less than the social optimum. For most plausible parameter values, however, mobility is too low. Intuitively, mobility has a beneficial externality: it helps workers remaining in the high-unemployment market by reducing competition for jobs. Mobility hurts workers in the market that movers join, but this effect is usually smaller.

Laurence Ball
NBER
1050 Massachusetts Avenue
Cambridge, MA 02138
and
Princeton University

# I. INTRODUCTION

In 1989, the unemployment rate was five percent in the South of England and nine percent in the North. In the United States, it was four percent in Virginia and nine percent in West Virginia. Similarly, unemployment is much higher in some industries, such as steel, than in others, such as computers. The usual explanation for these differences is "mismatch" between available jobs and the locations or skills of workers (e.g. Jackman et al., 1989). This explanation suggests that unemployment would fall if, through retraining or geographic relocation, workers moved where there are more jobs. This paper asks whether governments should promote such labor mobility, for example through subsidies. The answer depends, of course, on whether mobility in a decentralized economy is efficient. Moving has costs that workers weigh against the benefits of better employment prospects. Do workers' decisions produce less mobility than a social planner would choose?

Previous research has not answered this question. Lucas and Prescott (1974) show that mobility between labor markets is efficient if each market is perfectly competitive. Diamond (1982) shows that this result does not survive the introduction of frictions in job matching. Diamond does not, however, determine whether the likely outcome is too much or too little mobility. Many other papers study the welfare properties of job search (e.g. Mortensen, 1982; Pissarides, 1984; Hosios, 1990). But that literature considers behavior <u>within</u> a single market, such as choice of search intensity. This paper returns to Lucas and Prescott's problem of mobility <u>between</u> separate markets, which raises different issues. Under plausible conditions, I find that equilibrium mobility is too low.

Following Diamond, I assume that a local labor market is a search economy. The search technology produces a negative relation between unemployment and job vacancies -- a Beveridge curve. Markets differ in their numbers of workers and jobs, and hence their positions on the curve. I consider various assumptions about wage determination. Workers in a high-unemployment market can move to a low-unemployment market at a cost that varies across individuals. In this framework, I derive equilibrium mobility and compare it to the social optimum.

Mobility has both positive and negative externalities; thus, in principle, equilibrium mobility can be too high or too low. However, the positive externalities are larger for most plausible parameter values. To preview the argument, suppose that a depressed market D has high unemployment and low vacancies and a boom market B has the reverse. If a worker moves from D to B, he helps workers remaining in the depressed market by reducing competition for scarce jobs. The move also hurts workers in the boom market by <u>increasing</u> competition for their jobs. But for plausible Beveridge curves, the second effect is smaller. Unemployment falls significantly in D, and the large stock of vacancies in B allows the mover to be absorbed at little cost to incumbents. (The move may also affect firms in the two markets, but these effects do not prove important for the results.)

As this discussion suggests, a positive net externality from mobility is most likely when the ratio of unemployment to vacancies in market B is very low. Perhaps surprisingly, the higher ratio in D must not be too high. In addition, a positive externality is most likely when the friction in job matching is large, so substantial numbers of unemployed and vacancies can coexist in a market. Finally, a positive externality requires that wages are not too responsive to unemployment.

The remainder of the paper contains six sections. Section II presents the basic model of a local market. For simplicity, this model suppresses wage setting by assuming that workers receive their entire output (they simply pick unowned trees). Sections III and IV compare equilibrium and optimal mobility when there are two markets and workers can move between them at a cost. Section V extends the basic model, and Section VI considers the case in which workers split output with firms. Section VII compares the model to previous work and offers conclusions.

## II. A LOCAL ECONOMY

This section describes a local labor market. I simplify the model as much as possible; extensions are considered below.

Following the usual parable, an economy is an island. N infinitely-lived workers reside on the island. J fruit trees, or "jobs," are distributed about the island. Trees die with hazard rate s and are replaced by a flow of sJ new trees, where s and J are constants determined by nature. A single "employed" worker can pick and consume the fruit of a tree, which yields flow utility of one. The worker remains with his tree until it dies, leaving him unemployed. He then wanders around the island until he finds an unoccupied tree -- a "vacancy" -- and becomes employed. While unemployed, the worker receives flow utility of zero.

A "matching function" determines the rate at which unemployed workers meet vacancies. As in previous search models, the flow of meetings increases with the stocks of unemployed and vacancies. Specifically, I assume a Cobb-Douglas function with constant returns to scale:

$$(1) \qquad H = h(N-L)^a (J-L)^{1-a}, \qquad L \le N, J,$$

where L is the number of employed workers and h and a are constants. (N-L) and (J-L) are unemployment and vacancies. The qualitative features of this function, such as concavity in unemployment and vacancies, are realistic.[1] Indeed, Blanchard and Diamond (1989) find that a Cobb-Douglas function with a=.4 fits U.S. hiring data. Constant returns imply that unemployment and vacancy rates depend only on the ratio of workers to jobs, not on the scale of the market.

Since trees die with hazard s, the flow of workers from employment to unemployment is sL. Setting this flow equal to the flow of hires, (1), defines steady-state employment. This condition can be written as

$$(2) \qquad \frac{J-L}{L} = k\left(\frac{N-L}{L}\right)^{-\frac{a}{1-a}}, \qquad k \equiv (s/h)^{\frac{1}{1-a}}.$$

Equation (2) is a Beveridge curve -- an inverse relation between the unemployment and vacancy rates. (The rates are defined as (N-L)/L and (J-L)/L rather than the usual (N-L)/N and (J-L)/J, but this difference is minor.) In the analysis below, I take a=1/2 and k=.001 as base parameter values. The choice of a is convenient and close to Blanchard and Diamond's estimate of .4. k is chosen to produce realistic combinations of unemployment and vacancies. In particular, the Beveridge curve passes through (N-L)/L=.05, (J-L)/L=.02 (equivalent to conventional unemployment and vacancy rates of 4.8% and 2.0%). For 1968-81, Blanchard and Diamond report average unemployment and vacancy rates of 4.8% and

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[1]Equation (1) implies that a searcher's hazard of finding a job (the flow H divided by the stock of unemployed) is decreasing in the ratio of unemployment to vacancies. A firm's hazard of filling a vacancy is increasing in this ratio. Finally, the flow of matches approaches zero as either unemployment or vacancies approach zero.

2.2% (excluding temporary layoffs).

For given a and k, (2) defines L as a function of N and J. This function is homogeneous of degree one. In the case of a=1/2, one can derive an explicit expression for L:

$$(3) \qquad L = \frac{J + N - \sqrt{(J-N)^2+4kJN}}{2(1-k)} \qquad for\ a=\frac{1}{2}\ .$$

I complete the model by describing workers' objective functions. Ignoring discounting, a worker's objective is his average flow utility (discounting is introduced below). Since utility is one when the worker is employed and zero otherwise, his average utility equals the proportion of time he is employed. And since workers are identical, this proportion equals the steady-state employment rate L/N. Aggregate welfare is defined as N(L/N) = L.

## III. MOBILITY BETWEEN MARKETS

In this section, there are two islands called B (for boom) and D (for depressed). I assume that workers can move between islands at a cost, and compare equilibrium and optimal mobility.

### A. The Experiment

B and D have identical Beveridge curves. Initially they have the same numbers of workers and jobs, but there is a one-time, permanent shock: the number of jobs in D falls (or the number in B rises). After the shock, each worker in D decides whether to move to B for better employment prospects. Moving entails a permanent cost C in flow utility. One can think of the shock and subsequent moves as instantaneous, but this is inessential. With no discounting, workers care only about the new steady state, not the transition path.[2]

The moving cost C varies across workers with distribution function $F(C)$. $F(\cdot)$ and $F'(\cdot)$ are continuous, $F(0)=0$, $F'(0)>0$, and $F(1)<1$. As described below, these assumptions imply a unique equilibrium in which a fraction of D workers move. Even after moving, the unemployment rate is higher in D than in B.

In this experiment, the difference between booming and depressed markets is the number of workers per job. This specification captures the idea of mismatch between the locations of jobs and workers. Section V considers another motivation for mobility: differences in the returns from employment.

B. Equilibrium and Optimal Mobility

A D worker moves if this raises his average utility in the final steady state. If the worker stays in D, his average utility is $L_D/N_D$, where subscripts denote markets. If he moves, his average utility is $L_B/N_B - C$. Thus a worker moves if his moving cost lies below a cutoff $C^*$ defined by

$$(4) \qquad \frac{L_B}{N_B} - \frac{L_D}{N_D} = C^* ,$$

with all variables evaluated at the steady state. The equilibrium proportion of D workers who move is $F(C^*)$. One can show that $C^*$ is unique, and that $0<F(C^*)<1$. $C^*$ is strictly positive, so the equilibrium employment rate is higher in B.[3]

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[2]In terms of underlying parameters, the fall in the number of D jobs means a lower birth rate of trees. The flow cost of moving can be interpreted as the disutility of living away from home. (With infinite horizons and no discounting, a one-time moving cost would have no effect on mobility.)

[3]The equilibrium is unique because an increase in $C^*$ (i.e. greater mobility) reduces the difference in employment rates on the left side of (4). The assumptions that $F(0)=0$ and $F'(0)>0$ imply that $C^*>0$ and $F(C^*)>0$. Finally, the result that $F(C^*)<1$ follows from the assumption that $F(1)<1$ and the fact that the difference in employment rates is bounded by one. Similar considerations assure that equation (5) below defines a unique cutoff $C^{**}$, and that $0<F(C^{**})<1$.

How much mobility would a social planner choose? Recall that total welfare in a market is L. The planner maximizes $L_B+L_D$ minus moving costs. Thus he moves all D workers with costs below a cutoff $C^{**}$ defined by the first order condition

$$(5) \qquad \frac{dL_B}{dN_B} - \frac{dL_D}{dN_D} = C^{**} .$$

The left side of (5) is the employment gain from moving a marginal worker, which raises $N_B$ and lowers $N_D$. This net effect is positive: reducing the mismatch between workers and jobs raises total employment. The planner equates this gain to the cost of moving the marginal worker. The optimal proportion of movers is $F(C^{**})$.

Since conditions (4) and (5) differ, equilibrium mobility is generally inefficient. But is mobility too high or too low? Starting at the private equilibrium, I compute the welfare effect of moving an extra worker -- one with cost $C^*$. One can show that this experiment answers my global welfare question: optimal mobility exceeds equilibrium mobility if and only if an extra mover raises welfare.[4]

Moving an extra worker raises total employment by $dL_B/dN_B - dL_D/dN_D$, with derivatives evaluated at the equilibrium. Thus moving the worker raises welfare if

$$(6) \qquad \frac{dL_B}{dN_B} - \frac{dL_D}{dN_D} > C^*$$

and reduces welfare if the inequality is reversed. Using the equilibrium condition (4), this condition can be written as

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[4]This follows from the fact that the marginal gain from mobility, net of moving costs, is monotonically decreasing. (As workers move, the left side of (5) falls and the marginal moving cost rises.)

(7) $$\frac{dL_B}{dN_B} - \frac{dL_D}{dN_D} > \frac{L_B}{N_B} - \frac{L_D}{N_D} ,$$

with all terms evaluated at the equilibrium.

Recall that L(N,J) is homogeneous of degree one. This implies that L/N and dL/dN depend only on n=N/J, the ratio of workers to jobs. Using this fact and rearranging terms, (7) can be written as

(8) $$\phi(n_B) < \phi(n_D) ,$$

$$\phi(n) \equiv \frac{L}{N}(n) - \frac{dL}{dN}(n) .$$

Moving an extra worker raises welfare, so equilibrium mobility is too low, if $\phi(n_B)<\phi(n_D)$.

The basic source of inefficiency is the fact that social and private returns from joining a search market are unequal (Diamond, 1982). In this model, the private return is L/N and the social return is dL/dN. This is the "tragedy of the commons": individuals consider average products and the planner considers marginal products. $\phi(n)$, the difference between private and social returns, is the adverse externality from joining a market. As shown below, $\phi(n)$ is positive: a worker hurts his fellows by increasing competition for the fixed number of jobs. The overall situation is more complicated than the usual case of one commons, because joining a market means leaving another market. When a worker moves to B, the adverse externality there is offset by the beneficial externality from leaving D. The relation between equilibrium and optimal mobility depends on the sizes of the externalities in the two markets. When the externality is smaller in B, there is too little mobility.

## IV. COMPARISON OF $\phi(n_B)$ AND $\phi(n_D)$

### A. Overview

This section compares the equilibrium values of $\phi(n_B)$ and $\phi(n_D)$ to see whether there is too much mobility (overmoving) or too little (undermoving). $\phi(n)$ is determined by L(N,J), which follows from (2). When a=1/2, (3) implies

$$(9) \qquad \phi(n) = \frac{1}{2(1-k)}\left[\frac{1}{n} - \frac{\sqrt{X}}{n} + \frac{X'}{2\sqrt{X}}\right] ,$$

$$\textit{where} \quad X = (n-1)^2 + 4kn ;$$

$$X' = \frac{dX}{dn} = 2(n-1) + 4k .$$

For the base case of a=1/2 and k=.001, Figure 1 plots L/N, dL/dN, and $\phi(n)$ against ln(n). Figure 2 shows a close-up of $\phi(n)$ for $n \in [.75, 1.25]$. The pictures are similar for other a and k.[5]

My assumptions about F(C) imply $n_B < n_D$: even after moving, there are fewer workers per job in B. Otherwise, the model yields no restrictions on $n_B$ and $n_D$; any pair is an equilibrium for some choice of $F(\cdot)$ and the initial numbers of workers and jobs. Figure 1 shows that $\phi(\cdot)$ is not monotonic, so $n_B < n_D$ does not determine the relation between $\phi(n_B)$ and $\phi(n_D)$. In general, the relation between equilibrium and optimal mobility is ambiguous.

The rest of this section derives conditions for over- and undermoving. I begin with special cases and then consider the general model with plausible parameter values. The sizes of moving costs in actual economies are unclear. Thus, instead of specifying F(C), I calibrate the model by directly choosing the equilibrium $n_B$ and $n_D$. (These choices implicitly restrict F(C) and the values

[5]One exception is that the results are quite different for k>1. This case is implausible: either the unemployment rate or the vacancy rate must exceed 50%.

of $n_B$ and $n_D$ before moving.) Along with the Beveridge curve, n determines the unemployment and vacancy rates. Thus one can choose plausible values of n by examining these rates in booming and depressed sectors of actual economies.

B. Special Cases

To build intuition, I first consider two limiting cases:

Case 1: $n_B \to 0$ and $n_D < \infty$ implies undermoving;

Case 2: $n_D \to \infty$ and $n_B > 0$ implies overmoving.

The explanation for Case 1 is clear from Figure 1 (the general proof is straightforward). When $n_B$ approaches zero (i.e. $\ln(n_B) \to -\infty$), $\phi(n_B)$ approaches zero. Thus $\phi(n_B) < \phi(n_D)$, which implies undermoving. The reason that $\phi(n_B)$ approaches zero is that both L/N and dL/dN approach one. Intuitively, $n_B \to 0$ means an unlimited number of jobs per worker in B. Everyone is employed, and a new worker is absorbed without hurting incumbents. In this case, the only externality from mobility is the beneficial effect on D.

Case 2, which is perhaps more surprising, also follows from Figure 1. When $n_D \to \infty$, $\phi(n_D) \to 0$, implying overmoving. $\phi(n_D)$ approaches zero because both L/N and dL/dN approach zero. Intuitively, this case means that D has zero jobs per worker. In this situation, mobility has no externality for D: the prospects of D workers are hopeless regardless of whether anyone leaves. The only externality is the adverse effect on B.

These results suggest that governments should encourage workers to leave a market with moderate unemployment for one with very low unemployment, but not to leave a very depressed market. Of course worker-job ratios of zero or infinity are highly unrealistic, so I now turn to other cases. The next special case concerns the matching technology:

Case 3: $k \to 0$ implies efficient moving if $n_B, n_D < 1$ ;

undermoving if $n_B < 1 < n_D$ ;

overmoving if $1 < n_B, n_D$ .

$k \to 0$ means that searchers meet vacancies instantly, so unemployment and vacancies cannot coexist.[6] In this case, $L = \min(N, J)$. One can show that $\phi(n)$ is 0 for $n<1$ and $1/n$ for $n \geq 1$, which implies Case 3. Intuitively, if $n<1$ in both markets -- there are fewer workers than jobs -- then perfect matching implies that everyone is employed. Nobody moves, which is efficient. If $n_B<1$ and $n_D>1$, then moving has positive externalities: workers in D benefit from less competition for scarce jobs, and workers in B, who have jobs to spare, do not suffer. Finally, if both markets have a shortage of jobs, then moving has negative externalities. There are positive private gains from moving to the lower-unemployment market, but the social gains are zero: moving just redistributes the fixed number of jobs.

Overall, these results suggest that undermoving occurs only in quite limited circumstances. A typical U.S. labor market contains more workers than jobs (equivalently, unemployment exceeds vacancies). Thus n is usually greater than one. If B is an average market, or even a bit more booming than average, too many workers move there from a high-unemployment market. Undermoving occurs only if B's situation is so much better than average that jobs exceed workers.

In contrast to Case 3, the final result suggests that undermoving is likely:

Case 4: For $k>0$, $a=1/2$, and $\Delta$ sufficiently small, undermoving occurs if

$$n_B, n_D \in [1-\Delta, 1+\Delta].$$

That is, there is undermoving if matching is imperfect and $n_B$ and $n_D$ are close to one. The source of this result is that $\phi(n)$ has a single peak to the right

[6]More precisely, $k \to 0$ as matching becomes instantaneous or the separation rate approaches zero.

of one (see Figure 2). With this shape, $n_B<n_D$ implies $\phi(n_B)<\phi(n_D)$ in the neighborhood of one.[7]

This result is important because n's near one are realistic: while workers usually exceed jobs, the differences are small. Blanchard and Diamond's unemployment and vacancy rates of 4.8% and 2.2% imply n=1.03. For k>0, n's close to one imply undermoving, even if both $n_B$ and $n_D$ exceed one. It is not necessary, as for $k \to 0$, that $n_B<1$.

Of course this local result does not determine how large a range of n's produces undermoving. I now consider a wider set of cases.

C. The General Case

In examining wider ranges of n, I focus on the base case of a=1/2, k=.001. Again, these parameters imply that the Beveridge curve passes through an unemployment rate of 4.8% and vacancy rate of 2.0%, close to the Blanchard-Diamond averages. I consider mobility between D and B when their positions on the curve differ from this average point by realistic amounts. For $n \in [.75, 1.25]$, Table I presents $\phi(n)$, its components L/N and dL/dN, and the unemployment and vacancy rates.

As suggested by Cases 1-2 above, undermoving occurs when $n_B$ is sufficiently low and $n_D$ is not too high. Table I shows that these conditions hold in most plausible cases. $\phi(n)$ peaks at n=1.12, which implies unemployment and vacancy rates of 11% and 1% If both markets have n's below this level, then $\phi(n_B)<\phi(n_D)$, implying undermoving. And if B is moderately better off, there is undermoving even if D is very depressed. If $n_B$=1.06 (7% unemployment), there is undermoving as long as $n_D$<1.25 (20%). If B is an average market with n=1.03 and

[7]Formally, Case 4 is proved by differentiating (9), which establishes that $\phi'(1)>0$.

4.8% unemployment, there is undermoving as long as $n_D<1.46$ (32%). Note that the results for $k=.001$ are quite different from those for $k \to 0$, which implies overmoving if $n_B>1$. The case for undermoving is greatly strengthened by frictions that allow modest numbers of unemployed and vacancies to coexist.

Further, for plausible cases in which B's unemployment is lower than average, the net externality from mobility is not only beneficial but large. Suppose that $n_B=1.00$ and $n_D=1.10$, which imply unemployment rates of 3% and 10%. (These figures are near the lowest and highest state unemployment rates in many periods.) In this case, the net externality from mobility, $\phi(n_D)-\phi(n_B)$, is .34. The private gain, $L_B/N_B-L_D/N_D$, is only .07. Thus externalities comprise most of the social gains: the private incentives for mobility are much too weak.

Table I provides intuition for this result. When $n_D=1.10$ and $n_B=1.00$, $L_B/N_B=.97$ and $L_D/N_D=.90$. That is, average employment is fairly close to one in both markets. The small difference in employment rates implies small private gains from mobility. In contrast, there are substantial social gains from moving a worker, because $dL_B/dN_B=.49$ and $dL_D/dN_D=.08$. The large difference in $dL/dN$ reflects a sharp bend in the Beveridge curve near $n=1$. As n rises above one, vacancies are soon pushed near zero, so extra workers contribute little to employment.

These results are robust to reasonable variation in the parameters a and k. The case for undermoving is stronger for larger a's and for larger k's, but the effects are not dramatic.[8]

[8] If k is raised from .001 to .002, $\phi(n)$ peaks at $n=1.15$ rather than $n=1.12$. If a is reduced from 1/2 to 1/4, with k adjusted to keep $(N-L)/L=.05$ and $(J-L)/L=.02$ on the Beveridge curve, then $\phi(n)$ peaks at $n=1.10$.

## V. EXTENSIONS

This section briefly considers two extensions of the basic model.

### A. Discounting

Here I introduce a positive discount rate r. With discounting, currently unemployed workers are worse off than employed workers in the same market, and workers move only when unemployed. I assume that movers immediately join the pool of unemployed in B. I compare the private and social gains from moving an extra worker after each market has adjusted to its steady state with equilibrium mobility. The results show that discounting weakens the case for undermoving, but does not reverse it.[9]

In each market, the return to an unemployed worker -- the analogue of L/N in the basic model -- is $rV_u$, where $V_u$ is the present value of the worker's utility. $V_u$ is derived through simple dynamic programming, given the utility from unemployment (zero) and the hazard of becoming employed. The result is

$$(10) \qquad rV_U = \frac{L}{N + (N-L)(r/s)}$$

(note that $rV_u$ approaches L/N as $r \to 0$).[10] The social return from a new worker is $rV_v$, where $V_v$ is the present value of the gain in employment, which moves over time to a new steady state. Diamond (1982, equation 24) derives the social return for a general matching function; substituting (1) into his result and setting $a=1/2$ yields

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[9]The transition to the steady state is a complicated process, with low-C workers becoming unemployed in D and moving, and with employment adjusting according to the matching function (1). In the limit, all workers with C below a cutoff leave D. In principle, one could ask whether the transition path is efficient, but I focus on perturbations of the steady state.

[10]Dynamic programming yields $rV_u=\gamma/(r+s+\gamma)$, where $\gamma$ is the hazard of becoming employed. $\gamma$ equals H/(N-L), where H is the flow into employment. In steady state, H equals the outflow sL. Combining these results yields (10).

$$(11) \qquad rV_w = \frac{R^{-\frac{1}{2}}}{2\sqrt{k}(1+\frac{r}{s}) + R^{-\frac{1}{2}} + R^{\frac{1}{2}}} \qquad for\ a=\frac{1}{2},$$

where R equals (N-L)/(J-L), the ratio of unemployment to vacancies.

The adverse externality from a worker, $\phi(n)$, is the difference between (10) and (11). One can again show that undermoving occurs if $\phi(n_B)<\phi(n_D)$. Here, $\phi(\cdot)$ depends on r/s, the ratio of the discount and separation rates, as well as on $\sqrt{k}$=s/h. Two is a generous value of r/s (corresponding, for example, to r=10%/year and s=5%/year). Figure 3 and Table II present $\phi(n)$ for k=.001 and several values of r/s.

Raising r/s from zero to two (or even five) does not change the qualitative results. However, the range of n's that produces undermoving decreases a bit, and the net externality falls. Recall the case of $n_B$=1.00 and $n_D$=1.10. For r=0, the net externality $\phi(n_D)-\phi(n_B)$ is .34, and the private gain from mobility is .07. For r/s=2, the corresponding figures are .22 and .16: the private gain rises considerably relative to the externality. Intuitively, for r=0 the private gain is small because $L_D/N_D$=.9: even in D, an unemployed worker will be employed most of the time. With discounting, the worker takes account of the expected wait for his next job, which is long in D because vacancies are scarce. The worker gains considerably by moving to B, where the wait is shorter.

B. Differences in Productivity

So far I have assumed that B and D differ in their numbers of workers per job. Here I consider an alternative reason for labor mobility: differences in the returns from employment. The results are quite different from before: the likely outcome is overmoving.

Assume that B and D are initially identical, but a shock raises the amount of fruit produced by trees in B. The flow utility from working in B rises to $z>1$. Given my assumptions about moving costs, a fraction of D workers moves. With fixed numbers of jobs, equilibrium unemployment is higher in B, but B workers are better off because of the higher returns from work.

Ignoring discounting, total welfare in B is $zL_B$. A worker's average utility is $zL_B/N_B$, and the social return from a worker is $zdL_B/dN_B$. Thus the externality from a worker in B is $z\phi(n_B)$, where $\phi(\cdot)$ is the externality in the basic model. The externality in D is still $\phi(n_D)$. Thus undermoving occurs if

$$(12) \qquad z\phi(n_B) \;<\; \phi(n_D) \;.$$

For most plausible parameter values, this condition does not hold. $n_B>n_D$ in this experiment, and (as described above) $\phi(\cdot)$ is increasing for plausible n's. Thus $\phi(n_B)>\phi(n_D)$, which implies $z\phi(n_B)>\phi(n_D)$ for $z>1$.

The crucial difference between this case and earlier ones is that workers move to the market with higher unemployment. The robust result is that adverse externalities are larger in that market, so too many workers move or stay there. In the current case, moving is wasteful rent-seeking. Workers crowd into B for a share of the high returns, ignoring the fact that, with few vacancies, their gains are mainly taken from others.

## VI. TREES OWNED BY FIRMS

So far I have assumed that workers receive all the fruit that they pick. It is more common in search models, and more realistic, to assume that workers split their output with firms who employ them. This section considers several assumptions about how workers' wages are determined. The analysis becomes more complicated, because moving has externalities for firms as well as other workers. However, under plausible conditions the results do not change greatly.

Undermoving is likely unless wages are extremely responsive to unemployment.

A. The General Case

Assume that each tree is owned by a firm. (It does not matter who owns firms.) In each market, an employed worker produces flow output of one and receives a wage $w<1$; the firm receives $1-w$. The wage in a market depends on the worker-job ratio: $w=w(n)$. Intuitively, a higher n raises unemployment, which influences wages through various channels (see below). Employment is still determined by the Beveridge curve (2) and the numbers of workers and jobs (there is no feedback from wages to employment). As in the basic model, B and D are initially identical, but a shock reduces the number of D jobs, causing some workers to move.[11]

Ignoring discounting, a worker's return in a market is average employment, L/N, times the wage. I continue to measure welfare by total output L (I ignore distribution between workers and firms). Thus a worker's social product is still dL/dN. By reasoning analagous to Section III, the externality in a market is

$$(13) \qquad \hat{\phi}(n) = w(n)\frac{L}{N} - \frac{dL}{dN} .$$

Equilibrium mobility is too low if $\hat{\phi}(n_B)<\hat{\phi}(n_D)$.

The externality $\hat{\phi}(\cdot)$ can differ greatly from the externality in the basic

[11]I continue to treat the number of jobs in each market as exogenous. An alternative approach is to assume that firms can create jobs at a cost, and close the model with a zero-profit condition (Pissarides, 1985). If the cost of a job is fixed, this approach yields a fixed worker-job ratio. In this case, there are no externalities from joining a market: a change in N is matched by a change in J, leaving incumbents' welfare unchanged. On the other hand, one could assume increasing marginal costs of adding jobs to a market (for example, the most fertile sites for planting trees are used up first). In this case, an increase in N is offset only partially by an increase in J, so a new worker hurts his fellows. I conjecture that my qualitative results about undermoving carry over to this case.

model. If w is low enough, $\hat{\phi}$ is negative: a worker's presence benefits others. Intuitively, the worker hurts other workers but helps firms, who receive part of the gains from higher employment. The externalities from mobility again depend on the relation between $\hat{\phi}$ in the two markets, which I determine for several specifications of w(n).

B. Equal Wages

Suppose first that w(n) equals a constant $w_0$, which is the same in B and D. (This wage might reflect common norms about fairness.) With this assumption, the case for undermoving is stronger than in the basic model without firms (where it is already strong). To see this, recall that L/N is higher in B than in D. Reducing a worker's return from L/N to $w_0L/N$ has a larger effect in B, so $\hat{\phi}(n_B)$ falls more than $\hat{\phi}(n_D)$. The range of cases in which $\hat{\phi}(n_B)<\hat{\phi}(n_D)$ becomes wider. Intuitively, workers' inadequate incentives to move become even smaller when firms take part of the gains from higher employment.

C. Nash Bargaining

In many previous search models, wages are determined by symmetric Nash bargaining. A higher n improves firms' threat points relative to workers' by raising unemployment and lowering vacancies, which changes each side's expected wait for a new match. The effect on threat points implies that the Nash wage is decreasing in n. Specifically, for a class of models including the current one, Diamond (1982) derives

$$(14) \qquad w = \frac{v}{u+v},$$

where $u=(N-L)/N$ and $v=(J-L)/J$ are unemployment and vacancy rates. Equation (14) implies that wages are very responsive to n; for example, $w(1.00)=.50$ and $w(1.10)=.08$. The unemployment rates for these cases are 3% and 10%. Thus a moderate rise in unemployment cuts wages by more than four fifths.

Substituting (14) into (13) yields a striking result:

$$(15) \qquad \hat{\Phi}(n) \equiv 0 .$$

With Nash bargaining, a worker's presence in a market has no externality: his private return wL/N just equals his social contribution dL/dN. This result implies $\hat{\phi}(n_B)=\hat{\phi}(n_D)$, and hence that equilibrium mobility is efficient. The explanation is that wages are higher in the market with lower unemployment. This wage differential increases the private incentive for mobility, eliminating the undermoving that occurs when the markets have the same wage.

While this result is theoretically interesting, it depends on implausibly large effects of unemployment on wages. I now consider more realistic cases.

D. Empirical Wage Curves

There are various reasons that unemployment reduces wages less than with simple Nash bargaining. For example, wages may stay high because of efficiency wage considerations, or because of "ranking" of job applicants (Blanchard and Diamond, 1990). Choosing among microeconomic models of wage determination is beyond the scope of this paper. Thus, to find the implications of plausible wage behavior, I simply calibrate w(n) with empirical estimates of the wage-employment relation. For comparability with empirical studies, assume a constant elasticity of wages with respect to unemployment:

$$(16) \qquad w(n) = bu^{-e} ,$$

where b and e are parameters. I assume an elasticity e of .1, the consensus estimate in Blanchflower and Oswald's (1990) survey. I set b=.353 to obtain w(1)=1/2. That is, to isolate the effects of the elasticity, I set the level of wages when n=1 to the level under Nash bargaining.

Table III reports $w(n)$ and $\hat{\phi}(n)$ for $n\epsilon[.75, 1.25]$. Wages are much less flexible than under Nash bargaining: raising n from 1.0 to 1.1 reduces w only from .50 to .44. Perhaps surprisingly, the conditions for undermoving and the net externalities from mobility are very close to the results in the basic model without firms. That is, introducing firms reduces $\hat{\phi}$ substantially, but has little effect on the difference between $\hat{\phi}(n_D)$ and $\hat{\phi}(n_B)$. For example, $\hat{\phi}(1.1)-\hat{\phi}(1.0)$ equals .33; in the basic model, $\phi(1.1)-\phi(1.00)=.34$. Intuitively, the case for undermoving is weakened by the response of wages to unemployment, and strengthened by the fact that movers split their gains with firms (as described in VIB). But these effects are offsetting, and both are fairly small in plausible cases. As suggested by the Nash bargaining results, the conditions for undermoving change substantially only if the elasticity e is very large.[12]

## VII. CONCLUSION

### A. Summary

This paper assumes that workers can move from a high-unemployment market to a low-unemployment market at a cost. Equilibrium mobility is inefficient, because joining a market has externalities: it harms other workers by increasing competition for jobs. The relation between equilibrium and optimal mobility depends on the sizes of the externalities in the two markets. The relation is in general ambiguous, but most plausible cases produce undermoving. Intuitively, the social return from an extra worker is large in the boom market and small in the depressed market, where vacancies are scarce. In contrast, a worker's

[12]To see more precisely why the results are similar, note that introducing firms reduces $\hat{\phi}(n)$ by $(1-w)L/N$ (compare (8) and (13)). The values of L/N in B and D are fairly close, and so are the values of $(1-w)$ for plausible e's. Thus the reduction in $\hat{\phi}(n)$ is similar in B and D. As in the basic model, the main reason that $\hat{\phi}(n_B)$ differs from $\hat{\phi}(n_D)$ is the large difference in dL/dN.

private return is high in both markets, because employment rates are fairly close to one. Since the difference in social returns exceeds the difference in private returns, workers have insufficient incentives to move.

These results are robust to discounting, and to introducing firms who split output with workers. For plausible parameter values, the results change only when the reason for mobility is changed. If markets differ in output per worker rather than numbers of jobs, then overmoving is likely.

B. Comparison to Previous Work

Lucas-Prescott (1974) and Diamond (1982) compare the social and private gains from adding workers to a labor market. Lucas and Prescott assume that each market is perfectly competitive, so wages adjust to equate the private and social returns. Diamond shows that the returns generally differ in a search market, implying inefficient mobility between markets. Diamond focuses on whether the externality in a market -- $\phi(\cdot)$ in my notation -- is positive or negative, given Nash wage bargaining and various matching technologies. (In contrast to my Cobb-Douglas case, Diamond's technologies imply non-zero externalities even with Nash bargaining.) Diamond does not emphasize the difference in $\phi(\cdot)$ across markets, which determines whether mobility is too high or too low. I depart from Diamond in my specifications of matching and wage determination and, most important, by comparing $\phi(\cdot)$ in high- and low-unemployment markets.[13]

A number of other papers study the welfare properties of job search (Mortensen, 1982; Pissarides, 1984; Jovanovic, 1987; Hosios, 1990). However,

[13]While Diamond emphasizes the properties of $\phi(\cdot)$ in a single market, he also considers mobility between markets when mobility is costless and markets differ in output per worker. Diamond finds that too many workers join the high-output market (this is consistent with my results in VB). Note that my assumption of mobility costs is crucial for considering mobility motivated by differences in unemployment. With costless mobility and no output differences, unemployment is equalized across the two markets.

these papers consider search within a single market with a fixed number of workers. Search within a market is made non-trivial by introducing heterogeneous jobs or a choice of search intensity. With fixed numbers of workers, the models cannot capture the externalities from changing a market's labor force, which are central in this paper (and in Diamond). My model is better suited for analyzing mobility between separate markets, such as geographic regions or industries. Previous models are appropriate for studying policies affecting intra-market search, such as unemployment insurance.[14]

C. Future Research

I conclude with two suggestions for future research. The first is to explore additional externalities from mobility. If workers leave a geographic area, they might hurt the local economy through depressed housing prices or reduced demand for firms' products. Movers are unlikely to face the right incentives if product or housing markets are imperfectly competitive. It is unclear, however, whether these considerations make undermoving more or less likely.

Another possibility is to consider mobility by firms. One could assume, for example, that workers are immobile but firms can move between markets at a cost. Presumably workers would benefit from new firms in their market. Again, these externalities are likely to produce inefficient mobility, but the direction of the inefficiency is unclear. This issue is important in light of policy proposals to encourage firms to locate in depressed areas.

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[14]See Mortensen (1986) for a survey of the previous literature. While my central results are new, some effects in the model have analogues in previous work. In Mortensen and Pissarides, workers have insufficient incentives to search because they split the gains with firms. Similarly, undermoving in my model can be exacerbated by introducing firms (if wages are inflexible). In Jovanovic, search is excessive because searchers take good jobs from others. In my model, rent-seeking produces overmoving if markets differ in productivity.

REFERENCES

Blanchard, Olivier and Peter Diamond (1989), "The Beveridge Curve," Brookings Papers on Economic Activity 1989:1: 1-60.

________ and ________ (1990), "Ranking, Unemployment Duration, and Wages," MIT Working Paper #546.

Blanchflower, David and Andrew Oswald (1990), "The Wage Curve," Scandanavian Journal of Economics 92: 215-235.

Diamond, Peter (1982), "Wage Determination and Efficiency in Search Equilibrium," Review of Economic Studies 49: 217-227.

Hosios, Arthur (1990), "On the Efficiency of Matching and Related Models of Search and Unemployment," Review of Economic Studies 57: 279-298.

Jackman, Richard, Richard Layard, Stephen Nickell, and Sushil Wadhwani (1989), "Mismatch: The Structure of Unemployment," Chapter 5 in Unemployment, manuscript.

Jovanovic, Boyan (1987), "Work, Rest, and Search: Unemployment, Turnover, and the Cycle," Journal of Labor Economics 5: 131-148.

Lucas, Robert and Edward Prescott (1974), "Equilibrium Search and Unemployment," Journal of Economic Theory 7: 188-209.

Mortensen, Dale (1982), "Property Rights and Efficiency in Mating, Racing, and Related Games," American Economic Review 72: 968-979.

________ (1986), "Job Search and Labor Market Analysis," in Ashenfelter and Layard, Handbook of Labor Economics, Vol. II, Elsevier Science Publishers.

Pissarides, Christopher (1984), "Search Intensity, Advertising, and Efficiency," Journal of Labor Economics 2: 128-143.

________ (1985), "Short Run Equilibrium Dynamics of Unemployment, Vacancies, and Real Wages," American Economic Review 75: 676-690.

Figure 1

L/N, dL/dN, and $\phi(n)$
(a=1/2, k=.001)

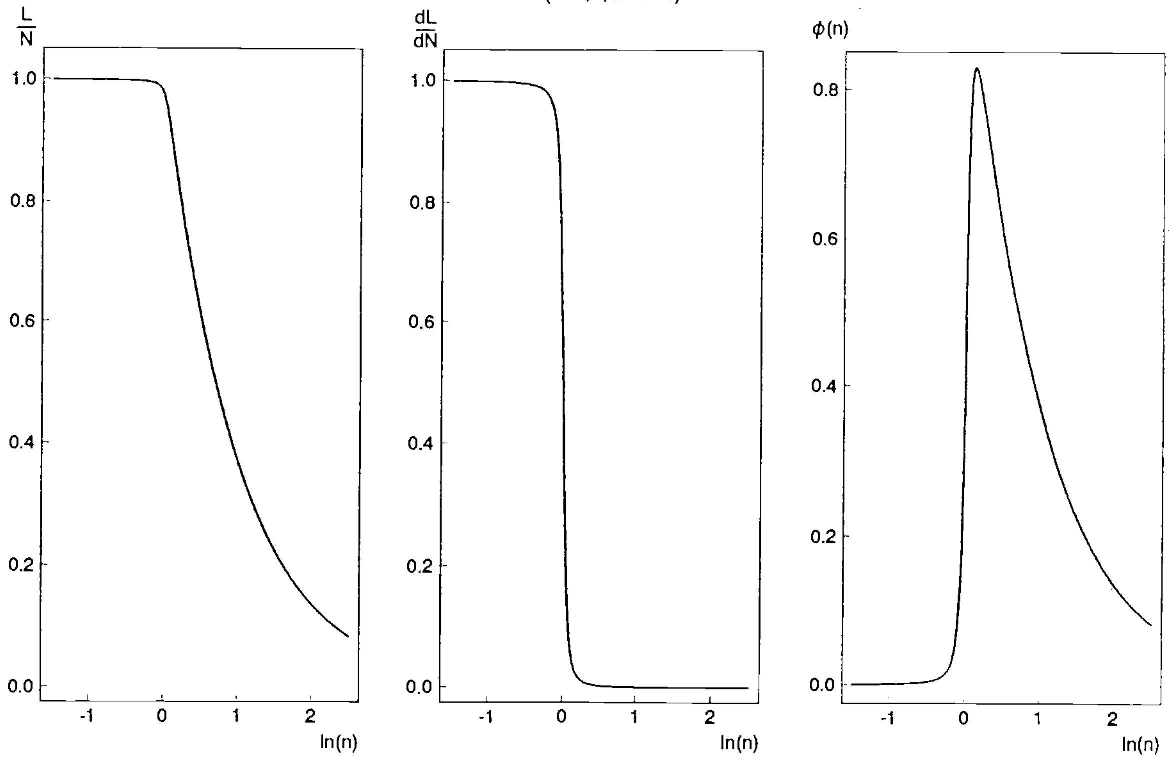

Figure 2

Close-up of $\phi(n)$ for $n \in [.75,1.25]$

(a=1/2, k=.001)

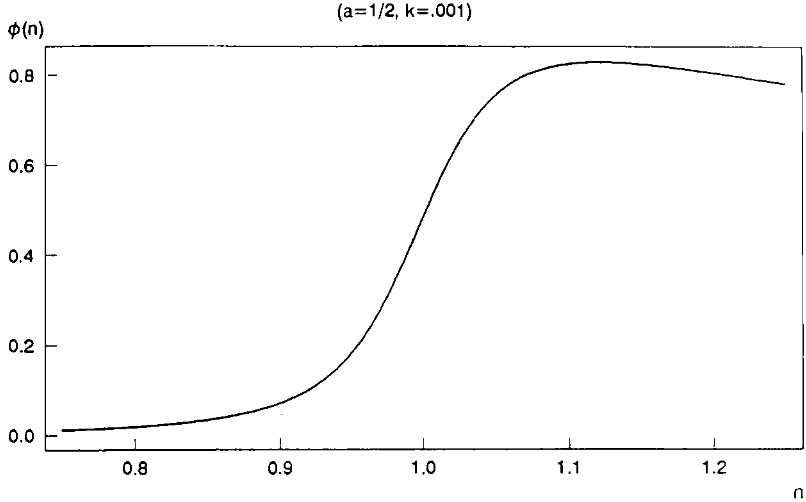


Figure 3

$\phi(n)$ with Discounting

(a=1/2, k=.001)

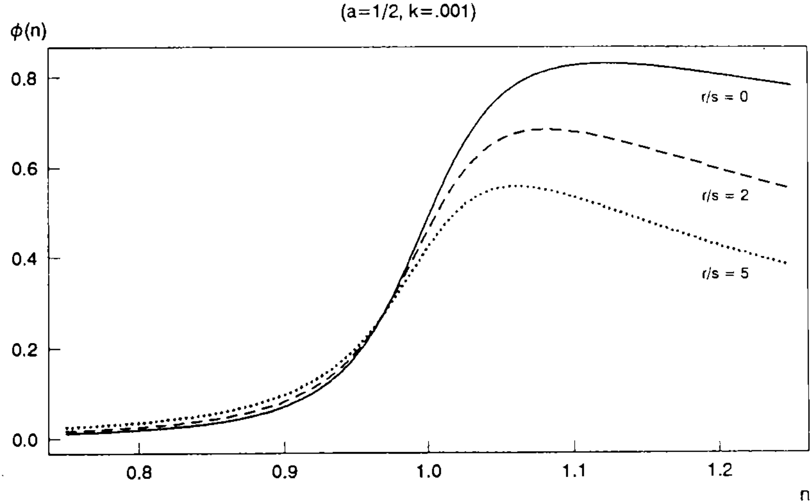

**Table I**

$\phi(n)$ and Related Variables
(a=1/2, k=.001)

| n | $\phi(n)$ | L/N | dL/dN | $u=\frac{N-L}{N}$ | $v=\frac{J-L}{J}$ |
|---|---|---|---|---|---|
| 0.76 | 0.013 | 0.997 | 0.984 | 0.003 | 0.242 |
| 0.78 | 0.015 | 0.997 | 0.981 | 0.003 | 0.223 |
| 0.80 | 0.019 | 0.996 | 0.977 | 0.004 | 0.203 |
| 0.82 | 0.023 | 0.996 | 0.972 | 0.004 | 0.184 |
| 0.84 | 0.030 | 0.995 | 0.965 | 0.005 | 0.164 |
| 0.86 | 0.039 | 0.994 | 0.956 | 0.006 | 0.145 |
| 0.88 | 0.051 | 0.993 | 0.942 | 0.007 | 0.126 |
| 0.90 | 0.071 | 0.992 | 0.921 | 0.008 | 0.107 |
| 0.92 | 0.101 | 0.990 | 0.889 | 0.010 | 0.089 |
| 0.94 | 0.148 | 0.987 | 0.839 | 0.013 | 0.072 |
| 0.96 | 0.225 | 0.983 | 0.758 | 0.017 | 0.056 |
| 0.98 | 0.340 | 0.978 | 0.638 | 0.022 | 0.042 |
| 1.00 | 0.485 | 0.969 | 0.485 | 0.031 | 0.031 |
| 1.02 | 0.622 | 0.958 | 0.336 | 0.042 | 0.022 |
| 1.04 | 0.722 | 0.945 | 0.224 | 0.055 | 0.017 |
| 1.06 | 0.781 | 0.931 | 0.150 | 0.069 | 0.013 |
| 1.08 | 0.812 | 0.916 | 0.104 | 0.084 | 0.011 |
| 1.10 | 0.826 | 0.901 | 0.075 | 0.099 | 0.009 |
| 1.12 | 0.830 | 0.886 | 0.056 | 0.114 | 0.008 |
| 1.14 | 0.828 | 0.871 | 0.043 | 0.129 | 0.007 |
| 1.16 | 0.823 | 0.857 | 0.034 | 0.143 | 0.006 |
| 1.18 | 0.815 | 0.843 | 0.028 | 0.157 | 0.005 |
| 1.20 | 0.806 | 0.829 | 0.023 | 0.171 | 0.005 |
| 1.22 | 0.797 | 0.816 | 0.019 | 0.184 | 0.004 |
| 1.24 | 0.787 | 0.803 | 0.016 | 0.197 | 0.004 |
| 1.26 | 0.777 | 0.791 | 0.014 | 0.209 | 0.004 |

**Table II**

$\phi(n)$ with Discounting
(a=1/2, k=.001, r/s=2)

| n | $\phi(n)$ | $rV_u$ | $rV_w$ | n | $\phi(n)$ | $rV_u$ | $rV_w$ |
|---|---|---|---|---|---|---|---|
| 0.76 | 0.018 | 0.991 | 0.972 | 1.02 | 0.567 | 0.885 | 0.317 |
| 0.78 | 0.022 | 0.990 | 0.968 | 1.04 | 0.639 | 0.852 | 0.213 |
| 0.80 | 0.026 | 0.988 | 0.963 | 1.06 | 0.674 | 0.818 | 0.144 |
| 0.82 | 0.031 | 0.987 | 0.956 | 1.08 | 0.684 | 0.784 | 0.100 |
| 0.84 | 0.038 | 0.985 | 0.947 | 1.10 | 0.679 | 0.752 | 0.073 |
| 0.86 | 0.048 | 0.983 | 0.934 | 1.12 | 0.667 | 0.721 | 0.055 |
| 0.88 | 0.062 | 0.980 | 0.918 | 1.14 | 0.651 | 0.693 | 0.042 |
| 0.90 | 0.082 | 0.976 | 0.894 | 1.16 | 0.633 | 0.666 | 0.033 |
| 0.92 | 0.112 | 0.970 | 0.858 | 1.18 | 0.614 | 0.641 | 0.027 |
| 0.94 | 0.159 | 0.963 | 0.804 | 1.20 | 0.596 | 0.618 | 0.022 |
| 0.96 | 0.230 | 0.952 | 0.721 | 1.22 | 0.578 | 0.597 | 0.019 |
| 0.98 | 0.333 | 0.936 | 0.602 | 1.24 | 0.560 | 0.576 | 0.016 |
| 1.00 | 0.457 | 0.913 | 0.457 | 1.26 | 0.544 | 0.557 | 0.014 |

**Table III**

w(n) and $\hat{\phi}(n)$
(a=1/2, k=.001, b=.353, e=.1)

| n | w(n) | $\hat{\phi}(n)$ | n | w(n) | $\hat{\phi}(n)$ |
|---|---|---|---|---|---|
| 0.76 | 0.628 | -0.358 | 1.02 | 0.485 | 0.129 |
| 0.78 | 0.622 | -0.362 | 1.04 | 0.472 | 0.222 |
| 0.80 | 0.614 | -0.365 | 1.06 | 0.461 | 0.279 |
| 0.82 | 0.607 | -0.368 | 1.08 | 0.452 | 0.310 |
| 0.84 | 0.599 | -0.370 | 1.10 | 0.445 | 0.326 |
| 0.86 | 0.590 | -0.369 | 1.12 | 0.438 | 0.332 |
| 0.88 | 0.581 | -0.365 | 1.14 | 0.433 | 0.334 |
| 0.90 | 0.570 | -0.356 | 1.16 | 0.429 | 0.333 |
| 0.92 | 0.559 | -0.336 | 1.18 | 0.425 | 0.330 |
| 0.94 | 0.546 | -0.300 | 1.20 | 0.421 | 0.326 |
| 0.96 | 0.532 | -0.236 | 1.22 | 0.418 | 0.322 |
| 0.98 | 0.516 | -0.133 | 1.24 | 0.415 | 0.317 |
| 1.00 | 0.500 | 0.000 | 1.26 | 0.413 | 0.312 |