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THE PACE OF STRUCTURAL CHANGE, CYCLICAL SHOCKS AND UNEMPLOYMENT DYNAMICS:
simulations using an empirical flow model

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Summary

During the last decade The Netherlands witnessed an increase in the pace of job creation and job destruction. A sensitivity analysis using an empirical model of labour market flows shows that 1. the congestion in the matching process due to the increase in the pace of job creation and destruction may have substantial effects on employment and unemployment; 2. the effects depend very much on the initial pace of labour market dynamics and they are larger when the initial pace is low; 3. the economy may be out of its unemployment equilibrium for quite a long time after a shock occurs. The novelty of the model is that it takes explicitly account of the propagation of shocks through the various duration classes of unemployment and allows for negative duration dependence. In the case of negative duration dependence caused by depreciation of human capital long-term unemployed become, to a certain extent, 'outsiders'. However, in the model simulations no much unemployment persistence is found as a consequence of cyclical fluctuations in the pace of job creation and destruction. The 'thin' market argument, i.e. the endogenous decrease in job creation in response to the depreciation of human capital following an adverse cyclical shock, does not lead to much persistence either according to our model, which assumes homogeneous (and equally productive) jobs and long run equlibrium unemployment.

Keywords: *Structural change, job destruction, job creation, impulse-response effects, matching process, hysteresis, cyclical shocks.*

1. Introduction

Technological progress, combined with preference shifts, forms the origin of structural change. It leads to the creation of new jobs, but also to the 'creative' destruction of jobs associated with techniques that become obsolete and unproductive. Changes in labour demand are the net result of these processes of job creation and job destruction. Empirical evidence indicates that the observed changes in employment, are rather small as compared to the underlying flows (see Davis, Haltiwanger and Schuh, 1996). Job destruction also causes workers to loose their jobs and become unemployed. On the other hand, part of the newly created jobs are taken by unemployed, who become employed. And again these flows into and out of unemployment

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appear to be much larger than the net unemployment effect of these reallocations of jobs and workers, which, in the rest of this paper, we will refer to as structural change.

The processes of job creation and destruction and the resulting labour market dynamics have been investigated using the flow approach to labour markets and equilibrium search theory (see e.g. Blanchard and Diamond, 1992, Pissarides, 1990. Mortensen and Pissarides, 1994, Mortensen, 1996). Unlike the traditional models of the labour market, which only describe net changes in stocks, the flow models of the labour market take account of the reallocation process, which concurs with structural change. Besides for industrialized countries the analysis of structural change is also warranted for economies, such as in Eastern Europe, which are in transition from a command to a market economy (see e.g. Burda, 1993).

Up to now the model based analysis of structural change and labour market dynamics has only been conducted using theoretical or calibrated empirical equilibrium search models, which focus on the comparative statics of long run equilibria, but which do not explicitly reckon with the propagation mechanism of cyclical or structural shocks on the short run (see e.g. Mortensen, 1996; Millard and Mortensen, 1995; Millard, 1996; see however Pissarides, 1990, Ch. 3 for a theoretical evaluation of the transition process). This paper purports to investigate the short run transition dynamics using a dynamic search model which describes the propagation of shocks through the various duration classes of unemployment and allows for (negative) duration dependence of unemployment. In doing so it illustrates the time pattern of the changes in the composition of the pool of unemployed, the escape probabilities from unemployment and unemployment duration in case of autonomous shocks to job destruction or job creation. Moreover, in contrast to the traditional dynamic policy models which describe adjustment mechanisms on an ad hoc basis by means of lag structures, our model derives its adjustment dynamics from the passage of time implicit in the search process.

Negative duration dependence may be a cause for unemployment hysteresis, when, after a negative demand shock, a relatively large number of unemployed gets 'locked up' into long term unemployment, where their escape probability is much lower in case of a subsequent positive shock then when no (cyclical) shocks would have occurred. Hence, in this modelling experiment unemployment hysteresis is merely due to the loss of skills (or ranking) associated with negative duration dependence. Layard and Bean (1989) have argued that this type of duration dependence is behind the persistence of employment shocks in Europe. However, the simulation results indicate that within the present modelling framework cyclical shocks to job creation and destruction do not cause much unemployment hysteresis when we calibrate the model using realistic parameter values for the matching function, duration dependence and the initial pace of structural change. It seems that an insider-outsider mechanism in wage formation in the vein of Lindbeck and Snower (1988) and Graafland (1991) is still needed to account for cyclically induced unemployment hysteresis. Alternatively unemployment hysteresis can result when the majority of newly created jobs is taken by new participants entering the labour market (schoolleavers, women) which mitigates the escape probabilities for those who have become unemployed due to job destruction.

The contents of this paper is as follows. The next section presents some stylized facts on the pace of structural change in The Netherlands and provides additional arguments for the simulation exercises. Section 3 discusses our empirical model of labour market flows and examines the construction of the dynamic unemployment equilibria, which act as central projections in various alternative versions of the model. These projections are used in the impulse analysis of section 4. This impulse analysis shows the quantitative effects of various autonomous shocks to job destruction and job creation on labour market dynamics. In this way variations in the pace of structural change and cyclical fluctuations are implemented in the model. A sensitivity analysis compares the effects according to the alternative versions of the model. Finally section 5 concludes.

2. Background and some stylized facts

Following Davis and Haltiwanger (1990, 1992) there is now ample empirical evidence on the basis of longitudinal establishment data sets that the major part of labour market dynamics is driven by idiosyncratic (firm specific) shocks and that most structural change takes place within sectors and regions. The evidence from these data sets also reveals that job destruction is countercyclical and job creation procyclical, but that the cyclicality of job destruction is much stronger than that of job creation. During bad times still a relatively large amount of job creation occurs. It implies that reallocation mainly takes place during recessions. A theoretical argument for this fact is that the opportunity costs of reallocation are lower in a recession than during cyclical upswings, when all productive capacity is needed for production (see Caballero and Hammour, 1994, 1996; Gautier and Broersma, 1995). Hence the pace of structural change and of the resulting labour market dynamics continuously changes over the phases of the cycle.

Table 1 shows some stylized facts on structural change and labour market dynamics in The Netherlands over the period 1970-1991. This evidence is based on a set of macroeconomic time series from a national accounting system constructed by Broersma and Den Butter (1995) which, as alternative to time series data derived from longitudinal microeconomic data sets, combines information on flows of jobs and persons from various data sources in a consistent way at the macro level. It should be noted that in this data set, and in the model of this paper, inflow of new vacancies is considered as part of job creation, and hence that, unlike in the methodology of data construction of Davis and Haltiwanger, a job is not necessarily taken by a worker.

The table confirms net changes in labour market stocks, such as employment, unemployment and vacancies, have been very small indeed as compared to the gross flows. Moreover, there is some evidence that the pace of structural change, as measured by total job turnover (job creation plus job destruction), has increased during the period under consideration. The same holds true for labour turnover, which includes job mobility for other reasons than creation and destruction of jobs. The table shows that about 60% of total labour mobility can directly be ascribed to structural change. Of course, much labour mobility is also connected indirectly with structural change, as some job movers will take newly created jobs and leave vacancies in case their old jobs are not destroyed. Finally we learn from the table that job creation and job destruction should not solely be associated with outflow from and inflow into unemployment. The empirical flow model of this paper gives a numerical description of all relationships between the keynote variables of the table and the calibration of the model is based on the size of the flows from the accounting system.

Table 1. Keynote figures on structural change and labour market dynamics in The Netherlands

	1970-1980	1981-1991	1985-1991
Annual averages of net absolute changes; × 1000 persons/jobs			
Employment	37	89	103
Unemployment	22	69	42
Vacancies	29	15	14
Annual averages; × 1000 persons/jobs			
Inflow into unemployment	335	465	473
Outflow out of unemployment	314	437	495
Job creation	497	627	727
Job destruction	488	578	615
Job turnover	985	1205	1341
Labour turnover	1802	1987	2247

Source: Broersma and Den Butter (1995)

As a our empirical flow model is centred around a matching function which describes the flow from unemployment to employment as the result of the search process between employers who post vacancies, the UV-curve can be considered as reduced form of our model. According to UV-analysis an increase in the pace of structural change leads to an outward shift of the UV-curve (see e.g. Den Butter and Abbring, 1994). That is because larger flows imply that more matches are to be made, so that, given the efficiency of matching, faster structural change may cause a rise in both unemployment and in vacancies due to congestion.

As mentioned in the introduction, a major aim of this paper is to give, by means of a sensitivity analysis, an impression of the empirical relevance of this phenomenon under various circumstances in the transition period after a temporary or permanent increase in the pace of structural change. Moreover, the paper purports to measure unemployment persistence in response to the observed cyclicality of labour market shocks. These shocks are implemented in the simulation exercises as autonomous shocks to job creation and/or job destruction. Hence we do not distinguish between the sources of these shocks, which may be preference shifts, product or process innovation, or other kinds of demand or supply shocks. Yet we note that the baseline projections of our simulations represent dynamic search equilibria where all stocks, and hence unemployment in the various duration classes are constant, but where the inflow of new vacancies and the outflow from employment to unemployment mimic the continuous processes of job creation and job destruction due to idiosyncratic shocks. For the sake of simplicity, and in order to facilitate the interpretation of the simulation results, these flows are kept constant in the baseline simulations. An alternative would be to model these idiosyncratic shocks as random drawings from some specific probability distributions.

The explicit modelling of the propagation of shocks through the various duration classes of unemployment in combination with the assumption of negative duration dependence is essential in order to obtain insight into the transition dynamics and the recognition lags in case of changes in the pace of structural change. However, this novelty of our approach goes at the expense of making the model less tractable analytically as compared to the theoretical or other calibrated empirical equilibrium search models from the literature. Our model can only be solved numerically. Besides, as the simulation exercises show that the propagation of shocks through the duration classes gives rise to quite complicated patterns of impulse responses, the specification of the rest of the model is deliberately kept rather simple, in order to enable an appropriate interpretation of the mechanisms at work.

3. The Model

Our model distinguishes three labour market positions for the working age population: the *employed* (E), the *unemployed* (U) and the *(voluntary) non-participants* (= outside the labour force) (see the list of symbols). In addition to the relevant flows of persons between these stocks (see also Marston, 1976), the model also describes the stock of *vacancies* (V) and the consequent flows of jobs. Obviously these flows of jobs are linked to the flows of persons: the model explicitly takes account of these relationships. The version of the model used in the simulation experiments is specified on a monthly basis, which proves to approximate the continuous time character of the theoretical model sufficiently. In case of longer time intervals, e.g. an annual model, in some versions the net outflow of vacancies became larger than the stock of vacancies, so that in the next period the stock of vacancies was negative.

At the core of the model is a matching function which is an equation describing search behaviour. Hence, search theory provides the micro-economic foundation of the model. As such matching functions are nowadays well established both theoretically and empirically in labour economics we will not further assert their relevance in the context of a model of labour market flows. In the basic version of our simulation model we distinguish between short term unemployment (U_S; < 1 year) and long term unemployment (U_L; > 1 year) in a Cobb Douglas specification of the matching function with constant returns to scale:

(1) $$F_{uev} = c\,V^{1-\alpha}(U_S + \theta U_L)^{\alpha}$$

Here c represents the efficiency of the matching process, α is the parameter of the Cobb Douglas function and θ is a measure of duration dependence of the escape probability of the unemployed ($0 < \theta < 1$ in case of negative duration dependence).

The disaggregation of the various duration classes of unemployment enables us to consider the escape probabilities and the resulting flows out of unemployment of several categories of unemployed separately. The escape probabilities from short term (π_S) and long term unemployment (π_L) are respectively:

(1b) $$\pi_S = UO / (U_S + \theta U_L)$$

(1c) $$\pi_L = \theta \pi_S$$

where $U_{1,t} = UI$[1]

is the inflow into the first duration class of unemployment; for the following duration classes holds:

$$U_{k,t} = (1-\pi_S)\,U_{k-1,t-1} \quad \text{for } k = 2,3,\ldots,12$$

$$U_S = U_1 + U_2 + \ldots + U_{11} + U_{12}$$

$$U_L = U - U_S$$

[1] As our simulation model is specified with discrete time intervals, we have also experimented with a model version which accounts for the outflow from unemployment within the first duration class (month) in the following way:

$$U_{1,t} = (1-0.5\pi_S)\,UI$$

This change in specification does not, however, alter the simulation results very much.

(and $U_L = (1-\pi_L) U_{L,t-1} + (1-\pi_S) U_{12,t-1}$).[2]

In order to account for feedback mechanisms we need to close the models using simple definition equations. Obviously the outflow of vacancies (VO_u), associated with the successful matches described by the matching function, is equal to the flow to employment of those who find a job by filling a vacancy (F_{uev}):

$$(2) \qquad VO_u = F_{uev}$$

Next we have the equations of motion which set the stocks of the model equal to the respective stocks in the previous period plus the inflows (VI, UI, EI) minus the outflows (VO, UO, EO):

$$(3) \qquad V = V_{-1} + VI - VO = V_{-1} + VI - VO_u - VO_{ex}$$

$$(4) \qquad U = U_{-1} + UI - UO = U_{-1} + F_{eu} + UI_{ex} - F_{uev} - UO_{ex}$$

$$(5) \qquad E = E_{-1} + EI - EO = E_{-1} + F_{uev} + EI_{ex} - F_{eu} - EO_{ex}$$

Here VI, VO_{ex}, F_{eu}, UI_{ex}, UO_{ex}, EI_{ex}, and EO_{ex} are exogenous flows and constant in all simulations (except when shocks are implemented through these variables). The five equations above constitute the flow model used in most of the simulation experiments.

As mentioned before in our model the autonomous flows VI and F_{eu} represent job creation and job destruction. It should be noted that the escape probabilities from short and long term unemployment, π_S and π_L, in equations (1b) and (1c) are *endogenous* in the model. The simulation experiments show that their value may change considerably in the transition period in response to an autonomous shock to job destruction and/or job creation. Yet we note that the exogenous flow UO_{ex}, which partly determines the size of these escape probabilities, includes both unemployed who become non-participants and unemployed who find a (new) job without filling a vacancy. According to the data set the latter flow is quite substantial and should be endogenised in future versions of the model.

Equation (4) shows that the inflow into unemployment (UI) consists of a part associated with job destruction (F_{eu}) and a residual part (UI_{ex}) which consists of non-participants who register as

[2] As the model is based on discrete time intervals, this identity only approximately holds in the simulation experiments.

unemployed. The present version of the model assumes that all inflow into unemployment joins the first duration class of unemployment. It implies that the individual labour market history of the newly unemployed does not matter and that heterogeneity at the micro level is not considered as a cause of duration dependence at the macro level. The latter case would require a desaggregation of the stock of unemployed and of the respective flows through the duration classes of unemployment. After a cyclical downturn the short term unemployed would in general have high induvidual escape possibilities, whereas after a cyclical upturn the stock of short term unemployed would mainly consist of unemployed with low individual escape possibilities. Therefore, under the assumption of heterogeneity at the micro level the (macro) value of θ would vary over the stages of the cycle. However, θ is constant in the present version of the model which implies that negative duration dependence is associated with loss of skills and stigmatizing of long term unemployed. A future version of the model could also relax the assumption that non-participants who register as unempoyed and unemployed due to job destruction are homogeneous and have the same escape probabilities from unemployment in the matching process.

The central projections of the simulation experiments are constructed as dynamic equilibria based on average monthly values in the last year of observation from the macro data set constructed by Broersma and Den Butter (1995), and are calculated given the equilibrium values of the stocks. The list of symbols shows the annual amounts for the respective equilibrium values of the flows (in numbers of persons/jobs x 1000) in parentheses. Nowadays much empirical evidence on the parameter values of (Cobb-Douglas)-matching functions is available. Therefore, rather than estimating the matching function we calibrate our model and base its empirical specification on estimates by Van Ours (1991) for The Netherlands (see also Blanchard and Diamond, 1989). In the basic version of our model we set $\alpha = 0.5$ and $\theta = 0.5$, but these parameter values will be subject of a sensitivity analysis. The constant term c of the matching function is determined by the dynamic equilibrium, given the other parameter values of the matching function, and given the data on F_{uev}. Hence, generally the value of c differs in each alternative central projection. The basic projection assumes 400,000 unemployed, 50,000 vacancies and a total employment of 6 million, which mirrors the present situation in The Netherlands. The fact that all (endogenous) stocks and flows are to be constant in the baseline simulation imposes restrictions on the exogenous flows from the data set. We corrected the data in such a way that they comply with these restrictions. According to the basic baseline projection the share of long-term unemployed in total unemployment amounts to 40%. This is in accordance with the actual percentage in the early 1990's, which indicates that the dynamic unemployment equilibrium and the escape probabilities from unemployment of our basic version of the model adequately describe the actual situation in that period. Yet we note that the baseline simulation of our model does not purport to mimic the actual time path of keynote variables in the past, as central projections of traditional dynamic policy models do. The baseline of our model just describes a benchmark equilibrium with realistic values. This is in conformity with the calibration of general equilibrium models. The baseline equilibria of our model, where the inflow in each duration class of unemployment should be equal to the outflow from that class, is calculated using a non-linear solution algorithm from the GAUSS-programme (see Den Butter and Abbring, 1994, for a proof of the existence of such unemployment equilibria with heterogeneous unemployment).

The main characteristic of the basic specification and of the alternatives used in the sensitivity analysis are given in table 2. The alternative projection 1 represents the situation with an equal number of vacancies and unemployed[3]. This projection yields a dynamic unemployment equilibrium in which, given the specification of the matching function, the effects of shocks which affect U' ($= U_S + \theta U_L$) and V are symmetrical. Alternative projection 2 illustrates a situation of low labour market dynamics: in the central projection all data on labour market flows are set to 1/3 of their original value in the basic projection. Now, in equilibrium, the share of long-term unemployment in total unemployment is 72.6%. In this case U' is smaller than U' of the basic projection so that, according to the matching function, an increase in job creation which enhances the stock of vacancies, is expected to have a smaller effect on employment in this situation of low labour market dynamics than in the basic projection. Alternative projection 3 has the same low labour market dynamics as alternative 2 but also a lower escape probability for long-term unemployed: $\theta = 0.2$ instead of 0.5. Additionally, in alternative projection 4 unemployment obtains a high weight in the matching function (0.8 instead of 0.5), which will again reduce the relative employment effect of an increase in job creation as compared to the effect according to the basic simulation.

Alternative projection 5 considers the case where the escape probability from unemployment for the long term unemployed is zero. Here we distinguish two groups of short term unemployed: the escape probability to employment for the unemployed in the first 6 duration classes is higher than for those in duration classes 7-12 (see the Annex for a discription of this version of the model). It should be noted that the condition of constant unemployment in the baseline simulation only holds for short term unemployment in this model. We investigate this boundary case in order to see whether this specification of the model may generate hysteresis in unemployment, when negative cyclical shocks are followed by positive shocks. The intuition behind it is that after negative shocks with zero escape probability, part of the additionally unemployed will be locked up completely into long term unemployment and will not be available for matches when more jobs are created during a subsequent upswing.

[3] This alternative version of the model needs a monthly specification (or a specification with smaller intervals) because in a quarterly specification the escape probability of the short term unemployed ($\pi_S = UO / (U_S + \theta U_L)$) exceeds unity.

Table 2. Numerical values for baseline models

Specification	U (x 1000)	V (x 1000)	α	θ	U_L/U (in %)	Flows
Basic	400	50	0.5	0.5	39.9	according to data set
Alternative 1	100	100	0.5	0.5	1.1	according to data set
Alternative 2	400	50	0.5	0.5	72.6	1/3 of flows data set
Alternative 3	400	50	0.5	0.2	76.4	1/3 of flows data set
Alternative 4	400	50	0.8	0.2	76.4	1/3 of flows data set
Alternative 5[1]	400	50	0.5	0.5	19.0	according to data set
Alternative 6[2]	400	99.6	0.5	0.5	39.9	according to data set

[1] Version of model with no escape from long term unemployment to employment (see Annex)

[2] Wage formation and vacancy supply are endogenised following Gautier and Den Butter (1996); Autonomous shocks to VI are implemented by adding an exogenous variable VI_{ex}, which is set equal to zero in the baseline projection.

Finally alternative projection 6 relates to a version of the model by Gautier and Den Butter (1995) where wage formation and vacancy supply are endogenized. In this version of the model the surplus value of a match is determined by the differences between the assets value of being employed and being unemployed. Subsequently wages are determined in a bargaining game between employers and unemployed as the Nash solution of sharing that surplus value. Given the general wage level calculated in this manner, the vacancy supply can be derived from the assumption that in the equilibrium all profit opportunities from new jobs are exploited. In case of transition to a new dynamic equilibrium, this assumption implies that employers have myopic expectations and consider the actual values of the labour market variables as equilibrium values. The reason for considering this version of the model in the present paper is to see whether endogenizing wages in accordance with equilibrium search theory would, like insider-outsider theory, generate hysteresis in case of cyclical shocks. Moreover, as the surplus value of a match will decline in case of depreciation of human capital of job seekers, the model may replicate the thin market externality of Pissarides (1992) as possible cause of unemployment persistence.

4. Effects of increases and cyclicality in the pace of structural change

In order to get insight in the working of the model by means of an impulse-response analysis we start by assessing the impact of an autonomous increase in job destruction. We consider a temporary increase in job destruction with 5,000 jobs which is implemented as an autonomous additional outflow from employment to unemployment of 417 in each month of the first year of the simulation period. However, as the main purpose of the model simulations is to illustrate the relative effects of changes in the pace of structural change, the specific size of the shock is rather irrelevant. Table 3 gives the effects of these simulations according to the basic version of the model and according to alternative versions considered in this paper. The impulse-response effects in this table, and in the tables to come, are measured at the end of the year - i.e. the 12th month of the year.

Table 3. The effects of an autonomous temporary increase in job destruction implemented as an impulse to the outflow from employment to unemployment (F_{eu})

		Model specification						
		Basic	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
effect on employment (in % of the size of the shock)								
effect after								
1	yr.	-92.4	-72.2	-95.1	-92.5	-86.1	-126.2	-75.2
2	yrs.	-91.1	-59.4	-91.9	-89.8	-77.6	-144.5	-45.3
3	yrs.	-91.8	-57.9	-91.6	-91.5	-78.0	-156.6	-29.3
6	yrs.	-91.9	-57.6	-91.4	-93.0	-78.6	-164.9	-8.0
10	yrs.	-91.9	-57.6	-91.4	-93.2	-78.8	-165.6	-1.4

Explanatory note: shocks are represented by an autonomous change of 417 in each month of the first year of the simulation period.

Table 3 shows that according to the basic version of the model the loss of jobs leads to a fall in employment, and hence to an increase in unemployment of almost the same size. Yet, some additional vacancies are filled, because the probability of filling a vacancy has become somewhat larger due to the increase in unemployment. About 8% of those whose job is additionally destroyed, find a new job by filling an existing vacancy. Table 3 also demonstrates that according to the basic specification and alternatives 2 to 4 there is no much difference between the short term and the long term effect. Reaction lags are somewhat longer in the case of alternatives 3 and 4 with a low initial pace of structural change. In the case of alternative 1 the negative effect of job destruction on employment is larger in the short run than in the long run. Although the baseline of alternative 1 has as many vacancies and unemployed, the effects are not completely symmetric: more than a half of the employed who now loose their job become unemployed and only less than half of these job loosers find a new job by filling an existing vacancy. Alternative 5, with no escape probability for long term unemployed, shows a large reaction and long recognition lag as reaction to a temporary increase in job destruction. Finally in the case of alternative 6 with endogenous wage formation and vacancy supply, the economy returns to its original equilibrium, but the transition period appears to be rather long. Here the increase in job destruction leads more short-term unemployed, which makes the opening of new vacancies more profitable so that in the end the creation of new jobs fully compensates the temporary increase in the pace of job destruction.

Table 4. The effects of an autonomous temporary increase in the pace of labour market dynamics implemented as simultaneous impulses to the outflow from employment to unemployment (F_{eu}) (job destruction) and to the inflow of new vacancies (VI) (job creation)

	Model specification						
	Basic	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
effect on employment (in % of the size of the shock)							
effect after							
1 yr.	-38.8	-41.0	-68.5	-65.5	-74.1	-81.4	-67.7
2 yrs.	-5.1	-7.5	-33.9	-31.4	-48.5	-65.6	-40.6
3 yrs.	-0.8	-1.6	-17.2	-16.7	-36.2	-65.5	-26.2
6 yrs.	-0.0	-0.0	-2.1	-2.4	-14.7	-65.6	-7.1
10 yrs.	-0.0	-0.0	-0.1	-0.2	-4.2	-65.7	-1.3
average monthly escape probability from unemployment (π = UO/U) in %							
after							
0 yr.(st. state)	8.8	35.0	2.9	2.9	2.9	8.8	8.8
1 yr.	9.2	31.9	3.2	3.2	3.1	8.4	8.5
2 yrs.	8.8	34.3	3.0	3.0	2.9	8.1	8.5
3 yrs.	8.8	34.8	3.0	3.0	2.9	8.1	8.6
6 yrs.	8.8	35.0	2.9	2.9	2.9	8.1	8.7
10 yrs.	8.8	35.0	2.9	2.9	2.9	8.1	8.7

Explanatory note: shocks are represented by an autonomous change of 417 in each month of the first year of the simulation period.

Table 4 gives the effects of simultaneous job creation and job destruction, which represents a temporary increase in the pace of structural change. As before, job destruction is implemented as an autonomous impulse to the outflow from employment to unemployment, whereas job creation is implemented as an additional and autonomous inflow of new vacancies. These temporary increases are again evenly distributed over the 12 months of the first year of the simulation period. Table 4 illustrates that the increase in the pace of structural change leads to an outward shift of the (reduced-form) UV-curve in the basic version of the model and in all alternatives. Total labour demand and supply are fixed in these versions, so that the decrease in employment reported in the table coincides with increases in both the number of unemployed and the number of vacancies after the shock. A similar outward shift is also apparent in alternative 6 with endogenous wage formation and vacancy supply. Yet, as the impulses are temporary, the model finally returns to its original dynamic equilibrium, with the exception of alternative 5. In this alternative, due to the increased pace of job destruction the flow into long term unemployment becomes larger than in the baseline; these long term unemployed do no longer count as effective labour supply in the matching process so that the final effect of the temporary increase on employment remains negative. It appears that the outward shift of the UV-curve because of the congestion effect is much smaller and the return to the original equilibrium is much faster according to the basic version of the model, and alternative version 1, than according to the alternative versions 2 to 4 with low initial labour market dynamics. It illustrates that the speed of return to equilibrium appears to depend much on the specification of the model. Alternative 4, with low labour market dynamics, high duration dependence of unemployed and a large weight of unemployed in the matching function, has the longest recognition lag. Together with alternative 5 this version of the model also yields the largest short run impulse-response to a concurrent increase in job destruction and job creation. A comparison with the time profile of impulse-responses according to alternatives 2 and 3 reveals that the relatively large short run effect can mainly be attributed to the initial low pace of labour market dynamics, whereas the long recognition lag relates to the high weight of unemployment in the matching function. The fact that the return to baseline equilibrium is almost as fast in alternative 1 as in the basic specification of the model, indicates that the initial position on the UV-curve (a high number of unemployed and a low number of vacancies versus an equal number of unemployed and vacancies) does not change the working of the model very much in this simulation experiment. It is noticeable that reaction lags are also quite long in alternative 6 with endogenous wage formation and vacancy supply, and with an initial pace of structural change which is equal to that of the basic version.

The lower half of table 4 shows the dynamics of the average monthly escape probabilities from unemployment which result from the increase in labour market dynamics. As we have seen that according to all alternative model specifications considered here the economy returns to its original equilibrium, the escape probabilities also move back to their original steady state values. In the basic specification of the model and in alternatives 2 to 5 the increase in the pace of labour market dynamics leads to an increase in the escape probability on the short term. On the other hand, in alternative 1 with an equal number of vacancies and unemployed, in alternative 5 and in alternative 6 with endogenous wage formation and vacancy supply, the escape probability decreases in the first years after the shock. All in all, these results illustrate that the propagation dynamics of macroeconomic shocks through the escape probabilities can be rather complicated. Therefore, these dynamics may be misspecified in microeconomic studies of the determinants of escape probabilities, where macroeconomic determinants are added to the list of personal characteristics as explanatory variables and where lag structures are not taken into account in a proper way. More in general, it shows that at the macro level the focus should be on the explanation of flows and that, as our model does, escape probabilities and durations should be determined endogenously by the model.

Table 5. The effects of an autonomous permanent increase in the pace of labour market dynamics implemented as simultaneous impulses to the outflow from employment to unemployment (F_{eu}) (job destruction) and to the inflow of new vacancies (VI) (job creation)

	Model specification						
	Basic	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
effect on employment (in % of the size of the shock)							
effect after							
1 yr.	-37.7	-41.0	-67.4	-64.8	-73.6	-413.1	-67.5
2 yrs.	-42.5	-48.5	-99.8	-95.2	-120.7	-592.2	-108.0
3 yrs.	-43.3	-50.1	-116.2	-111.1	-155.5	-667.9	-134.3
6 yrs.	-43.4	-50.5	-130.8	-126.5	-215.0	-721.6	-169.4
10 yrs.	-43.4	-50.5	-132.9	-129.0	-244.4	-726.5	-180.2

Explanatory note: shocks are represented by an autonomous change of 417 in each month of the simulation period.

Table 5 gives the results of a permanent change in the pace of structural change. Now the economy moves to a new dynamic equilibrium with less employment when job destruction and job creation increases. This is not only true for the basic specification and alternatives 1 to 5 with fixed labour demand but also for alternative 6 with endogenous wage formation. In all simulation experiments the new equilibrium is reached monotonously: there is no overshooting. The transition to the new equilibrium is relatively fast according to the basic model specification and according to alternative 1. These model versions also show rather moderate final effects of a permanent change in the pace of job creation and job destruction. The effects are about half the size of the shocks. However, the reaction of the model appears to be much more substantial if the initial pace of structural change is low. Alternatives 2 to 4 yield long-run impulse-responses which considerably exceed the size of the shocks. This is especially true for version 4 where unemployment has a high weight in the matching function. The simulation also shows that it takes far more than 10 years before the new equilibrium is reached. The reaction lag is somewhat shorter in alternative 5 with no escape for the long term unemployed, but the negative employment effect of the increase in the pace of structural change is very large in this case. This sensitivity analysis indicates that a proper specification and estimation of the matching function is especially important in case of low labour market dynamics.

The results for alternative version 6 in table 5 show that, when wage formation and the supply of vacancies (and hence labour demand) are endogenized in the model, the negative effect of a permanent increase in the pace of labour market dynamics on employment is much higher than in the similar specification with fixed wages and labour demand. The major reason is that with increased labour market dynamics, there is more job destruction, which makes job tenure more uncertain and therefore leads both to a rise in wage demands and to a fall in profitability of opening a vacancy.

We also calculated the impulse-response effects of a slowdown in the pace of structural change. It appeared that for all versions of the models the impulse-responses are almost the mirror image of those in case of positive shocks to job creation and job destruction. Therefore we do not present these results in the table. Now there is a temporary increase in employment resulting from an inward shift of the UV-curve.

Table 6 summarizes the results of a number of simulation experiments which mimic the cyclical pattern in job destruction and job creation. In the experiments of the upper part of the table a positive temporary shock to job creation in the first year of the simulation period is followed by a temporary shock of the same size to job destruction in the fourth year of the simulation period. Similarly, the experiments of table 7 have a temporary increase in job destruction followed after three years by an increase in job creation. Hence, the former experiments represent a cyclical upswing followed by a downswing, whereas the latter experiments picture bad times followed by good times.

Table 6 shows that, according to the basic model specification and according to alternatives 1, 2 and 3 the economy returns to its original steady state equilibrium after a full cycle. It implies that according to these versions of the model an economy which is hit by symmetrical cyclical shocks does not deviate permanently from its structural trend. Hence, there is no sign of hysteresis or of positive or negative welfare effects from cyclical fluctuations. The same holds for these four models specifications in case of reversed cyclical fluctuations as is shown in table 7.

Table 6. Effects of cyclical changes in the pace of structural change where a temporary increase in job creation (VI) in the first year is followed by a temporary increase in job destruction (F_{eu}) after 3 years (starting in the first month of year 4).

	Model specification						
	Basic	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
effect on employment (in % of the size of the shock)							
effect after							
1 yr.	51.2	25.5	25.0	24.6	10.0	5.1	7.5
2 yrs.	83.2	40.7	54.7	54.0	24.0	22.4	4.7
3 yrs.	89.0	43.6	71.1	71.0	35.0	29.1	3.1
6 yrs.	0.1	-0.7	-2.9	-1.1	-16.9	-61.2	-28.5
10 yrs.	0.0	-0.0	-0.2	-0.1	-4.9	-65.5	-5.0
effect on unemployment (in 1000 labour years)							
effect after							
1 yr.	-25.6	-12.7	-12.5	-12.3	-5.0	-2.6	-3.7
2 yrs.	-41.6	-20.4	-27.3	-27.0	-12.0	-11.2	-2.4
3 yrs.	-44.5	-21.8	-35.5	-35.5	-17.5	-14.5	-1.5
6 yrs.	-0.1	0.3	1.4	0.5	8.5	30.6	14.2
10 yrs.	-0.0	0.0	0.1	0.0	2.4	32.8	2.5
average monthly escape probability from unemployment (π = UO/U) in %							
after							
0 yr.(st. state)	8.8	35.0	2.9	2.9	2.9	8.8	8.8
1 yr.	10.2	41.8	3.4	3.4	3.1	9.2	8.9
2 yrs.	9.9	44.3	3.4	3.4	3.1	9.1	8.8
3 yrs.	9.9	44.8	3.3	3.3	3.2	9.1	8.8
6 yrs.	8.7	34.9	2.9	2.9	2.9	8.1	8.6
10 yrs.	8.7	35.0	2.9	2.9	2.9	8.1	8.7

More interesting but also puzzling results are obtained for alternatives 4 to 6. For alternative 4 we obtain a negative effect on welfare on the long run, both in the case that good times are followed by bad times as in the case that bad times are followed by good times. The negative effect is, by the way, more substantial in the latter case than in the former case. Both when good times are followed by bad times and when bad times are followed by good times unemployment has risen with about 2/3 of the size of the shock on the long run in alternative 5. Hence, in case there is no escape probability for long term unemployed - and, as a matter of fact in case the model looses its character of an unemployment equilibrium model - cyclical fluctuations surely yield unemployment hysteresis. Hence, this alternative version 5 generates the type of hysteresis which was expected in this specification of the model with no escape probability from unemployment. We see that after a negative cyclical shock more people get trapped into unemployment, from which they are unable to escape during the cyclical upswing. This is hysteresis which results from a loss of skills during unemployment or from ranking. However, the size of the final effect does not differ from the effect found in table 4 with a temporary *simultaneous* increase in the pace of job creation and job destruction.

Table 7. Effects of cyclical changes in the pace of structural change where a temporary increase in job destruction (F_{eu}) in the first year is followed by a temporary increase in job creation (VI) after 3 years (starting in the first month of year 4).

	Model specification						
	Basic	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
effect on employment (in % of the size of the shock)							
effect after							
1 yr.	-92.4	-72.2	-95.1	-92.5	-86.1	-126.2	-75.2
2 yrs.	-91.1	-59.4	-91.9	-89.8	-77.6	-144.5	-45.3
3 yrs.	-91.8	-57.9	-91.6	-91.5	-78.0	-156.6	-29.3
6 yrs.	-1.0	-1.1	-17.0	-19.2	-37.3	-77.3	-4.9
10 yrs.	-0.0	-0.0	-1.0	-1.4	-11.1	-66.1	-0.9
effect on unemployment (in 1000 labour years)							
effect after							
1 yr.	46.2	36.1	47.5	46.2	43.0	63.1	37.6
2 yrs.	45.5	29.7	46.0	44.9	38.8	72.3	22.7
3 yrs.	45.9	29.0	45.8	45.8	39.0	78.3	14.7
6 yrs.	0.5	0.5	8.5	9.6	18.6	38.7	2.5
10 yrs.	0.0	0.0	0.5	0.7	5.6	33.0	0.4

In alternative 6 with endogenous wage formation and vacancy supply the economy has, after a full cycle, almost returned to base line values when bad times are followed by good times (table 7). However, when good times are followed by bad times the outcome for employment is, after 10 years, somewhat below that of an economy without cyclical fluctuations. In this case it is the rise in wages, induced by the good times, which is not completely matched by an equal decrease in wages during bad times. Yet, the effects on the long run are by no means substantial. It implies that the equilibrating mechanisms in the model are quite strong and that the model does not generate multiple equilibria which would result in unemployment persistence when the economy is hit by cyclical shocks. Therefore, the mechanism that depreciation of human capital, associated with long spells of unemployment, leads both to a lower escape probability from unemployment and to a thin market externality in this version of the model, appears to have no permanent influence on the economy. The thin market externality is illustrated by Pissarides (1992) in a stylized model where, because of the loss of skills of unemployed workers, they are less attractive for firms so that fewer jobs come to the market in the next period. This leads to more unemployed in the next period and to even more loss of skills and even less new jobs as compared to the baseline without shocks. However, unlike in the model of Pissarides, in our model a long spell of unemployment does not make a worker less productive in case he or she finds a new job. Jobs are homogeneous in our model. The only consequence of long term unemployment is that it is more difficult and takes, on average, more time before a long-term unemployed worker, as compared to a short-term unemployed worker, finds a new job. This can be the reason that the thin market externality does not show off in our simulation exercises.

In the previous analysis cyclical fluctuations are implemented as successive temporary increases in job creation and destruction. However, empirical modelling of the flow approach enables us to consider various other types of cyclicality, for instance a string of positive and negative shocks to job destruction. This representation of cyclicality would be in line with the empirical findings mentioned in section 2, that countercyclical fluctuations in job destruction are much larger than procyclical fluctuations in job creation, which implies job reallocation to be countercyclical. Table 8 gives the simulation results for this alternative implementation in the model of bad times followed by good times.

The results of table 8 show that in this case there is no unemployment hysteresis in alternatives 1 to 4. It is interesting to note that this alternative way of modelling bad times followed by good times yields substantial different long run outcomes for alternative 4 as compared to table 7. On the other hand, the results for alternative 5 with a considerable amount of unemployment hysteresis do not differ much from those in table 7. Finally the employment effect after 10 years is slightly positive for alternative 6, whereas it was slightly negative in table 7.

The sensitivity analysis shows large differences in responses to cyclical shocks according to the various versions of the model. There are large asymmetries with respect to the phases of the cycle. The pattern of response to the sequence downswing-upswing appears to differ quite a lot from the response to the string of shocks in the opposite order. This is also true for alternative 1, which has an equal number of vacancies and unemployed so that one would expect symmetrical reactions to increases in unemployment and in vacancies in the matching function. The asymmetries enter through the specification of heterogeneous unemployment and through the specification of the rest of the model.

Table 8. Effects of cyclical changes in the pace of structural change where a temporary increase in job destruction (F_{eu}) in the first year is followed by a temporary decrease in job destruction (F_{eu}) after 3 years (starting in the first month of year 4).

	Model specification						
	Basic	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
effect on employment (in % of the size of the shock)							
effect after							
1 yr.	-92.4	-72.2	-95.1	-92.5	-86.1	-126.2	-75.2
2 yrs.	-91.1	-59.4	-91.9	-89.8	-77.6	-144.5	-45.3
3 yrs.	-91.8	-57.9	-91.6	-91.5	-78.0	-156.6	-29.3
6 yrs.	-0.2	0.5	0.2	-1.9	-0.5	-70.7	21.3
10 yrs.	-0.0	0.0	0.0	-0.1	-0.1	-65.8	3.7
effect on unemployment (in 1000 labour years)							
effect after							
1 yr.	46.2	36.1	47.5	46.2	43.0	63.1	37.6
2 yrs.	45.5	29.7	46.0	44.9	38.8	72.3	22.7
3 yrs.	45.9	29.0	45.8	45.8	39.0	78.3	14.7
6 yrs.	0.1	-0.3	-0.1	0.9	0.2	35.4	-10.7
10 yrs.	0.0	-0.0	-0.0	0.1	0.1	32.9	-1.9

5. Conclusions

This paper investigates the sensitivity of an economy for cyclical and incidental changes in the pace of structural change by means of a small macro model of labour market flows. The model allows for heterogenous unemployment and it describes the flows of unemployed through the various duration classes explicitly. Search behaviour is modelled by means of a matching function for unemployed and vacancies. The reduced form of the model yields an UV-curve so that the model describes the sources of shifts of the UV-curve.

Simulation experiments using various versions of the models confirm that an increase in the pace of structural change results in an outward shift of the UV-curve, so that both the number of vacancies and of unemployed increase. According to all versions of the model the economy appears to return to its dynamic unemployment equilibrium of the baseline projection in case of a temporary shock. In spite of the fact that the model describes the depreciation of human capital of unemployed through its modelling of unemployment heterogeneity with (negative) duration dependence, cyclical shocks in the pace of structural change do only cause some hysteresis on the labour market in a version of the model with an extremely and implausibly low escape probability for long term unemployed. Moreover, none of the versions of the model considered in this paper are able to reproduce 'cleansing' (see Caballero and Hammour, 1994) effects of cyclical movements. Yet the recognition lags, and consequently the persistence of the temporary shocks are shown to be rather large in an initial situation of low labour market dynamics.

The reaction to permanent changes in the pace of structural change differs considerably from that of temporary changes. A permanent increase in job destruction and job creation eventually leads, in those versions of the model with fixed labour demand (= employment plus vacancies), to a new dynamic unemployment equilibrium with more unemployed and more vacancies, and hence less employment. This permanent outward shift of the UV-curve because of the congestion effect is rather large as compared to the size of the shock and much larger in the case of low labour market dynamics than in the case of a normal pace of structural change. It illustrates that enhanced structural change can have severe labour market repercussions for economies such as the Eastern European economies at the start of the transition process, which have low initial labour market dynamics. Countries accustomed to structural change will be less affected by such permanent increases in the pace of structural change. It may explain why the transition process in Eastern Europe brings about much turbulence at the labour market, even when the shocks are no larger than in Western Europe. The model may also explain why the recent increase in the pace of structural change in The Netherlands during the last decade resulted in more unemployment without much reduction in the number of vacancies. This observed outward shift of the UV-curve does not necessarily imply that labour market efficiency has decreased. On the other hand, when wage formation and vacancy supply (labour demand) is endogenised in the model in line with equilibrium search theory, the economy returns to its original steady state dynamic equilibrium after a permanent change in the pace of structural change.

The simulation exercises of this paper show that it is essential to incorporate the propagation of shocks through various duration classes of unemployment in an empirical model of labour market dynamics if the model is to be used to calculate the dynamic effects of various shocks at the macro level. This is especially true in case of (negative) duration dependence of the escape probability from unemployment, which seems a realistic assumption supported by much empirical evidence. Moreover, in contrast to models in the vein of traditional real business cycle theory, these empirical models of labour market dynamics allow to study the propagation of various types of cyclical fluctuations. However, a first experiment in considering other ways of implementing cyclicality suggest that it does not lead to drastic changes of the conclusions of this paper, namely that a loss of skills during unemployment is no major cause of unemployment hysteresis according to these unemployment equilibrium models unless the is no escape to employment for long term unemployed. May be this conclusion will be amended when we take individual unemployment histories into consideration or allow for the fact that new entrants on the labour market have a higher probability to take a newly created job than unemployed.

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Annex. List of symbols

Flows of persons

EI	(420)	Inflow into employment
EI_{ex}	(220)	Autonomous inflow into employment (other than unemployed filling a vacancy)
EO	(420)	Outflow from employment
F_{eu}	(300)	Inflow into unemployment from employment
F_{uev}	(200)	Unemployed who find a new job by filling a vacancy
F_{nu}	(120)	Non-participants who register as unemployed (additional labour supply)
UI	(420)	Inflow into unemployment
UO	(420)	Outflow out of unemployment
UO_{ex}	(220)	Autonomous outflow out of unemployment

Flows of jobs

VI	(600)	New vacancies (additional labour demand)
VO	(600)	Outflow of vacancies
VO_{ex}	(400)	Autonomous outflow of vacancies
VO_u	(200)	Vacancies filled by unemployed

Stocks

E	Employment
U	Unemployment
U_S	Short term unemployment ($<$ 1 year)
U_L	Long term unemployment ($>$ 1 year)
V	Vacancies

Other symbols

$\pi_{1,t}$	Escape probability of unemployed from the first duration class
$\pi_{k,t}$	Escape probability of unemployed from the k-th duration class
π_S	Escape probability of short term unemployed
π_L	Escape probability of long term unemployed
$U_{k,t}$	Number of unemployed in the k-th duration class
θ	Duration dependence parameter

Explanatory note: *values in parentheses represent the annual size of the flows used in the basic projection (in 1000 persons)*

Model specification for Alt.5:

(1) $F_{uev} = c\, V^{1-\alpha} (U_{S1} + \theta U_{S2})^{\alpha}$

(1b) $\pi_{S1} = (F_{uev} + F_{uej}) / (U_{S1} + \theta U_{S2})$

(1c) $\pi_{S2} = \theta \pi_{S1}$

where $U_{1,t} = UI$

$U_{k,t} = (1-\pi_{S1})\, U_{k-1,t-1}$ for $k = 2,3,\ldots,6$

$U_{k,t} = (1-\theta\pi_{S1})\, U_{k-1,t-1}$ for $k = 7,8,\ldots,12$

$U_{S1} = U_1 + U_2 + \ldots + U_6$

$U_{S2} = U_7 + U_8 + \ldots + U_{12}$

$U_L = U - U_{S1} - U_{S2} = U - U_S$

(2)-(5) as in basic version of the model

NB: $U' = U_{S1} + \theta U_{S2}$ = constant in baseline projection