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A quarterly simulation model

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DUTCH LABOUR MARKET:

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STOCKS AND FLOWS IN THE DUTCH LABOUR MARKET:
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by F.A.G. den Butter and J.C. van Ours

1. Introduction

Labour demand and supply equations are at the core of the usual macroeconomic models of the labour market. In an equilibrium model wage formation follows implicitly from the equality of labour supply and demand. In that case labour supply is identified as effective labour supply; there is no involuntary unemployment. In disequilibrium modelling unemployment marks the difference between registered labour supply and labour demand, whereas wage formation is described explicitly by a wage equation, in which a Philips-curve term acts as equilibrating mechanism. In such disequilibrium model actual labour demand may be somewhat below notional labour demand in case of supply constraints on the labour market (see Malinvaud, 1977). Moreover, according to new Keynesian macroeconomics, hysteresis may lead to persistence in unemployment, and hence to a partial fallacy of the equilibrating Phillips-curve mechanism (see Cross, 1988).

A common feature of both equilibrium and disequilibrium models is their focus on labour market stocks. Yet, the same levels of labour demand, supply and unemployment may be the result of quite different flows on the labour market. Hence, a considerable part of labour market dynamics - e.g. variations in persistence of unemployment - is not captured by the usual stock models of the labour market. In models which concentrate on the search process on the labour market the focus is on flows. At the core of these models is a so called matching function which describes labour market search behaviour by the relation between the flow of filled vacancies and the stock of unemployed and vacancies in a kind of production function (see Holmlund, 1980, 1984, for a Swedish example, Jackman, Layard and Pissarides, 1989, for a UK study and Blanchard and Diamond, 1989, for a US labour market model). The well-known UV-curve can be regarded as the iso-product curve defined by such matching function (see Van Ours, 1991). Whereas historical simulations with empirical disequilibrium models can provide an estimate of classical and Keynesian unemployment, the UV-curve analysis allows us to estimate the size of a third type of unemployment, viz. frictional unemployment (or unemployment due to malfunctioning of the labour market) (see Muysken, 1989).

The present paper seeks to combine both approaches mentioned above into a consistent stock-flow model of the Dutch labour market. In our model a matching function plays the central role as a description of labour market behaviour. Labour demand and supply are represented in the model in a very simple way by new vacancies and inflow into unemployment respectively. Unemployment dynamics are specified using duration dependent escape and retention probabilities. In this way the model endogenizes the persistence of unemployment, so that we get insight into the degree of hysteresis implicit in the model (See Budd, Levine and Smith, 1988, and Möller, 1990, for analogous studies combining UV-analysis and long term unemployment relationships). However, until now, wage formation and the determinants of the duration dependency of the escape and retention probabilities are not yet included in the model, so that the model still has a somewhat mechanical character.

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* Professor of Economics and Senior Lecturer of Economics respectively, members of the Applied Labour Economics Research Team (ALERT), Free University, P.O. Box 7161, 1007 MC Amsterdam, The Netherlands. Excellent research assistance by J. Tas and P.H. Weverling is gratefully acknowledged. A previous version of this paper was presented at the Second Conference of the European Association of Labour Economists, Lund, Sweden, September 1990.
The model is used to simulate developments on the labour market in the Netherlands during the seventies and the eighties. The focus is on changes in unemployment and more specifically on the explanation of the explosive growth of long term unemployment.

The next section discusses time series data on unemployment and on the duration of unemployment in the Netherlands and briefly informs on the construction of the data needed for our model, which were not readily available from statistical sources. Section 3 specifies the model with special emphasis on the interaction of in- and outflow of vacancies and unemployment, and on the consistency of overall escape probability implied by the model. This imposes a restriction on the transition probabilities between the various duration classes of unemployment. Section 4 reports on the parameter values of the model which are calibrated in such a way that a historical simulation with the model reproduces the actual data of the reference period. Section 5 analyses the working of the model by means of an impulse analysis simulating labour supply and demand shocks. This section also contains a sensitivity analysis on the major parameter values of the model. Finally section 6 gives conclusions and suggestions for extension of the model.

2. The Dutch labour market

There is discussion in the Netherlands about the actual number of unemployed. Unemployment is registered at public employment offices. According to recent estimates due to registration problems actual unemployment is some 40% lower than registered unemployment. The main problem is that the public employment offices are not notified in time that unemployed workers have found jobs. Estimates of actual unemployment corrected for these registration inaccuracies are however available for recent years only. Therefore we use data on registered unemployment (See Appendix 2 for more details on our data).

There are also registrations problems with job vacancies. If employers have vacancies they can use various recruitment methods in order to fill their vacancies: advertise, notify the vacancy to the public employment office, internal or informal recruiting, etc.. The basis of the regular information about the stock of job vacancies in the Netherlands consists of vacancies notified to the public employment service. As in most EC-countries the employer has in the Netherlands no obligation to notify the public employment service, so that notified vacancies are only a part of the actual number of vacancies. There is a vacancy survey of the Central Bureau of Statistics (CBS), but it only was started in 1980. From this vacancy survey it appears that in 1988 36% of the job vacancies were reported to public employment offices. Using the information from the CBS vacancy survey we corrected the vacancy data from the employment offices for changes in notification rate.

The developments in the Dutch unemployment and vacancy rates are shown in figure 1. Until the end of the sixties the Netherlands experienced a situation of near full employment characterized by a low and stable rate of unemployment, fluctuating around 1% of the labour force (35,000 unemployed), and a high vacancy rate of about 3.5% (120,000 vacancies). In the beginning of the seventies the small open economy of the Netherlands met with the consequences of the first oil crisis and declined profitability of enterprises due to increased real labour costs: unemployment rate reached 6%, while the vacancy rate declined to 1.5%. In the beginning of the eighties unemployment grew explosively. The unemployment rate increased to 16% in 1984 (800,000 unemployed), while the vacancy decreased to less than 0.5% (10,000 vacancies). The sharp increase of unemployment in the Netherlands in the beginning of the eighties was caused by the combination of the stagnation in employment growth, which was in line with developments in other West-European countries, and an increase of labour supply, which was rather high as compared to other European countries. Since 1984 employment started to grow quite rapidly again.
As stated before, an important aspect of the labour market is the search of employers on the one hand and both employed and unemployed workers on the other hand. This simultaneous process results in a flow of filled job vacancies. There are almost no published data on total vacancy flow or vacancy durations in the Netherlands. The flow of vacancies reported to the public employment offices is available until 1978 (Hartog, 1980). From the CBS vacancy survey we have information about elapsed vacancy durations over the period 1980-1987. Applying the method as described in Van Ours en Ridder (1991) we calculated completed vacancy durations over this period. Using this information and the information on the vacancy flows towards the public employment office we constructed a 1961-1987 series of vacancy durations and flows of filled job vacancies. Figure 1 also shows that the yearly flow of filled job vacancies in the seventies fluctuated around 10% of the labour force. In the beginning of the eighties there was a sharp decline to 5%. Since 1984 the flow of filled job vacancies increased substantially to about 17% in 1987. Figure 1 illustrates that the discrepancy between the stock and flow of vacancies becomes larger in the eighties as compared to the beginning of the reference period. It indicates a decline in the duration of job vacancies. In other words, job vacancies are filled much quicker in the eighties than in the early seventies.

Figure 2 shows that the share of long term unemployed in total unemployment varied from 10% in the beginning of the seventies to 25% in the late seventies. In the beginning of the eighties the share increased within a few years till almost 60%. The rapid employment growth did not lead to a substantial reduction of the share of long term unemployed, indicating the importance of the problem of persistent unemployment in the Netherlands.

1 The duration of job vacancies notified to the public employment office is equal to the average vacancy duration (Van Ours, 1990). See Appendix 2 for details on the data.
Information on labour mobility on the Dutch labour market is scarce. There is some information derived from labour force surveys, which were held two-yearly in the period 1975-1985. From these surveys it appears that in this period on average 6.3% of the employed workers moved from job to job every year, while 7.2% left their job, either because they were dismissed or because they left their job voluntarily (Van Ours, 1990).

3. Stock-flow dynamics

3.1 The matching function

Search theory describes how employers and (unemployed) job seekers are searching for each other. This search process eventually leads to vacancies that are filled. Vacancies originate because workers leave the job market or change jobs with different employers or because employment grows. Vacancies are filled by workers who change jobs with different employers or by unemployed. We distinguish short term unemployed workers (less than 1 year) from long term unemployed workers (1 year or more). The probability \( P^L \) that a long term unemployed worker finds a job may be less than the probability \( P^S \) that a short term unemployed worker finds a job. Long term unemployed workers may search less intensive or less efficient. Furthermore employers may be less willing to hire a long term unemployed worker. We specify the relation between both probabilities as:

\[
p^L = c_1 \cdot c_2 \cdot P^S = \Theta \cdot P^S \tag{1}
\]

in which: 
- \( c_1 \) = search efficiency of a long term employed worker compared to a short term unemployed worker
- \( c_2 \) = employers' acceptance probability of long term unemployed workers compared to short term unemployed workers
- \( \Theta \) = duration dependency parameter; \( 0 \leq \Theta \leq 1 \)
If $c_1=1$, long term unemployed workers search as intensive and efficient as short term unemployed workers; if $c_2=1$, employers do not discriminate between long term and short term unemployed workers. If $0<c_1<1$, the probability that a long term unemployed worker contacts an employer with a vacant job is smaller than that of a short term unemployed worker. If $0<c_2<1$, the employers are less willing to hire a long term unemployed worker. If $c_1=0$ long term unemployed workers do not search at all; if $c_2=0$ employers are not willing to hire a long term unemployed worker. Note that if there is duration dependency ($0<\delta<1$), this may be due to either workers behaviour, employers behaviour or a combination of both.

Empirical evidence on duration dependency is not conclusive. Empirical studies usually investigate whether the hazard rate, i.e. the conditional escape probability from unemployment, is duration dependent (see Kiefer (1988) for a survey of hazard functions). Kooreman en Ridder (1983) using aggregate data found duration dependency for female unemployed, but not for male unemployed. Van Opstal and Theeuwes (1986) using micro data on youth unemployment spells are inconclusive. Depending on the specification of the hazard rate they found negative duration dependency or a duration dependency which could not be distinguished from the so-called heterogeneity effect. This effect is caused by omitted variables or misspecification of the baseline hazard rate and may lead to fallacious duration dependency if it is not counted for. Groot en Ter Huurne (1988) is the only study which concludes that there is negative duration dependency of the escape probability from unemployment. Ridder (1987) and Gorter, Nijkamp and Rietveld (1991) find no significant negative or positive duration dependency.

Our model assumes that the probability that a short term unemployed worker finds a job increases with the number of vacancies and decreases with the weighted number of unemployed:

$$P^S = k \frac{V}{(U^S + \alpha U^L)^{1-\alpha}}$$  \[2\]

in which: $V =$ number of vacancies
    $U^S =$ number of short term unemployed
    $U^L =$ number of long term unemployed
    $k =$ efficiency parameter of the labour market
    $\alpha =$ parameter; $0<\alpha<1$

The flow of vacancies filled by unemployed in a period of time can be specified as:

$$F^u = P^S U^S + P^L U^L$$  \[3\]

in which: $F^u =$ flow of vacancies filled by unemployed

Combining [1] - [3] we get:

$$F^u = k \frac{(V^S + \theta U^L)^{1-\alpha}}{(U^S + \alpha U^L)^{1-\alpha}} \cdot V^{1-\alpha}$$  \[4\]

Equation [4] is a so called constant returns to scale Cobb-Douglas matching function of the labour market which specifies the relation between the flow of filled job vacancies and the stocks of unemployed and vacancies. If there is no duration dependency, the flow of filled job vacancies depends on the total number of unemployed workers. If there is the probability that a long term unemployed worker finds a job is zero and therefore the flow of filled job vacancies only depends on the number of short term unemployed workers.

Matching functions are not necessarily constant returns to scale Cobb-Douglas functions, but may also be specified more generally as for example constant elasticity of substitution functions. Empirical research indicates however that a constant returns to scale Cobb-Douglas matching function gives an adequate description of labour market developments.
Both Blanchard and Diamond (1989) and Van Ours (1991) estimate a Cobb-Douglas matching function and find constant returns to scale with an $\alpha$ of about 0.4.

Figure 3 Stocks and flows on the labour market

3.2 Employment, unemployment and vacancies

The relationships between stocks and flows, outlined in the following model, is illustrated in figure 3. Introducing time we specify equation [4] in such a way that the flow out of unemployment in quarter $t$, $F_{t}^{su}$, depends on the stocks of unemployed and vacancies in quarter $t-1$:

$$F_{t}^{su} = k \left( U_{t-1} + \theta U_{t-1}^{L} \right) \alpha V_{t-1}^{1-\alpha}$$

[5]

The total flow of filled job vacancies $F_{t}^{xv}$ is equal to the sum of the flow of unemployed workers finding jobs and the flow of the employed workers finding new jobs:

$$F_{t}^{xv} = F_{t}^{su} + S_{t}^{e}$$

[6]

in which: $S_{t}^{e} = \text{flow from job to job}$

The flow from job to job, for which data are constructed, is considered autonomous in the model, and could, in a later version be explained by a behavioural equation.
The stock of vacancies depends on inflow and outflow of vacancies:

\[ V_t = V_{t-1} + F_{t}^{iv} - F_{t}^{iv} \]  \[7\]

The inflow of vacancies \( F_{t}^{iv} \) is equal to the sum of vacancies originating from job leavers and the flow of new vacancies because of employment growth:

\[ F_{t}^{iv} = \mu_2 E_{t-1} + S_{t}^{v} + \mu_3 S_{t}^{e} \]  \[8\]

in which: \( E = \) employment

\( \mu_2 = \) fraction of workers leaving their job and the labour force

\( \mu_3 = \) the share of unfilled jobs becoming vacancies

\( S_{t}^{v} = \) new vacancies because of employment growth

The new vacancies variable \( S_{t}^{v} \) represents labour demand behaviour in the model and is, as yet, like the flow from job to job, considered autonomous. The formula above assumes that not every job left turns into a new vacancy. Some jobs left unfilled by workers moving to another job or retiring do not become vacant but obsolete.

In a dynamic labour market the stock of unemployed depends on inflow into, and outflow from unemployment:

\[ U_t = U_{t-1} + F_{t}^{iu} - F_{t}^{iu} \]  \[9\]

The flow into unemployment \( F_{t}^{iu} \) is equal to the sum of the inflow of workers from outside the labour market and the flow of workers losing their job due to dismissals:

\[ F_{t}^{iu} = \mu_1 E_{t-1} + S_{t}^{u} \]  \[10\]

in which: \( \mu_1 = \) fraction of workers losing their job

\( S_{t}^{u} = \) inflow from outside the labour market

Inflow from outside the labour market, \( S_{t}^{u} \), represents labour supply behaviour, and is, as yet, like the flow from job to job and the new vacancies variable, considered as an autonomous factor in the model. Now employment in quarter \( t \) becomes:

\[ E_t = E_{t-1} + F_{t}^{iu} \cdot \mu_1 E_{t-1} \cdot \mu_2 E_{t-1} \]

\[ = F_{t}^{iu} + (1-\mu_1-\mu_2) E_{t-1} \]  \[11\]

### 3.3 Unemployment dynamics

The model ([5]-[11]) above implies that the average probability \( P^S \) for short term unemployed to escape unemployment in quarter \( t \) should be equal to the ratio of the flow in quarter \( t \) of unemployed finding jobs and the sum of the stock of unemployed in quarter \( t-1 \) and the flow into unemployment in quarter \( t \):

\[ P^S_t = \frac{F_{t}^{iu}}{U_{t-1} + \theta U_{t-1}} \]  \[12\]

We have specified the escape probabilities in [1] and [2] in such a way, that they are consistent with [12]. Hence, equation [12] is implied by the model. In other words, the description of labour market behaviour in the matching function endogenizes the escape probability in our model, so that we do not need to specify a hazard function, which gives
a sheer probabilistic, as opposed to behavioural, explanation of the outflow from unemployment. We now built unemployment dynamics into our model by distinguishing $n$ duration classes of unemployment where $U_{it}$ (i=1,...,n) represents the unemployed over a period of {i-1,i} quarters with i=ω for i=n. By definition it holds that

$$U_t = U_{1t} + U_{2t} + U_{3t} + \ldots \ldots + U_{nt}$$

[13]

The number of unemployed in the first duration class is equal to the inflow into unemployment:

$$U_{1t} = F_{it}u$$

[14]

The numbers of unemployed in the next duration classes depend on the escape probabilities:

$$U_{jt} = (1 - P_{st}) U_{j-1,t-1} \quad \text{for } j=2,5,6,\ldots,n-1$$

[15]

As the highest class $n$ is an open class the number of unemployed in this class is equal to:

$$U_{nt} = (1 - P_{Lt}) (U_{n,t-1} + U_{n-1,t-1})$$

[16]

4. Model calibration

Now our dynamic labour market model consists of equations [5]-[16] with $S_t^v$, $S_t^u$ and $S_t^v$ as exogenous variables and $\alpha$, $\mu_1$, $\mu_2$, $\mu_3$ and $\theta$ as parameters which should be determined empirically and which represent labour market behaviour incorporated in the model.$^2$

The model is specified on a quarterly basis. Rather than estimating the parameters of the model, these parameters are set to plausible values, which are partly based on empirical results from the literature. Moreover, some crucial parameters are used as instruments to calibrate the model so that it gives good ex post predictions of labour market developments in the 1970s and 1980s.

Table 1 summarizes the results of several calibration experiments. The table presents two yardsticks for the adequacy of the model to describe past developments, namely the root mean square prediction error (RMSE), and Theil's inequality coefficient (INEQ). The latter provides a measure of the relative deviations of the ex post predictions from their realisations. These yardsticks are applied to the projections and realisations of the four main endogenous variables of the model, namely vacancies, unemployment, employment, and the share of long term unemployment (LU=U^L/U).

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$^2$ As can be seen from equation [5] the efficiency parameter of the labour market $k$ is determined by the values of both $\alpha$ and $\theta$. 
Table 1. Model calibration with selected parameter values.

<table>
<thead>
<tr>
<th>parameter values</th>
<th>fit of dependent variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha ) ( \theta )</td>
<td>( \mu_1 ) ( \mu_2 ) ( \mu_3 )</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0125 0.005 0.9</td>
</tr>
<tr>
<td>0.4 0.5</td>
<td>0.0125 0.005 0.9</td>
</tr>
<tr>
<td>0.6 0.5</td>
<td>0.0125 0.005 0.9</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0100 0.005 0.9</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0150 0.005 0.9</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0125 0.0075 0.9</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0125 0.0025 0.9</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0125 0.005 1.0</td>
</tr>
<tr>
<td>0.5 0.5</td>
<td>0.0125 0.005 0.8</td>
</tr>
<tr>
<td>0.5 1.0</td>
<td>0.0125 0.005 0.9</td>
</tr>
<tr>
<td>0.5 0.25</td>
<td>0.0125 0.005 0.9</td>
</tr>
</tbody>
</table>

Explanatory note: RMSE: Root mean square error  
INEQ: Theil's inequality coefficient

The table shows that the various parameter values selected by us do, in general, not influence the fit of the model very much. Moreover, none of the sets of parameter values clearly gives the best fit for all dependent variables. Consequently no model emerges distinctly as the best from this calibration procedure. We selected the model of the fourth line of table 1 as our basic model for the simulation experiments, because this model gives a reasonable fit for all variables involved. In the basic model we have a Cobb-Douglas matching function in which the number of unemployed have the same influence on the flow of job vacancies as the number of job vacancies \((\alpha = 0.5)\). The duration dependency parameter \( \theta \) is equal to 0.5, which means that the probability a long term unemployed worker escapes from unemployment is half of that of a short term unemployed worker\(^3\). The value of \( \mu_1 \) indicates that on a yearly basis 4% of the workers are dismissed, while the value of \( \mu_2 \) indicates that on a yearly basis 2% of the the workers leave their job and the labour force. Finally the value of \( \mu_3 \) of 0.9 indicates that of the jobs that are left voluntarily (due to job mobility or retirements) 90% turns into a job vacancy, while 10% is lost.

\(^3\) Our model describes aggregate labour market behaviour. Duration dependency originating from aggregate heterogeneity, the 'best' unemployed leaving unemployment first, is not inconsistent with duration independency on a micro-level. As stated before empirical studies using Dutch micro-data are inconclusive on duration dependency.
Figure 4. Realisations and model projections over the reference period 1971-1987.

Figure 4 pictures the fit of the four main endogenous variables in the basic model in the reference period. The model appears to describe the stocks of vacancies and unemployment very well, albeit that some computational problems occurred because of the low level of vacancies in the period 1981-1985. In this period the calculated stock of vacancies sometimes assumes negative values, which we have corrected to a small positive value. The good fit for these two variables is, however, rather obvious because they are largely determined by the autonomous inflow variables $S_u$ and $S_v$, which represent labour supply and demand behaviour. The time profile of employment is also reproduced quite well by our model. Finally, the share of long term unemployment in total unemployment is described with somewhat less accuracy by our model. Here, an overestimation of the flow into long term employment in the beginning of the 1980s leads to a projected long term unemployment, which lies above actual long term unemployment after that period.
5. Model simulation

We use the model to illustrate labour market dynamics by means of an impulse analysis, viz. by simulating labour supply and employment demand shocks (autonomous impulses in $S^*$ and $S^*$). Moreover a sensitivity analysis shows how the working of the model depends on major parameter values.

The baseline for each simulation run is a projection over 6 years, starting in 1988:1, in which the exogenous variables are given realistic values. As impulses we consider autonomous increases or decreases in the inflow of vacancies or inflow into unemployment by 50,000 labour years in each quarter of the first year of the simulation period. Hence, after the first year the total autonomous change is 200,000 labour years. The impulse effect is measured as the difference between the impulse projection and the baseline.

Table 2. The effects of an autonomous change of the number of vacancies by 50,000 in each quarter of the first year of the simulation period.

<table>
<thead>
<tr>
<th>Effects on</th>
<th>Increase of vacancies</th>
<th>Decrease of vacancies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>after</td>
<td>after</td>
</tr>
<tr>
<td></td>
<td>1 yr 3 yrs 6 yrs</td>
<td>1 yr 3 yrs 6 yrs</td>
</tr>
<tr>
<td>(numbers x 1000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>employment</td>
<td>97 134 91</td>
<td>-110 -161 -118</td>
</tr>
<tr>
<td>vacancies</td>
<td>47  5 4</td>
<td>-85  -6   -4</td>
</tr>
<tr>
<td>unemployment</td>
<td>-96 -140 -105</td>
<td>111 187 134</td>
</tr>
<tr>
<td>(% points of baseline projection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% unempl. 0-3 months</td>
<td>1.7  2.3  1.5</td>
<td>-1.4  -2.0  -1.5</td>
</tr>
<tr>
<td>% unempl. 3-6 months</td>
<td>1.2  2.1  1.4</td>
<td>-1.0  -1.8  -1.4</td>
</tr>
<tr>
<td>% unempl. 6-12 months</td>
<td>-1.0  2.6  1.7</td>
<td>0.3    -2.4  -1.8</td>
</tr>
<tr>
<td>% unempl. &gt; 12 months</td>
<td>-1.9  -7.1 -4.6</td>
<td>2.1    6.2  4.6</td>
</tr>
</tbody>
</table>

The left hand side of table 2 shows that after a few years an increase in the number of vacancies leads to a considerable growth of employment and a decrease of unemployment. About 2% of the newly created vacancies can, according to our model, not be filled. This employment shock also results in a decrease of long term unemployment. Apparently these new jobs are taken by those people who, according to our baseline projection, would become long term unemployed.

The right hand side of table 2 gives the results of an opposite demand shock: now the number of vacancies decreases by 200,000 in the first year of the simulation period. It appears that the model is not completely symmetrical. On the other hand, our model does not generate obvious asymmetries or ratched effects, in this simulation experiment.

Table 3. The effects of an autonomous change of the number of unemployed by 50,000 in each quarter of the first year of the simulation period.

<table>
<thead>
<tr>
<th>Effects on</th>
<th>Increase of unemployed</th>
<th>Decrease of unemployed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>after</td>
<td>after</td>
</tr>
<tr>
<td></td>
<td>1 yr 3 yrs 6 yrs</td>
<td>1 yr 3 yrs 6 yrs</td>
</tr>
<tr>
<td>(numbers x 1000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>employment</td>
<td>13  35  56</td>
<td>-14  -49  -72</td>
</tr>
<tr>
<td>vacancies</td>
<td>-6  -4  -3</td>
<td>7    4    3</td>
</tr>
<tr>
<td>unemployment</td>
<td>187 164 141</td>
<td>-186 -149 -122</td>
</tr>
<tr>
<td>(% points of baseline projection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% unempl. 0-3 months</td>
<td>2.8  -1.8 -1.4</td>
<td>-4.4  2.3  1.6</td>
</tr>
<tr>
<td>% unempl. 3-6 months</td>
<td>2.7  -1.6 -1.3</td>
<td>-4.2  2.1  1.4</td>
</tr>
<tr>
<td>% unempl. 6-12 months</td>
<td>4.6  -2.0 -1.6</td>
<td>-6.9  2.5  1.8</td>
</tr>
<tr>
<td>% unempl. &gt; 12 months</td>
<td>-10.1  5.4  4.3</td>
<td>15.5 -6.8 -4.7</td>
</tr>
</tbody>
</table>

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Table 3 summarizes the effects of a labour supply shock simulated by an increase and a decrease in the number of unemployed. We see that, according to our model, a supply shock does not enhance employment as much as a demand shock. It illustrates that the model with a high number of unemployed and a relatively low number of vacancies describes a labour market regime which is to a major extent demand determined. Due to the inflow of new unemployed, the share of short term unemployment in total unemployment increases in the first year of a simulation period. Consequently the share of long term unemployment decreases, but obviously not the number of long term unemployed. In the medium term most of the generation of unemployed due to the supply shock have become long term unemployed, so that the share of the long term unemployed increases as compared to the baseline. The results of table 3 again show that the model is symmetrical with respect to such shock, albeit that the long run employment effect of the negative supply shock is substantially larger (in absolute value) as that of the positive supply shock.

Table 4 The effects of an autonomous increase of the number of unemployed and vacancies by 50,000 in each quarter of the first year of the simulation period, using a different Cobb-Douglas function ($\alpha = 0.6$).

<table>
<thead>
<tr>
<th>Effects on</th>
<th>Increase of vacancies after</th>
<th>Increase of unemployed after</th>
</tr>
</thead>
<tbody>
<tr>
<td>(numbers x 1000)</td>
<td>1 yr</td>
<td>3 yrs</td>
</tr>
<tr>
<td>employment</td>
<td>86</td>
<td>110</td>
</tr>
<tr>
<td>vacancies</td>
<td>85</td>
<td>6</td>
</tr>
<tr>
<td>unemployment</td>
<td>-86</td>
<td>-115</td>
</tr>
</tbody>
</table>

(% points of baseline projection)

| % unempl. 0-3 months | 1.6 | 2.1 | 1.3 | 2.8 | -1.8 | -1.4 |
| % unempl. 3-6 months | 1.2 | 1.9 | 1.1 | 2.8 | -1.6 | -1.2 |
| % unempl. 6-12 months | -1.0 | 2.3 | 1.4 | 4.6 | -2.0 | -1.5 |
| % unempl. > 12 months | -1.7 | -6.3 | -3.8 | -10.2 | 5.5 | 4.1 |

Another way to investigate how the working of the model is affected by the modelling of labour market efficiency is to perform a sensitivity analysis on the parameter value in the matching function. Table 4 gives the results of that analysis. When unemployment obtains a somewhat higher weight in the matching function and vacancies a somewhat lower weight, it appears that a demand shock leads to less employment than in the basic model (compare table 2). In case of a supply shock, more employment results than in the basic model (compare table 3). The effect of a supply shock on employment is now about the same as the effect of a demand shock, indicating that a higher value for unemployment in the matching function makes the model drift away from the demand regime. Yet, from estimation of the matching function and from calibration over the reference period we learned that the parameter values of the matching function in the basic model ($\alpha = 0.5$) are rather stable and that a sensitivity analysis is realistic for small changes of these values only.

Finally we investigated the influence of duration dependency on the working of the model. Table 5 presents the results of supply and demand shocks, if we assume that there is no duration dependency in the probability that unemployed find jobs. It appears that a demand shock leads to less employment growth and a smaller decline in unemployment than according to a model with duration dependency. The difference, however, is small. The mechanism causing this phenomenon is complex. There are two opposite effects. The matching of vacancies and unemployed is, due to the value of the parameter $k$, more efficient in the model with duration dependency, than when no duration dependency has been assumed. On the other hand, the influence of the (weighted) unemployed is smaller with duration dependency. Apparently, the former effect dominates in case of a demand shock so that the model with duration dependency gives better results in terms of employment and unemployment. A supply shock in a model with no unemployment
duration dependency leads to almost the same effects as in a model with duration dependency.

### Table 5

The effects of an autonomous increase of the number of unemployed and vacancies by 50,000 in each quarter of the first year of the simulation period, using a model with no duration dependency.

<table>
<thead>
<tr>
<th>Effects on</th>
<th>Increase of vacancies after 1 yr</th>
<th>Increase of vacancies after 3 yrs</th>
<th>Increase of vacancies after 6 yrs</th>
<th>Increase of unemployed after 1 yr</th>
<th>Increase of unemployed after 3 yrs</th>
<th>Increase of unemployed after 6 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>employment</td>
<td>75</td>
<td>124</td>
<td>79</td>
<td>10</td>
<td>30</td>
<td>52</td>
</tr>
<tr>
<td>vacancies</td>
<td>90</td>
<td>7</td>
<td>4</td>
<td>-5</td>
<td>-6</td>
<td>-5</td>
</tr>
<tr>
<td>unemployment</td>
<td>-76</td>
<td>-129</td>
<td>-91</td>
<td>190</td>
<td>169</td>
<td>145</td>
</tr>
</tbody>
</table>

(Numbers x 1000)

<table>
<thead>
<tr>
<th>(% points of baseline projection)</th>
<th>% unempl. 0-3 months</th>
<th>% unempl. 3-6 months</th>
<th>% unempl. 6-12 months</th>
<th>% unempl. &gt; 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.3</td>
<td>2.4</td>
<td>1.6</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>2.3</td>
<td>1.4</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
<td>2.9</td>
<td>3.9</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>-2.7</td>
<td>-7.6</td>
<td>-4.9</td>
<td>-10.1</td>
</tr>
</tbody>
</table>

6. Conclusion

This paper presents a stock-flow model of the Dutch labour market, which describes the relationships between labour market efficiency and the duration of unemployment and vacancies in a consistent way. The model, which still has a somewhat mechanical character, is calibrated to reflect labour market developments in the Netherlands in the last two decades. From impulse simulations with the model we infer the following conclusions:

- With a relatively high number of unemployed and a low number of vacancies which is the actual situation in the Netherlands, the model mirrors a demand determined labour market regime. An increase in labour demand leads to a strong reduction of unemployment whereas very few of the additional vacancies remain unfilled. On the other hand, a labour supply shock creates less additional employment.

- The model generates not much asymmetry between positive and negative demand or supply shocks, although we assume that the escape probabilities from unemployment are duration dependent. It shows that the hysteresis mechanism built into the model appears not to be of major quantitative importance in the present simulations.

- The endogenous distinction between unemployment duration classes enables us to make labour market efficiency dependent upon the distribution of unemployment over the various duration classes in our model. As yet, the working of our model appears not to be affected very much by the influence of these unemployment characteristics on labour market efficiency.

As mentioned, our model still has a somewhat mechanical character, and contains, apart from a matching function, no behavioural relationships. It is remarkable that in a regime of high unemployment the simulation results resemble those of the traditional macro-economic disequilibrium models, with the usual behavioural equations for the stocks of labour demand and supply: employment can only be increased by a demand shock, whereas a supply shock results in an about equal increase in unemployment. As in our model demand and supply have been modelled by the matching function in a fully symmetrical way, we would have expected the effect of a supply shock on employment to be more substantial. Such effect of an increased participation to the labour force would be relevant from a policy point of view in the Netherlands, where high unemployment nowadays coincides with supply constraints on some sectors of the labour market.
Our model can, however, very well be extended into various directions. Firstly, the model parameters, especially those parameters representing the duration dependency of the escape probabilities from unemployment and of labour market efficiency, could be estimated instead of being determined by calibration. However, the highly non-linear character of the model and the many unobserved variables contained in it, will complicate such estimation. Secondly an extension of the model with behavioural equations for e.g. the inflow of vacancies (labour demand), the inflow into unemployment (labour supply) and a wage equation with endogenous hysteresis effects is desirable.

Such extensions may lead to a fully fledged model of the labour market, which incorporates several modern labour market theories that, up to now, have only be modelled separately. Our first experiments with the model indicate that it is a promising line of research.

References


Holmlund, B., 1984, Labor Mobility, Stockholm, Industrial Institute for Economic and Social Research.


List of symbols

$c_1$ relative search efficiency of long term unemployed
$c_2$ relative employers' acceptance probability of long term unemployed
$E$ employment
$F_{lu}$ flow into unemployment
$F_{lu}$ flow of unemployed finding jobs
$F'$ inflow of vacancies
$F''$ flow of filled vacancies
$k$ indicator for labour market efficiency
$LU$ share of long term unemployed in total unemployment
$P_e^l$ probability a long term unemployed worker find a job
$P_L$ probability a short term unemployed worker find a job
$P_{j,t}$ escape probability from duration class $j$ in period $t$, $j=1,..,n$
$S$ flow from job to job
$S'$ inflow from outside the labour market
$S''$ new vacancies because of employment growth
$U$ number of unemployed
$U^S$ number of short term unemployed (less than 1 year)
$U_L$ number of long term unemployed (1 year or more)
$U_{it}$ unemployed over a period of $[i-1,i)$ quarters where $i=1,..,n$ and with $i=\infty$ for $i=n$
$V$ number of job vacancies
$\alpha$ scale parameter in matching function; $0<\alpha<1$
$\theta$ duration dependency parameter; $0<\theta<1$
$\mu_1$ fraction of workers loosing their job
$\mu_2$ fraction of workers leaving their job and the labour force
$\mu_3$ fraction of unfilled jobs due to job mobility which become vacancies
Appendix 1. Source of the data

**Unemployment**

**Employment**
Yearly data on employment of wage earners and salaried employees (in persons) in the period 1971-87 are from OECD (1988). We used quarterly employment data from the Dutch Central Bureau of Statistics of the period 1984-1987 to determine quarterly fluctuations in employment. We then imposed this quarterly pattern on the yearly OECD data.

**Vacancy stock**
We used quarterly data on the number of notified vacancies from OECD (1989). To correct for the decline of the share of vacancies notified to the public employment office we used corrected vacancy data for the 1980s. These data are corrected using information from the CBS vacancy surveys. The CBS vacancy surveys are from October 1980, 1981, 1982, 1983, September 1984, January 1986, 1987, 1988. By interpolating we calculated the average share of notified vacancies for the years 1980-1987. We assumed that for the period 1961-1979 this share was equal to the share of 1980.

**Vacancy flow**
We used yearly data on vacancy flows to the public employment office of the period 1971-1978 from Hartog (1980) to calculate average vacancy durations (duration = stock/flow). 1980-1987: calculated using CBS vacancy survey data and applying the method described in: Van Ours/Ridder (1990). The average vacancy duration of 1979 was calculated by interpolating the durations of 1978 and 1980. By interpolating the yearly data we calculated quarterly duration data. Finally we calculated quarterly vacancy flows as the quotient of vacancy stocks and vacancy durations.

**Duration of unemployment**
Quarterly information on the elapsed duration of unemployment in classes 0-1 month, 1-3 months, 3-6 months, 6-12 months, more than 12 months, is from the Ministry of Social Affairs and Employment.
Summary

Traditional labour market models do not distinguish between stocks and flows. For a proper understanding of the functioning of the labour market and the persistence of long term unemployment, which has become a major problem in the Netherlands, it is, however, necessary to focus on labour market dynamics.

This paper specifies a quarterly stock-flow model of the Dutch labour market with a matching function and system of unemployment dynamics as its two main characteristics. The matching function specifies the flow of filled job vacancies as a constant returns to scale Cobb-Douglas function of the stocks of unemployed and vacancies, while the size of the vacancy flow also depends on an efficiency parameter. Unemployment dynamics are specified using duration dependent escape and retention probabilities. The efficiency parameter of the matching function depends on the share of long term unemployed: the higher this share the lower labour market efficiency.

The model is calibrated to simulate developments on the labour market in the Netherlands during the 1970s and 1980s. The main aim of the model is to analyze the relationship between the matching function and unemployment dynamics by simulating labour supply and demand shocks. With a relatively high number of unemployed and a low number of vacancies which is the actual situation in the Netherlands, the model mirrors a demand determined labour market regime. An increase in labour demand leads to a strong reduction of unemployment whereas very few of the additional vacancies remain unfilled. On the other hand, a labour supply shock creates very little additional employment. The simulations with the model show that in this regime unemployment dynamics do not affect the functioning of the labour market very much. Extensions of the model, e.g. by including behavioural labour demand and labour supply functions, and an equation describing wage formation, may challenge that conclusion.