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The Timing of Labor Reallocation and the Business Cycle

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Second Version

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Abstract:

In this paper we study the cyclical behavior of job and worker flows. We find for the Netherlands that employment and unemployment flows are large, relative to the stocks, that both the sum of employment in and outflow and the sum of job creation and destruction (jc and jd) move countercyclical. Other issues that we examined include the importance of aggregate vs. sectoral shocks, the persistence of jc and jd over the cycle and the relation between job and worker flows. The empirical results can be explained with a model in which the timing of labor reallocation is endogenous and concentrated in recessions. (JEL classification: E24 E32 J20 J60 L60, Keywords: business cycle, job creation, job destruction, gross worker flows, reallocation, unemployment).

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1 Introduction

Since the pioneering work of Blanchard and Diamond (1989,1990), Davis and Haltiwanger (1990) and Pissarides (1990), among others, the "flow approach" to labor markets is now a mature research area. The great advantage of not only considering stocks of employed and unemployed workers but also taking the behavior of the gross flows of jobs and workers into account is that one gets much more insight into the dynamic relation between unemployment, employment and nonparticipation.

In this paper we study the relation between the allocation of labor and the business cycle. In section two we will discuss some new empirical results on worker and job flows for the Netherlands and compare them with recent studies for other European countries and the U.S. The evidence suggests that: (1) flows into and out of the labor market are large in relation to the stocks. (2) The sum of employment inflow and outflow and the sum of job creation and job destruction, which can be viewed as a proxy for reallocation activity, move countercyclical. (3) Both the extent and the cyclical behavior of job creation and job destruction varies remarkably between sectors. (4) The level and the persistence of newly created jobs are strongly pro-cyclical, while the level and persistence of destroyed jobs are strongly counter-cyclical. (5) The time variation of job creation and job destruction in the Netherlands is more driven by aggregate shocks than by sectoral shocks. Other foreign studies that also take the effect of idiosyncratic shocks into account, find that those shocks explain the majority of time variation in job creation and job destruction. (6) About one third of the worker flows are generated by job creation and job destruction.

These results challenge a large class of business cycle models which predict that flows into employment grow during expansions, for example the monetary misperception model of Lucas (1972) in which inflow into employment increases through misperceptions about the real wage or some of the earlier real business cycle models, e.g. Kydland and Prescott (1982) and Long and Plosser (1983), which portray expansions as times when productivity is high and because of that labor supply increases. Those theories cannot explain the fact that booms are times when employment outflow is low rather than times when the inflow into employment is high.

In section 3 we will come up with a number of explanations for our findings. Most of our attention will go out to Davis and Haltiwanger's (1990) "proto type" model of job reallocation. We will use and extend this model to explain the empirical findings. The basic idea can be compared with a cycle race. Imagine a cyclist who has to drive a circuit with hills. Since he has to cycle all day, he has to eat and drink during the race, otherwise he will slow down at the end of the day. However he cannot consume any food or drinks when he drives too fast. When should this cyclist eat or drink? Well clearly he will not take any consumptions when he goes downhill, where he can reach speeds of 70 km an hour. Also when he is going down the wind, the opportunity costs of going slower are higher. The best time for him to slow down and "invest" in his physical condition by eating and drinking, will be either when he goes uphill or when he cycles against the wind. Moreover it might pay for him to wait with drinking while he is thirsty till a hill arrives or postpone his food consumption even when he is hungry, till he cycles against the wind. If one thinks of the hills and the wind as corresponding to a recession then one would expect that during that period, firms will engage in activities that increase future productivity at the expense of current production, just as the cyclist would do. According to this view, recessions are not necessarily times when activity is low. In section 4 we will shortly discuss some policy issues and study the implications of a "reallocation timing effect" in an economy with many profit maximizing firms that cannot coordinate their actions. Finally some preliminary remarks about the relation between job creation and economic growth will be made.

2. An Overview of Empirical Results

What would we expect about the cyclical behaviour of gross worker and job flows? We would expect job creation to rise and job destruction to fall in an expansion while in a recession we would expect the opposite. But will those responses be symmetric? If we think of the effects on entry and exit of firms, the answer is no, since an existing firm only has to cover marginal costs, while a new firm will only be opened if anticipated average costs are met. In terms of job creation and job destruction, in a recession we would expect job creation to fall more than job destruction rises. The few studies on the cyclical behavior of job creation and job destruction that have been done so far find exactly the opposite. We will discuss our results and compare them with other recent studies in section 2.2.

Usually worker flows will exceed job flows, since except for the case of an unfilled vacancy, a newly created job goes hand in hand with a worker movement but worker movements are not necessarily accompanied by job creation and job destruction, since they may reflect for example life-cycle or career decisions. Recent studies, e.g. Anderson and Meyer (1994) find that about one third of the worker flows is driven by job creation and destruction. This is also about the fraction we find for the Netherlands.

The cyclical response of worker flows is also unlikely to be symmetric if we take into account that quits move procyclical. Given that fact we would expect the sum of inflow into and outflow out of employment to move procyclical. Again, this is not what is found in the data. Blanchard and Diamond (1990) find that the sum of flows out of and into U.S. employment are anti-cyclical. In the next section we will show, with a less sophisticated method, that a similar result holds for the Netherlands.

Burda and Wyplosz (1993), (1994) confirm those results for other European countries and Japan. Our most surprising result is that the inflow into employment is countercyclical. Burda and Wyplosz find that gross unemployment outflow in most countries also moves counter cyclical. For the U.S. and the Netherlands, as we will show below, this last result does not hold.

2.1 The Cyclical Behavior of Worker Flows in the Netherlands.

In this section we will first describe how we identified the gross employment flows, then we will analyze their cyclical behavior and finally we will compare our results with other worker flow studies.

2.1.1 The data[1]

Annual data on the flow of unemployed workers into unemployment (Feu) and disability (Fed) are available for the Netherlands. Furthermore, we have data on the outflow of workers into early and normal retirement and the mortality of workers (Feer, Fer, Fem respectively). We thus have the total gross flow of persons from employment to unemployed (Feu) and non-participation (Fen=Fed+Feer +Fem). Together with the net change in employment, we can now easily construct the gross inflow of new workers into employment, since:

$$\Delta E = Inflow - Outflow \qquad thus$$

$$Inflow = \Delta E + Outflow = \Delta E + (Feu + Fen)$$

In our analysis we will consider both the cyclical behavior of the flows in and out of employment and unemployment as well as the flows between employment and ww[2] unemployment (Feu and Fue).

Note that our series do not include the job to job movers.[3] This flow is typically associated with voluntary quits and will make the relation between worker and job flows more fuzzy. For example if two persons switch jobs, both employment inflow and outflow will increase while in fact no jobs have

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[1] For a complete treatment of the data we refer to Appendix 4.

[2] One was eligible (in the sample period) for ww benefits when one has worked for at least 156 days (from 1987 onwards this is 182 days) in the 12 months before one got unemployed. The height is 70% of the daily wage. The duration of ww entitlement varies from 6 months to 4.5 years. Furthermore one has to be "unvoluntary" unemployed, in practice this means unemployed due to firing.

[3] We have experienced with an approximation of job to job flows. This flow series moved significantly pro-cyclical. Including this component in "inflow" and "outflow" did however not change our main result that the sum of employment inflow and outflow moves counter-cyclical.

been created and destroyed. An advantage of using Dutch data, is that in the Netherlands, temporary layoffs[4] are a rare phenomenon. In the presence of temporary layoffs, the relation between worker flows and job creation and job destruction again becomes much more unclear. For more details about the data, we refer to appendix 4.

2.1.2 Magnitude and cyclical behavior of the worker flows

As can be seen in Table A1 and A2 (in the appendix), flows into and out of unemployment and employment are substantial. Thus despite the well-known hysteresis effects, the Dutch labor market is in fact quite active. This is also true for other European countries, like France, Spain, Germany and the U.K. as Burda and Wyplosz (1993, 1994) show. Table A3 shows that the flows between employment and unemployment are also quite large. The Feu flow will be closely related to the job destruction flow, since it measures the flow of fired workers.

Table A4 and figure 1 show that employment and unemployment inflow and outflow are highly coherent. Burda and Wyplosz (1993) show that this also holds for France, Germany, the U.K. and Spain. Of course part of the high correlation is due to non-stationarity, but it may also reflect the importance of reallocation.

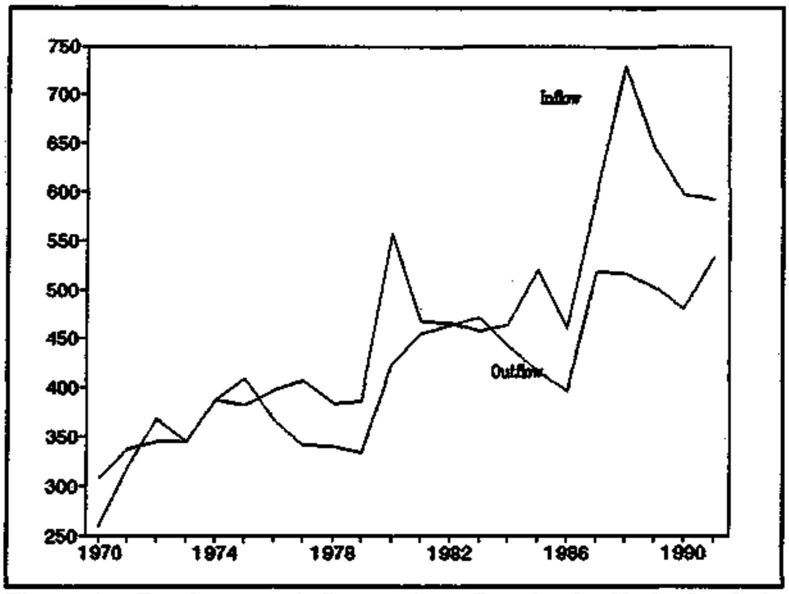

Figure 1 **Employment inflow and outflow in the Netherlands in (1000 persons)**

We also see from figure 1 that employment inflow and outflow move close together (the correlation

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[4] In the United States, a significant part of the layoffs is temporary.

coefficient is 0.86), except for the periods 1980 and 1988 in which employment inflow strongly increased. Part of this increase can be attributed to part-time work, which biases employment figures.

Table 1 The cyclical behavior of unemployment and employment flows

Dependent variable	cap. utilization	real GDP growth	unemployment growth[5]
Employment Flows			
Inflow (log)	-0.38. (-0.71)	-0.85 (-1.20)	0.23 (1.59)
Outflow (log) *	-1.22 (-1.73)	(*) -0.952 (-1.58)	0.41 (4.19)
Outflow rate (log)[6]	-0.144 (-2.27)*	-0.08 (-1.57)*	0.04 (3.90)
SUM (log)	-0.95 (-2.16)	-1.19 (-1.98)	0.24 (2.00)
Unemployment Flows			
Inflow (log)	(*)-1.35 (-2.33)	(*)-1.04 (-2.10)	(*)0.25 (3.43)
Outflow (log)	0.38 (0.71)	0.80 (1.08)	-0.20 (-1.46)
Outflow rate (log)	3.84 (2.24)	2.36 (1.55)	-0.50 (-1.54)
Sum (log)	-0.31 (-0.65)	-0.27 (-0.43)	0.09 (0.73)
Flows between Employment and Unemployment			
Feu (log)	-1.90 (-2.47)	-1.94 (-1.87)	0.61 (3.91)
Fue (log)	1.23 (1.28)	2.40 (1.96)	-0.02 (-0.09)
Fue/U(-1) logs	1.62 (1.18)	2.45 (1.98)	-0.08 (-0.29)
Sum (log)	(*)-0.36 (-0.53)	(*)-0.11 (-0.13)	0.44 (2.92)

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[5] We choose unemployment rather than employment growth because the variation in unemployment is much bigger. Later, in section 2.2.4 when we analyze the cyclical behavior of job flows in the manufacturing sector, we will use net employment change in the manufacturing sector because we don't have information about unemployment in the manufacturing sector.

[6] The Outflow rate is defined as the outflow/stock(-1)

Table 1 shows the cyclical behavior of flows into and out of employment, ignoring the job to job flows[7]. The most striking result is that gross inflow into employment moves counter cyclical. Again this result is also found in other European countries.

In the table coefficient estimates are given of respectively: the log of capacity utilization, differences of the log of real GDP and differences of log employment, in a regression of the dependent variable on itself lagged (coefficients with an asterisk are from regressions with two lags of the dependent variable), a constant, a linear time trend and the cyclical measure. The sample period is 1971-1991. In table A5, R^2 and autocorrelation tests are presented.

With the information of table 1 we are now able to say a little bit more about the anti-cyclicality of employment inflow. We can see that the Fue flow is pro-cyclical and that total unemployment outflow is also procyclical. How can those facts be explained? We know that unemployment outflow consists of the flow from unemployment to employment and of the flow from unemployment to nonparticipation. We do not have data on this last flow but it is likely to be anti-cyclical because in recessions the chances of finding a job (and hence the rewards to search) decrease, so more people will get discouraged and will stop to search actively. A second reason for the anticyclicality of the Fun flow is that the larger the stock of unemployment is, the larger the outflow will be[8]. Since unemployment moves countercyclical, unemployment outflow into non-participation will also move anti-cyclical. From the lower part of table 5 we see that the flow from (ww)-unemployment (see footnote 2) to employment moves procyclical and it is likely that the flow from (rww)-unemployment[9] to employment also moves pro-cyclical (since total unemployment outflow moves pro-cyclical). But this means that the anticyclicality of employment inflow is caused by a countercyclical non-participation-employment flow (Fne). Blanchard and Diamond (1990) find however for the U.S. that Fne decreases and that Fue increases after a negative demand shock. A tentative explanation for our findings may be the following: When employers have imperfect information about the quality of workers, the fact that a worker is unemployed can be viewed as a negative signal from the employer's point of view. Therefore, employers prefer non-participants. In recessions, therefore the inflow into employment will consist of a relatively large share of non-participants (for example school leavers) while in booms, the unemployed workers also get a chance to enter employment. Another explanation for the countercyclical employment inflow, following the "matching-literature," is that when the stock of non-

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[7] Recently we calculated job to job movements, which, as one would expect, appear to be strongly pro-cyclical. If the job to job flows are included in "inflow", the total flow into employment becomes insignificantly pro-cyclical.

[8] If we take the extreme case in which unemployment is zero, it is obvious that unemployment outflow is also zero.

[9] School leavers and long-term unemployed are eligible for RWW unemployment (70% of the minimum wage).

Since reallocation shocks will generate both high rates of employment inflow and outflow, the sum of those variables can be used as a proxy for reallocation activity. As can be seen in figure 2 dlreall[10] moves countercyclical. This result is in agreement with the findings of Blanchard and Diamond (1990).

In section 3 we will describe a model that explains why reallocation activities are concentrated in recessions.

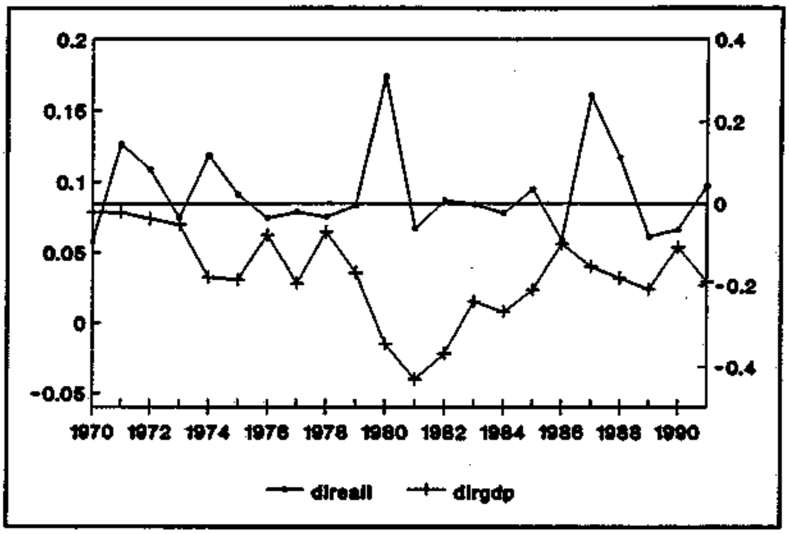

Figure 2 The cyclical behavior of employment reallocation

For the Feu flows we have got separate information about males and females. It appears that the employment-unemployment flow for males is strongly countercyclical, while the employment-unemployment flow for females is unrelated to the business cycle[11].

2.2 Job Flows

In this section, we present the results of our study on job flows in the Netherlands. First we will give a short description of the data. Then we will discuss the magnitude, time variance and persistence of the job flows and in addition analyze the relative importance of aggregate and sectoral shocks in explaining the time variance of job creation, destruction and reallocation. Finally we will discuss the relation between job and worker flows.

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[10] dlreall is defined as the growth rate of the sum of employment in and outflow and dlrgdp is the growth rate of real GDP. The right scale gives growth rates of reall, while the left scale gives growth rates of real GDP.

[11] The coefficient of log capital utilization in a regression as in table 5, with log Feu males as the dependent variable, is -1.77 (-2.04) while for females this coefficient is 0.12 (0.76)

relation between job and worker flows.

2.2.1 The Data

We use a panel of 3044 manufacturing firms (about 70 % of total employment) having more than ten employees, over the period 1978-1992. The data were collected by the Dutch Central Bureau of Statistics, on the basis of yearly questionnaires including the number of employees. There is substantial attrition in the production statistics because of bankruptcy, mergers, firms dropping below the employment threshold etc. Therefore we mainly focused on the data of firms that were available over the full fourteen year period[12]. Gross job creation is then calculated by summing up net employment changes at expanding firms within a sector. Gross job destruction is calculated by summing employment losses at shrinking firms within a sector. Dividing by sector sizes then gives gross rates of job creation and destruction. It is thus assumed that job creation and job destruction do not simultaneously take place within a firm. Hamermesh et al (1994). show that this assumption is acceptable for the Netherlands[13]. Secondly, since only plant level employment is observed, it is impossible to determine whether different employment levels for different periods, represent different employment positions. Thus, the gross job creation and gross job destruction rates are lower bounds on the actual values.

Before we continue, some short remarks will be made about how representative the manufacturing sector for the whole economy is. In the Netherlands, the manufacturing industry accounts for only one fifth of employment, this is about the same as in the U.S.. Anderson and Meyer (1994a,b) show that the job creation rates in the manufacturing sector of the U.S. do not differ very much from those based on all industries. Davis and Haltiwanger, for example find values for manufacturing job creation and job destruction of 0.092 and 0.113, while the corresponding rates in Anderson and Meyer's sample of all industries are 0.102 and 0.115. Blanchflower and Burgess (1994) report that manufacturing accounted for about one-third of total job creation while the share of the manufacturing sector is also around one third in the U.K.

2.2.2 Measurement

The notation, as was introduced by Davis and Haltiwanger, that is used to define the job flows is now commonly used in the literature. Formally, job creation and destruction per sector are calculated as:

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[12] In appendix A2 an analysis of job creation and job destruction due to entry and exit of firms is given.

[13] They show that in 1990 the average external flows are more than seven times as large as the internal mobility

$$POS_{st} = \sum_{e \in E_{st}, g_{ft}>0} \left[\frac{x_{ft}}{X_{st}} \right] g_{ft}$$

$$NEG_{st} = \sum_{e \in E_{st}, g_{ft}<0} \left[\frac{x_{ft}}{X_{st}} \right] |g_{ft}|$$

Where E_{st} is the set of firms in our panel, x_{ft} is the average employment at firm f between t and t-1 and X_{st} is the size of sector s. The sum of POS_{st} and NET_{st} (SUM_{st}) is a measure of job reallocation or job turnover between period t and t-1.

2.2.3 Magnitude and persistence of job creation and destruction

Table 2 presents job creation, job destruction and job reallocation in rates and in persons (POSP and NETP). Our sample period (79-91) gives a balanced view of the business cycle. During this period, employment in the manufacturing sector contracted seven times and rose six times. EXCESS measures the difference between total job reallocation and the absolute value of employment change (which is the minimum of job reallocation that is required[14]). EXCESS can be interpreted as a measure for heterogeneity. A nonzero value for EXCESS implies that firms are not homogeneous.

Table 2 Job Creation and Job Destruction in the Netherlands (79-91)

Variable	Mean	S.D. (cross industry)	Maximum	Minimum
POSP	28129.5	5805.7	36575 (1990)	17858 (1982)
NEGP	37144.4	7485.43	48232 (1981)	26476 (1982)
POS	4.06	1.22	5.77 (1990)	1.93 (1982)
NEG	4.95	1.04	6.73 (1983)	3.63 (1986)
SUM	9.00	0.96	10.95 (1990)	7.26 (1980)
NET	-0.89	2.06	1.15 (1985)	-4.10 (1983)
EXCESS	7.32	1.87	10.36 (1990)	3.87 (1982)
EMP	720604	41636	798213 (1979)	678493 (1985)

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[14] It is an indication for the dispersion of firm growth rates around the mean of net employment change.

The rates of job creation and job destruction, that we find are smaller than the values found by Davis and Haltiwanger (1990, 1992) for the U.S.. This is partly due to the fact that they included the birth and death of firms in their series. But that is not the whole story, since births and deaths of firms only account for 25% of job destruction and 20% of job creation. Other reasons may be that they used establishments, rather than firms and that they also included establishments with 5-10 employees. Those are typically the ones were lot of job creation and destruction takes place. Of course there are also institutional reasons, e.g. that it easier to hire and fire people in the U.S than in the Netherlands.

We found a strong negative correlation (-0,67)[15] between gross job creation and destruction rates over time, just as Boeri (-0.65) and Davis and Haltiwanger (-0.86). Table (A6) in the appendix, shows that large rates of job creation and destruction take simultaneously place in all sectors.

Figure 3 shows clearly that POS moves pro-cyclical and NEG moves counter-cyclical. SUM moves less counter-cyclical than in the U.S.. In the next section we will show that SUMP (the sum of job creation and job destruction in persons) does move significantly counter-cyclical.

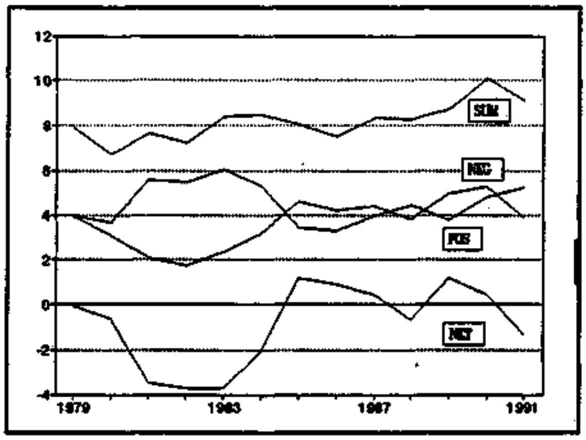

Figure 3 Net and gross job flows (in percentage of total manufacturing employment)

In addition we found that on average 56.3% of the jobs created in period t still existed in period t+1. with a maximum of 71,2% in 1989 and a minimum of 41.4% in 1984 . Job destruction is slightly more persistent. On average 59.4% of the jobs destroyed in one year, were still closed a year later. In 1982 a maximum of 74% of the destroyed jobs one year earlier were still closed, while in 1986 only 46.8% of the destroyed jobs were not opened again. Those values are lower than the ones found in the U.S.. Davis and Haltiwanger report an annual job creation persistence rate of 68% for job creation and

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[15] t-value = 3.87

81% of job destruction.

2.2.4 The cyclical behavior of job creation and job destruction

Table (3) shows the cyclical behavior of job creation, job destruction and job reallocation. Reported are the coefficients of a cyclical measure, CU (capacity utilisation) and NET (net employment change) in an OLS regression with a constant, a deterministic time trend and if necessary, the dependent variable one period lagged (the latter case is indicated with a *). As we would expect, job creation is strongly pro-cyclical and job destruction is strongly anti-cyclical. Just as found by Davis and Haltiwanger (1990) and Blanchard and Diamond (1990) in the U.S., job reallocation in the Netherlands moves counter cyclical. In section 3 we will discuss several possible explanations.

Table 3 The cyclical behavior of job flows

	POSP *	NEGP *	POS	NEG	SUMP *	SUM
NET (P)	0.332	-0.654	0.46	-0.54	-0.296	-0.076
t-value	(4,79)	(-8.89)	(9.44)	(-11.01)	(-2.22)	(-0.51)
R^2	0.87	0.93	0.95	0.92	0.48	0.64
DW			2.34	2.20		2.24
Durbin h	0.277	0.332			0.778	
CU	178414	-355775	0.37	-0.32	-2.12	0.051
t-value	(2.38)	(-3.52)	(4.54)	(-2.47)	(-2.03)	(0.55)
R^2	0.71	0.70	0.82	0.38	0.45	0.63
DW			1.94	1.74		2.11
Durbin h	-0.810	-1.269			-0.01	

sample period 79-91.

Table (A6) in the appendix shows the cyclical behaviour of job reallocation per industry. It appears that in most sectors job reallocation is (insignificantly) countercyclical. Only in the primary metal sector and the electronic and other equipment sector there exists a significant anti-cyclical pattern of job-reallocation.

There is a lot of variation in the persistence of job flows over the cycle. The correlation coefficient of net employment changes (NET) with the fraction of newly created jobs that still existed a period later is 0.86, while for the fraction of destroyed jobs that were not filled up a period later, the correlation with NET is -0.84. The persistence of job creation is thus strongly pro-cyclical, while the persistence of job destruction is strongly countercyclical.

2.2.5 How important are aggregate shocks?

Davis and Haltiwanger (1990) found that the time variation in job creation and job destruction in the U.S. was primarily driven by idiosyncratic shocks. Unfortunately our data set does not allow us to decompose the employment growth rates of individual firms into an idiosyncratic, a sectoral and an aggregate part. However we could test whether sectoral changes in job creation and job destruction are primary driven by aggregate or sector specific shocks.

First we will decompose the establishment growth rate per sector in a sector specific and an aggregate part:

$$g_{st} = g'_{st} + g_{aggr}$$

where g_{st} is the sectoral growth rate g'_{st} is the residual component of the sectoral growth rate and g_{aggr} is the aggregate growth rate. Now if the economy is primary driven by aggregate shocks (oilprice changes, growth of the world economy etc.), then $g'_{st} = g_{st} - g_{aggr}$ will be small compared to $g_{aggr} = g_{st} - g'_{st}$.

The sector weighted growth rates are given by:

$$POS = \sum_{sc=sic\ 21}^{39} \left(\frac{x_{sct}}{EMP} \right) g_{sct}$$

$$g_{sct} = \frac{\sum_{e \in E_{st},\ x_{et} > x_{et-1}} |x_{et} - x_{et-1}|}{x_{sct}}$$

$$NEG = \sum_{sd=sic\ 21}^{39} \left(\frac{x_{sdt}}{EMP} \right) g_{sdt}$$

$$\textit{where} \quad g_{sdt} = \frac{\sum_{e \in E_{st},\ x_{et} < x_{et-1}} |x_{et} - x_{et-1}|}{x_{sdt}}$$

$x_{sd(c)t}$ is the average of total employment at shrinking (growing) establishments in sector s at time t and t-1, EMP is total employment, E_{st} is the set of firms in s at t, and x_{et} is firm level employment at time t. The SUM series can be obtained by summing up POS and NEG.

Given the decomposition of growth rates, we use the same methodology as Davis and Haltiwanger, to investigate whether job creation, job destruction and job reallocation are primary driven by sectoral or aggregate shocks. we therefore define the adjusted sectoral job creation rate as:

$$POSadj = \sum_{i=sic\ 21}^{39} \left[\frac{x_{scit}}{EMP} \right] g_{scit}^{I} = \sum_{i=sic\ 21}^{39} \left[\frac{x_{scit}}{EMP} \right] (g_{scit} - g_{aggr})$$

NEGadj and SUMadj are calculated in a similar way.

Now consider the following identities:

POS = POSadj + (POS - POSadj)
NEG = NEGadj + (NEG - NEGadj)
SUM = SUMadj + (SUM - SUMadj)

Which imply the following variance decompositions:

Var(POS) = Var (POSadj) + Var(POS - POS adj) + 2Cov(Posadj, (POS - POSadj))
Var(NEG) = Var (NEGadj) + Var(NEG - NEG adj) + 2Cov(NEGadj, (NEG - NEGadj))
Var(SUM) = Var (SUMadj) + Var(SUM - SUM adj) + 2Cov(SUMadj, (SUM - SUMadj))

The sign of the covariance term tells us something about the interaction of aggregate and sectoral shocks, a positive sign implies that the shocks move in the same direction.

Table (4) shows that both job creation and job destruction are mainly determined by aggregate shocks. While the time variation in gross job reallocation is also for a large part driven by sectoral shocks.

We do want to stress that including idiosyncratic effects can change the results. Davis and Haltiwanger (1990) find that 80% of the variation of job reallocation in continuing establishments is due to idiosyncratic effects.

Table 4 The relative impact of sectoral and aggregate shocks[16]

$\mathrm{Var(POSadj)/Var(POS)} = 0.121$

$\mathrm{Var(POS - POSadj)/Var(POS)} = 0.902$

$\mathrm{2Cov(POSadj,(POS\text{-}POSadj))/Var(POS)} = -0.007$

$\mathrm{Var(NEGadj)/Var(NEG)} = 0.117$

$\mathrm{Var(NEG - NEGadj)/Var(NEG)} = 1.331$

$\mathrm{2Cov(NEGadj,(NEG\text{-}NEGadj))/Var(NEG)} = -0.380$

$\mathrm{Var(SUMadj)/Var(SUM)} = 0.475$

$\mathrm{Var(SUM - SUMadj)/Var(SUM)} = 0.405$

$\mathrm{2Cov(SUMadj,(SUM\text{-}SUMadj))/Var(SUM)} = 0.107$

2.3 The relationship between job and worker flows

If we calculate employment in and outflow (excluding job-to-job-flows) as fractions of total employment for the period 79-91 and if we use our manufacturing rates of gross job creation and destruction as proxy for the whole economy, we can tentatively say something about the fraction of worker flows that is driven by job flows. We find that the average sum of employment in and outflow is on average 21.5% of total employment when job-to-job movements are excluded and 32.5% of total employment when they are included. The sum of job creation and destruction is 8.21% of employment [17], which is 25.3% of the total worker flows (including Fee) and 38.2% of employment in and outflow (excluding Fee). Those numbers can exceed the true values because of double-counting of the lay-offs in shrinking firms who directly find a job at a growing firm in the same sector. We therefore define a new variable, MAX_{st} which measures max $\{POS_{st}, NET_{st}\}$. The average value of MAX_{st} is 5.34% which is 16.5% of the total worker flows, including the job to job movements and 24.8% of the worker flows, excluding job to job movements.

Hamermesh et al. (1994) used a representative sample of Dutch firms which also gave information on internal mobility at the firm level and found that job flows account for 31.81 % of the worker flows. This is about the same order as Anderson and Meyer (1994) find for the U.S., they report that 31% of

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[16] We have excluded SIC 28 (petroleum) and SIC38 (instruments) because of missing data. Including those sectors (period 82-91) leads to very similar results.

[17] This is probably a lower bound on the true value for the whole economy, because of the way job creation and job destruction were calculated.

the worker flows in the manufacturing sector are driven by job reallocation, while for the other sectors this is 40%. Davis and Haltiwanger (1992) estimate that between 35 and 56 % of the worker flows are driven by job creation and destruction.

The empirical results can be explained with a model in which the timing of labor reallocation is considered to be endogenous and mainly takes place in recessions. Davis and Haltiwanger's (1990) model is a good starting point for analyzing this issue. In the next section we will therefore work out a model very similar to theirs to study the effects of demand and allocation shocks on an efficiently working market economy. We will also give an explanation for the fact that worker flows move in the same direction, while job flows move in different directions.

3. A Model of Labor Reallocation

Let us first summarize very shortly the most important stylized facts we have to explain. (1) Flows into and out of employment and unemployment are large, relative to the stocks. (2) The sum of employment inflow and outflow and job creation and destruction moves countercyclical. (3) A large fraction of worker flows is associated with job creation and job destruction. (4) Employment inflow and outflow move in the same direction, while job creation and job destruction move in opposite directions.

We will explain those facts with a model in which reallocation takes time and resources. When a firm engages in reallocation some of its resources cannot be used for "normal" production, thus according to this view the costs of reallocation are in the form of foregone production. Since recessions are times when aggregate demand falls, the costs of reallocation are lowest during those periods. First we will look at some of the other explanations and comment on them briefly.

3.1 Other Explanations

In the literature there are a number of different possible explanations for the empirical results of section 2, which will be discussed briefly below.

-Caballero and Hammour (1992) come up with a model in which fast job creation is costly and fast job destruction is not. Because of this, job destruction is concentrated in short periods, while job creation takes place all over the cycle.

- Related is Nickel's (1992) model that explains the anti-cyclical behavior of job reallocation (job creation plus job destruction) by noticing that in booms, labor markets are tighter and hiring labor is more expensive. This makes job creation more expensive in booms. A problem with this explanation is that in recessions quit rates are much lower, which makes job destruction more expensive due to positive firing costs. Nickel argues that the costs of job destruction in recessions are lower than the costs of job creation in booms and hence job reallocation is anti-cyclical. A better explanation that is also related to adjustment costs would probably be that if the costs of firing are fixed, then it would pay for a firm to fire workers in large groups.

-Lame duck effects (the least productive firms go bankrupt in a recession) could explain part of the story, but Davis and Haltiwanger (1990) show that the proportion of job destruction due to plant closings decreases slightly during recessions (the absolute rate of dying establishments does increase). Blanchard and Diamond (1990) believe that the fear for bankruptcy could explain the asymmetry. In good times, firms do not worry much about slack, while in bad times, when there is the threat of bankruptcy, the slack is squeezed out.

-Explanations with a matching function, see e.g., Blanchard and Diamond (1990), Pissarides (1991) and for the Netherlands van Ours (1991) and Lindeboom et al. (1993).

Frictions on the labor market, imply the existence of a matching function, often in the form $h=m(U,V)$, where h is the number of hires which is increasing and concave in U and V, m is the number of primary workers getting a job, U is unemployment and V is the number of vacancies. It is assumed that the economy is subject to continual job creation and job destruction. In recession here interpreted as an increase in job destruction and a decrease in job creation), the flow of workers out of employment increase, but because of the increase in U, the number of successful matches will also increase. On the other hand, the decrease of vacancies will lead to fewer successful matches[18] This implies that worker flows can either be pro-cyclical or anti-cyclical. In Mortenson and Pissarides (1993), job destruction can take place instantaneously, while job creation is, through the presence of a matching function, a more time-consuming process.

3.2 The assumptions of the labor reallocation model

Since the main goal in this section is to study the behavior of the labor reallocation process, under aggregate demand and allocation shocks, we will abstract here from all kinds of possible market clearing disturbances.

We will consider an economy with two production sites, high productivity sites and low productivity sites. At the beginning of period t, H_t infinitely lived consumer-workers are matched to high-productivity sites, each producing output Y_H. For simplicity, we will distribute all the workers over the unit interval. In this case there are thus $1-H_t$ workers matched with low-productivity sites, producing

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[18] A vacancy can arise by job creation or by a quit

output Y_L, where $Y_L < Y_H$. Let σ_t be the fraction of high-productivity sites that revert to low productivity sites within period t; thus a fraction $(1-\sigma_t)$ of the high-productivity sites remains high [19].

We will assume that there are operation costs involved for a worker who moves from a low-productivity site to a high-productivity site. Those costs are equal to one unit of time input by one (low-productivity) worker. Davis and Haltiwanger (1990), give three interpretations for those costs:

(1) The worker's time cost of moving (according to this interpretation, unemployment is a direct consequence of employment reallocation).
(2) An adjustment cost, in the form of foregone production caused by the opening of a new site.
(3) An investment in human capital by the worker and site owner. The costs of this investment are foregone production.

Reallocation of labor can cause unemployment not only through the time it takes for a worker to move from a low productivity site to a high productivity site, but also for example through matching problems. Aghion and Howitt (1991) argue that if reallocation is the process of "creative destruction" of low productivity jobs and their replacement by new high productivity jobs, the inflow rate into unemployment will increase after reallocation. Although this effect is not present in our model it is useful to recognize that reallocation may lead to higher unemployment.

For a given σ_t, there has to be made a decision about the fraction of workers at low productivity sites who will be moved to high productivity sites, arriving at the beginning of period t+1. We will assume that the fraction of high productivity sites equals or exceeds the number of low productivity sites. Let Θ be the fraction of workers who move from low to high productivity sites. Then the law of motion for state variable Ht is given by:

$$H_{t+1} = (1 - \sigma_t)H_t + \Theta_t[1 - H_t + \sigma_t H_t] \tag{1}$$

The first term in this equation gives the number of high-productivity sites who remain high and the second term gives the fraction of [old lows + new lows] which become high productivity sites in the next period.

The utility of consumption for all consumer-workers in period t is given by: $A_tU(C_t)$, where A_t is a utility shifter. A change in A_t will be interpreted here as an aggregate demand shock. A_t and σ_t are

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[19] In multi sector economies with central wage bargaining, a rise in σ is equivalent with a situation in which productivity in one sector rises less than the centrally bargained wage.

assumed to follow a first order Markov process.

At time t, a worker chooses a contingency plan that maximizes life time utility, given by

$$\sum_{t=1}^{\infty} \beta^{t-1} A_t U(C_t) \tag{2}$$

$$\mathit{Where} \quad U'(C) > 0, \quad U''(C) < 0, \wedge \lim_{C \to 0} U'(C) = \infty$$

Aggregate consumption in time t is equal to:

$$C_t = (1 - \sigma_t)H_t Y_H + [1 - H_t + \sigma_t H_t](1 - \Theta_t)Y_L \tag{3}$$

Thus all income from both high and low productivity sites is being consumed. The opportunity costs of reallocation are represented by the term $\Theta_t[1 - H_t + \sigma_t H_t]Y_t$, which denotes foregone production. Before we proceed, something will be said about the interpretation of σ_t. Since we assumed that the number of high productivity sites (operational and non-operational) always equals or exceeds the number of low productivity sites, we can think of σ_t, not only as the rate at which high-productivity sites become low-productivity sites, but also as the rate at which new high-productivity sites become available. Hence σ_t can be seen as a reallocation shock. The causes of the reallocation shocks will not be discussed in detail here, we can think of them as idiosyncratic productivity disturbances. In a multi good model taste shocks could play the same role.

For our purposes it is not necessary to specify the whole wage process. We will assume that the wage formation process supports efficient mobility behavior. Some kind of Nash-equilibrium model, in which workers will get part of the extra earnings due to a successful match, will do the job.

Finally we will assume that there are no taxes or other distortions so that the competitive equilibrium is equal to the solution of the social planner's problem of the model (see, e.g. Stokey and Lucas, 1989).

3.3 The Social Planner's Problem

The social planner's problem can be formulated as a stochastic dynamic programming problem, with Bellman's functional equation given by:

Subject to the law of motion (1).

$$V(H,A,\sigma) = \max_{\Theta\in[0,1]} \; [AU[(1-\sigma_t)H_tY_H + (1 - H_t + \sigma_tH_t)(1-\Theta_t)Y_L] + \beta E[V(H_{t+1}, \sigma_{t+1}, A_{t+1})]] \tag{4}$$

Under the assumptions that A, σ, Θ and H_t can take a finite though large number of values and that H_{t+1} can take the same values as H_t, the value function will be a finite dimensional vector. A unique optimal reallocation policy function Θ(H,A,σ) can then be found in five steps: (1) Make an initial guess for V on the r.h.s. of (4). (2) Solve the maximum problem in (4) for Θ_t, given each H_t, σ_t, and A_t combination. (3) Substitute the maximized solution into the objective function of (4). (4) Solve for V on the l.h.s.. (5) iterate with this solution as a new guess for V on the r.h.s.

For now, we are only interested in how the optimal policy function Θ(H,A,σ) reacts to innovations in A and σ.

Off corners and under the optimal reallocation policy function, the value function, V, is differentiable in H[20] with:

$$\frac{\partial V(H,A,\sigma)}{\partial H} = A(1 - \sigma)[Y_H - (1 - \Theta)Y_L]U'(C) + \beta(1 - \sigma)(1 - \Theta)E\left[\frac{\partial V(\overline{H},\overline{A},\overline{\sigma})}{\partial \overline{H}|A,\sigma}\right] \tag{5}$$

$$Where\ \overline{H} = (1 - \sigma)H + \Theta(1 - H + \sigma H) \qquad (See\ equation\ (1)).$$

overlined variables denote next period values.

Because a unique value function exists and since (5) holds for the optimal value of Θ(H,A,σ), the r.h.s. of (5) can be treated as a standard maximizing problem. If we substitute eq. (3) for C and also substitute the law of motion (1) in (5) and then differentiate (5) with respect to Θ we get:

$$Y_LAU'[(1 - \sigma)Y_HH + (1 - \overline{H})Y_L] = \beta E\left[\frac{\partial V(\overline{H},\overline{A},\overline{\sigma})}{\partial \overline{H}}|A,\sigma\right] \tag{6}$$

Equation (6) tells us that under an optimal reallocation policy, the utility costs from foregone output, caused by moving a worker from a low productivity site to a high productivity site is equal to the expected utility gains resulting from a better allocation of employment at the beginning of the next period.

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[20] For a proof, see Lucas and Stokey (1989), ch 9.

It will be interesting to see how the number of badly matched movers responds to a change in the number of currently employed high-productivity workers. Therefore let us define M, the number of workers who move, $M = \Theta(1 - H + \sigma H)$, thus:

$$\frac{\partial M}{\partial H} = -(1 - \sigma)\Theta, \quad \textit{Since } \frac{\partial \overline{H}}{\partial H} = (1 - \sigma) - (1 - \sigma)\Theta, \quad \textit{We can write:} \\ \frac{\partial M}{\partial H} = \frac{\partial \overline{H}}{\partial H} - (1 - \sigma) \tag{7}$$

The first part of the r.h.s. of (7) represents the consumption smoothing effect, as discussed above. The response to a positive wealth shock, is not to consume everything at once but to invest part in an improved future allocation of workers. The second term of the r.h.s. of (7), gives us the direct effect of H on M. For a given Θ, an increase in H will reduce the necessity to open more high productivity sites.

The marginal rate of transformation between future and current consumption is given by[21]:

$$\frac{AU'(C)}{\beta E(\overline{A}U'(\overline{C}))} = \beta E[(1 - \overline{\sigma})\left(\frac{Y_H}{Y_L}\right)|A,\sigma] \tag{8}$$

Equation (8) tells us that the greater the number of high productivity sites which are operational in the future and the higher the ratio Y_H/Y_L, the more current consumption will be allocated to the future.

One problem with this model is that, while it can explain unemployment fluctuations, labor supply is implicitly assumed to be inelastic. Davis and Haltiwanger (1990) introduce a downward sloping demand for leisure, to get a positive relation between aggregate demand shocks and labor supply.
In the next paragraph, a slightly different model will be presented in which aggregate demand disturbances also have direct effects on labor demand, this model is very similar to Townsend's (1990) model.

3.4 Firm specific demand shocks and leisure

In the previous section we assumed that output was random across sectors, now we will extend the model and assume that the output of each plant within the two sectors is random. People employed in

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[21] For a derivation, see appendix A1.

the different sectors and people who are searching have different utility functions caused by different labor supply behavior, given by, $AU(C, T - a_H)$ in the high-productivity sector, $AU(C, T - a_L)$ in the low productivity sector and $AU(C,T - S)$ in the search status mode. Here T is common available time, aH is labor time in high productivity sectors, a_L is labor time in low productivity sectors and S is the time spent searching. Accordingly we will define the production functions $f(a_H)$ and $f(a_L)$ to be equal to the output of working *a* hours in respectively the high productivity and the low productivity sector.

In this section we will interpret the reallocation costs as the time it takes for a worker to move from a low productivity site to a high productivity site. During that time he is thus unemployed. We will also give a different interpretation for Θ_t, instead of the fraction of workers being reallocated, Θ_t will represent the probability for an individual low productivity household to be moved to the high productivity sector. The problem now is to find a functional equation for the "representative consumer," since we have explicit diversity across firms and households. We can do this by weighting the utility functions for consumption and leisure, over the different sectors.

The social planner's problem is then to find:

$$\begin{aligned} V(H,\sigma,A) = \underset{a_H,a_L,\Theta}{Max}[(H - \sigma H)AU(c,T-a_H) + (1 - H + \sigma H)[(1-\Theta)AU(c,T-a_L) \\ + \Theta AU(c,T-S)] + \beta EV(\overline{H},\overline{\sigma},\overline{A})] \\ s.t.: \quad c = (1-\sigma)Hf(a_H) + (1 - H + \sigma H)(1 - \Theta)f(a_L) \end{aligned} \tag{9}$$

and the law of motion (1).

The weights are given by: $(1-\sigma)H$ (the number of workers in the high productivity sector), $(1-H+\sigma H)(1-\Theta)$ (the number of workers in the low productivity sector) and $(1-H+\sigma H)\Theta$ workers in the search state mode.

The "Benveniste and Sheinkman-equation" (the equivalent of equation 5) of this problem is extremely messy and does not give much information. In the appendix, A2 it will be shown that the first order condition with respect to Θ implies:

$$A[U(c,T-a_L) - U(c,T-S) + f(a_L)[(1-\Theta)U_c(c,T-a_L) + \Theta U_c(c,T-S)]] = \beta E\left[\frac{\partial V(\overline{H},\overline{A},\overline{\sigma})}{\partial \overline{H}|A,\sigma}\right] \tag{10}$$

The first term of the l.h.s. of equation (10) represents the difference in utility between working a_L units of time in the low productivity sector and being in the search status mode, this term could be interpreted here as the disutility of working instead of enjoying leisure. The second term represents the utility of consumption from working a_L units of time, where the (low productivity) output is shared between low productivity workers and the unemployed. A different interpretation for this term is the foregone utility of consumption, caused by reallocation in the current period. The r.h.s. of (10) gives the expected utility gains resulting from an improved future allocation of labor. Thus at an interior solution for Θ, the total utility of leisure and improved future allocation is equal to the current consumption loss due to reallocation.

Equation (9) has got the following implications for leisure:

$$-U_{a_H}(c,T-a_H) = A(1-\sigma)Hf'(a_H)U_c(c,T-a_H) \qquad (11\ a)$$
$$-U_{a_L}(c,T-a_L) = A(1-H+\sigma H\Theta)f'(a_L)U_c(c,T-a_L) \qquad (11\ b)$$

A derivation of (11 a) and (11 b) can be found in the appendix A2.

Equations (11 a b) tell us that at an interior solution, the utility that one gets by consuming the output of one extra hour of work equals the disutility of working one extra hour (or the utility of one hour of leisure). Implicitly it is assumed that U_{Ah} and U_{Al} are negative (or that the value of leisure is positive). Thus at an equal weight Pareto optimum, one is indifferent between working one hour extra (and getting more consumption) or enjoying one hour extra free time.

A problem with the model above, is that one is either in one sector or in another or being reallocated, while it would be more realistic that labor supply decisions would vary over the three states. Townsend (1990) shows elegantly how one could do this while maintaining the setup of a representative consumer. For a summary of his model, see appendix A3.

3.5 The effects of Demand and Allocation shocks on Labour Reallocation

When there is a temporary fall in aggregate demand (a negative innovation in A), consumption will decrease but job reallocation, and the number of movers, M will increase. More labor is reallocated (Θ rises) because the marginal utility costs of foregone production, given by the l.h.s. of (6), are lower when aggregate demand, A is lower. An increase in Θ, will, according to the equation above (7) lead to an increase in M, by ($1 - H + \sigma H$) times the change in Θ.

When we also take the effects of leisure and labor demand into account, the increase in Θ will even be bigger because the relative rewards of working as opposed to leisure will be lower when aggregate demand has fallen. In terms of equation 11: When A falls, the marginal value of leisure $-U_{Al}$ rises, which means that in equilibrium more leisure is consumed. In addition the demand for labor will decrease in response to an adverse aggregate demand shock. The same story can be told for a negative productivity shock. To sum up: the largest rates of job reallocation (in particular job destruction) will take place in sectors that face low productivity or low aggregate demand.

Thus the observed correlation between aggregate demand and unemployment fluctuations can (at least partly) be explained with a model that takes the influence of aggregate demand disturbances on labor reallocation into account. In this simple model, the ultimate sources of temporary unemployment are not aggregate demand disturbances, but allocative disturbances.

Market economies in general, but in particular economies which are in a transformation process from a centrally planned economy to a market economy face large allocative shocks. We will now analyze two different kinds of allocative shocks which lead to different outcomes. First, consider an unexpected increase in σ, this is similar to a decrease of high productivity sites, H. One direct effect of this shock will be a lower demand for labor, since output per worker will fall. Another direct effect will be substitution from work into leisure. Job destruction will thus rise in response to a positive innovation in σ. If the innovation in σ is considered to be persistent, the marginal rate of transformation (from future to current consumption) will fall (see equation (8)) this makes it less attractive to transform lows into highs. In addition, we can see from equation (11) that a positive innovation of σ increases the relative utility of leisure since the rewards of work fall. This will lead to substitution from allocation activity into leisure. In summary, a positive innovation of σ, leads to a strong increase of employment outflow and only to a small next-term increase of employment inflow[22].

An alternative form of an allocative disturbance, is an increase in the ratio f(aH)/f(aL). This will stimulate substitution out off leisure into the high productivity sector, since an increase in f(aH), makes working more attractive than leisure. But it will also increase the substitution from leisure into the low productivity sector since the marginal rate of transformation, given by (8), will rise. This causes substitution from leisure into reallocation activity[23]. So this type of allocative shock will have

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[22] For a given Θ, an increase in σ will lead to more "movers" from lows to highs

[23] If for example $f(a_H)$ increases, $f'(a_H)$ will decrease in equation (11) which will lead to substitution into leisure, it will be assumed that this income effect is lower than the substitution effect from leisure into production.

substitution from leisure into reallocation activity[23]. So this type of allocative shock will have different effects on the magnitude of employment inflow compared to an innovation of σ, since now near-term job creation will also rise.

There are still two more important stylized facts that we have to explain. The first one is the observed procyclical behavior of productivity. According to the model in the previous sector, reallocating is going on during recessions. Bean (1990) comes with a similar kind of explanation. He argues that a large share of the labor force is diverted to the production of goods in times when the marginal revenue is high (in booms) and that in recessions a relative larger share is diverted towards investment-like activities like human capital formation, which do not count as output in the official statistics. So the procyclical movement of productivity may result from the static concept of productivity in the statistics. Moreover Bean finds, with a VAR model a negative long run effect of a demand innovation on productivity. Saint Paul (1993), who also used a VAR model, concludes that in most countries both the short and long run effect of a positive demand shock on productivity, are negative in most countries. Those results are in line with the job reallocation model.

Another puzzle is that gross employment inflow and outflow seem to move closely together, while gross job creation and job destruction move in opposite directions. Burda and Wyplosz (1993) explain those facts with a model in which unemployment outflow and job creation are determined by a non-increasing matching function and in which it is costly to create new jobs. Because of that, worker reallocation is preferable to job destruction. They also make a distinction between vacancies corresponding to an existing position and vacancies for which a workplace has yet to be created. Before we proceed with summarizing their model, first some variables will be defined; e is the total number of workers being employed, j is the number of jobs and is equal to e plus the unfilled jobs, and vacancies (v) are unfilled jobs j-e plus **planned** positions v-(j+e). They argue, that if the value of a match (y) declines, e.g. because of a demand shock, the v,u ratio (v/u) will decrease. If the economy achieves this reduction by (1) laying off workers (reducing e) or (2) destroying filled jobs (reducing j and e simultaneously), the observed patterns of job and worker flows can be explained (discrete jumps in job destruction, accompanied by large worker flows). The higher unemployment level leads to more matches and thus inflow into employment. All of this happens independently of job creation. One necessary condition is that the amount of planned positions has to be smaller than the number of unfilled jobs (because the cheapest way to decrease vacancies is by elimination of planned positions). Furthermore in case one, the capital value of an open job must exceed the capital loss associated with a layoff and the reverse must hold in case two.

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[23] If for example $f(a_H)$ increases, $f'(a_H)$ will decrease in equation (11) which will lead to substitution into leisure, it will be assumed that this income effect is lower than the substitution effect from leisure into production.

4 Complementaries, Complexity and Policy issues

When the perfect competition framework is dropped, several interesting issues arise. In the previous section we saw that the best time to reallocate is in a recession. If firms have (partly) common expectations about the date and size of a recession, they might time their reallocation policies simultaneously in a recession, thereby making this recession a reality. This is so because reallocation involves both large outflow of workers and low production. According to this view, allocation and aggregate demand are strongly connected, in their timing as well as on their effects on unemployment flows. It is therefore difficult to distinguish between them empirically.

Moreover, when there are complementaries, for example through positive demand linkages between firms, any (common) expectation about a recession can lead to that particular recession. In other words, multiple cyclical equilibria can arise,[24] only because firms cannot coordinate their actions. Those equilibria may well be Pareto ranked. Less efficient outcomes arise when firms postpone their reallocation activities too far away.

Another important issue is the relation between job creation, job destruction and economic growth. Economic history shows us that new technologies can lead to a chain reaction of job destruction and job creation. This observation has led to a promising new approach that views the economy as an evolving complex system, see, e.g. Anderson et al. (1988). When a new innovation is implemented, for example the car, lots of jobs were destroyed like the pony-express, coachmen etc.. On the other hand a new network of jobs was being created like paved road builders, taxi drivers, mechanics etc. If we define, following Kaufman (1988), the complexity of a good, to be a function of its *uses* (e.g. for a car: a medium of transport) and its *needs* (for a car: roads, steel, traffic rules etc.). Now if the average *need* is greater than one, a new innovation will lead endogenously to a higher demand and need for more innovations. The key issue is that the number of possible innovations goes up very rapidly as more technologies become available. This process will go hand in hand with job creation, job destruction and employment in and outflow.

The ideas of the economy as an evolving complex system arose at the "Santa Fe" institute, in California, where many scientists from different disciplines (e.g. the Nobel prize winners Gell-Mann and Anderson (Physics) and Arrow (economics) work together. Kaufman, a biologist at the Institute pointed out that an economic invention often becomes a catalyst for other inventions. Kaufman himself had been working in the beginning of the seventies, on the question how nature could have developed

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[24] In a similar way as in Shleifer's (1986) model.

a protein molecule. If the amino-acid building blocks had to chain together randomly, the expected time for the building of such a molecule would be more than the history of the universe. Kaufman then came with the idea of autocatalytic sets. An autocatalytic set can be described as follows: When one starts with many random molecules, it can happen that molecule A has got a weak catalytic effect on B and molecule B on C and so on. Now if there would be some other molecule V that closed the loop and catalyzed the working of A then we would get more A around to produce B and more B to get C. The number of molecules in the chain will grow much faster than the molecules that are not part of the chain. If there are more sets around, then there will be competition for resources, which opens the door for natural selection so that those sets that are more robust to environmental changes are more likely to survive. In other words, under the right initial conditions the system itself can create more complex structures. Kaufman argued that an autocatalytic set is a web of transformations in the same way that an economy is a web of transformations among goods and services. If an economy gets beyond a certain level of complexity the economy can jump to a higher equilibrium[25]. But when the economy remains below that level of complexity, growth may be low and the country must rely on only a few major industries. This is the case in many under developed countries.

The new technologies will for mainly be implemented in newly created jobs[26]. This brings us at an important issue for policy makers. A policy that aims to lower job destruction may also slow down the development of new technologies and job creation[27].

Another (old) question is whether the government should (if she could) dampen the business cycle. We have seen from our reallocation model that when aggregate demand moves cyclically, firms get the opportunity to reallocate cheaply in recessions (thereby increasing productivity) and then harvest in booms. If this is the whole story, the best policy would be a passive one. But we have abstracted in our model from all kinds of market imperfections, e.g. the fact that firms are more equity constrained in recessions and will therefore cutback the expenditures on the most risky activities (which are often R&D activities), see Stiglitz (1993). We also abstracted here from loss of skill effects of unemployed workers, see Pissarides (1993). Those effects of recessions lead to lower long-run growth and hence there is a potential for government action. To sum up, if the government wants to take action to reduce unemployment, policies that increase job creation are preferred to policies that decrease job

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[25] Equilibrium is a risky term here.

[26] Baily et al.(1994) show that most of the increase in manufacturing productivity takes place in plants that have also have increased employment .

[27] Other arguments can be found in Broersma (1993).

destruction.

Conclusion

Let us start with summarizing the most important empirical facts. (1) The sum of job and worker flows moves anti-cyclical. (2) Job creation and the persistence of the newly created jobs is strongly pro cyclical, while job destruction and the persistence of destroyed jobs is strongly counter cyclical. (3) sectoral shocks seem to play a minor role in explaining the variation of job creation and job destruction. (4) About one third of the worker flows are generated by job creation and job destruction. The rest of the worker flows represents a "musical chair" among existing jobs.

Those facts can be explained with a model in which the timing of job reallocation is endogenous and mainly takes place in recessions because the opportunity costs of reallocation are lower then.

In a decentralized market economy, where there are positive demand linkages between sectors, any expectation about a recession can come true if firms postpone their reallocation activities till that recession.

If the economy faces unexpected shocks, the model discussed in this paper would predict that those shocks will have a greater impact than in traditional models of the business cycle, because of the reallocation timing effect. This could be one explanation for the larger than expected impact that the two oil crises had on the world economy, in the seventies.

The most important lesson for policy-makers is that it is not wise to prevent or stop job destruction at any rate because such policies may also impede job creation.

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Appendix 1 Tables:

Table A1. Basic characteristics of gross annual unemployment flows (x1000 persons)

Variable	Mean	S.D.	Maximum	Minimum
Unemployment Inflow	526.89	81.22	659.74	396.41
Unemployment Outflow	501.75	100.68	671.74	377.41
Unemployment Outflow Rate	1.96	1.83	8.16	0.58
Unemployment Inflow Rate	0.12	0.012	0.14	0.098
Inflow + Outflow	1028.65	171.32	1331.48	773.8
Unemployment (Level)	465.86	257.34	839	86

Sample Period:(71-91)

Table A2. Basic characteristics of gross annual employment flows (x1000 persons)

Variable	Mean	S.D.	Maximum	Minimum
Employment Inflow	472.65	109.94	729.03 (1988)	337.63 (1971)
Employment Outflow	420.46	67.82	532.90 (1991)	318.63 (1971)
Job to Job movements	495.6[28]	164	754.9 (1983)	235.7 (1990)
Employment Outflow Rate[29]	0.097	0.01	0.11 (1987)	0.08 (1971)
Employment Inflow Rate[30]	1.76	1.152	6.89 (1971)	0.55 (1984)
(Inflow+Outflow)	893.12	171.93	1246 (1988)	656.26 (1971)
Employment (Level)	4384.91	356.55	5170 (1991)	4023 (1975)

Sample Period: (71-91)

Table A3 Basic Characteristics of annual flows between employment and (ww)[31] unemployment (x1000 persons)

Variable	Mean	S.D.	Maximum	Minimum
FEU	287.32	63.81	382.70 (1987)	191.00 (1979)
FUE	161.35	35.51	227.90 (1988)	98.6 (1975)
FEU Rate	0.065	0.01	0.08 (1988)	0.05 (1979)
FUE Rate	0.66	0.67	2.83 (1971)	0.17 (1985)
Sum	448.67	90.98	609.1 (1988)	330.2 (1979)
Unemployment (Level)	446.91	266.40	839.00 (1983)	49.00 (1970)

Sample Period: (71-91), source: Sociale Verzekeringsraad (1992)

Table A4. Correlations between employment flows

correlation (employment in and outflow)	0.86 (10.53)[1]
correlation (employment inflow, outflow rate)	-0.51 (4.33)
correlation (FEU,FUE)	0.65 (5.78)
correlation (FEU-rate,FUE-rate)	-0.48 (4.08)
correlation (unemployment in and outflow)	0.77 (7.98)
correlation (unemployment inflow, outflow rate)	-0.66 (6.07)

[1] t-values in brackets

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[28] The job to job movement statistics were calculated for the period (79-91).During that period, employment inflow averaged 533.75 and the mean of employment outflow was 457.98.

[29] The Outflow Rate is defined as Outflow/E(-1).

[30] The Inflow Rate is defined as Inflow/U(-1)

[31] See footnote 2 for a description of ww unemployment benefits

Table A5 The cyclical behavior of unemployment and employment flows

Dependent variable	cap. utilization (log)	real GDP growth	unemployment growth
Employment Flows			
Inflow (log)	**-0.38 (-0.71)** R^2=0.84 DW=1.72	**-0.85 (-1.20)** R^2=0.85 DW=1.68	**0.23 (1.59)** R^2=0.84 DW=1.73
Outflow (log)	**-1.22 (-1.73)** R^2=0.77 h=0.69	**(*) -0.952 (-1.58)** R^2=- 0.86 LM(4):n*R^2=.30	**0.41 (4.19)** R^2=0.87 h=0.07
Outflow rate (log)[32]	**(*)-0.144 (-2.27)** R^2=0.44 LM:n*R^2=0.12	**(*) -0.08 (-1.57)** R^2- =0.35 LM:n*R^2=0.27	**0.04 (3.90)** R^2=0.54 LM:n*R^2=0.58
Sum (log)	**-0.95 (-2.16)** R^2=0.87 DW=1.47	**-1.19 (-1.98)** R^2=0.86 DW=1.46	**0.24 (2.00)** R^2=0.85 DW=1.72
Unemployment Flows			
Inflow (log)	**(*)-1.35 (-2.33)** R^2=0.88 LM:n*R^2=1.37	**(*)-1.04 (-2.10)** R^2=0.87 LM:n*R^2=1.28	**(*)0.31 (3.43)** R^2=0.91 LM:n*R^2=0.84
Outflow (log)	**0.38 (0.71)** R^2=0.81 h=0.67	**0.80 (1.08)** R^2=0.82 LM:n*R^2=1.83	**-0.20 (-1.46)** R^2=0.82 LM:n*R^2=0.26
Outflow rate (log)	**3.84 (2.24)** R^2=0.93 h=-0.46	**2.36 (1.55)** R^2=0.92 h=-0.29	**-0.50 (-1.54)** R_2=0.92 h=-0.44
Sum (log)	**-0.41 (-0.91)** R^2=0.87 LM:n*R^2=2.03	**-0.27 (-0.43)** R^2=0.86 LM:n*R^2=0.61	**0.09 (0.73)** R^2=0.85 LM:n*R^2=0.57
Flows between Employment and Unemployment			
FEU (log)	**-1.90 (-2.47)** R^2=0.83 h=0.60	**-1.95 (-1.88)** R^2=0.77 LM:n*R^2=2.05	**0.61 (3.91)** R^2=0.83 h= 1.88
FUE (log)	**1.23 (1.28)** R^2=0.42 DW=1.83	**2.40 (1.96)** R^2=0.47 DW=2.00	**-0.02 (-0.09)** R^2=0.40 DW=1.77
FUE/U(-1) logs	**1.62 (1.18)** R^2=0.08 DW=1.86	**2.45 (1.98)** R^2=0.10 DW=2.05	**-0.08 (-0.29)** R^2=0.02 DW=1.79
Sum (log)	**(*)-0.36 (-0.53)** R^2=0.78 LM:n*R^2=5.81	**(*)-0.11 (-0.13)** R^2= 0.75 LM:n*R^2=5.24	**0.44 (2.92)** R^2=0.80 h=0.0465

Reported are the coefficient estimates of the cyclical measure (see text), the t-values are in brackets and finally a measure for autocorrelation is reported. This is either the DW statistic or Durbin's h, in the case of a regression with the dependent variable lagged or an LM test with one or two lags, in case the h statistics could not be calculated or when the dependent variable had to be lagged twice (regressions with (*)).

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[32] The Outflow rate is defined as the outflow/stock(-1)

Table A6 The cyclical behavior of job creation and job destruction by sbi (sic) code.

SBI	POS rate (1987)	POS rate (mean)	NEG rate (1987)	NEG rate (mean)
20 & 21	4.78	4.74	5.04	4.84
22	3.4	3.50	6.63	6.41
23	4.23	3.76	6.11	8.71
24	3.31	3.46	6.43	6.33
25	6.39	4.81	4.46	6.49
26	4.57	3.22	1.36	3.67
27	5.51	3.87	3.59	3.73
28	0.66	1.92	3.48	3.38
29 & 30	3.56	2.93	3.97	2.80
31	5.18	4.76	3.63	3.90
32	3.51	4.15	3.33	5.069
33	1.22	1.17	2.57	2.79
34	5.73	4.60	5.15	5.18
35	5.77	4.54	5.33	4.76
36	2.28	1.88	1.28	4.31
37	6.44	3.89	7.41	5.17
38	3.95	4.22	6.60	5.93
39	8.17	4.45	8.19	7.58
total	4.41	3.66	3.97	4.54

Table A7 Cyclical behaviour of job reallocation per industry

SBI 20 & 21	-0.066 (-0.79)
SBI 22	-0.016 (-1.63)
SBI 23	-0.010 (-0.78)
SBI 24	-0.0014 (-0.30)
SBI 25	-0.021 (-1.65)
SBI 26	-0.016 (-0.94)
SBI 27	0.009 (1.14)
SBI 28	0.002 (0.225)
SBI 29 & 30	0.04 (1.44)
SBI 31	0.012 (0.97)
SBI 32	-0.037 (-1.83)
SBI 33	-0.020 (-2.98)
SBI 34	0.02 (1.53)
SBI 35	-0.005 (-0.17)
SBI 36	-0.10 (-2.16)
SBI 37	0.038 (1.04)
SBI 38	-0.01 (-1.66)
SBI 39	-0.45 (-1.22)

Reported are the coefficient estimates of NET (employment change), in a regression of: Job reallocation in SBIxx on itself lagged (if necessary), a constant, and a linear time trend. The sample period is 79-91.

Appendix 2 Entry and Exit

Our data for openings and closures are very weak, since it is not clear whether a reported entry or closure really takes place or if it is caused by a change in location or legal status. Nevertheless it may give us some additional information. In table 12, some basic statistics of job creation and destruction due to entry and exits of firms are presented. In addition we calculated total job creation, job destruction and job reallocation. The mean value for job reallocation is about the same as Boeri (1992) finds for Germany.

Table A8 Entry and Exit (79-90)

Variable	Mean	S.D.	Maximum	Minimum
Entries	0.039	0.010	0.058	0.024
Exits	0.033	0.06	0.042	0.025
POStot	0.079	0.016	0.104	0.061
NEGtot	0.082	0.015	0.109	0.061
SUMtot	0.161	0.020	0.190	0.123
NETtot	-0.003	0.023	0.0314	-0.041

In table 13 we see that the entry and exit of new firms is not cyclical. The pattern of total job creation and destruction (including the job flows due to entry and exit) remains the same. job creation is pro-cyclical, job destruction is anti-cyclical and job reallocation is anticyclical.

Table A9 The Cyclical Behaviour of Job Flows

Dependent variable	NETTOT	CU
Entry	-0.123 (-0.75) DW=2.04	-0.105 (-0.698) DW=1.86
Exit	-0.21 (-0.207) DW=1.88	0.021 (0.226) DW=1.74
POStot	0.274 (2.032) DW=1.75	0.252 (2.04) DW=2.18
NEGtot	-0.726 (-5.40) DW=1.75	-0.298 (-1.41) DW=1.68
SUMtot	-0.453 (-1.68) DW=1.75	-0.033 (-0.116) DW=1.47

Appendix 3 Derivations

(A1) Derivation of the marginal rate of transformation, from equations (5) and (6).

Dividing equation (5) by YL and substituting (6) AU'(C) = ßE [...] / YL, into this equation yields:

$$U'(C)A(1-\sigma)[\frac{Y_H}{Y_L}] - U'(C)A(1-\sigma)(1-\Theta) + U'(C)A(1-\sigma)(1-\Theta) = \frac{\left(\frac{\partial V}{\partial H}\right)}{Y_L} \rightarrow$$

$$\beta E\frac{\left(\frac{\partial V}{\partial \overline{H}}\right)}{Y_L} = \beta E[U'(C)\overline{A}(1-\overline{\sigma})\left[\frac{Y_H}{Y_L}\right]$$ *substitute* (6) *back into this equation gives:*

$$\frac{AU'(C)}{\beta E[\overline{A}U'(\overline{C})]} = \beta E\ [(1-\sigma)\left[\frac{Y_H}{Y_L}\right]]$$

(A2) Derivation of equations (10) and (11).

Substitute the law of motion (1) and the resource constraint,
c = (1-σ)Hf(aH) + (1 - H +σH)f (a_L) in (9) and note that:

$$\frac{\partial U}{\partial \Theta} = -(1-H+\sigma H)f(a_L)$$

$$\frac{\partial \overline{H}}{\partial \Theta} = (1-H+\sigma H)$$ *,so the f.o.c. for* Θ *is:*

$$\frac{\partial V}{\partial \Theta} = (1-H+\sigma H)A[-U(c,T-a_L) + U(c,T-s)] - (1-H+\sigma H)f(a_L)[(1-\Theta)U_c(c,T-a_L) + \Theta U_c(c,T-S)]$$

$$+(1-H+\sigma H)\ \beta E\left[\frac{\partial V}{\partial \overline{H}}\right] = 0 \rightarrow$$

$$A[U(c,T-a_L) - U(c,T-S) + f(a_L)[(1-\Theta)U_c(c,T-a_L) + \Theta U_c(c,T-S)]] = \beta E\left[\frac{\partial V}{\partial \overline{H}}\right]$$ *This is eq.* (10)

(11 a) and (11 b) can be found by taking the f.o.c. from (9) for aH and aL. It will be assumed here that A only shifts the utility of consumption. First note that:

$$\frac{dU}{da_H} = (1-\sigma)Hf'(a_H)U_c(c,T-aH) + U_{a_H}(c,T-a_H)$$

$$\frac{\partial V}{\partial a_H} = (1-\sigma)H[(1-\sigma)HA[f'(a_H)U_c] + U_{a_H}] = 0 \rightarrow$$

$$A(1-\sigma)Hf'(a_H)U_c(c,T-a_H) = -U_{a_H}(c,T-a_H)$$ (*This is equation* (11 *a*))

$$\frac{dU}{da_L} = (1-H+\sigma H)[(1-\Theta)f'(a_L)U_c(c,T-a_L) + U_{a_L}(c,T-a_L)$$

$$\frac{\partial V}{\partial a_L} = (1-H+\sigma H)(1-\Theta)[(1-H+\sigma H)(1-\Theta)Af'(a_L)U_c + U_{a_L}] \rightarrow$$

$$A(1-H+\sigma H)(1-\Theta)f'(a_L)U_c(c,T-a_L) = -U_{a_L}(c,T-a_L)$$ (*This is equation* (11 *b*))

(A3) The use of fractions in the dynamic programming problem

Let $\pi_H(a,q,c)$ denote the fraction of households in the high-productivity sector who work a hours, who produce output q and receive consumption c. Since we assumed output to be random, let $\pi_t'(q \mid a)$ denote the fraction of households in the high productivity sector who produce output q by working a hours. Then the following equation holds:

$$\sum_c \pi_H(a,q,c) = \pi_H'(q \mid a) \sum_{q,c} \pi_H(a,q,c) \qquad \text{(i)}$$

Furthermore we will define $\pi_L(a,q,c \mid m=0)$ to be the fraction of households working a hours, producing output q and receiving consumption c, conditioned on not moving, m=0.

$$\sum_c \pi_L(a,q,c \mid m=0) = \pi_L'(q \mid a, m=0) \sum_{q,c} \pi_L(a,q,c \mid m=0) \qquad \text{(ii)}$$

Let $\pi_M(c \mid m=1)$ denote the fraction of moving workers who receive consumption c and finally recall Θ to be the fraction of workers who move. From the point of an individual household, all the fractions are considered to be probabilities.

With this notation, the social planner's problem is to choose values for $\pi_{Ht}(a,q,c)$, $\pi_{Lt}(a,q,c)$ $\pi_{mt}(c \mid m=1)$ and Θ_t that maximize the functional equation:

$$\begin{aligned} V(H_t,A_t,\sigma_t) = {} & [(H_t - \sigma_t)[\sum_{a,q,c} AU(c,T-a)\pi_{Ht}(a,q,c)] + (1 - H_t - \sigma_t H_t)[\pi_t(m=0)\sum_{a,q,c} A_t U(c,T-a) \\ & \pi_{Lt}(a,q,c \mid m=0) + \Theta_t \sum_c A_t U(c,T-S)\pi_{mt}(c \mid m=1)]] + \beta EV[H_{t+1}, \sigma_{t+1}, A_{t+1}] \end{aligned} \qquad \textit{(iii)}$$

subject to (i) and (ii) and to the resource constraint, consumption is output.

$$\begin{aligned} H(1-\sigma)\sum a,q,c(c-q)\pi_H(a,q,c) + (1 - H + \sigma H)[\pi(m=0)\sum_{a,q,c} (c-q)\pi_L(a,q,c \mid m=0) \\ + \Theta \sum_c c\pi_m(c \mid m=1)] = 0 \end{aligned} \qquad \text{(iv)}$$

Finding a solution for this program is difficult and can not be done analytically. A strategy suggested by Townsend (1990), is to assume again that H_t can only take a limited number of values. The procedure then goes as follows: (1) Take an initial guess for V on the r.h.s. of (iii). (2) Fix Θ_t at some arbitrary value. (3) Solve (iii) and (iv) as a linear programming problem. (4) Do this for all possible values of Θ_t. (5) Take the best decision as the new guess for V.

(A4) Data Sources and Definitions

Abbreviations

CBS Centraal Bureau voor de Statistiek (Central Bureau of Statistics)
CPB Centraal Planbureau (Central Planning Bureau)
OECD Organisation for Economic Cooperation and Development

Definitions and Sources

Feu: Flow out of employment into unemployment due to firing, this equals the flow of persons into unemployment insurance (WW).
Source: Sociale Verzekeringsraad, Kroniek van de sociale verzekeringen, 1992

Fed: Flow out of employment into disability, this equals the inflow of persons in disability insurance (WAO/AAW).
Source: Sociale Verzekeringsraad, Kroniek van de sociale verzekeringen, 1992.

Feer: Flow out of employment into retirement (VUT).
Source: CBS, Statistisch Jaarboek.

Fer: Flow out of employment into retirement (AOW)
Source: CBS, Statistisch Jaarboek.

Calculated as inflow retired persons = (AOWt - AOWt-1 + deaths65+) * the participation rate of persons 60-64 years old (the outflow out of AOW equals the number of deaths in the cohort 65 and older) .

Fue: The number of persons on an unemployment benefit (WW) finding employment (x1000).
Source: Sociale Verzekeringsraad, Kroniek van de sociale verzekeringen, 1992.

Fee: This series is based on the labor mobility measure, as collected by the CBS, "arbeidskrachtentelling", for 1975, 1977, 1979, 1981, 1983 and 1985. The intermediate values were obtained by interpolation. For the period after 1985, we used figures from the Dutch Ministry of Social Affaires and Employment,*in Kwartaalbericht Arbeidsmarkt 1992 II.*

E: Employment
Source OECD, Labor Force Statistics.

U: Unemployment

The total outflow out of unemployment is calculated as: outflow = $U_{in} - \Delta U$, where U_{in} is the inflow into unemployment, which consists of the persons receiving unemployment insurance benefit (WW) and the inflow of persons on unemployment support (RWW).

The inflow of persons receiving unemployment insurance benefit is directly observable.
source: Sociale Verzekeringsraad, *Kroniek van de sociale verzekeringen, 1992.*

The inflow of persons into unemployment support consists of persons moving from an unemployment insurance benefit to unemployment support, the flow of people who leave school and enter unemployment support and the flow of persons (re)-entering the labor force via unemployment support. We approximate the latter two flows by the total flow of school-leavers.

source: CBS, *Het onderwijs vanaf 1950*
CBS, *Statistisch Jaarboek 1992, 1993.*
Ministry of Social Affairs, *Rapportage Arbeidsmarkt, 1988*

Tabel A10: Sic Codes

SIC code	Industry
20,21	Food, Kindred and Tobacco Products
22	Textile Mill Products
23	Clothing Products
24	Leather and Leather Products
25	Furniture and Fixtures
26	Paper and Allied Products
27	Printing and Publishing
28	Petroleum and Coal Products
29 & 30	Chemicals and Allied Products

SIC code	Industry
31	Rubber and Miscellaneous Plastics Products
32	Stone, Clay and Glass Products
33	Primary Metal Industries
34	Fabricated Metal Products
35	Industrial Machinery and Equipment
36	Electronic and other Electric Equipment
37	Transportation Equipment
38	Instruments and Related Products
39	Miscellaneous Manufacturing Industries

1992-1	R.J. Boucherie N.M. van Dijk	Local Balance in Queueing Networks with Positive and Negative Customers
1992-2	R. van Zijp H. Visser	Mathematical Formalization and the Analysis of Cantillon Effects
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