Abstract

This paper challenges the consensus on the nature of unemployment dynamics in Britain. We show that the argument that changes in unemployment arise mostly from changes in the duration of unemployment (rather than in the chance of becoming unemployed) is flawed. In fact, while shocks to the outflow do have a part to play up to the late 1970s, the huge changes in unemployment over the last two decades have been mostly driven by inflow shocks. Our model also provides a new explanation of aggregate unemployment persistence based on externalities at a market level rather than individual-level persistence.

This paper was produced as part of the Centre's
Labour Markets Programme

Unemployment Dynamics, Duration and Equilibrium: Evidence From Britain

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November 2000

Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

ISBN 0 7530 1418 1

Individual copy price: £5

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The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements

Thanks to UK Department for Education and Employment for funding this project, though they are not responsible for the views expressed in this paper, and the views expressed here may not be the same as theirs. Thanks also for comments from Carol Propper, David Winter, Gervas Huxley, Michael Burda, Juan Dolado, Dan Hamermesh and Andrew Oswald, and seminar participants at Bristol, Keele, LSE/CEP, and the Tinbergen Institute in Amsterdam.

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1. Introduction

This paper challenges the consensus on the nature of unemployment dynamics in Britain (and indeed in much of the rest of Europe). We show that the argument that changes in unemployment arise mostly from changes in the duration of unemployment (rather than in the chance of becoming unemployed) is flawed. In fact, while shocks to the outflow do have a part to play up to the late 1970s, the huge changes in unemployment over the last two decades have been mostly driven by the shocks to the inflow. We also provide a new explanation of the persistence and complex dynamics in unemployment, an explanation based on externalities at a market level rather than individual-level persistence.

It is widely believed that changes in unemployment arise mostly from changes in the duration of unemployment, rather than in the chance of becoming unemployed. In other words, the outflow rate matters more than the inflow rate; indeed, the standard view of the data appears to show that the inflow rate is largely irrelevant. Components of these views can be found for example in Pissarides (1986), Layard, Nickell and Jackman (1991), OECD (1994), and Nickell (1999). Possibly as a consequence of this, most policy directed at reducing unemployment focuses on improving the employability and search effectiveness of the currently unemployed. In this paper, we argue that the unemployment rate, the outflow rate and the inflow rate are all jointly endogenous variables. We show that since the late 1970s inflow rate shocks are far more important than outflow rate shocks in explaining the dynamics of unemployment. This occurs because the inflow rate is more responsive to aggregate shocks than the outflow rate. This fact is explained by our theoretical framework: the importance of endogenous employed job search amplifies the effect of the cycle on the inflow and damps the effect on the outflow. Consequently, we argue that the high correlation between the unemployment rate and the outflow rate (and its inverse, the average unemployment duration) is largely driven by the unemployment rate influencing the outflow rate and not *vice versa*. That is, the huge rises in unemployment duration are in fact an endogenous response to the higher unemployment itself and not its main source. The higher unemployment in turn comes mostly from inflow rate shocks.

The dynamics of unemployment are not well understood; at some times unemployment seems to be characterised by persistence and to change very slowly; at other times it changes dramatically. Models of hysteresis or persistence in general have been proposed, though none appear to fit the data very well. Dissatisfaction has been expressed with our understanding of unemployment dynamics by Bean (1994), Karanassou and Snower (1998), Nickell (1998), and Machin and Manning (1999) among others; see also the collection of papers edited by Henry, Nickell and Snower (2000). Most models are based on individual level persistence or on the specification of the wage equation. Our model explains the apparently non-linear dynamics in unemployment, including persistence in the sense of a slow response to some shocks. We show that the model implies asymmetric responses to

positive and negative shocks, and much slower reaction to large adverse shocks. That is, if unemployment is increased substantially above equilibrium, its rate of decline can be very slow. Normal shocks on the other hand are dissipated quickly. Our persistence model is based on the externalities arising in the job search process with employed job searchers[1]. These imply that high levels of unemployment reduce the outflow rate and raise the inflow rate; these effects work to offset the decline back to equilibrium and thus produce a slow change in unemployment.

To address these issues in this paper we first set up a framework for thinking about the relationships between the unemployment flows and the stock. We provide an economic model to support that framework. This is all in the next section. Section 3 briefly discusses the data. Section 4 reports on some simple techniques to explore the inter-related dynamics of the unemployment flow rates and the stock and Section 5 presents the results of our estimation. Section 6 illustrates the implications of these results using simulations. Finally, Section 7 concludes.

2. Theory

In this section we do two things. First, we show that by adopting a simple and intuitive model for the inflow and outflow rates, we can generate some striking results relating to the dynamics and duration of unemployment. Second, we provide a theoretical framework from which can be derived the foregoing model for the flow rates. We present the material in this order because it seems likely that other models could be used to derive the flow relationships, and therefore the particular details of the path we chose are less important. The key, necessary feature of the relationships is that the flow rates depend on the unemployment rate and the business cycle; this seems an unobjectionable feature and likely to arise in a number of different settings.

(a) Equilibria

We leave the details of the model to later and start by specifying the unemployment flow rates. The inflow rate, i, is defined as the number of people becoming unemployed (I) divided by the stock of employed (N). The outflow rate, x, is defined as the number of people leaving unemployment (X) divided by the stock of unemployed (U); the unemployed and employed together make up the labour force: $U + N = L$. We later discuss the duration of unemployment; this is clearly related to the outflow rate, and under some (common) assumptions average duration is simply the inverse of the outflow rate.

We begin by assuming simple reduced forms for the inflow and outflow rates:

$$i_t = i(u_t, y_t, Z_{it}) \qquad (1)$$
$$x_t = x(u_t, y_t, Z_{xt}) \qquad (2)$$

[1] Boeri (1999) has recently also argued for a relationship between employed job search and unemployment, although in a very different context. His model relates to the role of employment protection in generating pressures for job search by the employed, and thence affecting equilibrium unemployment.

where u is the unemployment rate U/L, y represents an untrended business cycle and Z_j, $j = i, x$, denote sets of exogenous variables. To complete the system, we have the intertemporal unemployment flow identity[2]:

$$u_{t+1} = u_t + i_t(1 - u_t) - u_t x_t = u_t(1 - i_t - x_t) + i_t \qquad (3)$$

We therefore have three equations with three endogenous variables (u_t, i_t, x_t) determined by the exogenous variables (y_t, Z_{it}, Z_{xt}). To investigate this system we need to make an assumption about the signs of the variables in (1) and (2); the effect of unemployment on i and x is crucial. The standard assumption would be as follows: high unemployment reduces wages, raises labour demand and hence reduces inflows and raises outflows. This implies $i_u < 0, \quad x_u > 0$. There is, however, another mechanism at work based on thinking about the unemployment flows as part of the whole set of labour market flows . Briefly, the intuition for this is as follows: a cyclical upturn reduces the need for firms to fire workers (reducing the inflow) and creates more vacancies thus raising the flow out of unemployment. High unemployment reduces possibilities for job-to-job moves, thus channelling more people fired by their firms into unemployment. High unemployment also has a negative impact on the flow rate out of unemployment: this can arise through a number of mechanisms implying that the increase in unemployment does not increase vacancy generation enough to keep the job finding rate constant. The analysis below derives these results. This line of argument suggests the following signs $i_u > 0, \quad x_u < 0$.

We choose to concentrate on the latter case in our analysis in this section. This is for two reasons. First, this case produces some interesting and novel adjustment dynamics similar to those observed in the data; the opposite (standard) case produces nothing new[3]. Second, this is the case that our empirical work below supports. We therefore assume the following signs for (1) and (2):

$$i_u > 0, \quad i_y < 0, \quad x_u < 0, \quad x_y > 0 \qquad (4)$$

The equilibrium rate of unemployment, u^*, is derived by setting $u_{t+1} = u_t$ in (3), substituting (1) and (2) in, and setting the business cycle $y = 0$:

$$u^* = \frac{i(u^*, Z_i)}{i(u^*, Z_i) + x(u^*, Z_x)} \qquad (5)$$

The dependence of $i()$ and $x()$ on u make this different from the usual closed form equilibrium unemployment formulation ($u = i/(i+x)$). We can explore the different results this implies most easily[4] by assuming simple linear forms for (1) and (2):

$$x_t = aZ_x - bu_t \qquad (6)$$
$$i_t = gZ_i + du_t \qquad (7)$$

[2] We assume zero growth in the labour force.
[3] In contrast to the case analysed below, this produces a unique feasible equilibrium unemployment rate with stable, fast-adjusting dynamics.
[4] In the general case, we have from (5) that u^* is a negative function of x/i. Combining (1) and (2) we have that x/i is a negative function of u^*. These two functions may cross one or more times.

with $y = 0$, and (aZ_x, b, gZ_i, d) all positive. In this case we end up with a quadratic for u^* with roots:

$$u_1^* = \frac{aZ_x + gZ_i - d - \mathrm{K}}{2(b-d)} \tag{8a}$$

$$u_2^* = \frac{aZ_x + gZ_i - d + \mathrm{K}}{2(b-d)} \tag{8b}$$

where $\mathrm{K} = \sqrt{(aZ_x + gZ_i - d)^2 - 4(b-d)gZ_i}$; we assume the term under the square root sign and $(b - d)$ to be positive[5]. Note that $u_2^* = u_1^* + \mathrm{K}/(b-d)$; also note that K depends on Z_i and Z_x, so that this distance between the equilibria depends on the structural factors. We can then deduce the equilibrium inflow and outflow rates by substituting (8) into (6) and (7). In this model, the unemployment rate, outflow rate and inflow rate are all jointly determined equilibrium outcomes.

The possibility of multiple equilibria in this model derives simply from the dependence of either or both of the flow rates on the unemployment stock. The intuition for the case of two equilibria is straightforward: a high unemployment rate implies a high inflow rate and low outflow rate, supporting the high unemployment rate; conversely a low unemployment rate yields a low inflow rate and high outflow rate thereby returning a low unemployment rate.

(b) Dynamics

We first check for the stability of the equilibria. Substituting in from the equilibrium linear forms of (1) and (2) into the intertemporal identity (3) we reach:

$$u_{t+1} - u_t = (d - (aZ_x + gZ_i) + 2(b-d)u_j^*)(u_t - u_j^*) + (b-d)(u_t - u_j^*)^2 \qquad j = 1,2$$

We can use this to evaluate the dynamics around each of the two equilibria we identified above:

$$u_{t+1} - u_t = -\mathrm{K}(u_t - u_1^*) + (b-d)(u_t - u_1^*)^2 \tag{9a}$$

$$u_{t+1} - u_t = \mathrm{K}(u_t - u_2^*) + (b-d)(u_t - u_2^*)^2 \tag{9b}$$

where recall $K > 0$ and $(b - d) > 0$. Note the presence of the squared term in unemployment disequilibrium implying a non-linear response of Du_{t+1} to $(u_t - u^*)$. This arises as long as b and d are not both zero, and are not equal. This nonlinearity is the basis for the 'non-standard' dynamics in unemployment we discuss below.

It is easy to see from (9b) that u_2^* is an unstable equilibrium. Shocks increasing unemployment above u_2^* lead u_t off to the maximum feasible level; negative shocks lead down to u_1^*. Around the low equilibrium, for $u_t < u_1^*$ unemployment is increasing. And for $u_1^* < u_t < u_2^*$ unemployment is decreasing.

We should emphasise two points: first, our argument is not the usual multiple equilibria one that unemployment is characterised by spending time at the two equilibria, since the high equilibrium

[5] Our empirical work below confirms this.

is unstable and the process would not remain there for significant periods of time. Second, the implication that unemployment rises continuously beyond u_2^* is not a worry: a fuller model would include a policy reaction function affecting y that would produce counter-vailing forces once unemployment became very high. Our interest is in the more complex and interesting dynamics affecting unemployment following an adverse shock from u_1^*. This arguably characterises much of the recent labour market history of the UK (and the rest of Europe).

The main results can be seen most easily by plotting out the function in (9a) relating the change in unemployment to the disequilibrium – Figure 1. This shows the following results. First, the response is not symmetric for positive and negative shocks. Second, and more importantly, large and small shocks produce different reactions. In fact small shocks (defined as less than $K/2(b - d)$) lead to a large subsequent fall in unemployment and are dissipated relatively quickly. Large shocks (between $K/2(b - d)$ and $K/(b - d)$) produce a slower reaction of unemployment and consequently take longer to disappear. That is, once unemployment is shocked up to just below the upper equilibrium, it decreases only very slowly.

One way to illustrate this is to compute the 'half-life' of shocks for this model. Adopting a continuous time version of the model[6] and parameter values from the estimation described below, we can plot out the half-life T of a shock of size S – see Figure 2. This is given by

$$T = K^{-1} \ln\left[\frac{2-l}{1-l}\right] \qquad (10)$$

where $l = S/(K/(b-d))$, showing the dependence of T on the size of the shock relative to the distance between the two equilibria. We see that the half-life is low for shocks up to around 70% of the distance between the two equilibria, but thereafter increases sharply. Given our parameters, for a shock equal to 90% of the distance between the two equilibria, the half-life is over four years. Here is a potential explanation of the peculiar dynamics of unemployment, that have been described as hysteresis, persistence, and so on.

The intuition for this persistence is as follows. Following a large shock pushing unemployment up to a high level, the inflow rate increases and the outflow rate falls. Unemployment falls as it is above equilibrium, but these endogenous adjustments of the rates mean that this fall is very slow.

(c) Duration

The final implication of the model set out above relates to unemployment duration, the inverse of the outflow rate. The dependence of the exit rate on the unemployment rate implies that the duration of unemployment is endogenous to the process. The high correlation between duration and unemployment (see below) is often taken to demonstrate that high unemployment is an "outflow problem". In fact, in our model, it could equally well arise from high unemployment leading to high duration – we show below that this is partly the case. Also, unemployment duration depends on the inflow process. Long run changes in the inflow (changes in Z_i) affect the equilibrium outflow rate[7], and pulses in the inflow will have a dynamic effect. Indeed, if the inflow shock is sufficiently high,

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[6] This is $du(t)/dt = -K(u(t) - u_1^*) + (b-d)(u(t) - u_1^*)^2$

[7] Substituting for u from (6a) into the outflow rate expression.

pushing unemployment into the slow adjustment region, then an inflow shock will have long-lasting effects on duration.

(d) Model of labour market flows

In this section we sketch out a model from which we derive $i = i(u, y, Z_i)$ and $x = x(u, y, Z_x)$ above[8]. The obvious route in constructing such a model is to start from and modify the workhorse model in the field, Mortensen and Pissarides (1994, 1999). However, this is not very productive since one factor playing a key role in the argument of this paper is the importance of employed job search and direct job-to-job moves, and this is largely at odds with the Mortensen and Pissarides setup[9]. We therefore need to come at this using a different framework, albeit one based in the ideas of search and matching, job creation and destruction. The focus of this paper is largely empirical and we show below that the facts fit well within our framework. We do not at all claim that the model presented here is the only way of deriving the forms for *i()* and *x()* given above, but it is a useful way to understand the behaviour underlying the effects. The key points of the paper are that both the inflow and outflow rates depend on unemployment, and that employed job search means that the inflow rather than the outflow is the main transmission mechanism for macro shocks to affect unemployment. These are supported by the model set out below.

2.i Workers

The model is set in a search and matching environment with imperfect information on job opportunities and dispersed trading. We follow convention in assuming that all the unemployed engage in job search. However, we also assume that job search is feasible for the employed. This is certainly a reasonable assumption granted the number of people we observe moving directly from one job to another: around about half of all new hires come from the ranks of the already-employed (Burgess, 1994; Boeri, 1999). We assume that some endogenous fraction of the employed, f, engage in job search. On-the-job search theory shows that this fraction depends chiefly on the probability of receiving an offer and a variety of other factors such as fear of job loss, job changing costs and the like[10], $f(q^N, z_1)$, where f is the fraction of the employed engaged in search, q^N is the offer arrival rate for the employed and z_1 collects a set of exogenous variables. As the job offer rate increases, more of the employed are tempted to search for a better job. This is one of the key behavioural responses in the model, and the elasticity is denoted h_{fq}.

We can now define the transition rates for the two searching groups. The outflow rate from unemployment is simply the job offer probability for the unemployed[11]. The job-to-job quit rate is

[8] This is based on some previous work by one of us on employed job search, job competition, and inflows (see Burgess, 1992b, 1993, 1994).
[9] See their 1999 survey where the model, once extended to include quits, explicitly does not include the full effects of the quits. Mortensen (1994) adapts the Mortensen and Pissarides (1994) to include job search by the employed. However, the assumptions imply that all jobs quit from are destroyed. It follows that total separations (quits plus fires) equals total jobs destroyed; and that total hires equals total jobs created. This is strongly counterfactual since worker flows far exceed job flows: see Burda and Wyplosz (1994), Boeri (1999) and Burgess, Lane and Stevens (2000).
[10] This can be derived from optimising behaviour by workers – see Burdett (1978), Mortensen (1986), Burgess (1992a).
[11] In common with most of the search and matching literature we ignore offer acceptance issues.

equal to the fraction of workers engaging in job search multiplied by the job offer rate for the employed:

$$q = f(q^N, z_1).q^N \tag{11}$$

$$x = q^U \tag{12}$$

where q is the job-to-job quit rate and x is the unemployment exit rate. Note that the employed and unemployed may well face different offer arrival rates. There are two points here. The first is the search intensity of the searchers, which may be different between the two groups. Second, each unit of search effort may yield unequal numbers of offers for the two groups. See Anderson and Burgess (2000) for a brief review and some evidence.

We assume the existence of a matching function, based on vacancies and the total number of job searchers, *J*:

$$M = M(J, V, z_2) \tag{13}$$

where M is the number of matches, J is the total number of searchers, V is vacancies and z_2 is matching efficiency (including the search intensity of firms). J is given by $J = U + f(q^N, z_1)$. N or dividing by the labour force:

$$j = u + (1 - u)\, f(q^N, z_1) \tag{14}$$

We can now define q. Let us assume initially that both unemployed and employed job searchers are treated identically by firms and face the same offer arrival rates; that is, assume $q^N = q^U = q = m/j$.

So q and j are jointly determined as functions of m and u. We can now use our analysis of job search along with the matching function to determine the transition rates. The outflow rate and quit rates can be written as:

$$x = q = \frac{m(j, v, z_2)}{j(m, u, z_1)} = w^x(u, v, z_1, z_2) \tag{15}$$

$$q = f(q, z_1).q = w^q(u, v, z_1, z_2) \tag{16}$$

The key elasticities for these functions are:

$$h_{x,v} = \frac{g}{1 + bh_{f,q}(1 - a)} > 0 \tag{17a}$$

$$h_{x,u} = -\frac{b(1 - a)}{1 + bh_{f,q}(1 - a)} < 0 \tag{17b}$$

$$h_{q,v} = \frac{g(1 + h_{f,q})}{1 + bh_{f,q}(1 - a)} > h_{x,v} > 0 \tag{17c}$$

$$h_{q,u} = -\frac{b(1 - a)(1 + h_{f,q})}{1 + bh_{f,q}(1 - a)} < h_{x,u} < 0 \tag{17d}$$

where g is the exponent on v in the matching function, a is the exponent on j in the matching function, and b is the proportion of searchers who are employed, $b = (1-u)f/j$. Note the role of employed job search and particularly the sensitivity of this to the job offer rate, $h_{f,q}$, in influencing the dependence of the outflow rate on vacancies. The larger is $h_{f,q}$, the lower is the responsiveness of the outflow rate to vacancies.

2.ii Firms

The basis of firm behaviour is profit maximisation and labour demand. Labour demand in turn depends on wages, capital and demand shocks. However, recent empirical work on micro labour demand, principally the work on job creation and destruction started by Davis and Haltiwanger (1990, 1992), has emphasised the importance of idiosyncratic effects on firms' labour demand. This presumably derives in turn from shocks to productivity or the firm's demand. We write firm *j*'s planned employment change[12] as a function of the aggregate cycle, the wage (*w*) and factors unique to it (ξ_{jt}):

$$\Delta n^{p}_{jt} = n(y_{t}, w_{t}, x_{jt}) \tag{18}$$

Davis and Haltiwanger's work shows the importance of the idiosyncratic component relative to the aggregate cycle and wage (and that the role of these may vary with variations in the the cross-sectional distribution of employment growth). The firm operates in a dynamic environment, facing quits and undertaking hiring and firing to achieve its planned employment growth. Firms may also engage in worker turnover for reasons other than employment growth – churning[13]. Each firm will then calculate its own optimal hiring and layoff rates as a function of its desired workforce change and churning, and anticipated quits. Firms also set vacancies and adjust their search intensity. Vacancy determination is not straightforward; standard models assume firms have at most one job, so the simple question for a firm is whether it is worth posting a vacancy or not. We will assume that for a firm with many job slots, vacancies are given by the difference between optimal employment in a friction-free environment and current employment (where this is positive) plus anticipated quits. This is different from the approach in the standard model, in that the number of vacancies is not influenced by the tightness of the labour market, but simply by firms' labour demand[14].

The firm determines its layoff rate, hiring rate, vacancy rate and search intensity (at least in expectation). Taking the layoff rate first, and using the intertemporal employment identity:

$$h_{jt} - l_{jt} = \Delta n^{p}_{jt} + q_{jt} \tag{19}$$

where *h*, *l*, and *q* represent the hiring rate, layoffs rate and quit rate. Firms may also hire and fire simultaneously to adjust the composition of their workforce. So, the layoff rate for firm *j* will depend on

[12] As explained below, this includes the firm's adjustment for hiring costs; therefore, Δn^{p}_{jt} will depend on the tightness of the labour market, *m/v*.

[13] This is simultaneous hiring and firing by firms to change the skill mix of their workforces.

[14] Search intensity will be influenced by tightness, but it seems likely that only special cases will yield the result that 'net' tightness is unaffected by unemployment.

$$l_{jt} = l_j(y_t, w_t, q_t, x_{jt}) \quad (20)$$

where we have absorbed the firm-specific element of quits into ξ_{jt}. We now need to aggregate these individual layoff rates into an aggregate rate. We know that the importance of the idiosyncratic component means that the relation between the layoff rate and the aggregate cycle and quit rate may be weak (and mediated by changes in the cross-sectional distribution of employment growth), but this does provide a basis for the aggregate layoff rate:

$$l_t = \bar{l}(y_t, w_t, q_t, s_{nt}) \quad (21)$$

where $\bar{l}$ is the average relationship between l_{jt} and (y_t, w_t, q_t, x_{jt}), and s_{nt} measures the variability of the cross-sectional distribution of employment growth. This may vary over time in accordance with the evidence.

This study does not focus strongly on wage determination. We assume that the wage can be written as a function of the unemployment rate and the cycle (clearly, we could also allow idiosyncratic elements too). This gives us our aggregate layoff relationship:

$$l_t = \bar{l}(y_t, u_t, q_t, s_{nt}) \quad (22)$$

Turning to vacancies, as noted above, these are set equal to

$$v_{jt} = \max(0, \Delta n^*_{jt} + q_{jt}) \quad (23)$$

where Δn^*_{jt} is the difference between firm *j*'s optimal employment in a friction-free environment and current employment. Because of the existence of adjustment costs, in this context search intensity costs, the firm will not necessarily aim to fill all vacancies immediately. Thus vacancies will differ from hires. Following the same argument as before we reach an aggregate vacancy equation of the form:

$$v_t = \bar{v}(y_t, u_t, q_t, s_{nt}) \quad (24)$$

This is not dissimilar to a standard vacancy setting equation, though note the role of the quit rate here.

Clearly, a similar procedure would yield an aggregate hiring relationship. However, we have already derived an expression for this as total hires and total matches are the same thing. These two are made consistent through the firm's choice of search intensity. This works as follows: vacancies are fixed by the definition that they are 'real' jobs, and by labour demand. The matching function gives the firm the relationship between its search intensity expenditure and the speed of hiring, given the state of the aggregate labour market. This provides the firm with the standard adjustment cost trade-off to make, and yields the value of Δn^p_{jt}. The implication is that hiring costs will be lower when unemployment is higher and firms will therefore increase their search intensity and generate more matches. The variability of search intensity ensures that the hiring rate derived from the matching framework will be consistent with that from the labour demand framework. For the purposes of this paper, it is easier to work with the matching framework.

2.iii Labour market flows

The presence of employed job search provides a feedback channel between vacancies and quits, as can be seen by comparing (16) and (24). High quit rates imply the need for more vacancies to replace some portion of those quits: only some are replaced, as some quits occur from jobs that would have been destroyed anyway (this factor also has important implications for the inflow rate – see below). High vacancies in turn lead to high quits through the matching function; an increase in vacancies produces a lower increase in quits, however[15]. Note that this mutually reinforcing structure between vacancies and quits means that any shock to either will have 'multiplier' effects. Putting together (16) and (24), q and v are jointly determined:

$$q_t = \tilde{q}(y_t, u_t, z_1, z_2, s_{nt}) \quad (25)$$
$$v_t = \tilde{v}(y_t, u_t, z_1, z_2, s_{nt}) \quad (26)$$

Substituting for v in (15), we can write the unemployment outflow rate as:

$$x_t = \tilde{x}(y_t, u_t, z_1, z_2, s_{nt}) \quad (27)$$

Two important points follow from this. First, note that factors affecting employed job search will influence the unemployment outflow rate. This widens the set of possible 'candidates' for explaining long-run changes in duration, and suggests the possibility that such changes may not arise from the search behaviour of the *unemployed* at all. Factors that might promote job search by the employed include falling job-changing costs, widening wage distribution and increased feelings of job insecurity. These factors all encourage more of the employed to engage in job search, thereby providing more competition for the unemployed and reducing their success rate[16]. This suggests potentially fruitful empirical work investigating these links.

Second, we have a relationship between the outflow rate and the unemployment rate. Conditional on vacancies, a rise in unemployment reduces the outflow rate (see 17b). However, vacancies respond to the rise in unemployment because of the complementarity in the matching function; if they do not rise sufficiently then the net effect of the rise in unemployment will be that the outflow rate falls. There are a number of reasons why vacancies may not rise enough: there may be decreasing returns to scale in the matching function[17], the vacancy setting rule may be such that vacancies and firm search intensity do not depend sensitively on labour market tightness[18], or the operation of competition between employed and unemployed job searchers. Any effect of unemployment on the outflow rate is ruled out in the models of Mortensen and Pissarides (1999) by their twin assumptions of constant returns in matching and the vacancy setting rule. The former implies that the outflow rate depends only on the U/V ratio. The latter fixes the U/V ratio equal to a constant depending on the value of output[19].

[15] We can be sure then that the equilibrium of this pair of equations is stable.
[16] Whilst an exogenous increase in employed job search reduces the outflow rate, it also reduces the inflow rate.
[17] See Burgess and Profit (1998) for some evidence on this for Britain.
[18] Our assumption above that vacancies must reflect 'real' jobs ties vacancies down, so in this case it is firms' search intensity that varies with labour market tightness. There is no reason to believe that search intensity will respond sufficiently to yield unchanged job offer rates.
[19] For example, Mortensen (1994, p. 1139) confirms that the model has the property that an increase in job search (in his case, an increase in search intensity by the employed) implies that "vacancies respond in proportion to offset congestion of this kind". See also p. 1124.

The flow into unemployment is the lay-off rate plus the rate at which people quit into unemployment. For the purposes of this model, we take the latter as exogenous:

$$i_t = \bar{l}(y_t, u_t, q_t, s_{nt}) + uq_t \tag{28}$$

As just noted, the fact that some jobs that would have been destroyed and given rise to layoffs do not because workers quit directly into another job, also has an impact on the nature of the inflow rate. Equation (28) shows that the inflow rate is therefore decreasing in the quit rate. Combining the quit rate model (25) with (28) for the inflow yields:

$$i_t = \tilde{i}(y_t, u_t, z_1, z_2, s_{nt}) \tag{29}$$

This has a number of implications. First, it provides a second channel for the cycle to affect the inflow rate, reinforcing the direct effect of the business cycle on labour demand and lay-offs. When a negative cyclical shock hits, this raises layoffs and reduces hires; the fall in hires plus the rise in unemployment reduce quits. The lower quits interact with the higher layoff rate to increase the inflow rate even more. Second, in the long run equilibrium, when average employment growth is zero, the inflow rate depends on the quit rate and structural factors only. For a given degree of employment heterogeneity, measured by σ_{nt}, the higher the quit rate, the more firms find they can accommodate their desired employment fall without needing layoffs, and hence the lower the inflow rate.

We are finally in a position to put this together to reach our reduced form modelling equations. We assume that s_{nt} depends on the cycle and job reallocation factors z_3. Collecting together all exogenous factors in Z, we can re-write the inflow and outflow models for estimation as:

$$i_t = \tilde{i}(y_t, u_t, Z) \tag{30}$$
$$x_t = \tilde{x}(y_t, u_t, Z) \tag{31}$$

This plus the intertemporal identity is our system.

$$u_{t+1} = u_t + i_t(1 - u_t) - u_t x_t \tag{32}$$

(e) The cyclicality of unemployment flow rates

We can use this framework to analyse the transmission of business cycle shocks to unemployment, in particular whether cyclical influences work mainly through the inflow or the outflow. We compare the relative sensitivity of the two flows to the cycle and explain why it is as it is.

The key finding is as follows. Suppose that business cycle shocks are symmetric in that positive and negative shocks are equally likely and of equal size. Then, if there is employed job search, and if it is sensitive to the job offer arrival rate ($f > 0$, $h_{f,q} > \bar{h}_{f,q}$), the unemployment flow rates will respond asymmetrically. The inflow rate will be more sensitive to the cycle than the outflow rate and the difference between them increases as $h_{f,q}$ increases[20].

[20] See Burgess (1994).

The intuition for this is straightforward and follows that given in Section (2a). Suppose there is a boom, raising the demand for labour. More firms offer vacancies and the chance of finding a job increases. However, this is offset for the unemployed by the externality imposed by the decisions of some of the employed to engage in job search, thus attenuating the impact of the higher vacancies. This means that the effect of the boom on the unemployment outflow rate is reduced, and it will be more reduced the more important and sensitive is employed job search. Turning to the inflow, the boom means that fewer firms will need to reduce their workforces. Of those that do, because of higher job-to-job quits out of the firm, more can do so through natural wastage and fewer will need to fire workers, reducing the inflow[21]. It also means that, of those who are fired, more can find new jobs without actually entering unemployment. These two additional channels mean that the effect of the boom on the inflow is exaggerated. Again, the more important endogenous employed job search is, the more sensitive is the inflow to the cycle.

We investigate these issues empirically below. First, we simply ask whether changes in unemployment arise principally through the outflow, or through the inflow or both. That is, taking the cyclical or secular factors as shocks, we investigate the data assuming the system $x_t = p_1 u_t + e_{xt}$, $i_t = p_2 u_t + e_{it}$ plus the intertemporal identity (32). Second, we estimate models (30) and (31) to evaluate the sensitivity of i and x to the cycle and unemployment.

3. Data

We use quarterly data on the unemployment stock and flows from 1967 to 1999. The data refer to claimant unemployment. Some series we use relate just to men, some to both men and women together. Comprehensive details of the construction of the dataset are given in Burgess and Turon (1999); and see also Burgess (1993) from which the earlier data are taken. We also illustrate some arguments using disaggregate data on Travel-to-work areas (TTWAs). These are described below. Note that these are 'real' inflows (people registering at the very start of their unemployment spell), not the stock in the shortest duration band as some authors are forced to do by data constraints (Darby, Haltiwanger and Plant, 1985, 1986; Abbring *et al*, 1997). There are a number of other data issues to discuss.

First, our timing convention is that inflows and outflows labelled t are the flows that occur during the period t. The quarterly stock dated t corresponds to the stock at the *beginning* of the period t. Thus the stock-flow identity is: $U_{t+1} = U_t + I_t - X_t$.

Second, the consistency of the time series needs to be checked. This has two aspects. First, the data show a discrepancy between the change in unemployment stock and the difference between inflows and outflows. This is acknowledged in the data documentation: "The figures for off-flows are not considered to be as complete as those for on-flows. A more accurate count of off-flows can be obtained by .... adding the stock at the beginning of the period to the total in-flows recorded during the period then subtracting the stock at the end of the period" (NOMIS Datasets guide, July 1995). This presumably arises from clerical (non-computerised) claims. By the end of the period, the discrepancy is a trivial fraction of the inflow, but in the late 1980s it amounts to 10% of the inflow. The pattern in the discrepancy does not appear to bear any particular relationship to

[21] This is carrying through the assumption of no correlation between employment growth rates and quit rates at firm level. Such a correlation would weaken or strengthen this argument depending on whether it was negative or positive.

the business cycle. We create a consistent outflow series from the inflow and stock series and the stock-flow identity. Second, the flow series are not adjusted for changes in the definition of unemployment; this is one of the unavoidable drawbacks of using administrative data. This is unfortunate, but these are the only flow data available, and are used by all researchers in the field. The two major changes were in October 1982 and April to August 1983. While an adjusted stock series has been produced, this obviously cannot be used to adjust the flows without further information; since it is important for the analysis that we have flows and stock series consistent with each other, we have used the stock series that links the flows. In fact, there has been relatively little disruption to the series since 1986, the period our estimation covers.

Third, data on other variables such as employment and the labour force are also derived from the Employment Gazette (now Labour Market Trends) and latterly from NOMIS. Employment includes all over the age of 16 in employment as an employee, self-employed or on work-related government programmes. These data are also collected for all and for males only[22]. Series for labour force are obtained by adding total unemployment and male unemployment to these employment series. All this data is unadjusted for seasonal variation.

Turning to the disaggregate data, we chose a travel-to-work area level of disaggregation as this offers a good approximation to a self-contained labour market. Each TTWA meets the following criteria: a minimum working population of 3500, 75% of those living in the area should also work there; 75% of those working in the area should also live there. We use Jobcentre best-fit TTWAs; there are 310 such areas in Great Britain. Unemployment stocks and flows have been extracted at the Jobcentre best-fit travel-to-work area level (*ttwa84jc*) from the NOMIS dataset UFP, quarterly[23].

Finally, in Table 1 we offer a brief description of the main series of interest. We see that on average about 1m individuals become unemployed every quarter and about the same number leave unemployment. Both series exhibit considerable variability over the horizon, moving between minima of about 0.68m per quarter to maxima of about 1.4m. These numbers can be contrasted with an average unemployment stock of about 1.72m. The unemployment flow rates are also presented, both relative to the labour force and relative to the relevant stock variable – unemployment for the outflow rate and employment for the inflow[24]. Expressing the inflow as a fraction of the employed shows that on average about 4% become unemployed each quarter, varying between 5.6% and 2.6%. Note that the unemployment outflow rate cannot be thought of strictly as a probability as for some dates it exceeds unity. Clearly the true outflow rate cannot exceed one: in the early years of the sample with relatively low unemployment, the pool 'at risk' of leaving unemployment increased during the quarter by the inflow to such an extent relative to the initial stock that more people left the state than occupied it at the beginning of the period. So this problem arises because of the use of quarterly data.

[22] To get data on male employment, some assumptions have had to be made as the disaggregation by sex is not available for all the components of the working population – see Burgess and Turon (1999).

[23] There is no employment data at the *ttwa84jc* level after 1991. However, the dataset UBRD provides data on labour force for all and for males only at the *ttwa84* level, on a yearly basis. This data refers to employees in employment plus unemployment plus self-employed plus armed forces plus participants in work-related schemes. The 310 TTWAs at the *ttwa84jc* level correspond to either one or the addition of two or three TTWAs at the *ttwa84* level. There are generally only small discrepancies between the *ttwa84* and the *ttwa84jc* level breakdowns. Given this, and the fact that there simply is no data for employment available at the *ttwa84jc* level, we take labour force data at the *ttwa84* level and use this to approximate the *ttwa84jc* level.

[24] Note that not all of the inflow come from employment, so the exactly appropriate denominator would also include some inactive.

4. Facts on Unemployment, Flows and the Cycle

We begin by exploring the cyclical and secular properties of the three inter-related series, x, i and u. The intertemporal accounting identity can be expressed in levels (and given our timing conventions) as: $\Delta U_t = I_{t-1} - X_{t-1}$, or in flow rates as:

$$u_t = \left[i_{t-1} + u_{t-1}(1 - i_{t-1} - x_{t-1})\right] \Big/ (1 + u_t) \qquad (33)$$

where $i_t = I_t / (L_t - U_t)$, $x_t = X_t / U_t$, $u_t = (L_t - L_{t-1}) / L_{t-1}$. The dependence of $i()$ and $x()$ on u and the cycle is behavioural and is the focus of interest. We first ask whether inflow shocks or outflow shocks contribute more to explaining movements in unemployment, controlling for the endogeneity of the flows themselves. We first present graphical analysis and then back this up with more formal econometric analysis.

(a) Graphical analysis

Figure 3 presents smoothed versions (5-quarter moving averages) of the unemployment flows, for all workers and separately for men. There is no strong overall trend in the flows: the figures are at the same level in 1987 as they were in 1967. The figure also presents the unemployment stock data. From the perspective of 1987 the picture looked very bleak with record levels of unemployment having persisted for a number of years. Twelve years on, we have seen unemployment fall more rapidly than could have seemed possible then, only to rise again almost as rapidly and fall back once more.

These figures embody one of the key points of the paper. Over the period as a whole, the inflow leads the outflow through the cycle. This is particularly marked since the early 1980s: the inflow clearly precedes the outflow by about a year. The pattern is remarkable: a very good approximation to the unemployment outflow over the last two decades is simply the inflow a year previously[25]. The figures also clearly show that the pattern is if anything stronger using the data on males only.

It is important to be clear that this need not be so, that this picture is informative. We can certainly write the outflow as an identity in terms of past inflows: unemployment exits at t are simply the sum of exits of all durations, s, at that date, $X(t) = \sum_{s=0}^{\infty} X(t,s)$, where $X(t, s)$ denotes outflows at time t of workers unemployed for duration s. $X(t, s)$ in turn is given by the number becoming unemployed $t - s$ periods ago, multiplied by the chance that they have remained unemployed for s periods, and then have left unemployment in t. We can therefore write total outflows as:

[25] Over the period 1981:1 to 1998:4, the inflow lagged a year by itself explains 58% of the movement in the outflow, with no other explanatory variables. Including inflow lagged 5 and 6 quarters raises this to 71%. To emphasise, these results require no lagged outflow terms. In fact, the representation of the outflow as a function of the inflow lagged a year only is robust statistically – showing negligible serial correlation, no heteroskedasticity and few signs of parameter non-constancy. This is quite a remarkable result for a macroeconomic model covering 71 quarters with just one explanatory variable.

$$X(t)=\sum_{s=0}^{\infty} I(t-s)\,x(t,s)\prod_{i=0}^{s-1}(1-x(t-i,s-i))$$

where $x(t,s)$ is the exit rate out of unemployment. But this is only going to imply the picture we see if the outflow rate is relatively constant; relative, that is, to the movements in the inflow. This is exactly the point we are illustrating here. If the outflow rate was highly variable, and was the channel through which shocks to unemployment were mostly transmitted, then this would imply that the outflow *X(t)* did not simply follow inflows *I(t)*[26].

It is also interesting to note that the behaviour of the flows appears different before and after 1980 (this is before the main breaks in the data arising from definitional changes). Before that, we can characterise the graphs as showing that the inflow was highly cyclical but that the outflow appeared to be largely acyclical and slightly related to the inflow. After that period, the behaviour was different and the relationship between inflow and outflow much stronger.

We now look at the unemployment flow rates. It turns out that the choice of normalising variable is crucial to the interpretation of the process of unemployment dynamics. There appear to be two main choices. Clearly, normalising by the labour force (as Darby, Haltiwanger and Plant, 1986, do for US data) will produce no meaningful change as in the UK the labour force has changed little, and any denominator common to both series will leave the picture unchanged. However, we can define the inflow rate as the numbers becoming unemployed relative to the employed population[27], and the outflow rate as the number leaving relative to the stock. These are shown in Figure 4, alongside the unemployment rate.

Again two very striking features are apparent. First, the inflow rate appears to be at least as important as the outflow rate in generating changes in unemployment. Second, the picture looks different either side of 1980. Before that date, the unemployment outflow rate was highly correlated with the unemployment rate – indeed, given the relatively acyclical nature of the outflow noted above in this period, the outflow *rate* is largely the mirror image of the unemployment rate. Afterwards, though the unemployment rate is more variable than in the earlier period, the outflow rate reacts much less: the standard deviation of the latter in 1967 – 1980 is 0.5674, and in 1981 – 1998 is 0.0825. The inflow by contrast is somewhat more variable over the latter period: a standard deviation of 0.0076 compared to 0.0040 before 1980. The picture also suggests that in the latter period the inflow rate is more variable and more closely correlated with unemployment than is the outflow rate, though this impression is misleading because of the split scale of the figure. In fact, taking the standard deviation relative to the mean shows that the inflow and outflow rates are about equally variable since 1981.

We noted above that because of time aggregation, the outflow rate is not straightforward to interpret as it cannot be thought of strictly as a probability. We can partially correct for this by taking as the denominator the beginning of period stock plus half the inflow[28]. The result of doing this is in Figure 5. There is quite a substantial effect in the early period when the inflow is high relative to the stock and roughly halves the extent of the decline in the measured outflow rate.

We now turn to the flow and stock data at TTWA level, observed over a window of 159 months. Since it would be difficult to present results for all 310 TTWAs, we present results for the largest 12 areas (in terms of the labour force). In Figure 6a we graph the smoothed inflow and outflows for these 12 areas. The inflow leads the outflow in most of these areas – see for example,

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[26] Simulations with a highly cyclical outflow rate show a different picture to that shown in Figure 3.

[27] Again, this is ignoring the fact that a lot of people enter unemployment from inactivity.

[28] This assumes a constant flow within the period.

Birmingham, Bristol, Heathrow, London and Manchester. It is interesting to note that in the depressed labour markets of Glasgow, Liverpool and Newcastle there is much less time series variability in the flows. Figure 6b graphs the flow rates. Note that the relative vertical position of the two curves is meaningless as the two lines are drawn to different scales. What is clear is the negative correlation between the two rates. This parallels the aggregate findings (see Figure 4, though the scale obscures it somewhat).

The figures displayed above suggest an important role for variation in the unemployment inflow in generating unemployment changes. However, the widely-held view is that in fact changes in the outflow rate or average duration drive unemployment dynamics. We can see the basis for that view in two other graphs. First, Figure 7 plots the proportion of unemployed who have been out of work for a year or more – one measure of duration – alongside the unemployment rate. The two are clearly closely related, whereas as we know the inflow rate is not trended upward. For example, comparing the unemployment rate in 1975 of 3.3% with that of 11.6% in 1985, the inflow rate is virtually unchanged between the two dates at 4.2% (1975) and 4.8% (1985) whereas the long-term unemployment proportion doubles from 19.2% to 38.0%. The second graph, Figure 8, works from the equilibrium identity $u^* = 1/(1 + x/i)$, and decomposes the evolution of x/i into x and i. It is clear that the movement of x/i is dominated by the movement of x, the outflow rate. This has supported the view that it is changes in the outflow rate that has been primarily responsible for the changes in unemployment. However, three factors show that this line of argument is flawed. First, the inflow and outflow *levels* are of very similar size. However, when we create the flow *rates*, we divide the outflow by unemployment and the inflow by employment, a number over twelve times bigger. It is therefore unsurprising and uninformative to see that the ratio of the two flows is largely driven by variations in the outflow rate. Changes in the inflow rate that are an order of magnitude smaller than than changes in the outflow rate will have the same effect on unemployment. Second, Figure 5 shows that once time aggregation is accounted for, some of the correlation of x and u is lost. Third, once we allow for the possibility that the outflow rate depends on the unemployment rate, this correlation clearly tells us nothing about causation. Movements in the outflow rate are endogenous and thus the co-movement of the outflow rate and the unemployment rate may not provide evidence that changes in the former have led to changes in the latter[29]. Over the early period to 1980, outflows trended downwards with little cyclicality and the movement in the outflow rate is derived from the movement in the unemployment rate itself. Over the later period, outflows appear to be driven by inflows. See below for the econometric evidence for this.

(b) Variance decompositions and VAR analysis

In an attempt to make sense of the graphical results, we employ a number of more formal techniques. There are two issues that have to be dealt with in evaluating these: the possible dependence of the flow rates on each other, and on the unemployment rate, and the fact that the intertemporal accounting identity relating the stock and the flows is non-linear.

4.i Variance decomposition

[29] This is not a reprise of the argument between Price (1985) and Nickell (1985) over whether it is better to model the number leaving unemployment, X, or the outflow rate, x. Rather, the argument is that the outflow rate has a behavioural dependence on unemployment which, if it had an elasticity close to –1, will generate a relatively flat outflow series.

The procedure we report in this section takes account of the non-linearity but not of the endogeneity. The technique is as follows: we set the unemployment rate at its initial value, and then simulate it forwards using the accounting identity (33). We first use the actual inflow rate but a constant outflow rate (equal to the sample average). This produces a synthetic unemployment history[30]. We then regress the actual unemployment rate on this synthetic series and note the R^2 as a measure of how much that constant outflow rate series explains. We repeat the procedure using an unemployment rate generated using a constant inflow rate. A comparison of these R^2 values is then an indicator of how much the inflow and outflow rates respectively explain.

The results are in Table 2. This table makes it strikingly clear how important the distinction is between outflows normalised by the labour force and normalised by the unemployment stock. Taking the former the inflow-constant explains 9% and the outflow-constant explains 50% of the variation in unemployment. On the other hand, using the outflow rate defined by the unemployment stock, the inflow-constant explains 92% of the variation compared to just 3% in an outflow-rate constant model. Repeating this analysis using an outflow rate adjusted for time aggregation shows no real difference. The table also reports changes in this statistic over time. Looking first at the rates defined by the labour force, we see that the relative explanatory power of the inflow rate has declined over time. This is explicable by looking again at Figure 4. We know that the behaviour of the outflows changed over time to more closely reflect the inflows after 1980. Thus in the last three sub-periods, the outflows are largely reflecting the lagged inflow rate. We would argue therefore that the real influence of the inflow has not in fact declined over the period.

Using the rates defined by the relevant stocks, we see further evidence of the change around 1980. As expected, relative to the unemployment rate normalised by the unemployment stock, the inflow rate explains none of the movement in unemployment until 1980. From then, however, and even using this outflow rate, the inflow rate explains about half of the variations in unemployment. Again, the basis for this can be seen in Figure 4. To repeat, this approach takes note of the non-linearity but not the potential endogeneity of the outflow rate.

4.ii VAR analysis with variance decomposition

Our preferred analysis is derived from a VAR (Vector Autoregression), combined with the same sort of variance decomposition just reported. This deals with both the endogeneity of the flow rates and the inherent non-linearity in the process. To construct the VAR we regress both the inflow and outflow rates (defined on the employment and unemployment stocks respectively) on twelve lags of each (plus a constant and seasonal dummies):

$$\begin{aligned} x_t &= \boldsymbol{a}_x(L)x_{t-1} + \boldsymbol{b}_x(L)i_{t-1} + \boldsymbol{e}_t^x \\ i_t &= \boldsymbol{a}_i(L)x_{t-1} + \boldsymbol{b}_i(L)i_{t-1} + \boldsymbol{e}_t^i \end{aligned} \qquad (34)$$

Since the intertemporal unemployment identity shows that unemployment can be written as a complex function of all past inflow and outflow rates, we can also think of this as regressing the flows on lagged unemployment rates. The coefficients are not presented here. This regression was run over the whole period. Given what we have seen before, this will tend to downplay the effect of the inflow rate. This procedure isolates the residuals and these can be identified with the original shocks or innovations driving the inflow and outflow rates. The coefficient estimates then track how

30 We tried following the work of Darby, Haltiwanger and Plant (1986) for the US in performing variance decompositions on this series but the covariances were so large and often negative that the results were difficult to interpret. Instead we adopted the following procedure.

both rates respond to both these initial shocks. So this approach captures the reaction of the outflow rate to the shock in the inflow rate (and *vice versa*).

We can compute the expected inflow and outflow rates as functions of the innovations, $\hat{i}(\hat{e}^i_t, \hat{e}^x_t), \hat{x}(\hat{e}^i_t, \hat{e}^x_t)$. We can then use these to compute a synthetic unemployment series, setting to zero in turn the inflow innovation series and the outflow innovation series[31]. This is a more sophisticated procedure than in the previous section because it is not the flow series itself that is held constant, but one source of shocks to it.

$$\begin{aligned} \hat{u}^{e\,i}_t &= \left\{\hat{i}(.,\hat{e}^i_t)_t - \hat{u}_{t-1}(1+\hat{i}(.,\hat{e}^i_t)_t - \hat{x}(.,\hat{e}^i_t)_t)\right\} \\ \hat{u}^{e\,x}_t &= \left\{\hat{i}(\hat{e}^x_t,.)_t - \hat{u}_{t-1}(1+\hat{i}(\hat{e}^x_t,.)_t - \hat{x}(\hat{e}^x_t,.)_t)\right\} \end{aligned} \tag{35}$$

This gives us two synthetic unemployment histories. We simply regress the actual unemployment history on these in turn and report the R^2s in Table 3. We find that over the period as a whole, we can explain 85% of the movements in unemployment without using the outflow innovations. Conversely, we can only explain 43% if we turn off the inflow innovation series. If we simply look at the period since 1979, we find that the outflow shocks explain essentially none of the changes in unemployment. We also repeat the procedure using the outflow series adjusted for time aggregation issues; the results are equally emphatic that the inflow innovations explain far more of the movements in unemployment, and almost solely so since 1979.

We also regress unemployment on both synthetic histories together and examine the coefficients. This can be thought of as being in the spirit of a Davidson-MacKinnon J-test. We find a coefficient on the no-inflow-shock history of 0.244 (s.e. of 0.049), and on the no-outflow shock of 0.826 (s.e. of 0.040). This suggests that taken jointly the inflow shocks matter more for unemployment dynamics.

One further point is of interest here, relating to the break in the time series. If we estimate these regressions using recursive least squares, we can check for changes in the value of the estimated coefficient over time. These are displayed in Figure 9 for the series with only inflow shocks, and the series for only outflow shocks. The key result is that the outflow rate equation shows a great deal of significant change around the time early/mid 1980s. It is true, as Table 3 suggests that shocks to the outflow rate are more important in the 1970s and largely irrelevant since then. This further reinforces the view espoused earlier that the dynamics of unemployment, particularly the outflow, change around that date.

Finally we can look at the implied response of unemployment to an inflow shock and to an outflow shock. Figure 10 shows the impact of a one-off shock to each flow rate (of size one standard-deviation), tracked over 16 quarters. The central estimate is shown with standard error bands. We see that there is a significant initial effect of the inflow rate on the outflow rate. There appears to be no reverse effect. We can use these simulated inflow and outflow rates to compute the implied unemployment rate. This allows the inflow rate shock to influence the unemployment rate both through its direct effect and through its effect on the outflow rate. Thus the endogeneity of the outflow rate is dealt with. Note, though, that it does not allow any feedback from lagged unemployment to the outflow or inflow rates. We compute the unemployment rate via the

[31] This would be problematic if the two series were highly correlated. In fact, the contemporaneous correlation is 0.21, against a 5% significance level of 0.19, and correlations at all other lags are insignificant. Using an SVAR we could force the orthogonality of the structural errors, but this is rendered a non-trivial undertaking by the nonlinear intertemporal identity at the heart of the model. Also, given the reduced form nature of this section, it is not clear that an SVAR is appropriate.

accounting identity (starting at an initial unemployment rate of 8%): this therefore takes account of the non-linearity in the unemployment process. The results are shown in Figure 11. The differential impact of the two shocks is quite striking[32]. The inflow rate shock has almost twice the impact of the outflow rate shock, peaking at an unemployment rate of 9.45% - a 15.3% proportionate increase. Note also that the effect is more immediate than that of the outflow shock.

We can now summarise the key features of the data that we have highlighted. First, the graphs show that the inflow series leads the outflow series with a lag of around one year. Second, it matters whether one investigates outflows normalised by the labour force, or outflows normalised by the unemployment stock, and a significantly different picture appears when we look at the latter. Comparisons of the latter outflow rate with the inflow rate in relation to the evolution of equilibrium unemployment appear to show that the outflow rate is more important in generating the latter than is the inflow rate. Third, we argue that the way these two facts can be understood together is if the unemployment outflow rate is endogenous, if it is itself influenced by the unemployment rate. So the model we propose is one in which inflows are driven by the cycle and lead outflows; this changes unemployment, which in turn has feedback effects on the flow rates. This endogenous response of outflow (duration), plus the denominator issue mentioned plus time aggregation explain much of the apparent importance of the outflow rate in Figure 8. Finally, the relationship between the stock and flow rates appears to change sometime around 1980.

5. Estimation

The next step is to estimate models for the inflow and outflow rates as functions of the unemployment stock, the business cycle and secular features. However, this is complicated by the fact that several factors can *induce* cyclicality in the measured aggregate outflow rate even if the underlying outflow rate is acyclical. Thus we need to isolate a measure of the 'core' outflow rate. We describe this induced cyclicality, a method to deal with it and the results.

(a) Induced cyclicality in the outflow rate

It is easy to see why duration dependence in the unemployment outflow rate, or heterogeneity in the flow into unemployment may induce cyclicality in the average measured outflow rate[33]. Consider a model with a cycle in the inflow rate, and an outflow rate process that is independent of the cycle but for each (identical) individual declines over duration. Suppose that the recently unemployed have a high chance of finding a job, but that the long term unemployed have a negligible chance. In this case, the average measured outflow rate depends on the duration structure of the unemployment stock, and this in turn depends on the movement in the inflow. As the economy turns down, more people flow in, the ratio of newly unemployed increases and hence so does the average outflow rate: induced counter-cyclicality.

[32] There are technical issues arising from the use of a VAR in the construction of impulse response functions. In particular the orthogonal decomposition of the error terms has to attribute any joint component to one or the other of the series. Traditionally this is just attributed arbitrarily to the first series in the list. Therefore, ordering matters. In this particular case, there does not appear to be a sizeable joint component in the residuals; in any case we have placed the outflow rate first in the list so any joint component is attributed to the outflow.
[33] See Burgess and Turon (1999) for a demonstration using simulation.

Turning to heterogeneity, suppose that there are two sorts of workers with high (*H*) and low (*L*) chances of finding a job. The 'weeding out' phenomenon will ensure a higher proportion of good searchers – and hence a higher exit rate – when the inflow has just risen. So this will induce counter-cyclical variation in the exit rate. Suppose further that the inflow quality is pro-cyclical so that in a boom, the inflow is composed of more *H* workers and fewer *L* workers. In this case, the average exit rate will be higher in a boom simply as the result of better quality searchers: pro-cyclical heterogeneity exaggerates the pro-cyclicality of the measured exit rate. This is the finding of Darby, Haltiwanger and Plant (1985) and Abbring, van den Berg and van Ours (1997) for the US. Alternatively, if the inflow quality is counter-cyclical then the pro-cyclicality of the measured exit rate underestimates the truth. This is the case proposed by Turon (2000) for the UK. All these cases show why we need to control for duration dependence and heterogeneity to isolate the underlying 'core' outflow rate.

(b) Estimating duration dependence and heterogeneity

A technique for separately identifying duration dependence and heterogeneity has been proposed by van den Berg and van Ours (1994, 1996) using aggregate data; this has also been used by Abbring, van den Berg and van Ours (1995, 1997). We use their technique, extended to take account of cyclical variation in the inflow quality (see Turon, 2000). The main assumption of their model is that the influences of the business cycle, duration of unemployment, and individual characteristics (all unobserved) are separable. Individual hazard rates can hence be written as in a simple mixed proportional hazard framework:

$$q(t,s,v) = m(t) \cdot j(s) \cdot v \qquad (36)$$

where s is the elapsed duration of the unemployment spell, t the calendar time and v represents unobserved heterogeneity between the unemployed in terms of their ability to find a job. The distribution of v is $G(v)$. The term $m(t)$ is not a direct function of time but represents the influence of the cycle on individual hazard rate. In other words, it is the 'core' outflow rate that we are to isolate.

Whereas van den Berg and Ours (1994, 1996) assumed a constant inflow composition, we allow it to vary with the cycle and incorporate a fourth term to the above expression (see also Abbring *et al* (1997) for another approach):

$$q(t,s,v) = m(t) \cdot j(s) \cdot p(t-s) \cdot v \qquad (37)$$

The strength of this method is that no parametric assumption is needed for the duration dependence pattern $j(s)$ or the heterogeneity distribution $G(v)$[34]. Lancaster(1979) showed that any parametric assumption on these would render the results unreliable, particularly with respect to the duration dependence phenomenon. However, we give a parametric form to the inflow composition variations[35]:

$$p(t-s) = l[u(t-s)]^{a} \qquad (38)$$

[34] Turon (2000) discusses identification issues.
[35] Experimenting with various functional forms showed that the results were robust.

The ratio of average exit rates from different duration bands d_1 and d_2 at the same calendar time t can then be expressed as the product of two ratios, representing the duration and inflow composition effects between these two duration bands, times the ratio of the mean of the heterogeneity distribution of individuals still unemployed after d_1 periods at time t to the mean of the heterogeneity distribution of individuals still unemployed after d_2 periods at time t. The term $m(t)$ therefore conveniently disappears in the process. This 'core' outflow rate is hence not estimated directly but (as shown in the Appendix) it is easy to retrieve it once the other parameters have been estimated. Some algebra shows that the ratios of average exit rates take the form of non-linear expressions shown in the Appendix and allow us to estimate features of the duration dependence pattern and the unobserved heterogeneity distribution as the following six parameters. Three duration dependence coefficients (the h's, where h_i represents the effect of duration on exit rates between the ith and $(i+1)$th quarter of unemployment), and three heterogeneity coefficients (the g coefficients which represent the second, third and fourth moments of the heterogeneity distribution). Three seasonal coefficients representing the impact of each quarter on the heterogeneity distribution (the w coefficients) are also estimated, as well as the coefficient a, which informs us whether the inflow composition varies pro- or counter-cyclically[36].

For the model to be applicable, the periodicity at which the data are collected has to equal the size of the duration class. The data used have been obtained from NOMIS and cover the period from October 1985 to April 1999. They refer to quarterly stocks of unemployed males, broken down by duration groups for the first five quarters of unemployment spells.

These results are reported in Table 4. The estimated η coefficients suggest some significant negative duration dependence, whereby individuals loose 22% of their chances of finding a job after the first quarter of unemployment, another 9% after the second quarter, and yet another 9% after the third quarter. The estimated γ_2 coefficient suggests a very small or zero variance of the heterogeneity distribution, which means that the size of the weeding out process must be small. The positive value of the estimate of α suggests that there is some substantial variation in the inflow composition and that the inflow is on average of a better quality (in terms of people's ability to find a job) in times of high unemployment than in times of low unemployment. With our estimated value of α, we can infer that when unemployment is at its highest, at about 12%, people entering unemployment have, on average, an ability to find a job in the next period which is 50% better (ceteris paribus) than people in the inflow pool at the time of lowest unemployment (about 6%). This is a significant departure from the assumption of constant inflow composition. This comparison refers to innate ability to find a job, linked with individual characteristics of workers entering unemployment.

From our results, we can estimate the "core" outflow rate, *i.e.* the influence of business cycle alone on the individual exit rate, the term $m(t)$ in the hazard rate specification (details of this procedure are in the Appendix). Note that the estimated core outflow rate is more responsive to the cycle than would have been the case if we had assumed a constant inflow composition.

(c) Inflow and outflow rate estimation

[36] The coefficient l in the expression of $y(t)$ is not identified.

We now turn to an empirical implementation of the model set out above for the inflow and core outflow[37]. As explanatory variables, we use the business cycle, the unemployment rate, and time trends to capture other secular factors. Our business cycle measure is based on a constant price GDP series; we fit a trend to this using the Hodrick-Prescott filter and use the residuals as a measure of the cycle.

Given the use of the core outflow rate from the previous section, we are restricted to a relatively short sample of 52 observations. This suggests that tests of integration and cointegration may have low power. While fundamentally the unemployment rate "must" be I(0) over a long enough historical period[38], in this sample window we cannot reject the hypothesis that it is I(1). Similarly, we cannot reject the hypothesis that the inflow rate, outflow rate and cycle are I(1), though the latter in particular is only borderline. We then ran Johansen tests for cointegration. In order to avoid the issues around cointegration in the presence of a nonlinear intertemporal identity, we ran these tests over two groups of three variables: first, the outflow rate, the unemployment rate and the cycle; and second, the inflow rate, the unemployment rate and the cycle. In both cases, we found a single cointegrating vector. This result, coupled with the results of Stock (1987) and Banerjee *et al* (1997) that in small samples a one-step estimator has less bias than the Engle-Granger two-step approach, we estimate the reduced forms directly.

The main results are presented in Tables 5 and 6. The unemployment rate is the beginning-of-period value, and the flows (both inflow and outflow) are within-period flows. Even so, we test for and reject the hypothesis that the unemployment rate is endogenous in both inflow and outflow equations. Taking the inflow rate in Table 5 first, we find that both the cycle and the unemployment rate have an effect. A negative cyclical shock raises the inflow, and higher rates of unemployment have both a transient and permanent positive effect on the level of the inflow. We discuss the interpretation of these results below. There is no role for time trends in the equation: the exclusion of a simple linear trend and of a quadratic in time can be easily accepted. The equation appears to fit the data well. There is no evidence of serial correlation in the residuals, nor of ARCH effects. There is also no evidence of parameter instability over this period. An example Chow breakpoint test is presented in the Table, and a fuller analysis using recursive techniques in Figure 12. We tested for interaction terms between the cycle and unemployment and, perhaps surprisingly, found none.

The core outflow rate estimation is presented in Table 6. The cycle has a transiently positive effect on this, and the unemployment rate has a depressing effect. There is evidence here of dynamics with both the first and second lags of the dependent variable proving significant. Again, time trends are insignificant. There is also no evidence of serial correlation in the residuals, nor ARCH nor heteroskedasticity. There was however, evidence of parameter instability, which is dealt with by including a (0, 1) dummy taking the value unity after 1996:1. This is likely to be related to new policies for the unemployed coming in then or shortly after.

One potential objection to the results in Table 6 is that the unemployment variable on the right hand side is endogenous (despite the evidence of the test). Stating the point more broadly, one of the key arguments of this paper is that the correlation between the unemployment rate and the outflow rate derives, at least in part, from a behavioural relationship of the former influencing the latter, and not just the outflow rate driving unemployment through the accounting identity. To

[37] Other empirical models of the flows for Britain include Nickell (1982), Junankar and Price (1983), Pissarides (1986) (outflow only), Burgess (1992, 1993, 1994); also see Burda and Wyplosz (1994), Blanchard and Diamond (1989, 1990).

[38] On the grounds that it cannot logically be outside (0,1), and historically has rarely been outside (0.02, 0.20).

establish this, we rerun the regression in Table 6 using reduced form forcing variables for unemployment. The results are in Table 7; note that we did not engage in any further specification search. First, we simply use the lagged inflow rate and show that this significantly influences the core outflow rate[39]. The rest of the equation continues to fit well (there is evidence of heteroskedasticity, so we report heteroskedasticity-consistent t-statistics). Second, we use annually cumulated inflow innovations, the innovations being derived from the VAR estimated in Section 4. This variable measures the inflow shocks that we argue drive unemployment and would seem likely to be exogenous for the core outflow rate. It thus provides a good test for this issue. The results show that this also has a significant effect on the core outflow, with the rest of the equation continuing to fit well. These two regressions give good grounds for arguing that the relationship estimated in Table 6 does not simply reflect the accounting identity, and that there is an important causal component[40].

We can interpret these results in the light of the model set out above. The negative impact of the cyclical variable on the inflow rate reflects the effect of a downturn in labour demand on layoffs. More firms find that they have to reduce their workforce as demand falls. It also has a secondary effect: the lower hiring rates reduce the scope for quits, which in turn means that more of the employment reduction at a specific firm has to be accomplished by layoffs. The influence of unemployment exacerbates this: higher unemployment also reduces the job offer rate, hence further reduces quits and raises layoffs and the unemployment inflow. This effect of unemployment clearly outweighs any counter-acting effect of wages on labour demand and layoffs. The effect of both the cycle and the unemployment rate on the outflow rate arise through a combination of job matching and job competition. In a boom, more firms engage in more hiring, raising the job offer rate. This is partially offset by an increase in job search by the employed raising the number of job seekers along with the number of job offers. Indeed, we find that the cyclical variable only has a transient effect on the outflow rate. This suggests that, holding all else constant, the numbers of workers engaging in employed job search varies to keep the offer probability roughly constant as the number of new hires changes. The role of unemployment is similar: this influences both the number of offers made, through the matching technology, and the share of these going to the unemployed, through the job competition process. The net effect of a rise in unemployment is to reduce the offer rate.

We can relate these results back to the analysis of Section 2. Setting the cycle to zero and incorporating the lags to get a long run solution we calculate the empirical counterparts to equations (6) and (7): $x^* = 0.64 - 2.09u^*$, $i^* = 0.03 + 0.17u^*$. These imply equilibrium unemployment rates of $u_1^* = 9.4\%$ and $u_2^* = 16.7\%$ for the period 1986 - 1998. Recall that the higher equilibrium rate is of interest really only as a way of defining the range of slow adjustment. Thus shocks pushing unemployment into the range 14% - 16% are likely to be long lasting.

6. Simulations

In this section we illustrate the main points of this paper using simulations based on our estimation results.

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[39] Note that the inflow effects are not due to duration or composition effects as these have been purged from the raw outflow rate by our use of the core outflow rate.

[40] If instead we include the unemployment rate and instrument it with these two variables, the unemployment rate remains significant with a t-statisitic of 2.7.

(a) Calculating equilibrium unemployment

The unemployment rate is the accumulation of inflows over the infinite past, less the outflow, written as[41]:

$$u(t) = \sum_{k=1}^{\infty} \left\{ i(t-k) \prod_{j=0}^{k-1} \left[1 - q(j, t-k+j) \right] \right\} \tag{39}$$

where the exit rate at time t of those unemployed for k periods is:

$$q(k,t) = d^k \cdot f(t) \cdot comp(t-k) \qquad \text{for } k > 0 \tag{40}$$

$$q(0,t) = 0.5 \cdot f(t) \cdot comp(t) \tag{41}$$

The coefficient 0.5 in the expression of $q(0,t)$ is used to reflect the fact that, on average over quarter t, only half the inflow for quarter t has already entered unemployment yet and is 'at risk' of leaving unemployment. $f(t)$ is the core outflow rate, d^k is the term representing duration dependence, and *comp(t-k)* represents the mean inflow quality at time t-k.

To keep things tractable, we truncate the infinite sum in (39) at eight periods, beyond which we assume that everyone leaves unemployment[42]. We use the inflow rate and core outflow rate processes estimated in the previous section[43]. We model the fluctuating composition of the inflow as:

$$comp(t) = u(t)^{0.568} \tag{42}$$

It should be noted here that we are therefore using results from two separate estimation procedures: the structural estimation of duration dependence and the time series estimation of the aggregate dynamics in this paper. This may be problematic, but note that since the van den Berg and van Ours method works precisely by eliminating the aggregate time effects, this is unavoidable.

We can now define the equilibrium rate of unemployment. In equilibrium:

$$cycle = \Delta cycle = \Delta u = 0$$
$$f(t) = f(t-1) = f(t-2) = \overline{f}$$

Therefore we have:

$$\overline{u} = \overline{i} \cdot \left(1 - 0.5 \cdot \overline{f} \cdot \overline{comp}\right) \cdot \left[1 + \sum_{k=2}^{8} \left\{ \prod_{j=1}^{k-1} \left(1 - d^j \cdot \overline{f} \cdot \overline{comp}\right) \right\} \right] \tag{43}$$

[41] To simplify the algebra, the inflow rate is here normalised by the labour force.

[42] We check whether this simplification has a significant impact on our results by tracking the proportion of the unemployed it affects, and we report below that it just affects 3% on average.

[43] The main estimation reported in the previous section was for the inflow rate defined relative to the stock of employed, as this is the key behavioural factor. For simulation purposes, we used the inflow relative to the labour force, and so re-estimated for that. The equation reported below is very similar to those reported above.

$$\bar{f} = 3.5752 - 14.0417 \cdot \bar{u}$$
$$\bar{i} = 0.0332 + 0.1102 \cdot \bar{u} \qquad (44)$$
$$\overline{comp} = \bar{u}^{0.568}$$

where the upper bars indicate equilibrium values. The duration dependence coefficient, δ, is set equal to 0.85 following our estimation results[44]. This gives us a complex polynomial equation to solve for $\bar{u}$. We approach the solution of this equation graphically by plotting the right hand side of equation (43) as a function of $\bar{u}$ against $\bar{u}$, and calculate the intersection(s) with the 45 degree line. The expression on the right hand side turns out to be a convex function of $\bar{u}$ and we find two values of equilibrium unemployment at 0.09 and 0.16. Note that this is a more complex model than the simple model in Section 2 since we now take account of duration dependence and heterogeneity. Even so, we find two equilibria with the upper one being unstable. We therefore conclude that the Section 2 model is a reasonable simplification of this more general one. We run the simulations below around the stable equilibrium.

(b) Results

The aim of this section is to illustrate the main points of the paper using the estimated relationships. First we look at the impact of an inflow shock on unemployment duration and the outflow rate. This is a pure inflow shock – the constant in the inflow equation is increased for 4 quarters. Figure 13 shows the results: it displays the inflow and core outflow rates in the top left quadrant, the unemployment rate in the bottom left, and the average exit rate and proportion of long-term unemployed bottom right. Focussing on this quadrant, we see that the inflow shock, via higher unemployment has raised the proportion of long-term unemployed, and that this effect persists for some time. Certainly it persists after the inflow shock has stopped. Similarly, the average exit rate (total exits over stock) declines. The point here is simply that the outflow rate and duration structure can change consequent upon an inflow shock. This is even after accounting for the duration dependence and heterogeneity we found in the first stage of the estimation.

Second, we investigate the nonlinear dynamics implied by the model we set out in Section 2. The feature of interest is the slow reaction to big shocks and the quick reaction to small shocks. In this case, the shocks are to the cycle variable, affecting both the inflow and (in a transient fashion) the outflow. The setup here is more complex than in Section 2 as we have incorporated the dynamics in the core outflow rate, duration dependence and the cyclical heterogeneity in the inflow rate.

Figures 14 and 15 show the results. The key feature is the delayed reaction of the unemployment stock following the large shock. Once past the initial peak in unemployment (this arises from over-shooting the high equilibrium u^*_2, but coming back, due to the dynamics in the core outflow rate), the rate of decline in uenmployment is lower than in Figure 14 with a much smaller shock. Again, note that the outflow rate is more persistently affected than is the inflow rate. This arises from its stronger dependence on the unemployment rate and the slow adjsutment of this.

[44] In the estimation, we allowed different rates of decline of the offer rate over the first four quarters. Here we impose a common value over eight quarters, the value used being an average of the estimates.

7. Conclusion

In this paper, we have made two main points. First, we have argued that the view that unemployment in Britain changes primarily because of changes in unemployment duration is wrong. Many authors have noted the association between the unemployment rate and unemployment duration, both within a country over time, and across countries. This association is, however, usually left unmodelled, although some authors do make explicit the implication that unemployment therefore is a duration problem. This is the standard interpretation of the high correlation between the unemployment rate and average unemployment duration (Figure 7), and the relative changes in the inflow and outflow rates (Figure 8). Using a model in which the unemployment rate, the outflow rate and the inflow rate are all jointly endogenous, we have investigated whether the correlation arises solely through the accounting identity linking these, or to a behavioural dependence of the outflow rate on unemployment. Our key results showed that outflow shocks are relatively unimportant for unemployment (*i.e.* there is not much action through the accounting identity from the outflow rate influencing unemployment), but that the outflow rate does indeed depend on unemployment.

Second, we have proposed a new explanation of the 'complex' dynamics in aggregate unemployment, including persistence at some times and not at others. Our explanation is based on market-level externalities arising through the processes of job matching and job competition between employed and unemployed searchers. Our results show that the data fit the model well.

Our line of argument suggests that the concentration of both policy and research on duration may have been over-done. Analysis of the unemployment flows needs to set them within the matrix of all the labour market flows. The importance of inflows in the dynamics of unemployment, and the role of job-to-job quits, now seems a ripe topic for further investigation.

Table 1: Unemployment Stocks and Flows. 1967:1 – 1998:4

Levels	Unemployment	Inflows	Outflows	Employment	Labour Force
Mean	1720.45	982.14	976.32	24537.78	26258.23
Median	1575.86	982.63	978.48	24242.00	25801.49
Maximum	3282.02	1352.48	1396.12	26701.07	28163.69
Minimum	436.47	679.87	682.51	22691.02	23995.08
Std. Dev.	922.01	133.84	137.16	1001.09	1394.77
Observations	127	127	127	127	127
Rates	**Unemployment Rate**	**Inflow[(1)] Rate**	**Outflow[(1)] Rate**	**Inflow[(2)] Rate**	**Outflow[(2)] Rate**
Mean	0.0644	0.0402	0.8304	0.0375	0.0372
Median	0.0565	0.0404	0.5363	0.0382	0.0379
Maximum	0.1205	0.0557	2.2764	0.0493	0.0509
Minimum	0.0174	0.0258	0.3069	0.0242	0.0244
Std. Dev.	0.0332	0.0063	0.5901	0.0055	0.0052
Observations	127	127	127	127	127

[(1)] Relative to the appropriate stock
[(2)] Relative to the labour force

Table 2: Variance Decomposition

Definition of inflow and outflow rates:	$R^2(i)$ (holding Outflow rate fixed)	$R^2(x)$ (holding Inflow rate fixed)	$R^2(i) / [R^2(x)+R^2(i)]$
I/L, X/L	0.50	0.09	0.84
I/L, X/U	0.03	0.92	0.03
I/L, X/L			
1967:3 – 1973:3	0.86	0.11	0.88
1973:4 – 1979:4	0.98	0.33	0.75
1980:1 – 1986:1	0.72	0.95	0.43
1986:2 – 1992:3	0.20	0.32	0.38
1992:4 – 1998:3	0.72	0.56	0.56
I/L, X/U			
1967:3 – 1973:3	0.00	0.67	0.00
1973:4 – 1979:4	0.02	0.91	0.02
1980:1 – 1986:1	0.80	0.97	0.45
1986:2 – 1992:3	0.97	0.86	0.53
1992:4 – 1998:3	0.86	0.93	0.48
Using data adjusted for time aggregation			
I/L, X/U	0.05	0.92	0.05

All regressions for (men+women), “dynamic” fitting of u.

Table 3: R^2 From Innovation Analysis

Sample	No Inflow Innovations	No Outflow Innovations
Raw Data		
1970:1 - 1998:3	0.43	0.85
1980:1 - 1998:3	0.11	0.67
Data adjusted for time aggregation		
1970:1 - 1998:3	0.56	0.80
1980:1 - 1998:3	0.02	0.52

Each entry is the R^2 from a regression of the unemployment rate against a constant and a synthetic unemployment series constructed as described in the text assuming either that all inflow innovations are zero (column 1) or all outflow innovations are zero (column 2)

Table 4: Estimation of the Structural Model

	Estimated coefficient	Standard error
η1	0.784	0.024
η2	0.908	0.018
η3	0.912	0.015
γ2	1.012	0.039
γ3	1.022	0.158
γ4	1.180	0.495
Woct	0.973	0.008
Wjan	0.985	0.008
Wapr	1.059	0.008
α	0.568	0.052

Table 5: Estimation of the Inflow Rate Model

Dep. Var. Inflow rate (male); Sample 1985:4 1998:3

Cycle (t-1)	-0.138	(2.38)	
Unemp. Rate	0.172	(5.69)	
D Unemp. Rate	0.460	(4.53)	
q3	0.000	(0.51)	
q2	-0.006	(4.98)	
q1	-0.008	(5.17)	
Constant	0.032	(10.10)	
# Observations	52		
R-squared	0.874		
Adjusted R-squared	0.857		
S.E. of regression	0.003007		
Sum squared resid	0.000407		
Breusch-Godfrey Serial Correlation LM Test: 2 lags			
F-statistic	1.328	Probability	0.275869
Obs*R-squared	3.023	Probability	0.220546
Breusch-Godfrey Serial Correlation LM Test: 5 lags			
F-statistic	0.892397	Probability	0.495388
Obs*R-squared	5.218461	Probability	0.389805
ARCH Test: 5 lags			
F-statistic	1.179408	Probability	0.335861
Obs*R-squared	5.909987	Probability	0.315076
White Heteroskedasticity Test:			
F-statistic	0.818967	Probability	0.678813
Obs*R-squared	18.94796	Probability	0.588478
Omitted Variables: TREND			
F-statistic	0.002284	Probability	0.962101
Log likelihood ratio	0.002699	Probability	0.958568
Omitted Variables: TREND, $TREND^2$			
F-statistic	0.778876	Probability	0.465287
Log likelihood ratio	1.850474	Probability	0.396437
Chow Breakpoint Test: 1991:1			
F-statistic	0.444147	Probability	0.867862
Log likelihood ratio	4.089364	Probability	0.769429
Hausman Test for Endogeneity of Unemp. rate			
t-statistic	0.53	Probability	0.60
Regressors: u(-1) to (-5), t, t^2, cycle(-1), q1, q2, q3.			

Table 6: Estimation of the Outflow Rate Model

Dep. Var. Core outflow rate (xc); Sample: 1986:2 1998:3

D_2 Cycle	4.015	(2.39)
Unemp. Rate	-3.901	(2.66)
xc(t-1)	1.121	(7.22)
xc(t-2)	-0.399	(2.88)
Dummy from 96:1	0.101	(3.37)
q1	0.712	(9.93)
q2	0.363	(10.32)
q3	0.481	(16.79)
Constant	0.503	(1.56)

# Observations	50
R-squared	0.980
Adjusted R-squared	0.977
S.E. of regression	0.068949
Sum squared resid	0.194913

Breusch-Godfrey Serial Correlation LM Test: 2 lags			
F-statistic	1.206386	Probability	0.310199
Obs*R-squared	2.913077	Probability	0.233042
Breusch-Godfrey Serial Correlation LM Test: 5lags			
F-statistic	0.769610	Probability	0.577872
Obs*R-squared	4.828405	Probability	0.437179
ARCH Test: 5 lags			
F-statistic	0.822730	Probability	0.369010
Obs*R-squared	0.842984	Probability	0.358545
White Heteroskedasticity Test:			
F-statistic	2.008319	Probability	0.097443
Obs*R-squared	43.04814	Probability	0.228241
Omitted Variables: Cycle			
F-statistic	0.027537	Probability	0.869037
Log likelihood ratio	0.034410	Probability	0.852838
Omitted Variables: TREND, $TREND^2$			
F-statistic	1.165203	Probability	0.322479
Log likelihood ratio	2.901841	Probability	0.234354

Table 7: Alternative Estimates of the Outflow Rate Model

$$S4II_t = \sum_{j=0}^{4} e^{i}_{t-j}$$

Dep. Var. Core outflow rate (xc) ; Sample: 1986:2 1998:3

Inflow rate			Inflow Innovations		
D_2 Cycle	3.314	(1.8)	*D_2 Cycle*	2.622	(1.4)
Inflow Rate (t-1)	-6.917	(2.5)	*S4II (t-1)*	-5.506	(2.4)
xc(t-1)	1.143	(6.3)	*xc(t-1)*	1.156	(6.5)
xc(t-2)	-0.293	(1.6)	*xc(t-2)*	-0.228	(1.2)
D(96:1)	0.100	(2.6)	D(96:1)	0.091	(2.5)
q1	0.677	(8.5)	q1	0.675	(8.7)
q2	0.350	(8.5)	q2	0.395	(9.6)
q3	0.436	(11.1)	q3	0.479	(15.7)
Constant	0.218	(1.0)	Constant	-0.265	(3.6)

	Inflow rate	Inflow Innovations
# Obs.	50	50
R^2	0.981	0.980
Adj. R^2	0.977	0.976
S.E.	0.06853	0.07027
SSR	0.19256	0.20244

Note: White Heteroskedasticity-Consistent Standard Errors

	Inflow rate	Inflow Innovations
Breusch-Godfrey Serial Correlation LM Test: 2 lags (F-statistic version)		
p-value	0.406	0.895
Breusch-Godfrey Serial Correlation LM Test: 5 lags (F-statistic version)		
p-value	0.693	0.908
ARCH Test: 5 lags (F-statistic version)		
p-value	0.116	0.465
White Heteroskedasticity Test: (F-statistic version)		
p-value	0.005	0.047
Omitted Variables: Cycle (F-statistic version)		
p-value	0.717	0.113
Omitted Variables: TREND, $TREND^2$ (F-statistic version)		
p-value	0.618	0.069

Figure 1: Dynamics of Unemployment

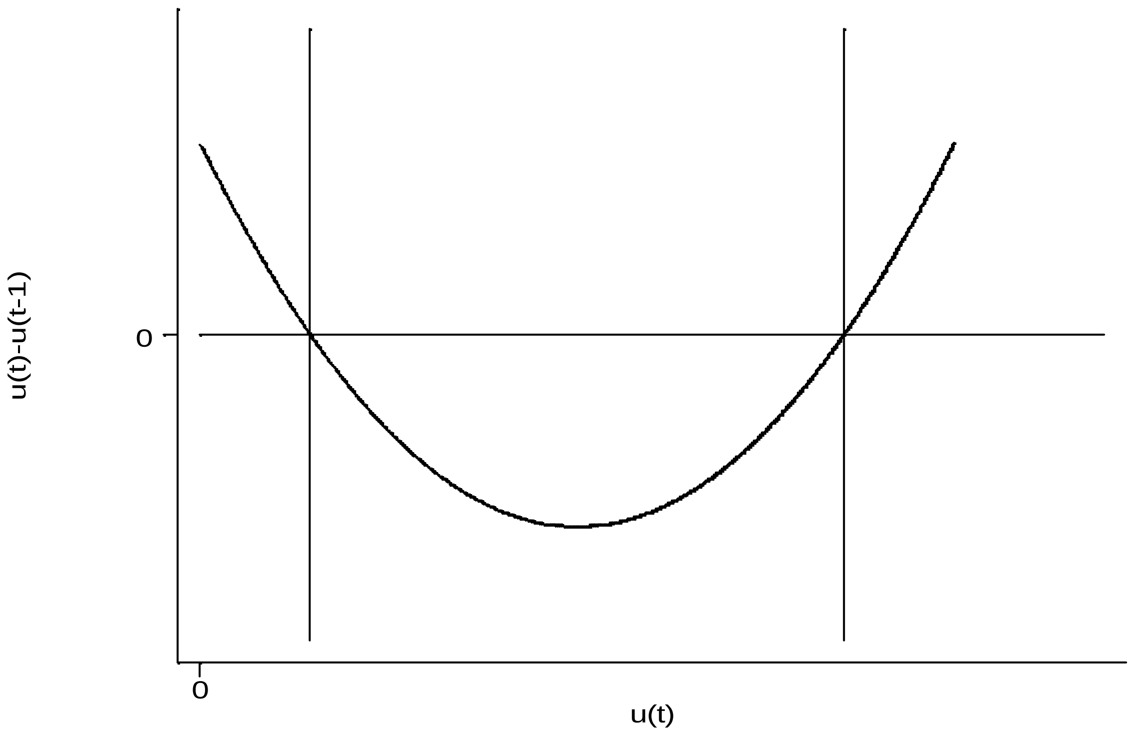


Figure 2: Half-Life of Unemployment Shocks

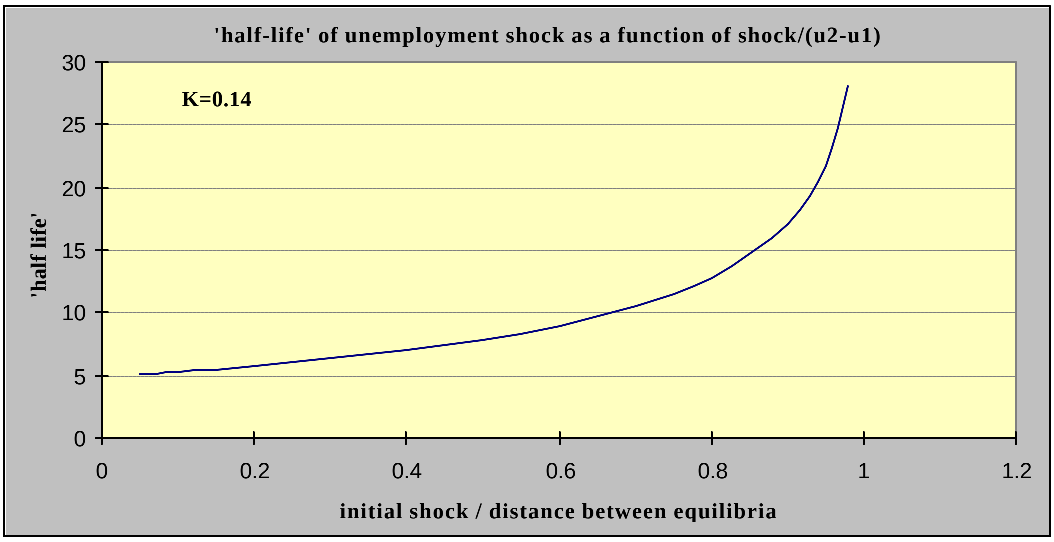
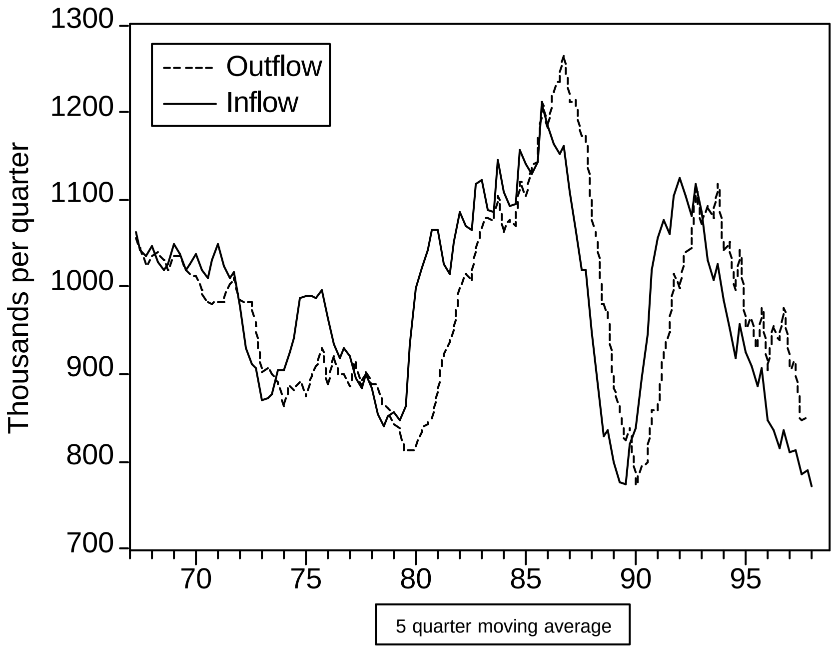
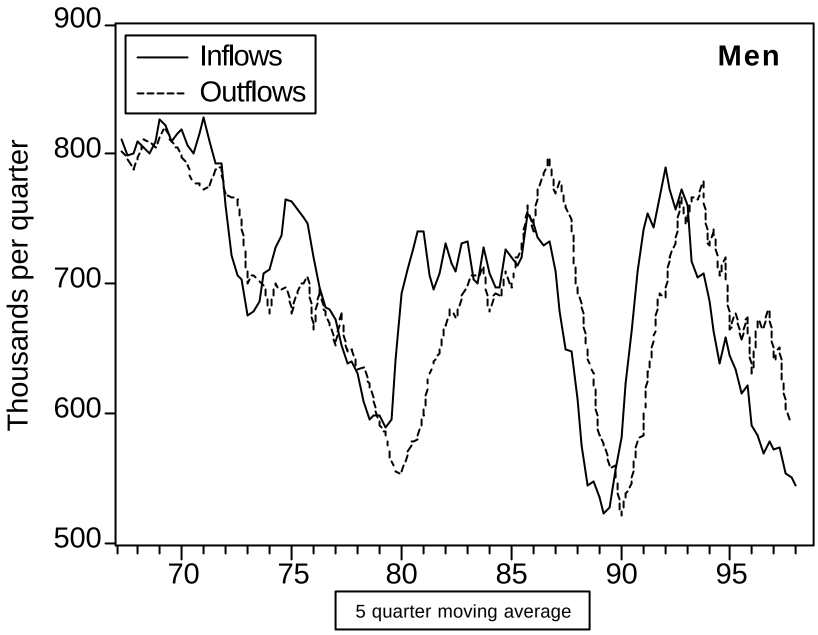


Figure 3: Unemployment Flows

A. Flows – All



B. Flows – Men



C. Unemployment Stock

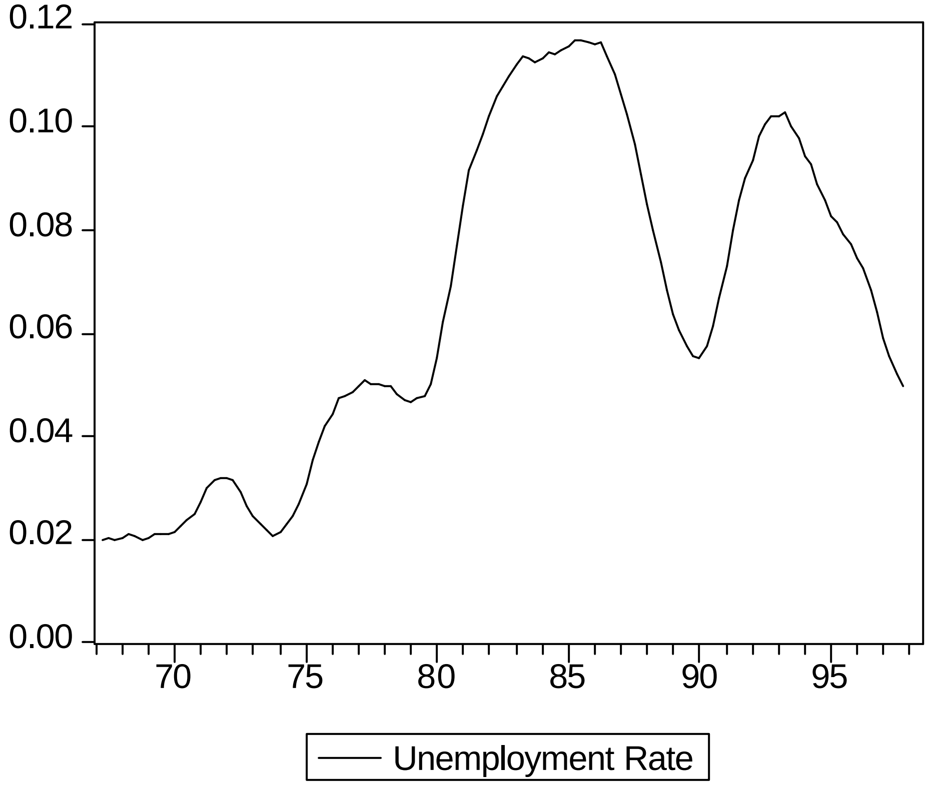
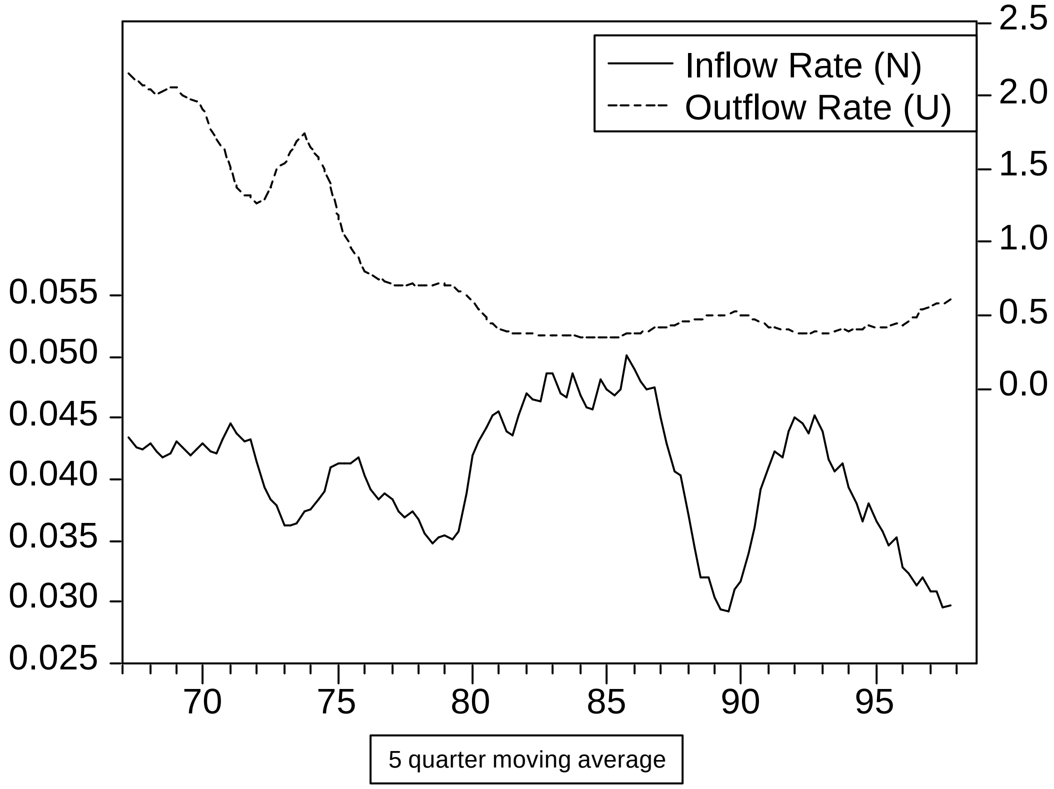


Figure 4: Unemployment Flow Rates



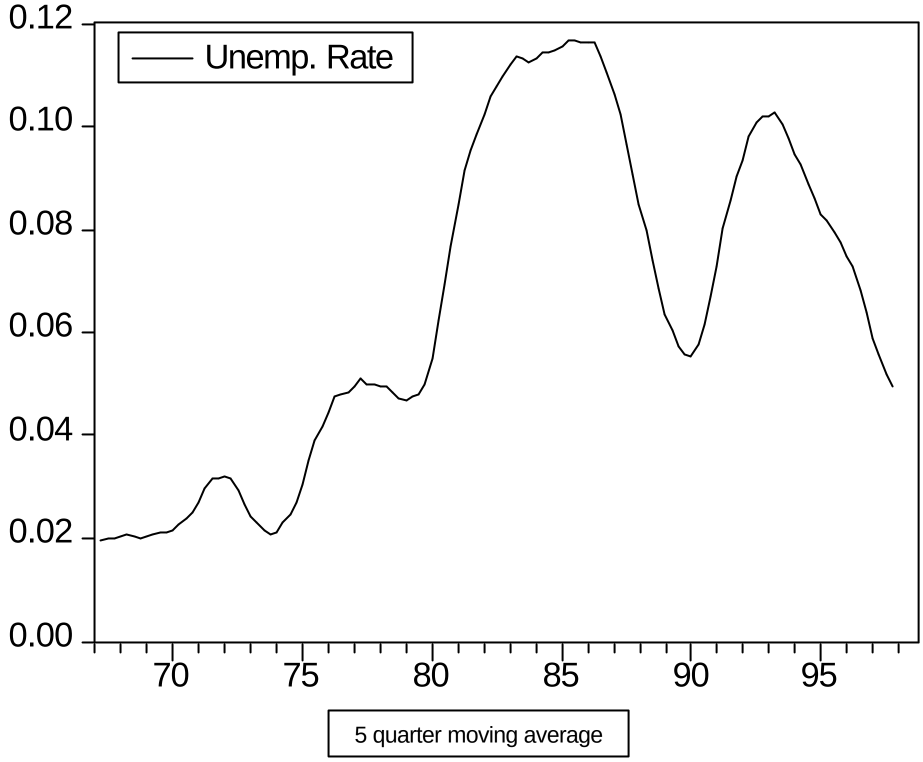


Figure 5: Time Aggregation

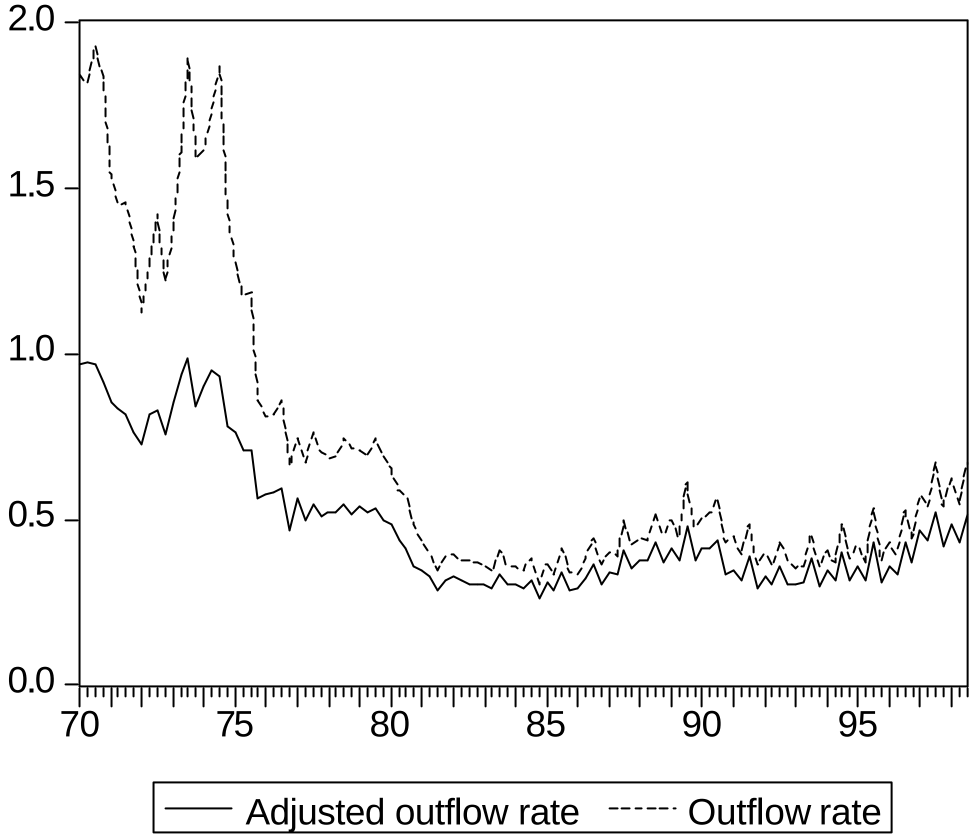


Figure 6a: TTWA Flows
Darker line is inflows

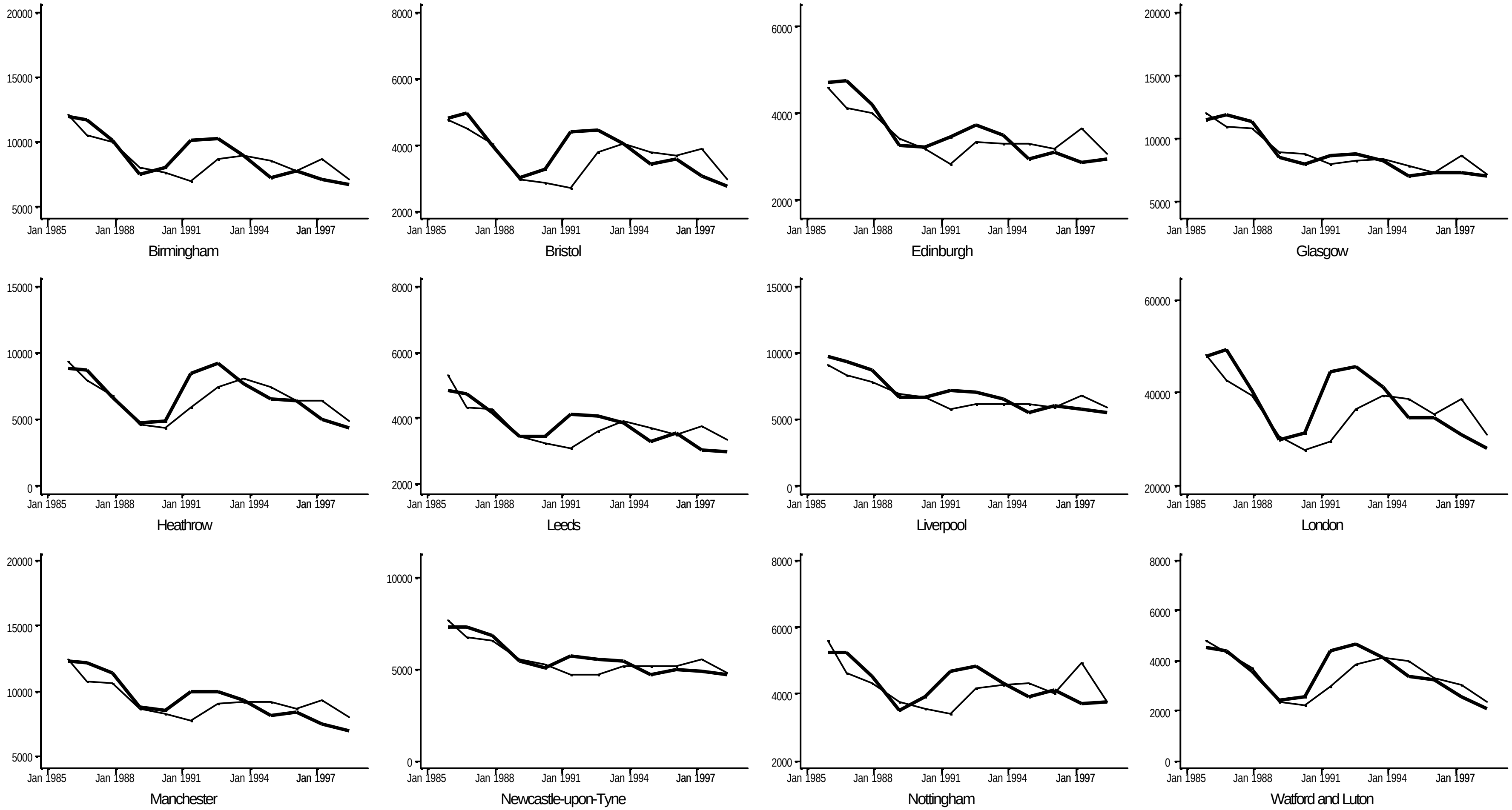


Figure 6b: TTWA Flow Rates

Darker line is inflow rate

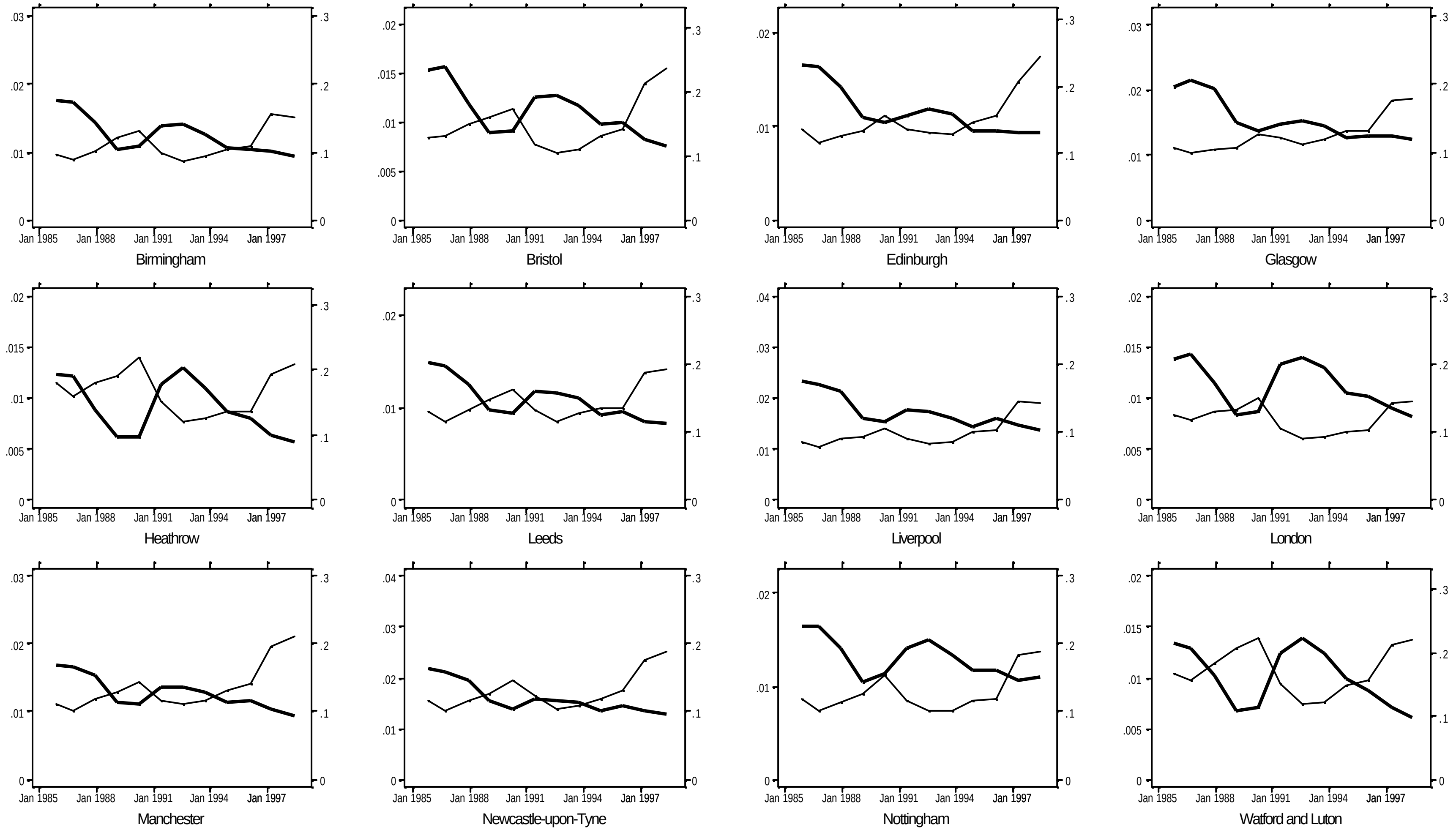


Figure 7: Unemployment Duration

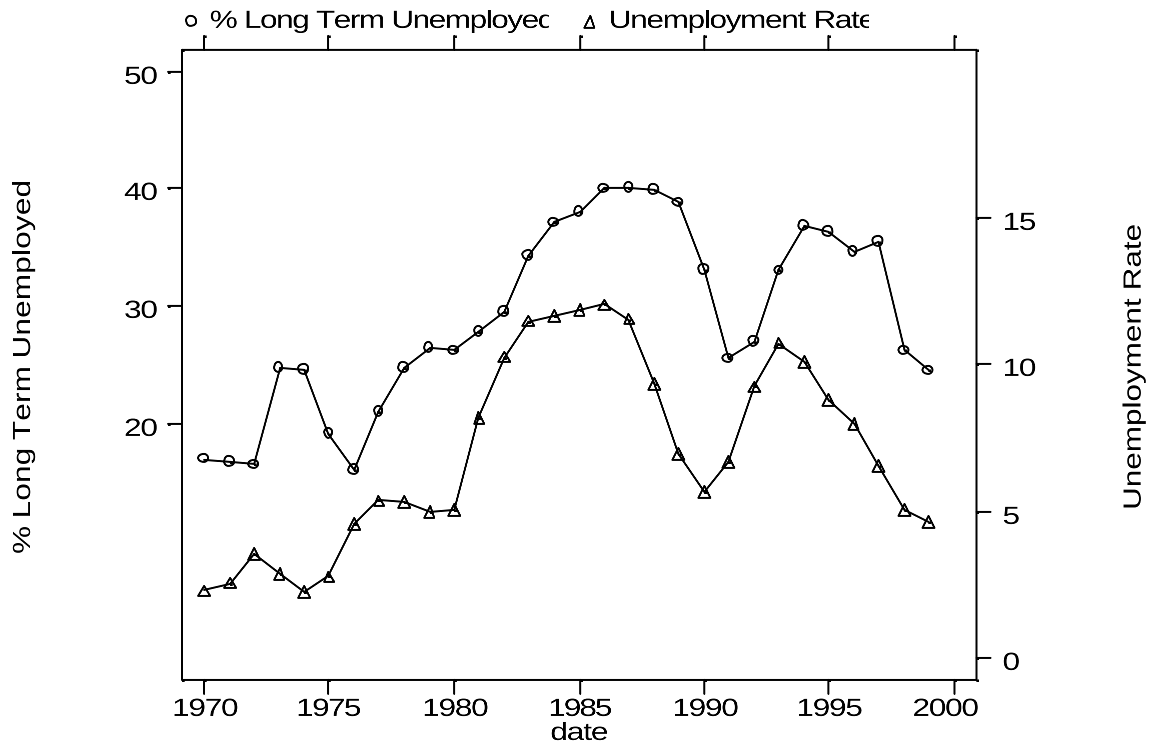


Figure 8: Unemployment Flow Rates and Equilibrium

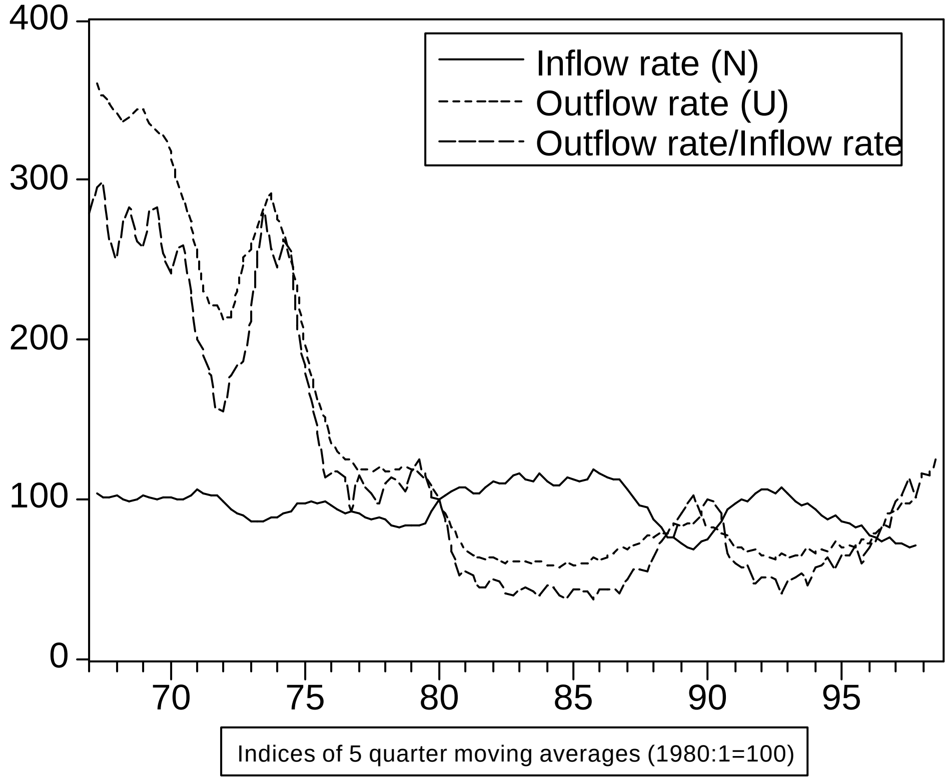
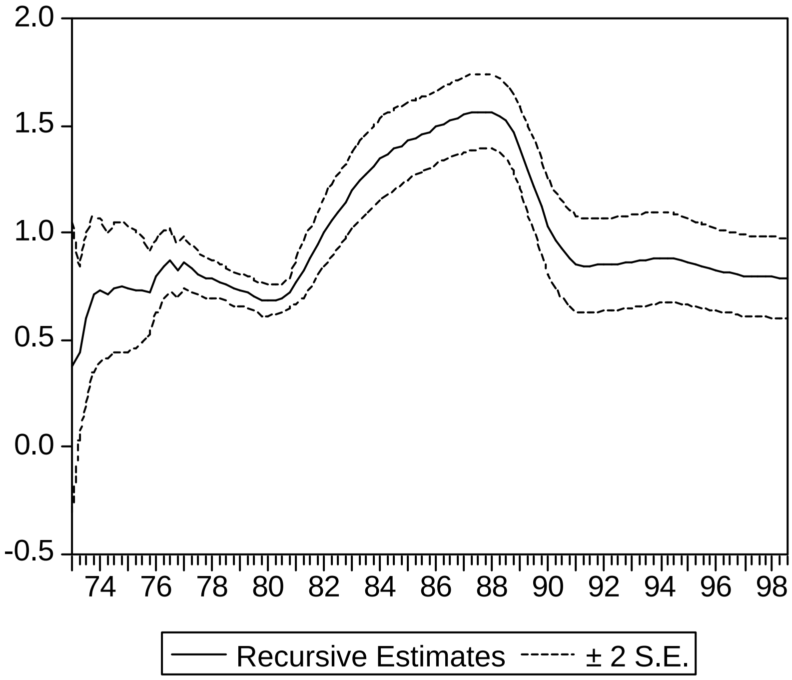


Figure 9: Recursive Least Squares

Coefficient on fitted unemployment rate using only outflow innovations



Coefficient on fitted unemployment rate using only inflow innovations

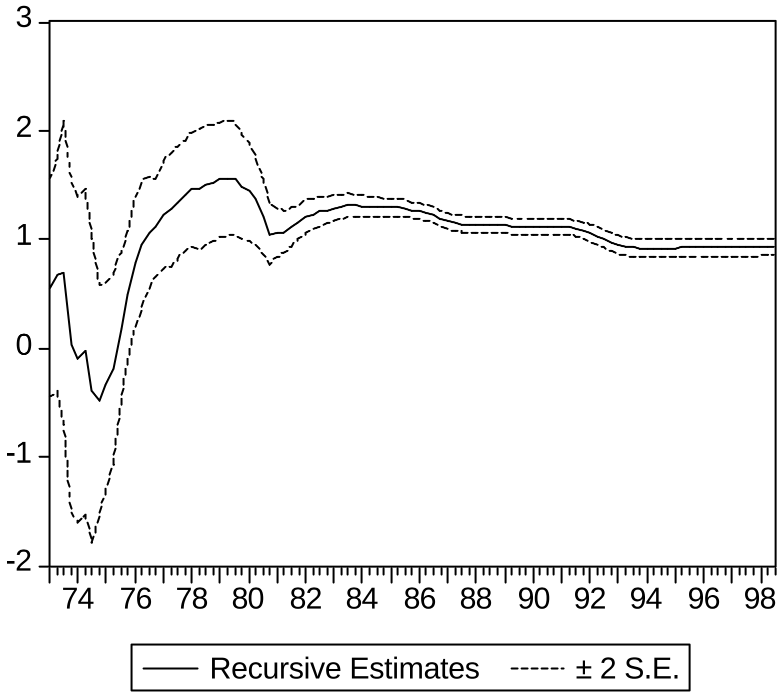


Figure 10: Impulse Response

Note: Outflow rate is X/U and inflow rate is I/L

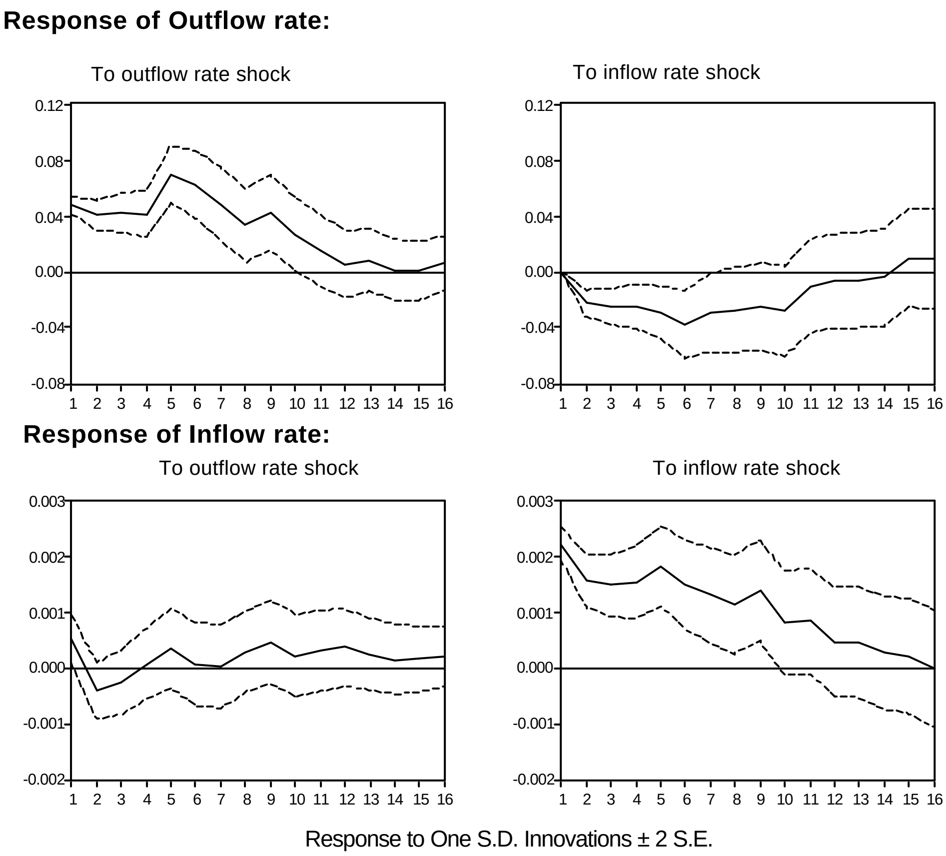
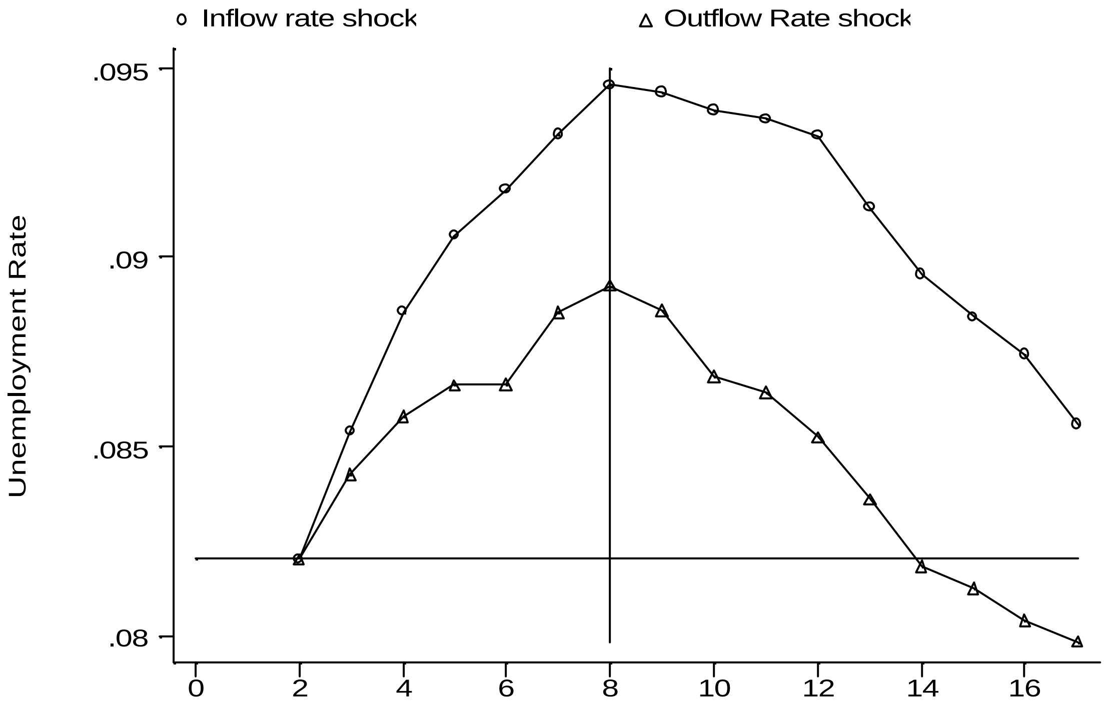


Figure 11: Comparison of Shocks to Unemployment



At the peak of 8 quarters:	Inflow shock,	Unemp. Rate = 0.0945 (15.3% higher than start of 0.0820)
	Outflow shock,	Unemp. Rate = 0.0892 (8.8% higher than start of 0.0820)

Figure 12: Recursive Estimation of Inflow Equation

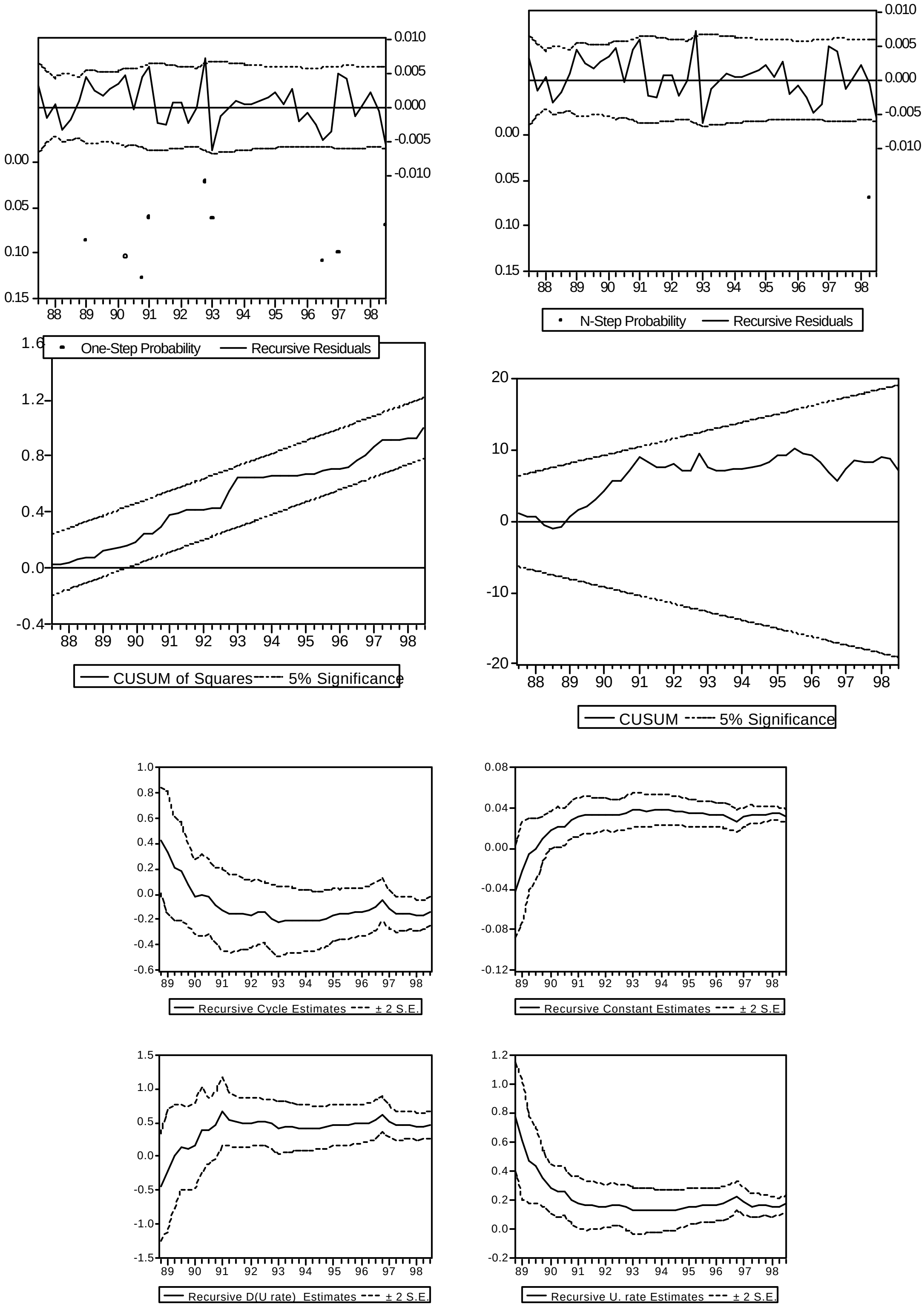


Figure 13: Effects of a Shift in the Inflow Function

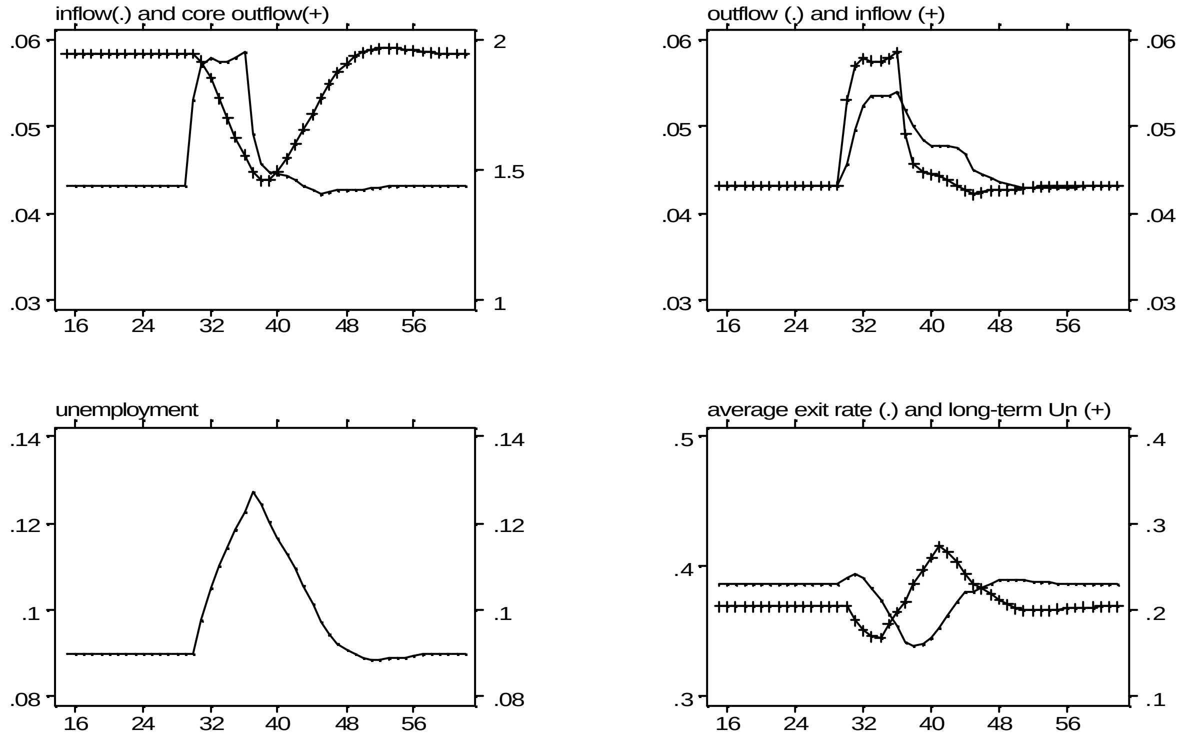


Figure 14: Effects of a Small Cyclical Shock

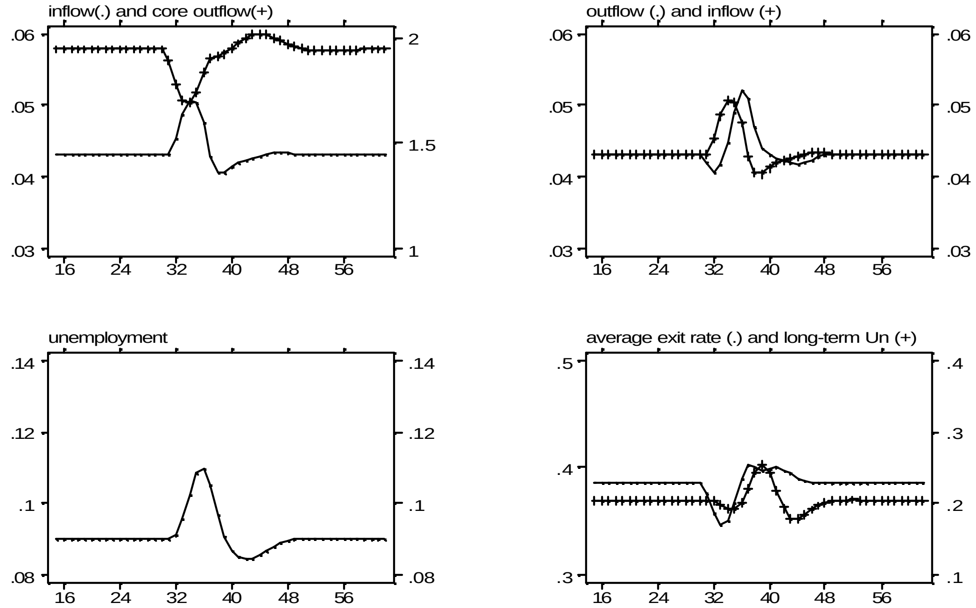
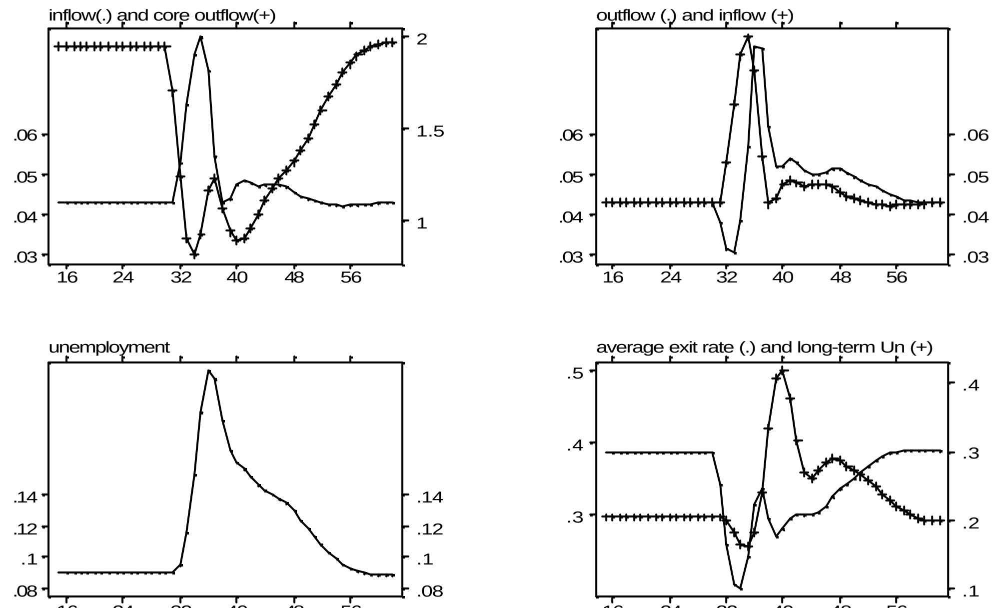


Figure 15: Effects of a Large Cyclical Shock



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