12 Vacancy data, the employment function and structural unemployment in the Netherlands[1]

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12.1 Introduction

The marked rise in unemployment in most OECD countries during the 1970s and 1980s has stimulated research on the nature of unemployment and its causes. The situation for the Netherlands in this respect is depicted in Figure 1. From the figure one sees that on the one hand the rise in unemployment is confronted with a decline in vacancies to a very low level. On the other hand, long term unemployment turns out to be very persistent.

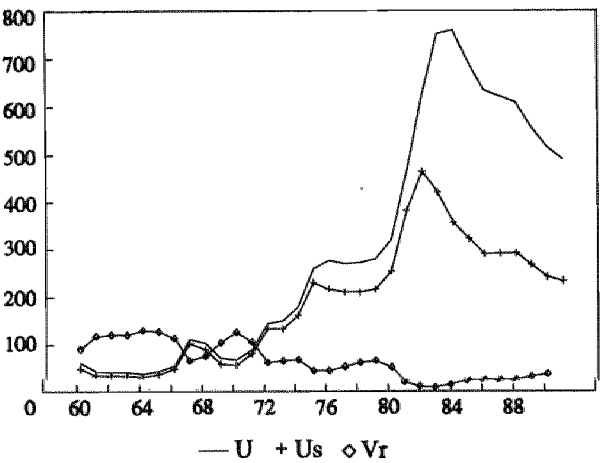
One of the categories of unemployment which has been studied intensively in this context - and still is - is structural unemployment (or sometimes called mismatch unemployment). This is the unemployment consistent with (stock)equilibrium on the labour market, i.e. when demand for labour equals supply. In the tradition of search theory this kind of unemployment was originally identified with frictional unemployment and measured by means of UV-analysis. More recently, however, a rise in structural unemployment is widely observed and explanations are also sought outside search theory. For instance, the notion of "hysteresis" focused attention to the role of lagged (or long-term) unemployment in explaining structural unemployment.

The use of UV-analysis to measure structural unemployment has severe drawbacks, both of a theoretical and an empirical nature (Muysken and Meijers, 1988). An alternative more valuable approach is to investigate the phenomenon of structural unemployment by means of aggregate employment functions (Bierings and Muysken, 1988). In this paper we are concerned with the measurement of struc-

tural unemployment by means of aggregate employment functions. This gives a new interpretation of the nature of structural unemployment.

Our starting-point is the widely accepted CES-like aggregate employment function of Sneessens and Drèze (1986) used in their macroeconomic disequilibrium model of the Belgian economy. It integrates the notion of spill-over effects from the goods market on the labour market such that Keynesian demand for labour and capacity demand are distinguished beside labour supply. We argue in section 12.3 of this paper that the employment function which results from aggregation over micro-markets, actually should be represented by a two-level (nested) CES-like employment function, in which the labour demand term in itself has a CES-like structure with Keynesian demand and capacity demand for labour as arguments.

Figure 1 **Unemployment and vacancies, 1960 - 1991**



In order to be able to estimate this function, we simplify the two-level (nested) CES-type employment function by capturing the CES structure of Keynesian demand and capacity demand in a single composite demand term. This demand term can be measured correctly by the sum of employment and job vacancies, given that reliable data on job vacancies are available. It is well-known that official job vacancy data registered at a public employment office are of doubtful value. The

registered data fail because firms only partly register their job vacancies and therefore would lead to a quite large underestimation of structural unemployment. This problem is discussed in section 12.2 and we use both data on advertisements and data from the job vacancy survey of the Central Bureau of Statistics to obtain more reliable job vacancy data.

In section 12.4 we estimate the rate of structural unemployment for the Netherlands in a recursive way, using the employment function derived in section 12.3. In doing this, we take the role of long-term unemployment into account by using the notion of "effective" labour supply. We also argue that the analysis should be extended towards a more dynamic setting. This enables us to include search unemployment in the analysis. Structural unemployment then can be decomposed in mismatch unemployment on the one hand and search unemployment on the other. Moreover it turns out that aggregation over micro markets not only yields an aggregate employment function (with dynamic elements), but also simultaneously an aggregate matching function. Recursive estimation of both functions then yields an interesting decomposition of structural unemployment in the Netherlands.

Finally some concluding remarks are presented in section 12.5.

12.2 The measurement of vacancies

Until the mid-eighties, vacancies were measured in the Netherlands as vacancies registered at the labour offices. It is obvious that this provides a biased estimate of the true vacancies, since employers are by no means obliged to register their vacancies - the only incentive to register vacancies is that a suitable candidate might be registered as unemployed at the labour office and thus a contact might be made.

From october 1980, vacancy surveys were held by the Central Bureau of Statistics. These resulted in quite reliable data on the true vacancies. The survey data are collected until 1988 on rather erratic moments in time, and from 1989 onwards systematically on a quarterly basis.[4] We have transformed the survey data to a yearly basis for the period 1981-1988, and present them (V) in Figure 2 together with the registered vacancies (V^r) and data on personnel advertisements (A) for the period 1960-1991.[5] The implied registration rate and ratio of advertisements to vacancies are presented in Figure 3.

Figure 2 **Vacancies and advertisements, levels, 1960 - 1991**

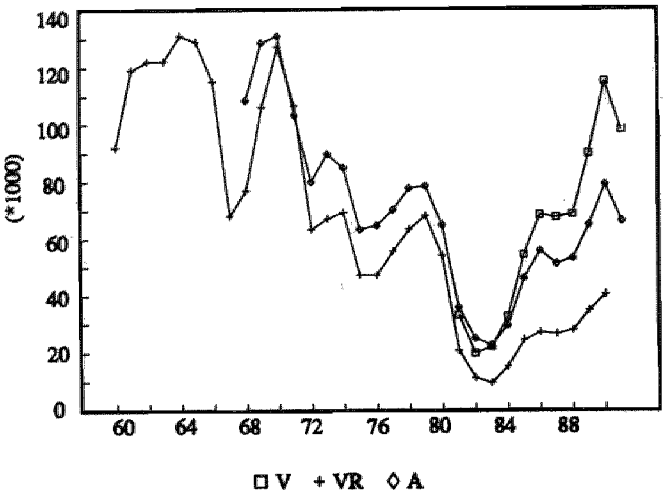
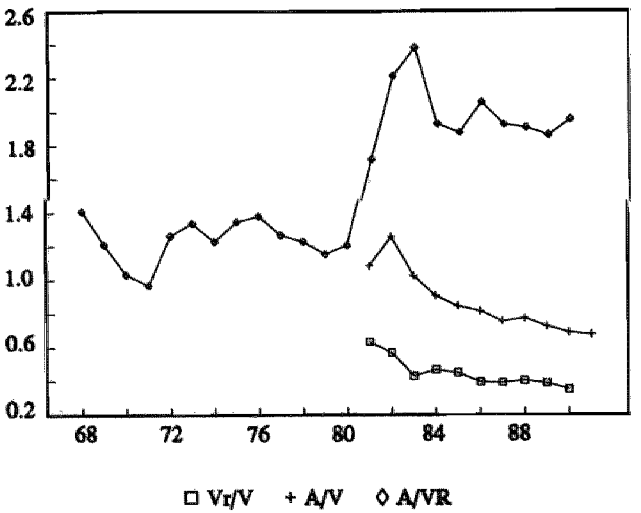


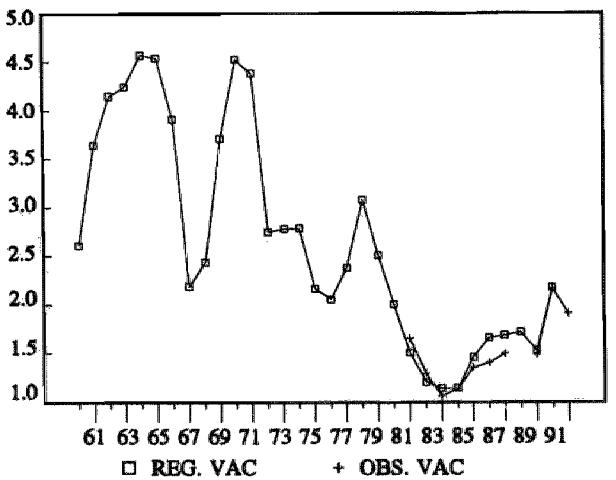
Figure 3 **Vacancies and advertisements, rates and ratios, 1968 - 1991**



One sees immediately from Figures 2 and 3 that the registration rate of vacancies to the labour office varies considerably over time. From over 60 per cent in 1981 it drops to almost 30 per cent in 1990. This stresses the biased nature of registered vacancies and underpins the importance to correct for this bias when one wishes to use vacancy data in economic analysis.

From Figure 2 it appears that data on personnel advertisements follow the survey data quite well. Compared to registered vacancies, the ratio of advertisements to observed vacancies is higher, although falling too. However, advertisement data are only available from 1968 onwards. Moreover, as one can see from Figure 3, the ratio of advertisements to registered vacancies lies around 1.2 in the period 1968-1980 and then jumps to a level of about 1.9 in the period 1984-1990. This phenomenon should be explained when one wishes to use the advertisement data in a further analysis of the registration rate.

Figure 4 Duration of vacancies, 1960 - 1991 (in months)



Both in the UK and in Germany, registered vacancies have been corrected on the basis of the assumption that the duration of registered vacancies is equal to the duration of observed vacancies - then the registration rate of flow data equals that of vacancies.[6] This assumption also holds for the Netherlands, as can be seen from Figure 4 - in the

period 1983-1990 observed and registered duration follow each other closely.[7] From that figure one also sees that the average duration was very low in the early eighties, just above one month, and increases somewhat in the early nineties, till a level of about 2 months. In the sixties, on the other hand it fluctuated around 4 months.

However, there are no reliable data available on observed inflow for the Netherlands for the period before 1988.[8] Hence we have to look for other ways to calculate the registration rate.

As an alternative approach, we assume that the registration rate varies with the situation on the labour market. For instance, it seems plausible that employers will be more inclined to register vacancies when the labour market is tight and the duration of vacancies is high.[9] As indicators of the tightness of the labour market one might think of the ratio of vacancies over unemployment but also of the rate of capacity utilisation - the higher both rates are, the higher the registration rate will be. Similar arguments hold for the ratio of advertisements to vacancies, except for the impact of duration - we shall elaborate this below. Thus the following equations seem plausible:

$$v^r - v = \mu_0 + \mu_1(v-u) + \mu_2 q + \mu_3 d + \mu_4 v^r \qquad 0 \leq \mu_1, \mu_2, \mu_3 \qquad (1)$$

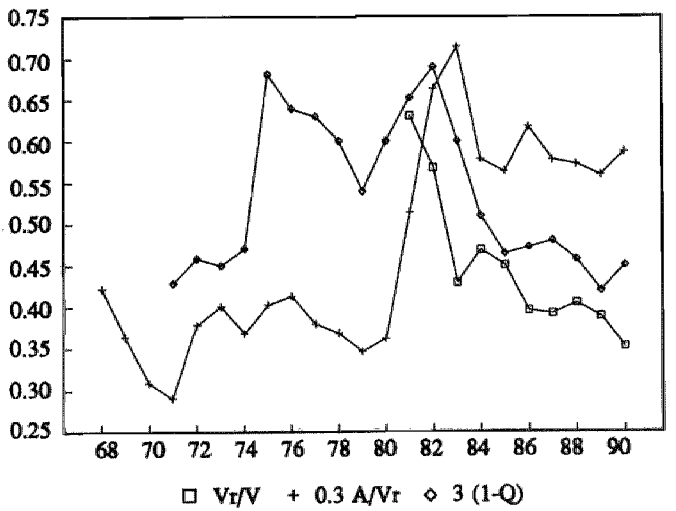
$$a - v = \alpha_0 + \alpha_1(v-u) + \alpha_2 q + \alpha_3 d + \alpha_4 a \qquad 0 \leq \alpha_1, \alpha_2 \qquad (2)$$

where all variables are in logarithms. The symbols v^r and v represent registered and observed vacancies, respectively, and u represents unemployment, a advertisements, q the rate of capacity utilisation and d the duration of vacancies. We also allow for a scale effect, measured by μ_4 and α_4, respectively. The sign of α_3 depends on the extent to which advertisements correspond to the stock of vacancies or to new vacancies only - except for the influence of duration analogous to that in equation (1). When advertisements correspond to the stock of vacancies posted as a whole, one should expect α_3 to be positive. On the other hand, when advertisements only appear for new vacancies, α_3 may very well be negative.[10]

Before estimating equations (1) and (2), we consider the evolution of the various variables over time. The registration rate, the ratio of advertisements to vacancies and the duration have already been discussed above. The data are presented in Appendix A.

With respect to the rate of registered vacancies over unemployment, one sees from Figure 1 that it has changed dramatically in the period 1960-1990. Total unemployment fluctuated around a level less than 100 thousands unemployed persons till the first oilcrisis in 1973/74. Then it jumped to a level of 300 thousands and remained at that level till the second oil crisis in 1979/1980. After that crisis it increased sharply to a level of almost 800 thousands unemployed persons in the years 1983 and 1984, and then gradually decreased till a level of about 500 thousands in 1991. It is obvious that some kind of hysteresis plays an important role here, which is also reflected in the large share of long-term unemployed persons as can be observed from Figure 1 in the period from 1980 onwards.[11] As a consequence there are structural tendencies underlying the behaviour of the ratio of vacancies to unemployment, which make it less suitable as a proper indicator of the tension on the labour market.[12]

Figure 5 Vacancy registration and capacity utilisation



With respect to the utilisation rate one sees from Figure 5 that the rate of capacity utilisation in manufacturing dropped sharply both after the first and the second oil crisis and in both cases increased again to a more normal level.[13] The increase after the second oil crisis, from

1982 onwards, coincides with a drop in the registration rate of vacancies, as can be seen from Figure 5. This indicates a negative relation between the rate of capacity utilisation and the registration rate. This negative relation can be understood once one realises that the sharp drops in the rate of capacity utilisation during both oil crises, not only indicated less tightness of the labour market, but also resulted in massive labour hoarding.[14] It then seems plausible that new vacancies were filled from hoarded labour and hence resulted in less than normal new registered vacancies and in less advertisements. This would explain a negative value of both μ_2 and α_2.

When we estimate equations (1) and (2) for the period 1981 -1990, the values of all coefficients, except α_2, turn out not to differ significantly from zero. When we ignore scale effects, only the values of the coefficients μ_2 and α_2 turn out to differ significantly from zero. That is neither duration, nor the ratio of unemployment over vacancies have a significant influence on the registration rate and the ratio of advertisements over vacancies - this also holds when we look at short-term unemployment instead of total unemployment. The rate of capacity utilisation, however, turns out to have a significant influence. When we omit the ratio of unemployment over vacancies, we obtain the estimation results presented in Table 1, equations (1′) and (2′). Again the rate of capacity utilisation has a significant influence in both cases. Its negative sign has already been explained above from labour hoarding. The impact of duration also is negative in both cases, and a scale-effect occurs in the rate of registration.

Equation (1′) yields significant results, as can be seen Table 1 - although the R^2 is not very high. The value for μ_4 is about 0.5, which points at a moderate scale-effect. The value for μ_2 is almost -6, which shows the impact of labour hoarding. A puzzling result remains, however, the finding that the impact of duration is negative: the value for μ_3 is about -0.9.

Equation (2′) gives a satisfactory fit to the data, moreover its coefficient values turn out to be rather insensitive when one or two years are omitted from the estimation period.[15] The impact of labour hoarding of -4 is smaller than that on registered vacancies. With respect to the impact of duration, we have already explained above, that its negative sign points at the facts that advertisements are posted, at least in part, specifically for new vacancies. Two extreme interpretations of this estimation result are possible. When advertisements are posted for new vacancies only, the value of α_3 of -0.27 implies that

the impact of the duration of vacancies on the ratio of advertisements to new vacancies is 0.73. On the other hand, the value of -0.27 of α_3 can also imply that the duration as such has no impact, but that advertisements are posted in 27 per cent of the cases for new vacancies only and in 73 per cent for all outstanding vacancies. Probably, the truth will lie in between both extremes.[16]

Table 1
Estimation results for the Netherlands, 1981-1990

		d	q	v^r	a	c	R^2	DW
(1′)	v^r-v	-0.85	-5.92	0.48		-3.10	0.86	2.11
		(0.26)	(1.01)	(0.15)		(0.53)		
(2′)	a-v	-0.27	-3.99			-0.79	0.96	2.29
		(0.08)	(0.41)			(0.10)		
(3)	v	-0.37	-4.30	-0.01	0.94	-1.08	0.99	2.33
		(0.23)	(0.83)	(0.19)	(0.30)	(-0.73)		
(4′)*	a-v^r	-0.14	2.00	-0.30		2.04	0.89	1.14
		(0.15)	(0.55)	(0.09)		(0.26)		
(1^+)		-0.13	-5.99	0.30		-2.83		

* estimated for the period 1960-1990
Standard errors are between brackets.

Both equations (1′) and (2′) seem reasonable candidates for a construction of vacancy data for the period before 1981 - although equation (2′) shows a better fit to the data. Since it is hard to choose between both a priori, we decided to estimate the observed vacancies as a convex combination of equations (1) and (2), that is (omitting labour market tightness):

$$v = \beta_0 + \beta_1 a + \beta_2 q + \beta_3 d + \beta_4 v^r \qquad (3)$$

The estimation results of equation (3) are also presented in Table 1. The estimated value for β_4 turns out to be very low, and does not differ significantly from zero, whereas the value for β_1 is close to unity, and does not differ significantly from 1. This implies that the advertisements provide superior information on the observed vacancies. Hence equation (2') can be used directly for the construction of vacancy data. This result is enhanced by the observation that the estimated values of β_0, β_2 and β_3 are almost identical to their counterparts found in equation (2').

A problem when using equation (2') from Table 1 to construct the data on observed vacancies, is that data on advertisements are only available from 1968 onwards. Hence data for the period 1960 - 1967 are missing. In principle we could solve this problem by using equation (1'). However, we prefer to look closer at those estimation results before doing so. Since the results of equation (3') stressed the importance of advertisement data, and the fit of equation (2') is quite good, we will take a closer look at the ratio of advertisements to registered vacancies. For this relation is implied by subtracting equation (1) from equation (2) and rearranging:

$$a - v^r = \delta_0 + \delta_1(v^r - u) + \delta_2 q + \delta_3 d + \delta_4 v^r \qquad (4)$$

Equation (4) can be estimated for the whole period 1968-1990 and not only for 1981-1990. And when the estimation results of equation (2') are used, the parameters of equation (1) can be identified.

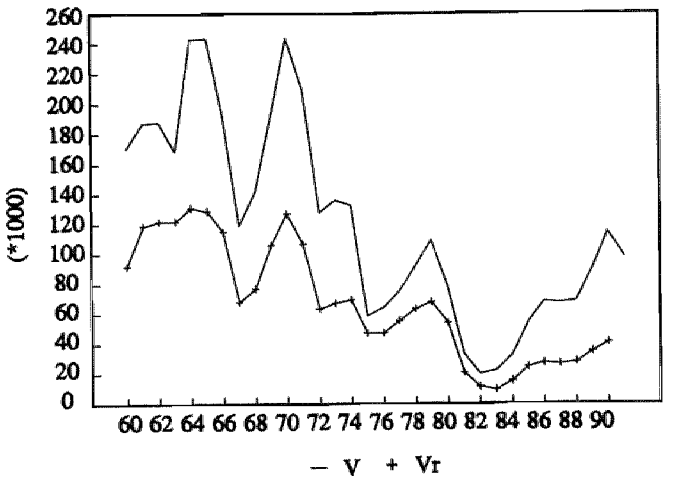
The estimation result of equation (4) is presented in Table 1 as equation (4'). The fit of this equation is reasonable, although some autocorrelation is present.[17] The jump in the ratio of advertisements to registered vacancies in the period after the second oil crises, which we observed in Figure 3, is explained by the sharp decline during that period in both the amount and the duration of vacancies.

When we subtract the estimation results of equation (4') from those of equation (2'), we find results that can be compared with equation (1') - see equation (1^+) in Table 1. When compared to equation (1'), one immediately sees that the impact of the rate of capacity utilisation is almost identical. However, the scale coefficient is somewhat lower, 0.3 instead of 0.5, and the impact of duration too, -0.1 instead of -0.9. The latter is still negative, however. We used the results of equation (1^+) to calculate the vacancies for the period 1960 - 1967.

The thus calculated vacancies are presented in Figure 6 for the period 1960 - 1990, together with the registered vacancies. From the

figure one sees that the registration rate varies considerably over time. Except for the years 1962 and 1963, it varies around 55 per cent until 1974. Then it jumps to a level of about 70 per cent, at which it remains until 1980 and thereafter it decreases till its present level around 35 per cent.[18] As we have explained above, these variations in the registration rate are determined by (dis)hoarding of labour, scale effects and variations in the duration of vacancies.

Figure 6 **"Observed" and registered vacancies, 1960 - 1991**



12.3 Vacancies and the employment function

In this section we review some theoretical results in the context of aggregate employment functions to measure structural unemployment. First the Sneessens and Drèze (1986) model is considered and second the generalization suggested by Bierings and Muysken (1988) and Gagey et al. (1990).

The aggregate employment function used by Sneessens and Drèze is derived from micro model specifications. It is assumed that there exists a continuum of N micro labour markets, indexed by i, where on each micro labour market employment, *l*, is determined by the

minimum of Keynesian demand or demand determined employment (i.e., the demand for goods translated in terms of employment), l^k and capacity demand for labour (i.e. the amount of labour required to run the available production capacity), l^c and labour supply, l^s. The vector (l^k, l^c, l^s) is assumed to be lognormally distributed. Formally,

$$\begin{aligned} \ln l_i^k &= \mu^k + \xi_i^k \\ \ln l_i^c &= \mu^c + \xi_i^c \\ \ln l_i^s &= \mu^s + \xi_i^s \end{aligned} \tag{5}$$

and

$$\ln l_i = \min(\ln l_i^k, \ln l_i^c, \ln l_i^s) \tag{6}$$

where:

$$E(l^k) = e^{\mu^k + 1/2\sigma_k^2} = L^K$$

$$E(l^c) = e^{\mu^c + 1/2\sigma_c^2} = L^C$$

$$E(ll^s) = e^{\mu^s + 1/2\sigma_s^2} = L^S$$

and:

$$(\xi^k, \xi^c, \xi^s) \sim N(O,\Sigma)$$

The aggregate level of employment, L, is proxied by the average level of employment across micro markets:

$$L = E(l) = E\left(\min(l_i^k, l_i^c, l_i^s)\right) \tag{7}$$

which can be rewritten, after some tedious manipulations with triple integrals as:

$$L = \varphi_K L^K + \varphi_C L^C + \varphi_S L^S \tag{8}$$

with φ_K, φ_C, φ_S denoting bivariate normal integrals.[19]

The specification according to (8) has a very complex form. As it stands the aggregate employment function according to (8) is analyti-

cal unattractive. Assuming all the mismatch-variances to be identical and equal to σ^* and choosing some appropriate approximation of the bivariate normal distribution function, the following CES-like aggregate employment function is obtained:

$$L = \left(L^{K-\beta} + L^{C-\beta} + L^{S-\beta}\right)^{-1/\beta} \tag{9}$$

where the parameter β is inversely related to the mismatch-variance, σ^*.[20]

A limitation of this aggregate employment function is its inability to distinguish between "capacity mismatch" (i.e. the inadequacy between the available installed capacities and the composition of the demand for goods) and "labour mismatch" (i.e. the inadequacy between labour demanded and supplied, qualification, location etc.) - they are assumed to be identical. However, as can be concluded from business survey data, both types of mismatch do occur. Since these two types of mismatch might call for different types of corrective policies, there is an interest in trying to distinguish between them. Allowing for different mismatch-variances, i.e σ_{c-s} is unequal to σ_{k-s}, Bierings and Muysken (1988) show that a two-level (nested) CES-like aggregate employment function is obtained. In a somewhat different setting Gagey *et al.* (1990) arrive at the same aggregate employment function. In the latter analysis, the two-level aggregate employment function simply follows by recognizing at the micro market (firm) level that matching is, in the short run, the result of a two stage process. Imagine the individual firm to determine firstly its labour demand, l^d, by comparing its Keynesian demand for labour, l^k, to its capacity demand, l^c:

$$l^d = \min(l^k, l^c) \tag{10}$$

and then confronts its labour demand to the available labour supply, l^s:

$$l = \min(l^d, l^s) \tag{11}$$

Admitting that the minimum of two lognormally distributed variables might, as an approximation, be considered to be itself lognormally distributed, the derivation of the aggregate employment function develops along the same lines as before, but now in a two-stage process. The following aggregate functions can then be specified

$$L^D = \left(L^{K^{-\beta_1}} + L^{C^{-\beta_1}}\right)^{-1/\beta_1} \tag{12}$$

and

$$L = \left(L^{D^{-\beta_2}} + L^{S^{-\beta_2}}\right)^{-1/\beta_2} \tag{13}$$

which yields a nested form:

$$L = \left[\left(L^{C^{-\beta_1}} + L^{C^{-\beta_1}}\right)^{-\beta_2/\beta_1} + L^{S^{-\beta_2}}\right]^{-1/\beta_1} \tag{14}$$

Note that this expression boils down to equation (9) when β_1 equals β_2. The interpretation of β_1 and β_2 in terms of the mismatch variances implicit in (14) is much more complicated than in (9). For this we refer to Bierings and Muysken (1993).

Equation (14) allows for two types of mismatches: the within mismatch in the labour demand term between Keynesian demand for labour and capacity demand for labour, and the mismatch between labour demand and labour supply.[21] Hence one would prefer to estimate equation (14) instead of equation (9). However, both equations (9) and (14) can only be estimated in a complete macroeconomic model, in whi Kcheynesian demand and capacity demand are unobserved endogenous variables. This is because Keynesian demand for labour and capacity demand for labour cannot be observed directly as a result of the absence of published data on the number of job vacancies arising from insufficient demand or from capacity constraints on production. Thus, at best reliable estimates of Keynesian demand for labour and capacity demand for labour are obtained from the model estimation. It is evident that the relialibity of the estimates heavily relies on the correct specification of the model (not to mention the conditions imposed on the error structure).[22]

To avoid these problems we opt for another approach by capturing the CES structure of Keynesian demand and capacity demand in a single composite demand term - *cf.* equation (12). Section 2 showed that reliable job vacancy data can be obtained using the results from the job vacancy survey of the Central Buaure of Statistics. This implies that the demand term can be measured correctly by the sum of employment and job vacancies. Then equation (13) can be estimated directly from the data. This also has the advantage that one no longer has to bother about the correct specification of Keynesian demand and capacity demand for labour. The latter would require to endogenize vacancies in terms of resulting from insufficient demand and from capacity constraints on production.

Estimation of equation (13) also allows us to identify the mismatch between demand and supply on the labour market by means of the rate of structural unemployment - consistent with stock equilibrium on the labour market, i.e. $L^D = L^S$. On the other hand, the mismatch within labour demand cannot be observed from the estimation results.

However, since we concentrate our analysis on the mismatch between demand and supply, we use equation (13) in the next section.

12.4 Matching and (un)employment in the Netherlands

For reasons that will become clear below, we introduce a slight change in notation, rewriting equation (13) as follows:

$$L \approx [L^{s-1/\theta} + L^{d-1/\theta}]^{-\theta} \equiv f(L^s, L^d; \theta) \tag{15}$$

The rate of structural unemployment, consistent with stock equilibrium on the labour market then is:

$$u^* = 1 - 2^{-\theta} \approx \theta \ln 2 \tag{16}$$

and it is obvious that θ can be said to indicate the mismatch on the labour market.

Since θ is the only parameter in equation (15), one might expect that it can be estimated rather easy. However, empirical studies consistently show that it varies over time. In its estimation often a time trend is included, and sometimes an indicator of excess supply such as lagged unemployment.[23] We prefer here to avoid the problems of the dynamic specification of θ, by estimating equation (15) recursively for each year separately, covering a period of the last 5 years each time.[24] The recursive estimation results of θ are presented in Figure 7.[25]

In order to show the importance of the data used and to show the sensitivity to those data, we estimated equation (15) for both sets of vacancy data discussed in section 2: the registered and the corrected data. Moreover, whereas employment in the Netherlands usually is measured in man-years, we corrected these data also such that employment is measured in persons. The implied person to man-year ratio is presented in Figure 8. It increases over time, reflecting both the reduction of standard working time and the increase of part-time work.

Figure 7 Recursive estimation θ, alternative data

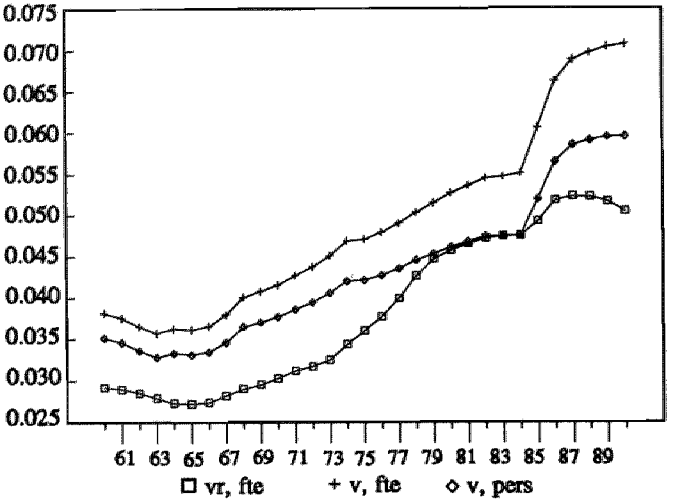
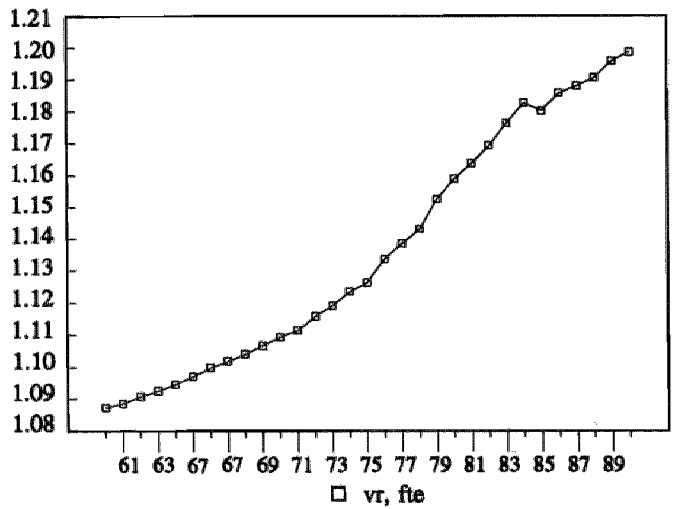


Figure 8 Persons man-years ratio



The standard estimation of θ uses data on registered vacancies and measures employment in man-years.[26] Estimation then results in low values for θ, except for the period 1978-1986, as can be observed from Figure 7 (*cf.* Vr, fte). Using then corrected vacancies, instead of the registered ones, yields much higher estimated values of θ (*cf.* V, fte). This is consistent with a registration rate of about 60 per cent, *cf.* Figure 6. However, when also data on employment are corrected such that they are measured in persons instead of man-years, the estimation results of θ become lower again - although higher than the original results [*cf.* (V, pers)]. This is also plausible, since the amount of persons employed is much higher than the amount of man-years. Then an equal amount of persons unemployed will result in a lower rate of unemployment, since the numerator increases, and hence also a lower value of θ - *cf.* equation (16). It is obvious that from the point of view of the data used, these last estimation results are the correct ones. Compared to the standard estimation results, the rate of structural unemployment is somewhat higher in the sixties and early seventies, but follows the same pattern. However, it increases much more sharply from the early eighties onwards, and it remains increasing while the standard estimation results show a downward trend in the mid-eighties.[27]

The recursive estimation results presented above reveal that the static nature of the above analysis is insufficient. Moreover, contemporary analysis of the labour market stresses the importance of stocks and flows. For that reason we have extended in Muysken and de Regt (1993) the analysis towards a dynamic setting.

An important feature of the dynamism is the recognition that the flows on the labour market should be recognised explicitly in the analysis. Thus the dynamics of micro market employment is given by

$$dl/dt = -ql+h \qquad (17)$$

where h corresponds to the number of matches (hires) within the micro labour market, and q to the rate of separations and quits. Equation (17) simply states that the change in employment is equal to difference between the number of new matches h on the one hand, and separations plus quits on the other hand.

We assume the rate of separations and quits to be exogenously determined. The number of matches should be explained, however. In line with the analysis above, then instead of the min-condition in

equation (11), the min-condition should apply to the fact that new hires, h, are the minimum of unemployment and vacancies. That is, with a fully efficient matching technology, the maximum number of instantaneous matches is given by min [u, v]. Essentially that constitutes the matching function at the micro level. However, an essential notion underlying the concept of a matching function is that matching is not fully efficient. We capture that notion in a rather crude way, by specifying the matching function as follows:

$$h = \lambda^{-1} min[u, v] \tag{18}$$

Here λ measures the inefficiency of instantaneous matching, which is assumed to be identical for all markets. The parameter λ has an obvious interpretation. From stock-flow labour market analysis it is well known that, at least in a flow equilibrium, the stock of unemployment equals inflow (or outflow) multiplied by duration. Accordingly, λ corresponds to the duration of the short side of the micro market. It is thus the duration of search unemployment (or search vacancies).

Substitution of the matching function (18) and the unemployment and vacancy definitions in the stock-flow equation (17) of employment yields:

$$dl/dt = -(q+\lambda^{-1})l + \lambda^{-1} min[l^s, l^d] \tag{19}$$

This is essentially our dynamic counterpart of the original minimum condition (11). For a better understanding of equation (19), we consider the steady state growth results, where supply and demand grow at some common constant rate j, even though their levels may differ. Obviously, the growth rate of steady state growth employment l^* also equals j. Hence, solving equation (19), steady state growth employment l^* is equal to

$$l^* = (1-\phi) min[l^s, l^d] \tag{20}$$

where

$$0 < \phi = \frac{\lambda(q+j)}{1+\lambda(q+j)} < 1$$

This equation yields an important insight. When one compares it with the original minimum condition (11), the conclusion must be that the static approach is *not* consistent with a (micro market based) stock-flow analysis of the labour market, as it ignores the always eminent search unemployment. This search unemployment occurs because quits take place continuously, even in a situation of perfect matching ($\lambda = 1$) and in the absence of growth ($j = 0$). For example, in the latter case, ϕ is reduced to $q/(1+q)$, but remains positive as long as quits are incorporated in the model.

The parameter ϕ can be given an useful interpretation, once one realises that along the steady state growth path

$$min[ur^*, vr^*] = \phi > 0 \tag{21}$$

holds, where ur* and vr* are the corresponding stationary micro market unemployment and vacancy rates, respectively. The micro market UV-curve thus has a Leontieff structure, and ϕ is the unemployment rate that prevails as long as supply is the short side of the micro market. As it is the minimum unemployment (or vacancy) rate, it is labelled search unemployment in the sequel. Search unemployment roughly equals the product of duration λ and inflow $(q+j)$, as $\phi \approx \lambda(q+j)$ for λ small. Therefore, it rises if the 'overall' quit rate q increases, if the common growth rate of supply and demand increase, or if the matching technology becomes less efficient ($d\lambda > 0$).

In Muysken and de Regt (1993) we show that aggregation over markets now yields the following employment function:[28]

$$L_t = f(e^{-\Psi_t^s} L_t^s, e^{-\Psi_t^d} L_t^d; \theta_1) \tag{22}$$

with

$$\Psi_t^x = \lambda(q_t + \Delta \ln L_t^x) \qquad x = s,d$$

where $f(\cdot)$ is the CES-function of aggregate supply and demand defined in (15). The new feature of the employment function (22), compared to equation (15) above, is that supply and demand are weighted with the factors ψ^s and ψ^d, which can be shown to be aggregate search unemployment and vacancies, respectively - compare equation (21) of which it is the aggregate counterpart. The result is that when supply is growing faster than demand, the probability

that there will be supply shortages decreases and hence the weight of supply in the aggregate employment function decreases - this is intuitively plausible. Moreover, the relation between the mismatch parameter θ_1 and the original parameter θ is:

$$\theta_1 = \theta[1+2(1-\rho)\lambda(\lambda-1)]^{1/2} \tag{24}$$

where the parameter ρ represents the strength of intertemporal spillover effects. Finally, since we have switched from continuous to discrete analysis, the parameter λ should be restricted by $\lambda \geq 0$ instead of $\lambda \geq 1$.

An additional element in the analysis of Muysken and de Regt (1993) is that they show that aggregation over micro markets not only yields the above aggregate employment function (20), but also an aggregate matching function. This matching function is the analytical counterpart of the employment function. Essentially it is identical to the employment function, but expressed in terms of flow analysis instead of stock analysis. Hence the explanation of shifts in the employment function implies a simultaneous explanation of shifts in the matching function.

It is obvious that due to the introduction of inefficient matching in a dynamic context, the rate of structural unemployment will be different. It turns out to be equal to:

$$u^* = \Psi^s + \theta_1 \ln 2 \tag{25}$$

Hence u^* consists of two elements, which may be labelled search and mismatch unemployment, respectively. The first part, ψ^s, corresponds to aggregate search unemployment. It is the direct result of matching inefficiencies. The second part, $\theta_1 \ln 2$, essentially corresponds to the mismatch unemployment $\theta \ln 2$ already identified in the static approach.[29] As a consequence, part of the structural unemployment that in the latter approach traditionally is interpreted as mismatch unemployment, will in effect be search unemployment.

The latter conclusion is confirmed when we estimate the parameters of the employment function (22) in the recursive way, explained in the previous section.[30] In estimating equation (22) we use effective labour supply instead of total labour supply, which is employment plus unemployment. Effective labour supply is obtained by subtracting 50 per cent of long-term unemployment from total labour supply. As a consequence long-term unemployment will always be a part of mismatch unemployment.[31]

Figure 9 Recursive estimation θ, with and without search

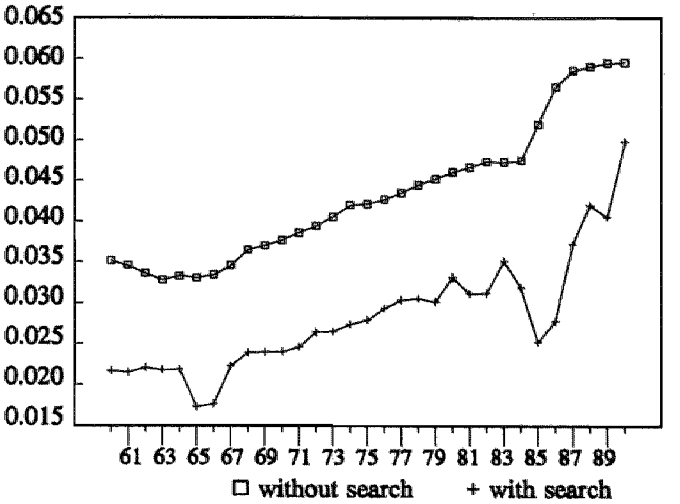
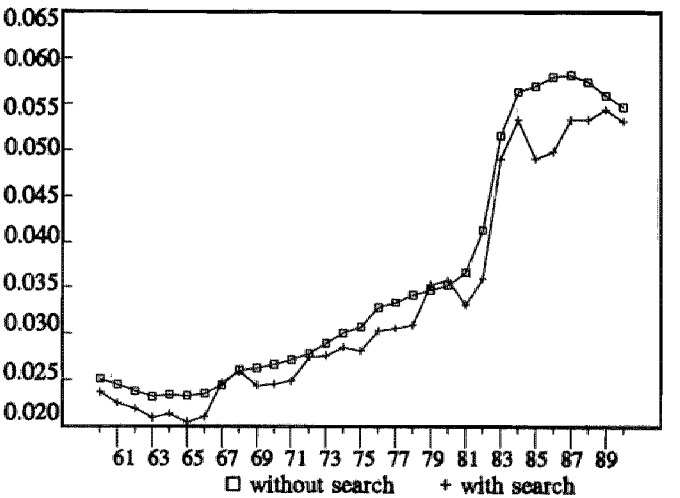


Figure 10 Structural unemployment, with and without search



From the estimation results, it turns out that the spill-over parameter ρ does not differ from 1, hence the mismatch parameters θ and θ_1 are identical. The estimated values of θ_1 are presented in Figure 9, together with those found for θ in the static analysis. From Figure 9 one sees that the value of θ when estimated in the dynamic specification turns out to be systematically lower than its static counterpart - although it follows the same development over time. This was to be expected as the dynamic specification (22) also incorporates search unemployment.

When the recursive estimation results are used to calculate the rate of structural unemployment according to equation (25), this rate turns out to be almost the same as its static counterpart corresponding to equation (16). Both rates are presented in Figure 10. As can be seen from that figure, only in the mid-eighties a somewhat smaller rate of structural unemployment is obtained from the dynamic specification.

Finally, a decomposition of structural unemployment is presented in Figure 11. This follows the decomposition of equation (25), although within mismatch unemployment a further decomposition is made by correcting for the impact of long-term unemployment. From Figure 11 one sees that search unemployment is rather stable over time, varying around a level of 1 per cent. This explains the gap between the value of the mismatch parameters from the static and the dynamic analysis in Figure 9. Mismatch unemployment clearly is seen to be increasing over time - although comparison with Figure 10 learns that it generally is one per cent lower. Finally one sees that the increase in mismatch unemployment is to a large extent due to an increase of the share of long term unemployed. But even when the impact of long-term unemployment is ignored, mismatch unemployment shows a tendency to increase over time.

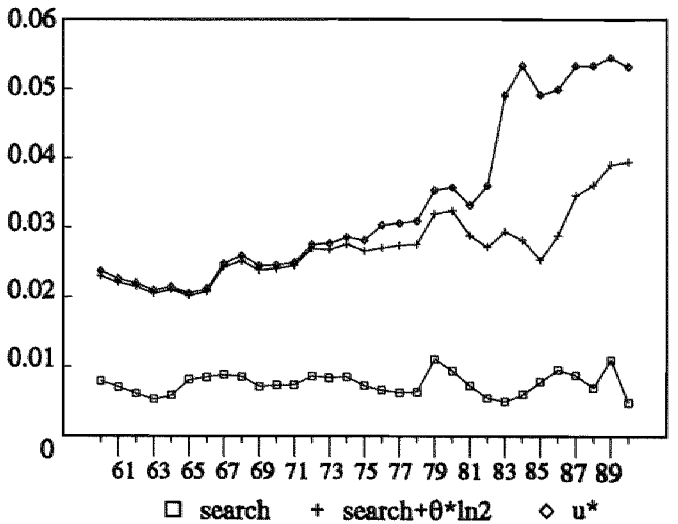
12.5 Concluding remarks

The above analysis has highlighted three important topics in the analysis of structural unemployment: the data, the specification of the relations and the estimation method. We will discuss each of these topics briefly.

With respect to the data, we have shown that one should not rely too easily on registered data and that the effort to correct for errors of registration is worthwhile. This is elaborated in section 12.2 where we used data on advertisements and survey data on vacancies to correct

data on registered vacancies. Moreover, the importance of using the correct data is illustrated in Figure 7. From this figure one sees that a higher structural unemployment results when one uses the correct vacancy data on the one hand, and measures employment in persons instead of man-years on the other.

Figure 11 Decomposition structural unemployment



With respect to the specification, we have shown in section 12.3 that actually the employment function has a two-level structure in which demand for labour is a composite of Keynesian demand and capacity demand. However, when vacancy data are used, demand for labour can be measured as the sum of employment and vacancies. The first level of the employment function then can be estimated separately. Then structural unemployment can be identified as resulting from the mismatch between micro markets.

An additional element is introduced in section 12.4 by on the one hand recognising the dynamic nature of the matching process on the labour market (it takes time) and on the other hand allowing for inefficiencies in the matching process. Structural unemployment then no longer results only from mismatch between micro markets, but

also comprises search unemployment. Figure 11 shows that search unemployment is rather constant over time, below 1 per cent. Mismatch unemployment increased from slightly over 1 per cent in the mid-sixties to over 3 per cent in the late eighties. In particular in the mid-eighties long-term unemployment plays an important role in that increase. However, even ignoring the effect of long-term unemployment, structural unemployment increases over time. Amongst others, this indicates an outward shift of the UV-curve.

With respect to the estimation method used, we avoid the problem of the specification of the factors underlying the shifts in the employment and matching functions, by using a recursive estimation method. The parameters are estimated for subsequent, revolving periods of five years. This method is possible when there are only few parameters to be estimated. And it is very fruitful when the parameters are not stable over time. The latter is illustrated by the results of Figures 7 and 9.

These results also point at the direction in which the analysis should be extended: a further explanation of the shifts observed in the employment and matching functions. In our opinion this presentation provides a fruitful basis for that extension.

Appendix A Data

year	Q %	Vr	Ir	A	V	Vr/V %
60	85	92	423		171	54
61	83	119	392		187	63
62	83	122	353		188	65
63	81	122	345		168	72
64	86	131	344		243	54
65	86	129	341		243	53
66	84	115	353		192	60
67	83	68	373		119	57
68	84	77	380	108	146	53
69	85	106	343	129	203	52
70	86	127	337	131	238	53
71	86	107	292	103	183	58
72	85	63	277	80	119	53
73	85	67	290	90	136	49
74	84	69	299	85	125	55
75	77	47	262	63	62	77
76	79	47	275	65	67	70
77	79	55	280	70	76	73
78	80	63	247	78	95	66
79	82	68	327	79	100	68
80	80	54	330	65	71	76
81	78	21	171	36	33	63
82	77	11	114	25	20	57
83	80	10	100	23	22	43
84	83	15	161	30	33	47
85	85	25	202	46	54	45
86	84	27	196	56	68	40
87	84	27	189	51	68	39
88	85	28	194	53	69	41
89	86	35	275	65	90	39
90	85	40	223	79	115	35

Symbols and data sources:

V: Vacancies (*1000). Source: Central Bureau of Statistics (CBS), *Sociaal Economische Maandstatistiek*. The yearly figures for 1981-1988 are obtained by weighting the incidental observations to july.

Vr: Registered vacancies (annual average *1000). Source: Ministry of Social Affairs (SZW), *Rapportage Arbeidsmarkt*.

Ir: Annual inflow of registered vacancies (*1000). Source: Hartog (1980) for the period 1960-1978, and kindly supplemented for the period 1983-1990 by SZW. Unfortunately, no data exist for the years 1979-1982. As the 'duration' for registered and surveyed vacancies are fairly comparable, see Muysken and de Regt (1990), we used the duration data (D) for observed vacancies to calculate inflow as Ir = Vr/D. These durations are 2.0, 1.5 and 1.2 month for the years 1980-1982, respectively. With the duration of registered vacancies being 3 month in 1978, the duration for 1979 was extrapolated to be 2.5 month.

A: Job advertisements (monthly average *1000). Source: CBS, *Sociale Maandstatistiek*, 1968-1983, supplemented with the CEBUCO-index 1983-1990 (1982=100, scaled by 0.25). Bastianen and van Ours (1990) have shown that both series correspond quit closely for the period 1978-1983.

Q: Utilisation rate (%, manufacturing). Source: CBS, *Conjuctuurtest*, 1971-1990. Data before 1971 are obtained using the CPB-utilisation (scaled by 0.86).

Appendix B Elaboration of equation (8)

The bivariate normal integrals in equation (8) are defined as follows:

$$\varphi_K = \varphi(x - \tfrac{1}{2}\sigma_{c\text{-}K},\ y - \tfrac{1}{2}\sigma_{K\text{-}s} | \rho_{K\text{-}c,\ K\text{-}s})$$

$$\varphi_c = \varphi(x - \tfrac{1}{2}\sigma_{c\text{-}K},\ z - \tfrac{1}{2}\sigma_{c\text{-}s} | \rho_{c\text{-}K,\ c\text{-}s}) \qquad \text{(B7)}$$

$$\varphi_s = \varphi(y - \tfrac{1}{2}\sigma_{K\text{-}s},\ z - \tfrac{1}{2}\sigma_{c\text{-}s} | \rho_{s\text{-}K,\ s\text{-}c})$$

φ denoting the bivariate normal integral and

$$x = \sigma_{c-K}^{-1}\, ln\, \frac{L^C}{L};\quad y = \sigma_{K-s}^{-1}\, ln\, \frac{L^K}{L};\quad z = \sigma_{c-s}^{-1}\, ln\, \frac{L^S}{L} \qquad \text{(B8)}$$

The variances in the above specifications are the mismatch-variances between any pair of variables in the above system, e.g.:

$$\sigma_{c\text{-}k}^2 = var(\xi_c - \xi_k) = \sigma_c^2 + \sigma_k^2 - 2\sigma_{ck} \qquad \text{(B9)}$$

The ρ parameters appearing in the bivariate integrals denote the correlation between any two mismatch pairs. It can be shown that they can all be written in terms of the mismatch variances, i.e.,

$$\rho_{k\text{-}c,\ k\text{-}s} = \frac{\tfrac{1}{2}(\sigma_{k\text{-}s}^2 + \sigma_{c\text{-}k}^2 - \sigma_{c\text{-}s}^2}{\sigma_{c\text{-}k}\sigma_{k\text{-}s}} \qquad \text{(B10)}$$

Finally, for the parameter β in equation (9) holds:

$$\beta = -\frac{ln3}{ln3 + ln\varphi(-\tfrac{1}{2}\sigma^*,\ \tfrac{1}{2}\sigma^* | \tfrac{1}{2})} \qquad \text{(B11)}$$

Notes

1. We would like to thank Ms. M. Rensman for her computational assistance.
2. University of Limburg, Dept. of Economics, P.O. Box 616, 6200 MD Maastricht, the Netherlands.
3. Central Bureau of Statistics, P.O. Box 4481, 6401 CZ Heerlen, the Netherlands. The views expressed in this paper are those of the authors and do not necessarily reflect the views of Netherlands Central Bureau of Statistics.
4. Data are published on October 1980-1983, September 1984, January 1986-1988, September 1988 and December 1988.
5. For 1991, no data on registered vacancies are available. Data on advertisements are available from 1968 onwards.
6. Jackman, Layard and Pissarides (1989) and Franz (1987).
7. The average duration is defined as the average vacancy stock in a certain period over the inflow during that period. For the period 1979-1982 data on registered inflow are not available, *cf.* Appendix A, hence we compare the data from 1983 onwards.
8. The data on duration presented in Figure 4 are based on estimations for the period 1981 - 1987, *cf.* van Ours and Hagens (1987) - we have interpolated their data. From 1989 onwards the data are directly observed from the survey.
9. However, one can think of a discouraged employer effect, implying that too high a level of vacancies can discourage employers to register their vacancies any longer. *Cf.* also Hartog (1980), p. 79.
10. When the impact of the duration on the ratio of advertisements to the inflow of vacancies is absent, we then will find $\alpha_3 = -1$. And α_3 will be negative as long as the impact is less than unity.
11. This is elaborated in Graafland (1990) and Muysken and de Regt (1990b).
12. Perhaps the ratio of vacancies to short-term unemployment is a better indicator, but this still shows similar structural breaks.
13. In Figure 5 we presented this rate in the form of 3*(1-q) for expository purposes. Moreover, the ratio of advertisements to registered vacancies has been multiplied by a factor 0.3. We used the rate of capacity utilisation in manufacturing because the registration rate is often observed to be low in services - *cf.* Thoolen (1992). Hence fluctuations in the utilisation rate of manufacturing can be expected to have a larger impact on the registration rate of total vacancies.
14. *Cf.*, for instance, Muysken (1991).
15. Allowing for scale effects through advertisements, yielded no significant results,

16. The conclusion in Van Ours (1990) that advertisements appear only for new vacancies is based on the assumption that the duration of vacancies has no impact on the ratio of advertisements to (new) vacancies.
17. In the various variants of this equation we estimated, the ratio of unemployment over vacancies did not have a significant impact. The rate of capacity utilisation on the other hand always was significant. Since the calculated amount of vacancies only differed little among the variants including vacancies and duration, or taking only one of them separately, we only present and discuss equation (4').
18. Hence, the approximation of van Ours (1991) of the registration rate in the period 1960 - 1979 by its value in 1980 leads to an over-estimation of that rate, and hence to an under-estimation of the amount of vacancies.
19. The precise definitions are given in Appendix B.
20. This is elaborated in Appendix B.
21. Moreover, the estimation results of Gagey et al. (1990) show that β_1 and β_2 are significantly different from each other. Hence the distinction between these two types of mismatches is also supported by empirical evidence.
22. *Cf.* Kooiman and Kloek (1979) who obtained very unreliable estimates of unobserved labour supply.
23. See Bean and Drèze (1990) for examples.
24. That is, for each year t, equation (15) is estimated over the period t-4, .., t.
25. We have used effective labour supply in this estimation in stead of actual labour supply, by subtracting 50 per cent of the long-term unemployed from actual labour supply. This is elaborated in Muysken and de Regt (1990b).
26. *Cf.* for instance Kooiman and Kloek (1979), FKSEC: A macro-economic model for the Netherlands (1992) and Muysken and de Regt (1990b).
27. This difference reflects the sharp drop in the vacancies registration rate in the early eighties and its low level since then.
28. Actually the aggregate employment function also includes an error correction component. However, we ignore this in this presentation since it consistently turns out to be empirically insignificant. From the theoretical specification one sees that this is to be expected when λ is small - which it turns out to be. *Cf.* Muysken and de Regt (1993).
29. The only difference is that in the present model it is the variance of 'effective' excess supply that matters, as opposed to the variance of gross excess supply.
30. As we elaborate in Muysken and de Regt (1993), in order to obtain more stable parameter values, the employment function is estimated simultaneously with the matching function.

31. In Muysken en de Regt (1993) we show that when effective labour supply is used, equation (25) changes to

$$u^* = \Psi^S + \theta_1 \ln 2 + 0.5\alpha u^l$$

where u^l is the rate of long-term unemployment and α is the proportion of long-term unemployment subtracted from effective labour supply. We use $\alpha = 0.5$ since this is the value found from time-series estimation, *cf.* Muysken en de Regt (1990).

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