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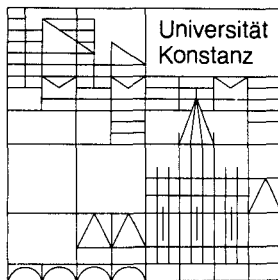
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Unemployment and Deterioration of Human Capital A Labour Market Model with Hysteresis Implications

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UNEMPLOYMENT AND DETERIORATION OF HUMAN CAPITAL

A Labour Market Model with Hysteresis Implications

Joachim MÖLLER

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Abstract

The paper deals with the deterioration of human capital during spells of unemployment. In our model the probability of leaving the unemployment pool decreases with the duration of unemployment. It can be shown that with a linear deterioration function and a simple distribution function for the reservation productivity of firms, unemployment duration is suitably described by a distribution of the Gompertz-Makeham type. In a numerical simulation it could be demonstrated that deterioration of human capital during unemployment affects the relation between vacancies and unemployment in a specific way: in the case of labour market slackness the steady-state Beveridge curve markedly bends away from the standard u-v-curve in an outward direction while in an almost full employment situation the effects are negligible. For higher deterioration parameters the Beveridge curve may even be upward sloping in a situation of excess supply on the labour market implying the existence of multiple equilibria. Empirical estimation of the distribution function with German labour market data 1984-1987 reveals that the multiple equilibrium case is likely to be relevant in reality.

1. Introduction

In their famous article about 'Hysteresis and the European Unemployment Problem' Blanchard and Summers list three different approaches which may be adduced to explain why shocks that cause unemployment might have long-term effects: shortage of physical capital, the insider-outsider approach and human capital theories. While the first two theories have been elaborated by several authors [see, for example, Blanchard, Summers (1986), Lindbeck, Snower (1986b, 1987a, b), Gottfries, Horn (1987) for the insider-outsider models, Burda (1988) for the capital shortage approach] the human capital approach has attracted much less theoretical interest. This was the case although it has already been pointed out by Phelps (1972) and Hargraves Heap (1980) that unemployment may have important effects on the skills and motivation of the unemployed which affect the matching process and labour supply in general.

One argument against the relevance of the very popular insider-outsider story is the observation that hysteresis seems to be a phenomenon of 'bad times' rather than of 'good times', i.e. persistent effects of adverse shocks are more likely to occur in an environment where a tendency to overall excess supply on the labour market prevails rather than in an economy which is geared to full employment. For example, why should insiders have acted completely different in the (severe, but short-lived) German recession of 1966/67 than in 1974/75 or in 1980/81 where much more persistent effects on unemployment were observed? An approach which concentrates on wage-setting behaviour in response to shocks has little to say with respect to this important discrepancy, so the insider-outsider aspect is not the complete story. Burda (1988) stresses another point which also is important for the understanding of the specific German situation: between 1980 and 1983 real wage income has been *declining* while unemployment has been rising. He presents a theoretical model which reconciles this empirical observation with an optimising model of wage-setting behavior in the presence of capital shortage. In our view, human capital aspects are equally important.

Empirical evidence indicates that the probability of leaving the unemployment pool falls essentially with longer duration of unemployment and long-term unemployment presents an increasing proportion of total unemployment. Although the studies of Budd, Levine, Smith (1987, 1988) combine this aspect with an empirical model of the Beveridge curve, a complete formal model of the matching process in the presence of deterioration of human capital during unemployment is still outstanding. In contrast to the study of Tötsch (1988) who stresses the role of a selection mechanism so that the less qualified are left behind and represent an important part of long-term unemployment, our paper explicitly assumes a depreciation process and concentrates on the matching problem.

The paper is organised as follows: In a first section a probabilistic model of the matching process is developed. We then derive the steady-state Beveridge curve and analyse the effects of an increasing 'depreciation rate of human capital' by means of a numerical simulation. The final section provides some estimation results for German labour market data.

2. A probabilistic model of the matching process

To keep the model tractable, some simplifying assumptions are made. First of all it is assumed that the working force of a representative labour market is homogeneous in the status of employment but inhomogeneous in the status of unemployment. The reason for the latter is that human capital deteriorates during unemployment because the 'workers who are unemployed lose the opportunity to maintain and update their skills by working' [Blanchard, Summers (1986, p.28)]. The deterioration only concerns those components of human capital which are perishable (for example those acquired by experience rating) but do not affect basic skills.

Since we are primarily interested in analyzing a situation of excess supply on the labour market the failure of an unemployed person to get a job is considered in more detail than the failure of a vacancy to be filled. Let us simply assume that vacancies which are unfilled after one period are independently re-announced in the next. The total number of vacancies per period is taken as exogenous to our model.

Firms differ in the extent to which the perishable components of human capital play a role for the productivity of their employees. Thus, each vacancy is associated with a specific qualification standard, expressed as a maximum tolerable duration of unemployment of the candidate¹. A contact between an employer and an applicant is successful (leads to an employment contract) if the applicant meets this standard.

Applicants for a job are randomly drawn from the unemployment register. It is possible that an unemployed person gets more than one chance per period, i.e. a probabilistic model with repetition is applied. For the search process of the worker a very simple stopping rule is chosen, which might be regarded as realistic in slack labour markets: the first possibility of getting a job is accepted. If a firm contacts a person who was in the unemployment register at the beginning of the time period but in the meantime has been successful, the corresponding vacancy remains unfilled.

The probability that a specific unemployed person is contacted for a specific vacancy is $1/U$, where U is the total number of the unemployed. Thus, the probability that an unemployed person has no contact if there are V vacancies in the period under consideration is $(1 - (1/U))^V$. Since $1/U$ is a small number, this probability can be rewritten by using the approximation $\ln(1 - 1/U) \approx -1/U$ as

$$(1 - \frac{1}{U})^V \approx e^{-k}, \quad (1)$$

where k denotes the ratio between vacancies and unemployment which characterises the labour market situation. If the unemployed - as has been assumed in traditional matching

¹ This assumption could also be justified by the argument that employers take the length of the unemployment period as a negative screening device, because they suppose that a selection mechanism is at work which leaves behind the less qualified.

models - are homogeneous, the probability λ for a specific person of leaving the unemployment register depends on k only

$$\lambda = 1 - e^{-k}, \quad (2)$$

with $\partial\lambda/\partial k = e^{-k} > 0$ and $\partial^2\lambda/\partial k^2 = -e^{-k} < 0$.

It is assumed that human capital deteriorates during unemployment according to a function $h(q)$ with $\partial h(q)/\partial q < 0$ where q is the duration of unemployment. More specifically, the following linear function for the development of human capital during unemployment is chosen for sake of simplicity:

$$h(q) = \max [h_0(1 - rq), \bar{h}], \quad (3)$$

where r is a depreciation parameter, h_0 is the human capital of the employed workers and $\bar{h} < h_0$ is the non-perishable part of human capital which remains after a critical duration of unemployment \bar{q} has been exceeded. Let us define unemployment up to duration \bar{q} as 'short-term unemployment' and unemployment with duration $q > \bar{q}$ as 'long-term unemployment'. In the following, we first concentrate on short-term unemployment.

Short-term unemployment

Let $F[h(q)]$ be the distribution function of the productivity requirement of the vacancies with $F[h(0)] = 1$. The fact that an unemployed person is drawn from the unemployment register by a searching firm now is no longer a guarantee that he or she gets the job. The probability that the employer refuses a contract because of inferior qualification of the applicant depends positively on the duration of unemployment and is

$$1 - F[h(q)]. \quad (4)$$

The probability for an unemployed person to be drawn x times from the unemployment pool is given by the Binomial distribution

$$p(x; k) = \binom{V}{x} \left(\frac{1}{U}\right)^x \left(1 - \frac{1}{U}\right)^{V-x} \quad (5)$$

with mean $V/U = k$. Since k is a relatively small number and there are V 'drawings' (where V is a large number), the Binomial distribution is suitably approximated by the Poisson-distribution:

$$p(x; k) \approx \frac{k^x}{x!} e^{-k} \quad (6)$$

For an unemployed person with x contacts the probability of being not accepted by the job-offering firms is $p(x; k) [1 - F(\cdot)]^x$. Hence the hazard rate, i.e. the probability that an unemployed person with duration q leaves the unemployment register is

$$\lambda(q) = 1 - \sum_{x=0}^{\infty} p(x; k) \{1 - F[h(q)]\}^x, \quad (7)$$

where $p(x; k)$ is the probability function of the Poisson distribution for a given vacancy-unemployment ratio k . As can be verified easily, the hazard rate λ is a non-increasing function in q and r . Since $F(q) = 1$ for all q if there is no depreciation of human capital ($r = 0$), eq.(7) covers eq.(2) as a special case. The second term on the right side of eq.(7) is a Maclaurin series, so the following approximation can be used for the hazard rate

$$\lambda(q) \approx 1 - e^{-k} e^{k(1-F[h(q)])} = 1 - e^{-kF[h(q)]}. \quad (8)$$

Now the unemployment distribution over time for a given labour market situation is analysed. In each period U_0 persons newly enter unemployment, while some of the unemployed leave the register with probability $\lambda = \lambda(q; k, r)$. The size of a cohort of unemployed persons with duration q is

$$U(q) = U_0 e^{-\int_0^q \lambda(\bar{q}) d\bar{q}}. \quad (9)$$

Since the probability of leaving unemployment is non-negative and declining with q for $r > 0$, eq.(9) is a non-increasing function in q and convex to the origin. Of course, the probability of leaving the unemployment pool is higher in the absence of deterioration of human capital during unemployment for all $q > 0$.

Let the reservation productivity of the firms (in terms of human capital) be identically distributed within the interval $[0, h_0]$. If human capital deteriorates according to a linear function, the distribution function of qualification requirements of the labour-seeking firms can be expressed as

$$F[h(q)] = \max[h(q)/h_0, 0] = \max[1 - rq, 0]. \quad (10)$$

Without loss of generality, it is assumed in the following that the human capital of a person just becoming unemployed (h_0) equals unity. *Figure 1* illustrates the depreciation of human capital depending on unemployment duration q and the corresponding distribution function of productivity reservation. An unemployed person with duration q_1 gets a contract with probability $F[h(q_1)]$, if chosen from the unemployment pool.

insert figure 1

For unemployment duration these specifications lead to a distribution function of the Gompertz-Makeham type ². This distribution function implies a hazard function of the general form $\lambda(q) = \alpha + \beta \exp(\gamma q)$. In our specific case we have $\alpha = 1$ and $\beta = -\exp(-k)/(kr)$ and $\gamma = kr$. Given a positive depreciation parameter r , the cumulative hazard function can be written as follows:

$$\begin{aligned} L(q) &= \int_0^q \lambda(\tilde{q}) d\tilde{q} \\ &= q - \frac{1}{kr} e^{-k} (e^{krq} - 1), \end{aligned} \quad (11)$$

and the ‘survivor function’ is

$$S(q) = \exp[-L(q)] = \exp\left[-q - \frac{1}{kr} e^{-k} (1 - e^{krq})\right]. \quad (12)$$

Total short-term unemployment is determined by the integral over the survivor function

$$U^{st} = U_0 \int_0^{\bar{q}} S(q) dq. \quad (13)$$

Since $L(q)$ is an exponential function in q , this integral cannot be solved analytically.

² See, for example, Blossfeld et.al.(1989).

Long-term unemployment

After each period a fraction of the unemployed exceeds duration \bar{q} and enters long-term unemployment. The size of this group is given by

$$U(\bar{q}) = U_0 e^{-L(\bar{q})}. \quad (14)$$

Let the chance that a long-term unemployed will be accepted if drawn from the unemployment register be

$$\sigma \equiv F[h(\bar{q})] = \frac{\bar{h}}{h_0}. \quad (15)$$

The critical duration of unemployment which separates short-term from long-term unemployment can then be expressed as $\bar{q} = (1 - \sigma)/r$. Substituting this relation in eq.(12) yields

$$L(\bar{q}) = \bar{q} \left[1 - \frac{1}{(1 - \sigma)k} (e^{-\sigma k} - e^{-k}) \right]. \quad (16)$$

The (constant) probability of leaving long-term unemployment by getting a job, is a function of k and σ :

$$\tilde{\lambda} = 1 - e^{-k\sigma}. \quad (17)$$

Solving the expression for total long-term unemployment by partial integration gives

$$\begin{aligned} U^{lt} &= U(\bar{q}) \int_{\bar{q}}^{\infty} e^{-(1-e^{k\sigma})(\bar{q}-\bar{q})} d\bar{q} \\ &= \frac{U(\bar{q})}{1 - e^{-k\sigma}}, \end{aligned} \quad (18)$$

where it has to be assumed that $\sigma > 0$.

3. The impact of deterioration of human capital on the Beveridge Curve

To begin with, the case $r = 0$ is analysed for reference purposes. According to our definition from above, no long-term unemployment occurs under this condition and total unemployment is simply

$$U(k) = \frac{U_0}{1 - e^{-k}}. \quad (19)$$

Eq.(19) implies a stable inverse relationship between vacancies V and unemployment U which is convex to the origin and can be taken as a theoretical foundation of the Beveridge curve [see, for example, Franz (1987)].

If deterioration of human capital takes place during unemployment, some of the unemployed lose all their perishable skills. Total unemployment is the sum of short-term and long-term unemployment:

$$\begin{aligned} U(k, r, \sigma) &= U^{st} + U^{lt} \\ &= U_0[s^{st}(k, r, \sigma) + s^{lt}(k, r, \sigma)] \end{aligned} \quad (20)$$

with

$$s^{st}(k, r, \sigma) \equiv \int_0^{\bar{q}} e^{-L(q; k, r)} dq$$

and

$$s^{lt}(k, r, \sigma) \equiv \frac{e^{-L(\bar{q}; k, \sigma)}}{1 - e^{-k\sigma}}$$

Eq.(20) also defines a steady-state relationship between vacancies and unemployment, but with somewhat different characteristics as compared to eq.(19). *Figure 2* shows the results of numerical simulations of eq.(20) for different parameter values r and σ . To transform the results into unemployment and vacancy *rates* we assumed an inflow to unemployment of 300000 thousand persons per month and a labour force of 25 millions, which roughly represents the situation of the German labour market in 1987. In the first simulation the parameter σ was chosen as 0.3, in the second as 0.5 (whereas the former is a rather realistic value for German data as will be shown below). To obtain a Beveridge-type relationship, the labour market parameter k was varied in the range 0.15 to 2.0 for given r and σ .

For $r = 0$ the simulation yields the traditional Beveridge curve which neglects the effect of deterioration of human capital during unemployment. As is evident from this figure, the Beveridge curves for $r > 0$ converge to the standard case in a situation when there is strong excess demand on the labour market. On the other hand, deviations markedly occur in a regime of predominant excess supply on the labour market. Hence, as might be

clear from intuition, the effect of deterioration of human capital appears to be primarily a phenomenon of ‘bad times’.

insert figure 2

As can be seen from the top of *figure 2*, the Beveridge curve will be a declining function over a realistic range of k if the parameter r is small. In situations of high unemployment the curve becomes rather flat if r is in the order of magnitude of 0.02. For larger values of the deterioration parameter the simulated steady-state Beveridge curve has a significant *positive* slope in the high-unemployment region. It is evident from the lower part of *figure 2* that the effects are less striking if the non-perishable part of human capital is larger ($\sigma = 0.5$). But also in this case, the steady-state Beveridge curve is upward sloping in the high unemployment region when r is 0.02 or higher.

This result has some important implications. If the Beveridge curve is almost horizontal or positively sloping within a certain range, combinations of u and v are no longer unique. According to the simulations we may obtain almost the same vacancy rate in a situation of low (say 4%) and high (say 9%) unemployment rate if the deterioration parameter r is about 0.02. Thus, significant deterioration of human capital during unemployment results in a situation of multiple equilibria. In the extreme, if deterioration of human capital takes place very quickly, an even higher number of vacancies than in high employment periods might be required in slack labour markets to prevent unemployment from further rising. This result can be explained as follows: In a model of the Beveridge curve with $r = 0$ less unfilled vacancies are observed when unemployment rises because the chance that an applicant for a job has only a small chance of being successful elsewhere. Thus the number of vacancies required to keep the unemployment rate constant falls with a growing excess supply of labour. In the case of a marked deterioration of human capital during unemployment, however, this positive effect on the matching probability can be over-compensated by a negative effect, which is caused by the fact that the mean duration of unemployment is higher in slack labour markets and human capital of the unemployed is lower in the average. Thus, an increasing portion of the unemployed does not meet the reservation productivity of the firms and the matching probability falls. Consequently, the steady-state condition only holds, if the number of vacancies rises. The deterioration of the $u - v$ -trade-off expresses the costs of an unfavourable term structure in the distribution of unemployment when labour markets are characterised by a high excess supply.

Furthermore, if the vacancy rate is related to wage inflation, we may conclude that a low-inflation economy is possible as well as in a state of low unemployment as in a state of high unemployment. In the case of marked deterioration of human capital during unemployment we might even expect an upward sloping Phillips curve in very slack labour markets.

Mean duration of unemployment and average human capital

The results reported so far can be explained by changes in the term structure of unemployment. The longer the mean duration of unemployment, the higher the loss in human capital and the less likely is that an unemployed which is randomly drawn from the unemployment pool meets the reservation productivity of a labour-seeking firm. If $g(q)$ is the density function for the distribution of unemployment, then the mean duration of unemployment can be expressed as

$$m_q = \int_0^{\infty} g(q) q \, dq. \quad (21)$$

For the special case $r = 0$ the integral is easily solved:

$$m_q = \frac{1}{1 - e^{-k}}. \quad (22)$$

Hence if human capital does not deteriorate during unemployment, mean duration of unemployment simply is a decreasing convex function in the vacancy-unemployment ratio k .

In the case $r > 0$, mean duration of unemployment is the weighted average duration of the short-term and long-term unemployed

$$m_q = G(\bar{q}) m_q^{st} + [1 - G(\bar{q})] m_q^{lt}, \quad (23)$$

where $G(\cdot) = \int g(q) \, dq$ is the distribution function of unemployment, i.e. $G(\bar{q})$ and $1 - G(\bar{q})$ are the shares of short-term resp. long-term unemployment in total unemployment. The mean duration of the long-term unemployed m_q^{lt} is $\bar{q} + 1/(1 - e^{-k\sigma})$ and the mean duration of unemployment of the short-term unemployed m_q^{st} is $\bar{q} - \int_0^{\bar{q}} G^{st}(q) \, dq$, where G^{st} is the distribution function of short-term unemployment. Furthermore, let us define $z \equiv \int_0^{\bar{q}} G(q) \, dq$. For eq.(23) this yields

$$m_q = \bar{q} - z + [1 - G(\bar{q})]/\bar{\lambda}, \quad (24)$$

since $G^{st}(q) = G(q)/G(\bar{q})$.

The loss of human capital during unemployment can be calculated as the difference between the human capital of the employed and the average human capital of the unemployed. In general, the latter is

$$m_h = \int_0^\infty g(q)h(q) dq. \quad (25)$$

In the case of a linear depreciation function the integral can be solved for the short-term unemployed to yield

$$m_h^{st} = \bar{h} + r \int_0^{\bar{q}} G^{st}(q) dq, \quad (26)$$

while the average human capital of the long-term unemployed is \bar{h} . Hence eq.(25) can be written:

$$m_h = \bar{h} + rz. \quad (27)$$

Thus, the total loss in human capital is $(h_0 - m_h) U$.

insert table 1

4. A look at the data

In order to check whether a flat or even rising steady-state Beveridge curve might be relevant in reality, we concentrate on recent German labour market data. *Table 1* gives some overall indicators of the labour market situation in the eighties. Inflows into unemployment were rising considerably during the OPEC II recession, followed by a rise in outflows from unemployment with a marked lag. Since 1983 inflows and outflows were roughly constant at a level of about 3.7 millions per year and the overall unemployment rate remained almost constant at a level of about 9%. The conclusion to be drawn from this observations is that the labour market situation since 1983 was close to a steady state. Allowing for some lags to capture the development in long-term unemployment, we used data from 1984 to 1987 to estimate the steady-state distribution of unemployment.

insert table 2

From the yearly special inquest of the Federal Employment Bureau (Bundesanstalt für Arbeit) in May/June data for completed spells of unemployment are available which are divided into those which are completed before 1, 3, 6, 12 and 24 months. Under the assumption 'inflows=outflows' survivor functions are easily calculated from this data (see *table 2*). The data also allow to discriminate between outflows into employment or in non-employment, where the latter essentially captures the discouraged worker effect.

insert table 3

Let $s(q)$ be the log of the survivor function $S(q)$. Taking differences between the data for q and $q + n$ and re-arranging gives

$$s(q + n) - s(q) + n = \frac{1}{kr} e^{-k(1-rq)} (e^{krn} - 1), \quad (28)$$

which can be estimated by non-linear least squares techniques.³ The results are shown in *table 3*. In the first regression the discouraged-worker effect was included in the data, while in the second only those outflows from unemployment were considered which led to new employment contracts. In both regressions r -squared is close to one. The parameters have the expected sign and are significant at the one percent level. The estimated k -coefficient is 0.20 in the first regression and somewhat higher (0.25) in the second. The deterioration parameter r is estimated as being higher (0.029) when the data are corrected for the discouraged worker effect against a value of 0.026 for the uncorrected data. This result reflects the fact that the discouraged worker effect increases markedly with longer duration of unemployment.

The magnitude and the high significance of the deterioration parameter r indicate that hazard rates decline considerably during unemployment. For a person who has just become unemployed the probability of getting a job within the next month is approximately 0.22, after one year of unemployment this probability falls to 0.15 and after two years of unemployment it is about 0.07 only⁴. For the results reported so far, it was implicitly assumed that 'short-term unemployment' is unemployment up to 24 months (see our definition from—above). Although this definition deviates from the official definition (unemployment up to 12 months), we decided to separate the unemployed this way because the deterioration

³ Since our definition for vacancies deviates from the statistical concept, the parameter k as the ratio of vacancies to unemployment cannot be taken directly from labour market data but has to be estimated.

⁴ This numbers somewhat underestimate the deterioration effect since with longer duration a growing part of the unemployed profits by public job creation ('Arbeitsbeschaffungsmassnahmen') or wage subsidies ('Eingliederungsbeihilfen'). Correcting for this effect, however, led to only minor modifications of the reported results.

process of human capital realistically cannot be considered as being completed after 12 months. On the other hand, for unemployment with a duration of more than 2 or 3 years, respectively, hazard rates between 0.07 and 0.05 are calculated. Hence the assumption of constant hazard rates for long-term unemployment with a duration of more than 24 months, seems far less critical with respect to the data than it would be the case if the same assumption was applied to the official definition. Given the hazard rates of (extreme) long-term unemployment, estimated values of k of 0.20 to 0.25 yield estimates of the parameter σ of $1/4$ to $1/3$. As has been shown in the previous section by numerical simulations, the parameter constellation obtained empirically, would imply a (moderately) upward sloping steady-state Beveridge curve in the relevant region.

5. Conclusion

The effects of deterioration of human capital are analysed in a probabilistic model of the matching process. It can be shown that the steady-state Beveridge curve which allows for hazard rates of the unemployed to decline with longer duration of unemployment bends away from the standard $u - v$ -curve in situations of excess supply on the labour markets. This effect implies that the same vacancy rate might be compatible with different unemployment rates, so that a situation of multiple equilibria arises. The larger is the deterioration parameter r and the lower the non-perishable part of human capital, the more likely is the occurrence of multiple equilibria. It can be shown that under specific assumptions about the distribution of reservation productivity of firms that the steady-state distribution of unemployment with respect to unemployment duration can be described by a Gompertz-Makeham distribution. Since the aggregate German labour market came close to a steady state between 1984 to 1987, existing data of completed spells of unemployment for this time period can be used to estimate the parameters of the steady state distribution empirically. It turns out that the deterioration parameter is highly significant and in a order of magnitude which at least does not exclude the possibility of multiple equilibria. Since the vacancy rate is related to (wage) inflation, this results might have severe policy implications. There are some indications that the economy has settled on a high unemployment equilibrium whereas a low unemployment equilibrium with the same inflation characteristics exists.

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TABLE 1

Inflows and Outflows from Unemployment and the Unemployment Rate 1980-1987

year	unemployment level	rate	inflows	outflows
1980	888900	3.8	3084068	2832549
1981	1271574	5.5	3531038	2945478
1982	1833244	7.5	3706655	3187165
1983	2258235	9.1	3704185	3578551
1984	2265559	9.1	3672791	3696594
1985	2304014	9.3	3750240	3728294
1986	2228004	9.0	3637266	3766214
1987	2228788	8.9	3726460	3636411

Notes:

- Source: Bundesanstalt für Arbeit, ANBA, 5,1988.

TABLE 2
Survivor Function for Unemployment (1984-1987)

year	Survival Rates after month				
	1	3	6	12	24
<i>including discouraged workers</i>					
1984	0.882	0.678	0.432	0.181	0.046
1985	0.865	0.636	0.368	0.158	0.039
1986	0.839	0.599	0.349	0.139	0.044
1987	0.832	0.591	0.332	0.137	0.047
<i>excluding discouraged workers</i>					
1984	0.859	0.628	0.364	0.128	0.030
1985	0.848	0.597	0.316	0.121	0.027
1986	0.817	0.553	0.291	0.100	0.030
1987	0.803	0.534	0.264	0.089	0.027

Notes:

- calculations by the author; source for original data: Bundesanstalt für Arbeit, ANBA, 5-1988,p.774.

TABLE 3

Non-Linear Least Squares Estimation of the Survivor Function (1984-1987)

coefficient	regression (1)		regression (2)	
	coeff.	s.e.	coeff.	s.e.
$r \times 10^2$	2.562**	0.205	2.937**	0.179
k	0.204**	0.011	0.254**	0.013
statistics				
R^2	0.999		0.999	
s.e.	0.078		0.091	

Notes:

- ** indicates significance at the 1% level
- regression (1) : including discouraged worker effect
- regression (2) : excluding discouraged worker effect

Figure 1

a) The distribution function of the employer's reservation productivity for job applicants (in terms of human capital)

b) Deterioration of human capital during unemployment

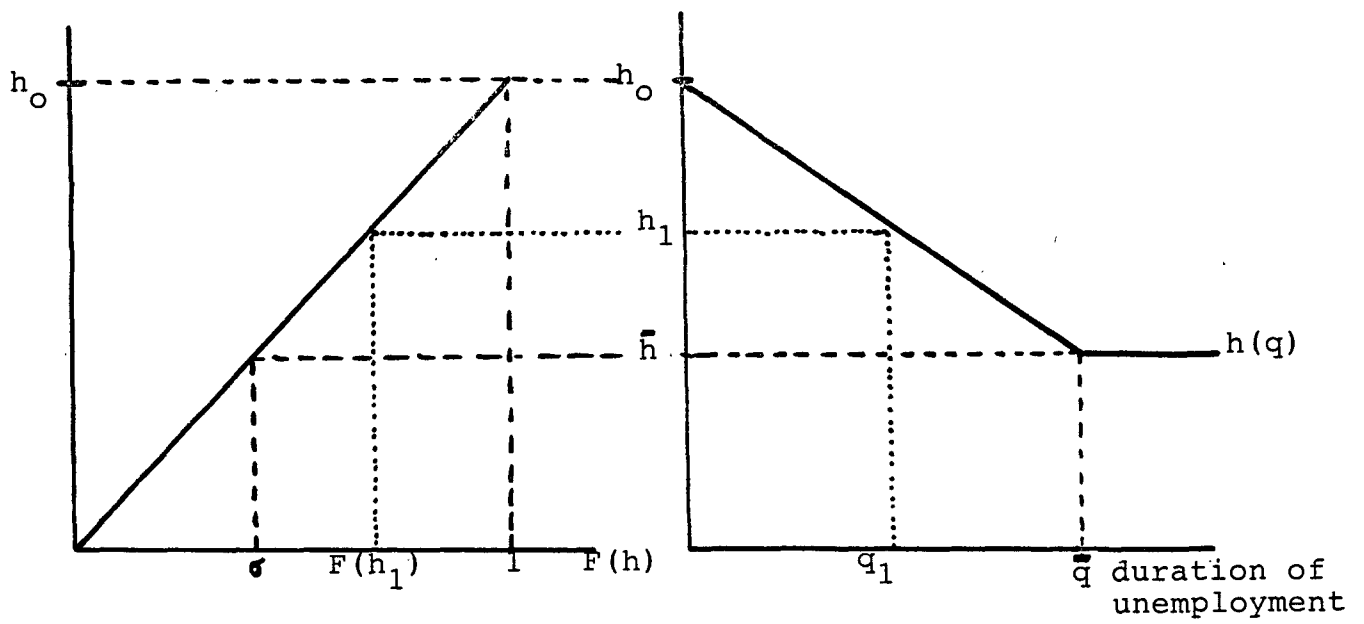


Figure 2. Simulations of the Beveridge-Curve with deterioration of human capital during unemployment

