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Explaining the Evolution of High Unemployment:

The Differential Role of Search Intensity,

Growth, Business Cycles

and Labor Supply Factors

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Abstract

This paper studies the question of the rise and persistence of high unemployment using a search-theoretic Beveridge curve model. In particular we seek to quantify the differential effects of search intensity of the unemployed, growth, business cycles and labor supply factors on the evolution of high unemployment. The effects of growth and business cycles are studied in the context of their role in job creation and job destruction.

We use a data set that is well suited for such empirical exploration. This is Israeli Employment Service data which is unique in the sense that it offers comprehensive and consistent coverage for a significant segment of the labor market, generating a well-defined vacancy series and the corresponding unemployment series.

Our main findings are that unemployment rose as a result of the operation of the following factors: decrease in search intensity - due to increased unemployment benefits and a higher proportion of long-term unemployment ; increases in various labor supply factors; decreases in growth and cyclical downturns. Using a structural VAR approach we characterize the dynamics of unemployment and vacancies in response to innovations in these factors.

Our results indicate that growth operates to increase both vacancy creation and seperations from jobs. However its net effect is to reduce unemployment.

Explaining the Evolution of High Unemployment: The Differential Role of Search Intensity, Growth, Business Cycles and Labor Supply Factors*

1. Introduction

This paper studies the question of the rise and persistence of high unemployment using a search-theoretic Beveridge curve model. We attempt to reestablish the Beveridge curve - which plots the relation between unemployment and vacancies - as a useful diagnostic tool. In particular we seek to quantify the differential effects of search intensity, growth, business cycles and labor supply factors on the evolution of high unemployment. We focus on two sets of issues that have been at the center of the recent literature: the role of structural factors in generating significant changes in the level of unemployment within the framework of search-theoretic models [initiated by Diamond (1982 a,b), Mortensen (1982) and Pissarides (1985)]; and the role of growth and business cycles in affecting unemployment through job creation and job destruction [as in the models of Aghion and Howitt (1994) and Mortensen and Pissarides (1993, 1994)].

While an outward shift of the Beveridge curve has been observed in many economies in the 1970s and the 1980s, accounting for this movement has met with limited success; empirical testing of the model has often run into difficulties with respect to data availability and its quality. The present study aims at shedding new light on the workings of the model and its policy implications by using a data set that is well suited for such empirical examination. This is Israeli Employment Service data which is unique in

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the sense that it offers comprehensive and consistent coverage for a significant segment of the labor market, generating a well-defined vacancy series and the corresponding unemployment series. The fact that the Israeli unemployment series has exhibited a pattern over time which is similar to major European economies unemployment series, makes this study useful for the understanding of the evolution of the latter as well.

Drawing upon the literature of macroeconomic models with micro foundations of search behavior, we use a two-sided search model with equilibrium unemployment along the lines suggested by Pissarides (1990). The Beveridge curve is derived from equating outflows from unemployment (i.e. matching of the unemployed to jobs) to inflows into unemployment from employment (i.e. layoffs and quits) and from out of the labor force. In estimation we seek to uncover the determinants of these various flows. We focus on several factors: first we look at the effects of **search intensity**. Outflows from unemployment have been shown to depend on the search intensity of the unemployed [see for example Layard, Jackman and Nickell (1991)]. We examine several probable determinants of intensity including real wages, unemployment benefits and the proportion of the long-term unemployed. **Growth** affects matching through the creation of vacancies (job creation) but it also generates job destruction hence inducing more unemployment. This mechanism was recently explored by Aghion and Howitt (1994) and by Mortensen and Pissarides (1993). These models generate ambiguous results concerning the net effect of growth on unemployment; here we present some estimates that quantify these effects. **Business cycles** too affect both outflows and inflows. Work by Blanchard and Diamond (1990), and antecedent work by Davis and Haltiwanger (1990, 1992), suggests that there are larger fluctuations in job destruction than in job creation over the cycle. This phenomenon is related to cyclical asymmetries, whereby recessions are associated with large increases in job destruction and only small decreases in job creation. These observations were accounted for theoretically in a search-theoretic framework [Mortensen and Pissarides (1994)]. We look at these cyclical effects by studying the relations between cyclical components of real activity variables and vacancy creation, seperation from jobs and unemployment. Finally we examine the role of **labor supply variables** such as participation rates and government hiring policy.

We investigate the search-matching approach from three angles: first we examine a traditional specification of the Beveridge curve which is derived from a search model. We show that in order to account for the curve's shift over time, variables determining search intensity and labor supply must be accounted for. We then cast the Beveridge relation in a wider macroeconomic context by examining the role of growth and business cycles in determining vacancy creation and workers' separation from jobs. This allows us to derive an estimating equation for unemployment which quantifies the differential effects of growth and business cycles as well as search intensity factors and labor supply variables. Finally we look at these variables in a dynamic context by estimating a structural VAR system. We examine the impulse responses of unemployment, vacancies and the labor force to structural innovations in matching, labor supply and productivity. We close the analysis by tracing out the implied movements of the Beveridge curve in response to these shocks.

We proceed as follows: in Section 2 we present a search-theoretic model which generates the Beveridge relation and study its implications with respect to the role of search intensity and labor supply variables. In Section 3 we briefly discuss the features of the Israeli labor market and the data. We note the similarity of its unemployment dynamics to the European experience and highlight the reasons why Israeli labor data has the unique qualities which are important in the present context. In Section 4 we present estimates of several specifications of the Beveridge relation. In this section we highlight the role of search intensity and labor supply factors. In Section 5 we discuss the issue of job creation and job destruction and their relation to growth and business cycles. This discussion enables us - in Section 6 - to estimate a modified equation for unemployment that explicitly takes into account the determinants of job creation and job destruction. In Section 7 we report the results of the structural VAR estimation, tracing out the effects of various structural innovations on the Beveridge curve. In the concluding Section

8, we discuss the implications of our findings. Data sources and definitions of the variables are outlined in the appendix.

2. The Model

The theoretical roots of the model to be used lie in a series of papers which depict a picture of the economy based on optimal search behavior by individual agents. The notable contributions are models suggested by Diamond (1982 a,b)[1], Mortensen (1982) and Pissarides (1985, 1986)[2].

In what follows we will use one variant of this model, a two-sided search model proposed by Pissarides (1986)[3]. We give a brief presentation of the essential aspects of the model, concentrating on the economic considerations involved, while abstaining from the full derivation [which can be found in Pissarides (1986, 1990)].

2.1 The Labor Market

There are two main agents: unemployed workers searching for jobs and firms deciding how many vacancies to open up. Workers and vacancies are faced with different frictions. Examples of these are heterogeneities in skills leading to some skill mismatch or differential geographical locations leading to some regional mismatch. Moreover there are lags and asymmetries in the transmission of information. We can sum all of this up in the concept of a matching function which produces hires (a flow) out of the stock of vacancies and unemployed, leaving certain jobs unfilled and certain workers unemployed. This is expressed as follows:

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1 Howitt and McAfee (1987) apply Diamond's (1982a) "coconut model" directly to the present context.

2 A survey is to be found in Mortensen (1989) while an exhaustive discussion may be found in Pissarides (1990). A related important contribution is Blanchard and Diamond (1989), further discussed in Blanchard and Diamond (1992).

3 This is an abridged version of the model presented in chapter 2 of Pissarides (1990). The model there includes capital, wage bargaining and aggregate demand which are suppressed here.

$$h = m\ (cU,V), \qquad m_{cU} > 0,\ m_V > 0 \tag{1}$$

where U is the stock of unemployment; c is search intensity to be examined below

V is the stock of vacancies

h is the flow of hires and m is the matching function which has positive first derivatives.

The model derives vacancy creation from firms' profit maximization, and workers' search intensity from unemployed workers optimization.

2.2 Firms' Vacancy Creation

The firms' supply of vacancies is derived from intertemporal profit maximization, i.e. the control variable of the firm is the number of vacancies. Formally the firm maximizes the discounted flow of profits:

$$\max \Pi = \int_0^{\infty} e^{-rt}\ [\ F(N) - wN - \gamma V\ ]\ dt \tag{2}$$

where N is the number of workers

F is the production function

w is the real wage

γ is the cost of a vacancy such as costs of advertising, interviewing applicants etc.

r is the interest rate

The firm is maximizing (2) subject to the evolution of employment given by:

$$\dot{N} = qV - sN \tag{3}$$

where q is the probability that a vacancy will be filled, which is defined as follows:

$$q = \frac{m(cU,V)}{V} = q(cU,V) \tag{4}$$

and s is the rate of separation from employment due to quits and layoffs.

The F.O.C in the steady state (where q is stationary) is:

$$F'(N) = w + \frac{(r+s)\gamma}{q} \tag{5}$$

The LHS of equation (5) is workers' marginal product; the RHS is the real wage and the expected cost of a vacancy (note that 1/q is the expected duration of a vacancy).

If we replace N in equation (5) by L-U, where L is the labor force, then this equation can be described as a vacancy-supply curve in unemployment-vacancy space. Implicit differentiation shows that this slope is positive if $m > vm_v$. In such a case - as with a constant returns to scale matching function - when unemployment increases, the cost of having a vacancy decreases as firms have a higher probability of filling the vacancy and the supply of vacancies increases.

2.3 Search Intensity of the Unemployed

From the workers' point of view the choice variable is job search intensity (denoted by c). Search intensity is chosen on the basis of cost-benefit analysis: the cost is the lost time and resources spent on search; the benefit is increased probability of hire. Formally the cost of search is a convex function of search intensity:

$$k = k\,(c)\ ,\ k' > 0\ ,\ k'' > 0 \tag{6}$$

The probability of a hire (p) is given by:

$$p = \frac{m(cU,V)}{U} = p(c,\frac{V}{U}) \tag{7}$$

The marginal benefit from moving from unemployment into employment is derived from subtracting the person's "asset value" (discounted net worth) during unemployment (denoted by W^U) from his "asset value" during employment (W^N) which is[4]:

$$W^N - W^U = \frac{w-(b-k)}{r+s+p} \tag{8}$$

The numerator is the difference between the real wage and net unemployment benefits (benefits, denoted by b, minus search costs, denoted by k). The denominator is the sum of the interest rate, the separation rate and the probability of a hire.

Workers equate the marginal cost of search and the marginal benefit of a hire multiplied by the increase in the probability of a hire:

$$k'(c) = \frac{\partial p}{\partial c}\frac{w-[b-k(c)]}{r+s+p(c,\frac{V}{U})} \tag{9}$$

---

[4] This is derived as follows:

$$rW^U = b-k+p(W^N-W^U)$$

The "asset value" of unemployment equals benefits (denoted b) minus search costs and the possible change (with probability p) in employment status. Similarly the "asset value" of employment is:

$$rW^N = w+s(W^U-W^N)$$

Under reasonable assumptions on the function p equation (9) implies the following relationship between search intensity and the other variables:

$$c = c(\underset{-}{U}, \underset{+}{V}, \underset{-}{b}, \underset{+}{w}, \underset{-}{s}, \underset{-}{r}) \tag{10}$$

We expect search intensity to fall if unemployment benefits increase or wages decrease i.e. intensity falls as the replacement ratio increases. If the separation rate or the interest rate increase the present value of any future job decreases and thus there is less incentive to search. A decrease in vacancies or a rise in unemployment will decrease search intensity as well, as the probability of moving into employment decreases.

2.4 The Beveridge Relation

Now consider the Beveridge relation ($\dot{u}= 0$): in the steady state the flow out of unemployment equals the flow into unemployment. The former depends on the matching function while the latter arises from separation of employed workers from jobs (quits and layoffs):

$$s(L-U) = m(\underset{+}{cU}, \underset{+}{V}) \tag{11}$$

The LHS is separation from employment while the RHS is hires. When unemployment increases the LHS declines while the RHS increases so vacancies must decrease in order to restore equality. Thus this steady state relation describes a downward sloping curve in u-v space.

2.5 Location on the Beveridge Curve

The location of the economy on the Beveridge curve is determined by the intersection of the vacancy-supply curve (equation 5) with the Beveridge relation (equation 11). This is described in Figure 1:

Figure 1

The analysis can be extended to cater for a growing labor force. If both sides of equation (11) are divided by the labor force (L) and the matching function has constant returns to scale then the curve (defined in terms of rates) does not move when the size of the labor force changes. However if there is a continuous increase in the labor force then an appropriate term must be added to both sides of equation 11, which then can be rearranged on the LHS to yield:

$$(\hat{L}+s)\ (1-u)=m(cu,v) \tag{12}$$

where u and v are the unemployment and vacancy rates and $\hat{L}$ denotes the rate of growth of the labor force (and of employment and unemployment in the steady state). Any increase in the rate of growth of the labor force will cause an outward shift of the curve thus defined (as well as an upward movement of the VS curve).

So far we have characterized the long-run properties of the model. A word must be said about the adjustment dynamics[5]: based on the same process of optimization that was described above, the model can be characterized as saddle point stable. The saddle path is a ray from the origin in Figure 1, i.e. along the adjustment path the ratio v/u is constant. Unemployment is a predetermined variable; thus, following a shock, vacancies jump so as to place the system on its unique convergent path. These dynamics describe anti-clockwise loops around the Beveridge curve. This characterization conforms the stylized facts of many economies including the Israeli one.

Equation (12) is a key equation for the estimation reported below. Basically it delineates a relationship between the rate of unemployment and the rate of vacancies, for certain values of search

[5] See Pissarides (1990, Chapter 3). We return to this issue in Section 7 below.

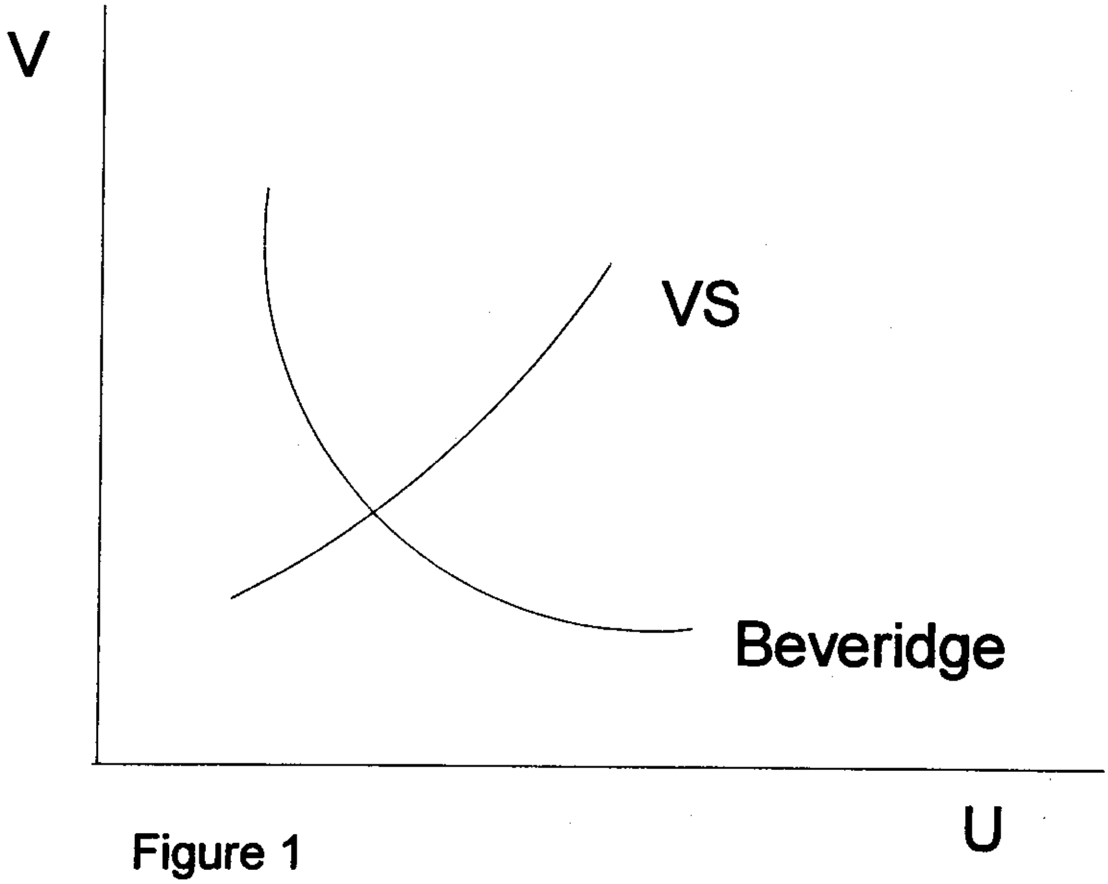


Figure 1

intensity, the separation rate and the rate of growth of the labor force. We now turn to a more detailed examination of this relationship.

2.6. The Role of Search Intensity and Labor Supply Factors in the Beveridge Relation

Equation (12) can be implicitly differentiated to yield the following relations:

$$\frac{\partial u}{\partial v} = - \frac{m_v}{m_u + (\hat{L}+s)} < 0 \tag{13}$$

$$\frac{\partial u}{\partial c} = - \frac{m_c}{m_u + (\hat{L}+s)} < 0 \tag{14}$$

$$\frac{\partial u}{\partial \hat{L}} = - \frac{-(1-u)}{m_u + (\hat{L}+s)} > 0 \tag{15}$$

Equation (13) describes the slope of the curve in the u-v space of Figure 1: as vacancies increase unemployment declines. Equations (14) and (15) describe the movements of the curve in this space as search intensity and labor force growth rates change: as search intensity falls and labor force growth increases the curve shifts out. With respect to search intensity we should note that beyond the factors discussed above [see equation (10)], it is useful to take into account the role of unemployment duration. Several models have investigated this role:

a. Search intensity of the unemployed may decline with long duration as discouragement effects occur. This is so because protracted unemployment causes demoralization and demotivation. Layard, Nickell and Jackman (1991, chapter 5) and the references therein summarize the adverse psychological effects of long-term unemployment.

b. Skills of the unemployed may deteriorate as unemployment endures [see Pissarides (1992) for a model of this argument in a theoretical framework akin to the present context].

c. Firms may employ a ranking criterion when hiring workers, preferring to hire workers with shorter durations. Blanchard and Diamond (1994) have developed a model of ranking within a search framework. Their results indicate that duration interacts with labor market tightness (V/U) and with search intensity in determining exit rates. The latter in turn affect search intensity. In particular exit rates decrease with duration and this effect is stronger the more depressed is the labor market (lower V/U). The intuition is as follows: in a tight market the ratio of applications to the number of vacancies is low, i.e each vacancy receives few applications. Thus the long-term unemployed stand a good chance to be hired, almost like the short-term unemployed. As the ratio V/U falls the number of applications per vacancy increases and ranking makes the long-term unemployed less likely to be hired.

d. There are interactions between unemployment benefits and duration affecting exit rates. For example Meyer (1990) has shown for U.S. data that there are dramatic rises in the exit rates just prior to when benefits lapse. These results are consistent with Mortensen (1977) which has the exit rate positively dependent on search intensity and negatively dependent on the reservation wage. As exhaustion of the benefits period approaches, intensity rises and the reservation wage declines generating higher exit rates.

3. The Stylized Facts of the Israeli Labor Market and the Data

In this section we describe the institutional set-up of the Israeli labor market (3.1), briefly describe the stylized facts that emerge from the data (3.2) and compare it to the European experience (3.3). We then discuss several data issues that are important for estimation (3.4).

3.1 The Institutional Set-Up

The Israeli labor market is essentially composed of two main segments: the market for jobs that do not require a university degree and the market for jobs that require academic qualifications. Matching of workers and jobs in the former segment is done by the main institutional intermediary in the Israeli labor market - the Employment Service (ES) which is affiliated with the Ministry of Labor. From 1959 until March 1991 private intermediaries were illegal and hires of workers for these jobs were required by law to pass through the ES. Moreover unemployed workers must register with the ES in order to qualify for unemployment benefits. Therefore ES data gives a comprehensive coverage and offers the unique opportunity to study unemployment, vacancies and matches that are well defined. Intermediation and matching of workers and jobs in the other segment are achieved in a variety of ways: newspaper ads, personal contacts and the academic exchanges of the ES. In this paper we deal with the first segment of the market.

It should be noted that the ES segment is quite large in comparison to the other segment: the share of university graduates among employed workers is currently around 39% and was lower throughout the sample period; recent figures from the Labor Force Survey (LFS) indicate that 61% of the unemployed searched through the ES.

The ES handles workseekers and vacancies in about 200 branches throughout the country. Unemployment benefits are paid by another institution affiliated with the Ministry of Labor, the National Insurance Agency. These are paid for a period of between 138 to 175 days and range from 48% to 80% of the average wage received by the unemployed in his last 75 working days.

3.2 Stylized Facts

Unemployment data is available from two sources: one is the Labor Force Survey (LFS) of the Central Bureau of Statistics (CBS); the other is Employment Service data on work-seekers based on statistics complied by its branches. A work-seeker is a person who has registered at the ES at least once a month in application for work. A work-seeker will be reported as unreferred if he was not referred to any employer in a given month. The last category yields a series which is basically a stock of unemployed workers as recorded at the end of the month.

These three series - LFS unemployed, ES workseekers and ES unreferred workseekers - are shown quarterly in rates for the years 1964-1990 in Figure 2:

Figure 2

For most of the sample period the ES figures are below those of the LFS. This is so because not all the unemployed show up at the ES exchanges: as noted most jobs requiring university degrees are matched outside the ES and a large part of government hiring is done independently. However there are fairly high correlations between the various unemployment measures: 0.89 between LFS unemployed and ES workseekers, 0.95 between LFS unemployed and ES unreferred workseekers and 0.91 between the two ES measures.

Several features of Figure 2 are noteworthy:

(i) There was a big rise in unemployment in 1966 and 1967 which were recession years.

(ii) There were 20 years of relative stability (excluding 1966-67) until the end of the 1970s.

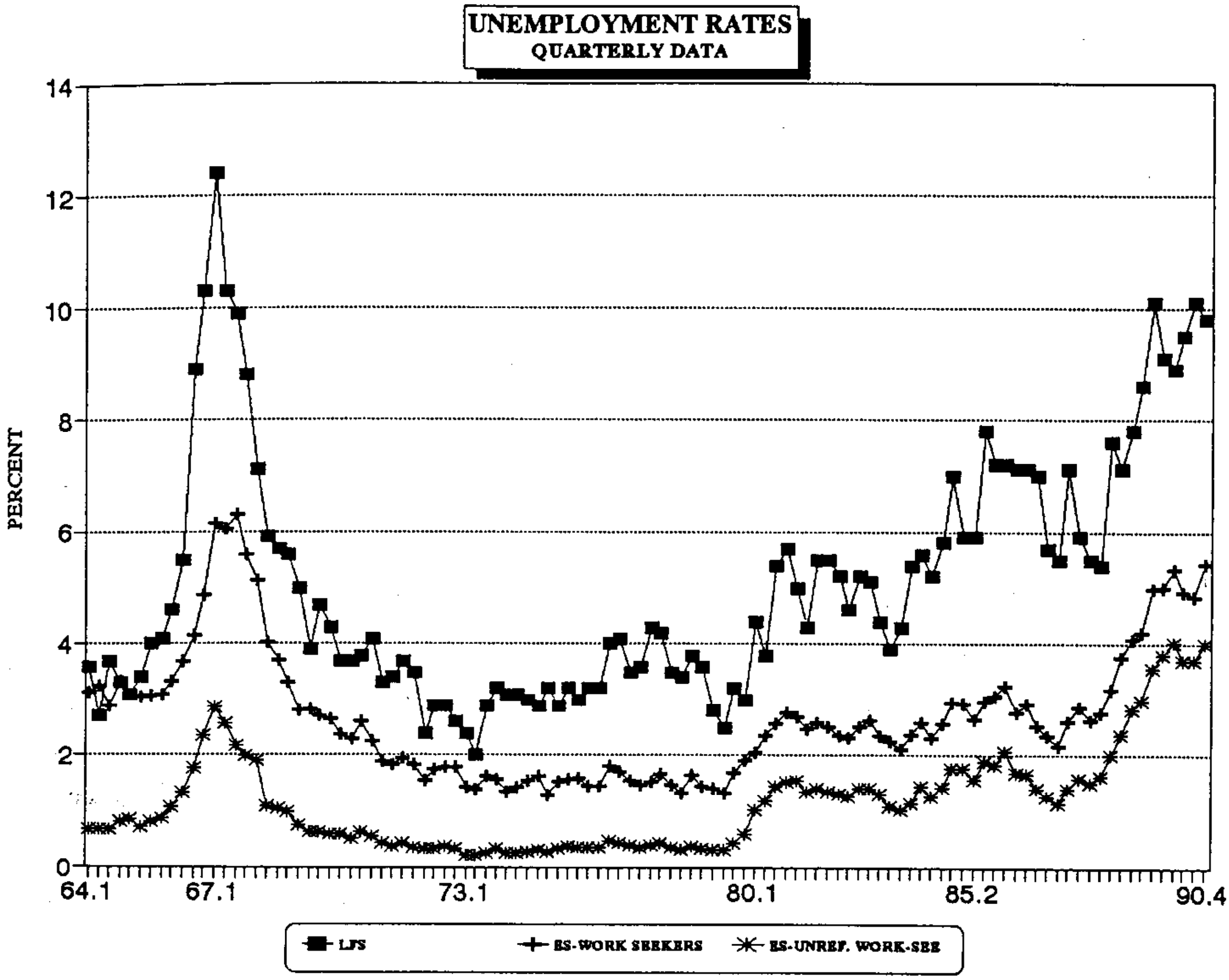
(iii) There was a spectacular rise from the last quarter of 1979 (2.9% in LFS terms) to the last quarter of 1980 (4.8%). This jump may possibly be associated with the term of office of Igael Horovitz as Finance Minister. This period, which lasted from November 1979 to January 1981, was characterized by very restrictive policy and had a significant psychological impact on the private sector (in 1980 private consumption per capita declined by 5.9%).

(iv) There was a second jump in the period 1987-1989 which was a recessionary period associated with high interest rates in the post-1985 stabilization period and following the onset of the uprising in the West Bank and Gaza.

(v) Since 1980, the rate of unemployment did not go back to its former level, i.e. there is high unemployment persistence. In between the two jumps there were fluctuations around a stable level.

(vi) Unemployment reached 9.1% in the last quarter of 1989 when a massive immigration episode

Figure 2



UNEMPLOYMENT RATES
QUARTERLY DATA
14
12
10
8
6
4
2
0
PERCENT
64.1
67.1
73.1
80.1
85.2
90.4
LFS
ES-WORK SEEKERS
ES-UNREF. WORK-SEE

began. It subsequently climbed to 9.6% in 1990, 10.5% in 1991 and 11.2% in 1992. In 1993 there was a decrease to 10% as more immigrants found employment, unemployment benefits payments policy was tightened and there was some substitution of Palestinian workers from the West Bank and Gaza by Israeli workers.

The ES reports the total number of vacancies posted in a given month and the number of vacancies that remained unfilled at the end of the month. The latter series represents the stock at the end of the month. ES vacancy data is available from 1962 onwards but due to changes in recording procedures in January 1974 care must be exercised when comparing the pre- and post-1974 data[6]. Figure 3 portrays these series in rates (out of the labor force) :

Figure 3

The main features that stand out in Figure 3 are:

(i) A decline in the 1966-1967 recession.

(ii) While total vacancies decline throughout the 1970s, unfilled vacancies remain fairly stable in that period.

(iii) A sharp decline in 1980 when the Horovitz era contractionary policies were implemented.

(iv) Vacancies remained lower throughout the 1980s compared to their level in the preceding 16 years.

We turn now to examine the joint evolution of vacancies and unemployment, i.e. to look at the Beveridge curve. Figure 4 shows the relation between the ES stock measures - unfilled vacancies and unreferred workseekers - in quarterly rates :

Figure 4a shows the longest sample possible 1964-1990 (data for 1991-1992 of unreferred

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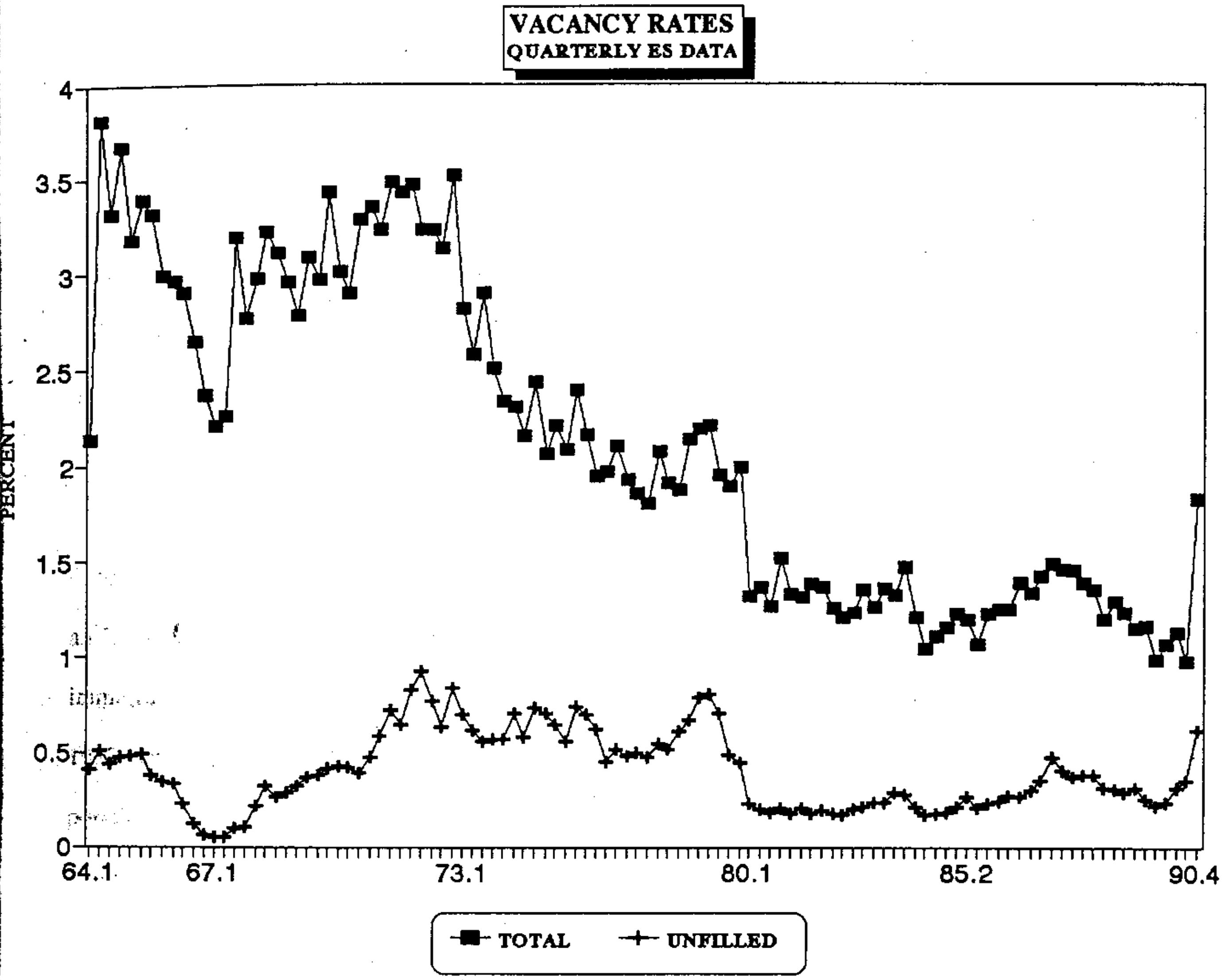
[6] In estimation we thus omit the period before 1975.

Figure 3


VACANCY RATES
QUARTERLY ES DATA
PERCENT
4
3.5
3
2.5
2
1.5
1
0.5
0
64.1
67.1
73.1
80.1
85.2
90.4
TOTAL
UNFILLED

workseekers and unfilled vacancies are unavailable). Figure 4b shows the curve up to 1979 (before the big rise in unemployment) while Figure 4c depicts the shift that took place in the 1980s.

Figures 4 a, b, c

Several features are noteworthy:

(i) The curve appears fairly stable from 1964 to 1979 (Figures 4a and b).

(ii) The standard counter-clockwise loops around the stable curve are usually observed for the period before 1980 (Figure 4b).

(iii) After a big jump to higher unemployment and lower vacancies in 1980 there was an increase in both unemployment and vacancies in the 1980s (Figure 4c).

Several events should be noted when looking at the time profile of unemployment and vacancies:

a. <u>Immigration</u> - In the last three decades there were three main episodes of immigration: the first occurred at the beginning of the 1960s, with annual immigration reaching an average of 57,000 a year, an increase of 2% a year in the population. The second episode occurred in 1972-1973 when 55,000 immigrants arrived annually (an annual population increase of 1.7%). The third big wave began in August 1989 with a massive influx of immigrants from the Soviet Union generating a 16.7% increase in the population in the years 1990 - 1993. The absolute figures are 200,000 in 1990, 176,000 in 1991 and around 77,000 annually in 1992 and 1993.

b. <u>Public Sector Hiring</u> - An important factor in the Israeli labor market is government hiring. The government employs around 30% of total employees and thus changes in its hiring practices have important consequences for unemployment. In terms of the model, the government can affect the rate of growth of the labor force ($\hat{L}$) as its own hiring is usually done outside the ES. In the 1970s there was a significant increase in the public sector's share in employment: out of total employee posts the share went

Figure 4a

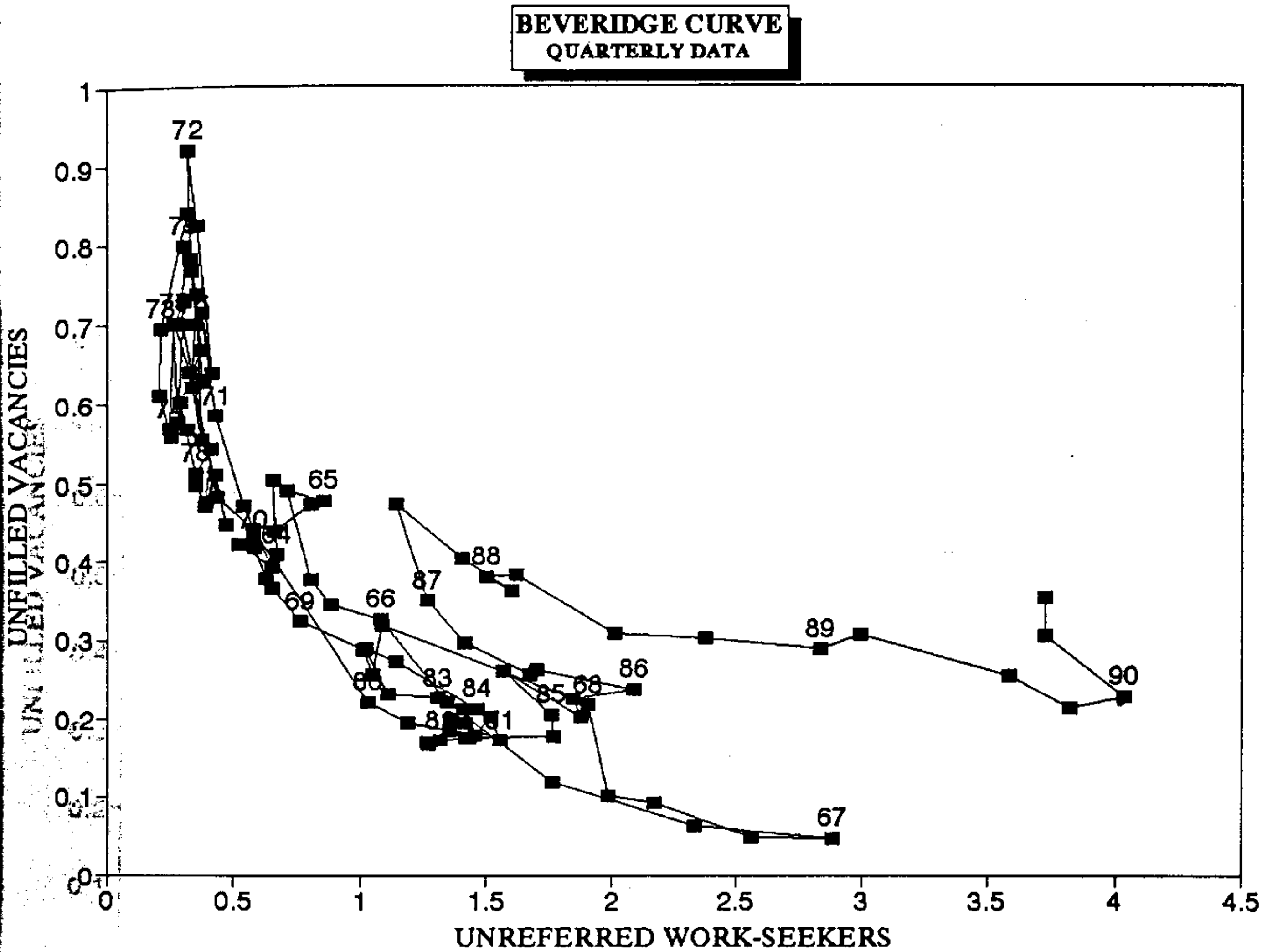
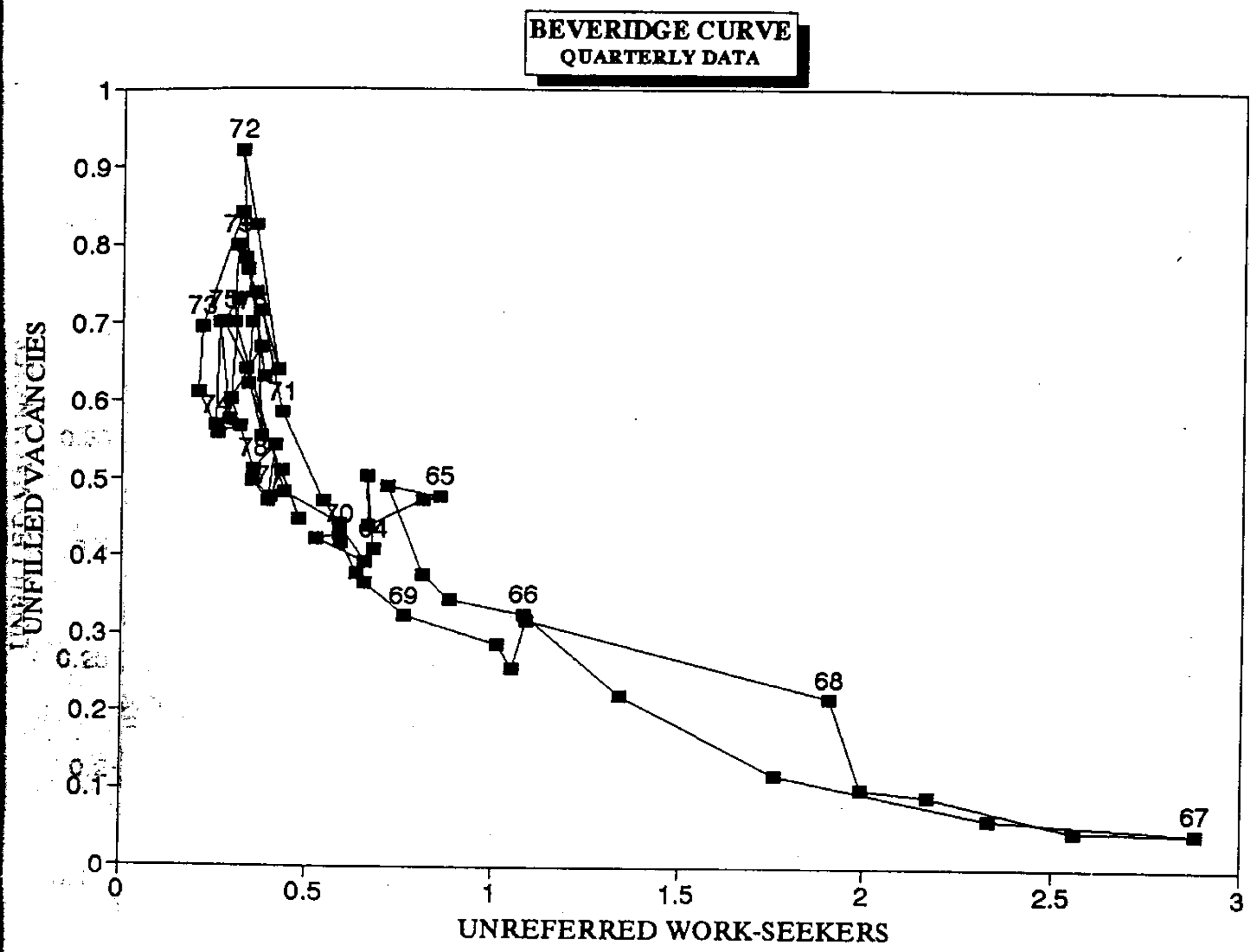
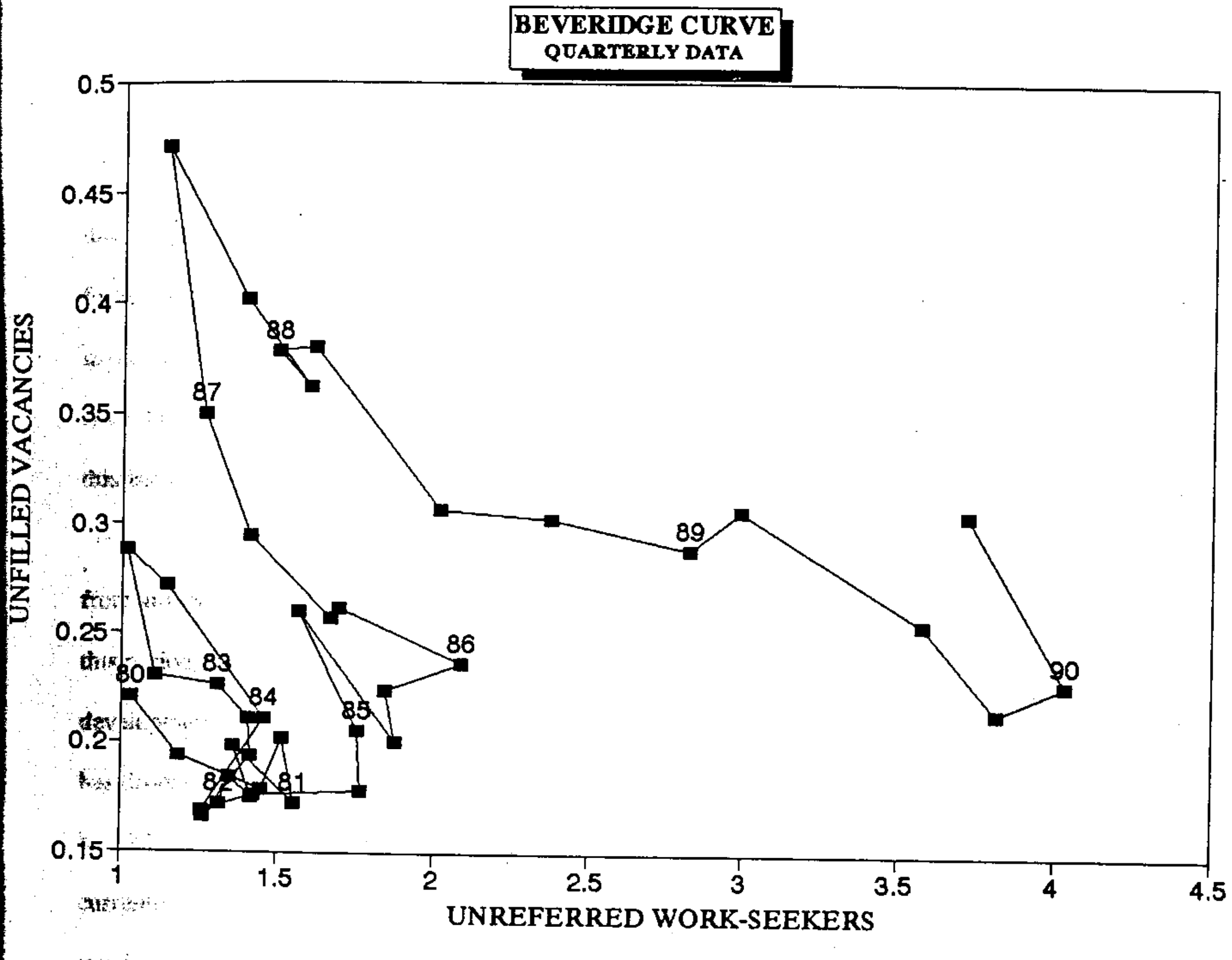

BEVERIDGE CURVE
QUARTERLY DATA
UNFILLED VACANCIES
UNREFERRED WORK-SEEKERS
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
72
65
88
87
66
69
83
84
85
86
68
89
90
67
71

Figure 4b



BEVERIDGE CURVE
QUARTERLY DATA
UNFILLED VACANCIES
UNREFERRED WORK-SEEKERS
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
1.5
2
2.5
3
72
73
75
71
65
70
64
69
66
68
67

Figure 4c


BEVERIDGE CURVE
QUARTERLY DATA
UNFILLED VACANCIES
UNREFERRED WORK-SEEKERS
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
1
1.5
2
2.5
3
3.5
4
4.5
80
81
82
83
84
85
86
87
88
89
90

up from 24.3% in 1972 to 30% by the end of the 1970s. The expansion in the 1970s was due to government hiring a large proportion of new additions to the labor force. Due to the slowdown in growth (from 9.2% annual GDP growth in 1960-1973 to around 3.5% in 1974-1985, with the business sector GDP figures showing an even worse decline) the public sector absorbed workers that may have been otherwise unemployed, particularly newcomers. In the 1980s the government absorbed less workers out of the pool that had recently joined the labor force. Thus while in the 1970s the absorption of newcomers was on average 50%, in the 1980s it absorbed 18% on average.

c. Unemployment Benefits and Duration - In April 1980 important changes were made in the unemployment benefit law. The main change was that the past average wage of the unemployed, which forms the basis for unemployment payments, was to be updated four times a year according to the rise in the average (economy-wide) wage. This generated a big increase in claims for unemployment benefits: from 18,000 in 1979 the total number of claims went up to 112,000 in 1980. We further elaborate on this issue in sub-section 3.4.2 below.

d. Participation Rates - The participation rate has displayed two major trends: a downward trend from around 53%-54% in the late 1950s to 48% in the mid-1970s, with several periods of stability during this period; an upward trend since that time, with the participation rate currently standing at 53%. These developments are the reflection of differential trends in male and female participation rates: the male rate has dropped from 80% in the mid-1950s to around 63% in the 1980s. Most of the decline has occurred by 1980. The female rate has steadily increased over the years, from 27% in the mid-1950s to 44.5% currently. Thus the downward trend in the overall rate is due to the male rate decline, while the upward trend is due to the male rate stability in the 1980s and female rate increase.

3.3 Comparison to the European Experience

Table 1 and Figure 5 document the time paths of unemployment in the biggest four European economies - Germany, Britain, France and Italy - and in Israel in the period 1970-1988 (i.e. before the onset of the latest immigration wave).

Table 1 and Figure 5

As can be seen in the figure there is considerable similarity between the time pattern of the different unemployment series with rising unemployment in the 1970s stabilizing at a higher level at some point in the 1980s. This visual impression is reinforced by the correlation matrix reported in the table.

3.4 Data Issues

While the exact definition and sources of the data are presented in the appendix, we briefly discuss here the main issues pertaining to the data used in estimation.

3.4.1 Unemployment and Vacancies: Stocks or Flows?

The model described in Section 2 is defined in terms of instantaneous unemployment and vacancy stocks. When coming to estimation there arises the question of which variable best approximates this definition. We try two kinds of series: end-of-month unreferred work-seekers and unfilled vacancies, which are indeed stocks but might have the unappealing feature of taking out of the data the matching done within the month. Alternatively we use total workseekers and total vacancies that are registered with the ES in any given month, which have the unappealing feature of mixing stocks and flows but which capture the within-month process. We also experimented with other specifications, such as an average of two consecutive end-of-month stocks, but found no significant difference in the results.

3.4.2 Search Intensity

Based on the discussion above on the determinants of search intensity we use three variables as explanatory variables for the shift of the curve due to variation in search intensity: real wages, unemployment benefits (in real terms) and unemployment duration. The latter variable is ideally some average measure of unemployment duration. Beyond the usual theoretical difficulties with such a measure

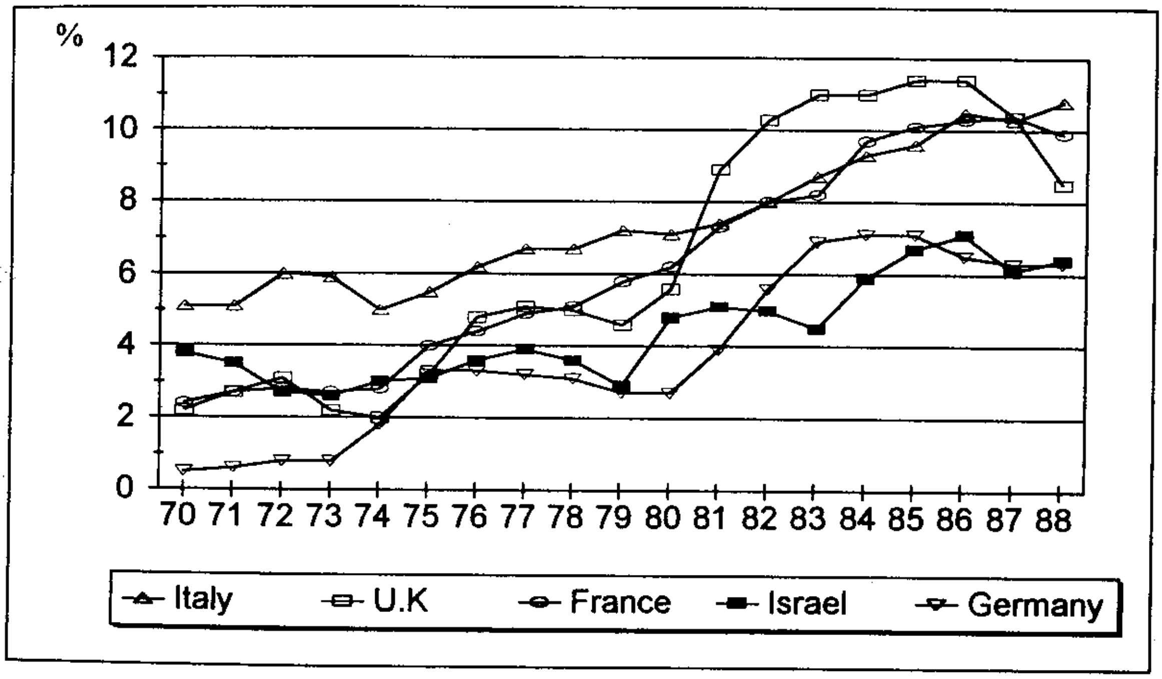
Table 1

Correlation Matrix for Unemployment Series

Period : 1970 - 1988

	Italy	U.K	France	Israel	Germany
Italy	1	0.899947	0.970432	**0.897759**	0.9022
U.K	0.899947	1	0.956494	**0.878469**	0.948728
France	0.970432	0.956494	1	**0.919851**	0.950837
Israel	0.897759	0.878469	0.919851	1	0.841111
Germany	0.9022	0.948728	0.841111	**0.841111**	1

Figure 5 : Unemployment in Four European Countries and Israel



[see for example Salant (1977)], it is difficult to obtain a good series of this variable as duration data for work-seekers is both censored and grouped in very wide categories. A better proxy is the share of unemployed work-seekers for 7 months or more out of total work-seekers. As unemployment benefits payments cease after at most 175 days, these work-seekers may be called "long term unemployed." Figure 6 shows the time plot of this series.

Figure 6

It is apparent that 1980 constitutes a major change point in the series.

3.4.3 Government Hiring

To model the effects of government hiring discussed above, we use the share of government employees in total employment depicted in figure 7.

Figure 7

The share of the government has climbed throughout the 1970s; in the 1980s it mostly fluctuated around the 30% mark.

4. Beveridge Relation Estimation

A major goal of this paper is to estimate the Beveridge relation - equation 12 above - so as to differentiate between the various factors that have engendered an increase in unemployment. In this section we estimate the Beveridge relation in several ways. We begin by a simple specification that should serve as a benchmark case (4.1). We then discuss various richer specifications (4.2). The outcome of estimation is discussed in 4.3. In the next section we build upon this section's results to link the evolution of unemployment to growth and cyclical factors.

4.1. A Benchmark Specification

The simplest specification of the Beveridge relation is a regression of u on v in logs adding time

Figure 6

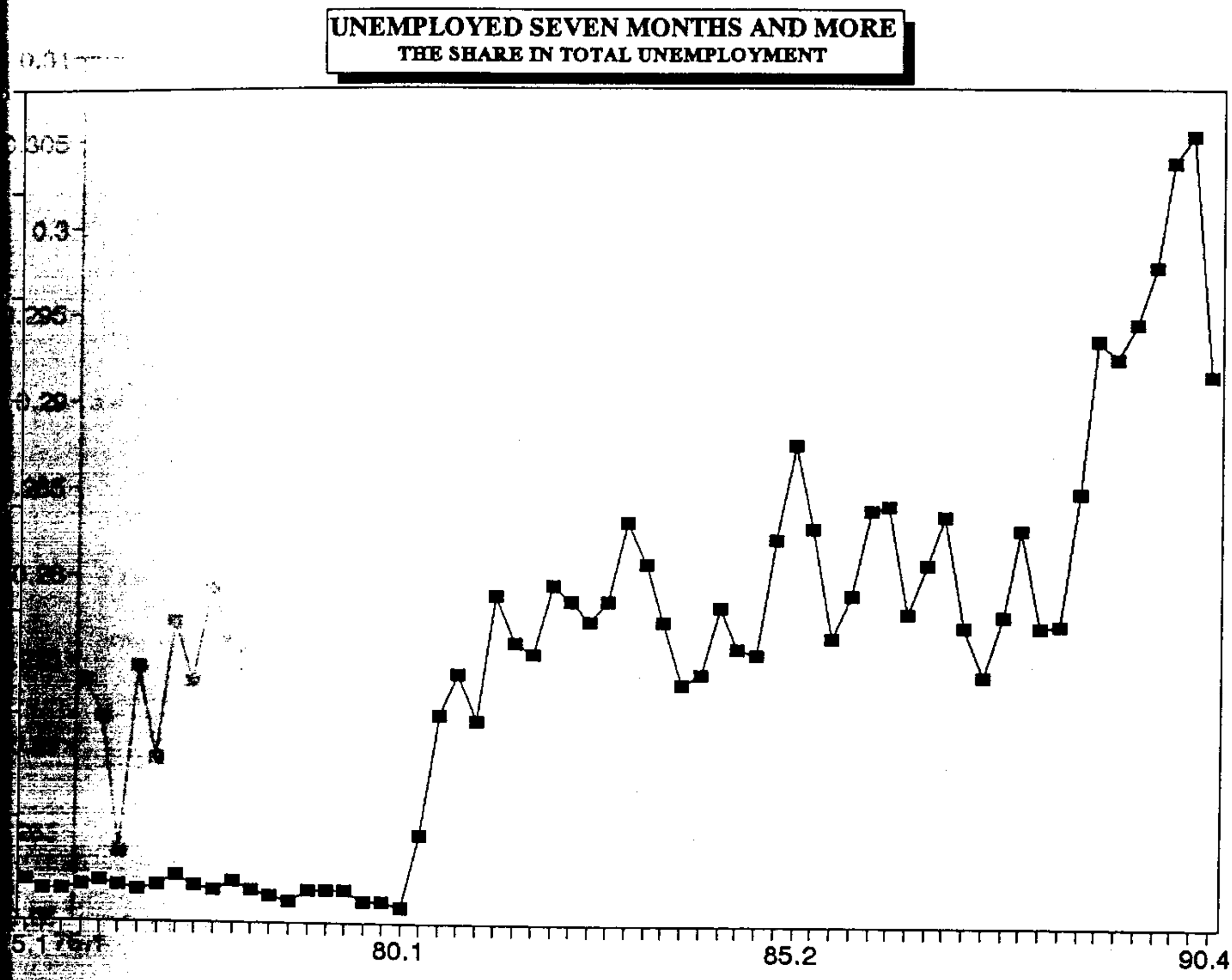
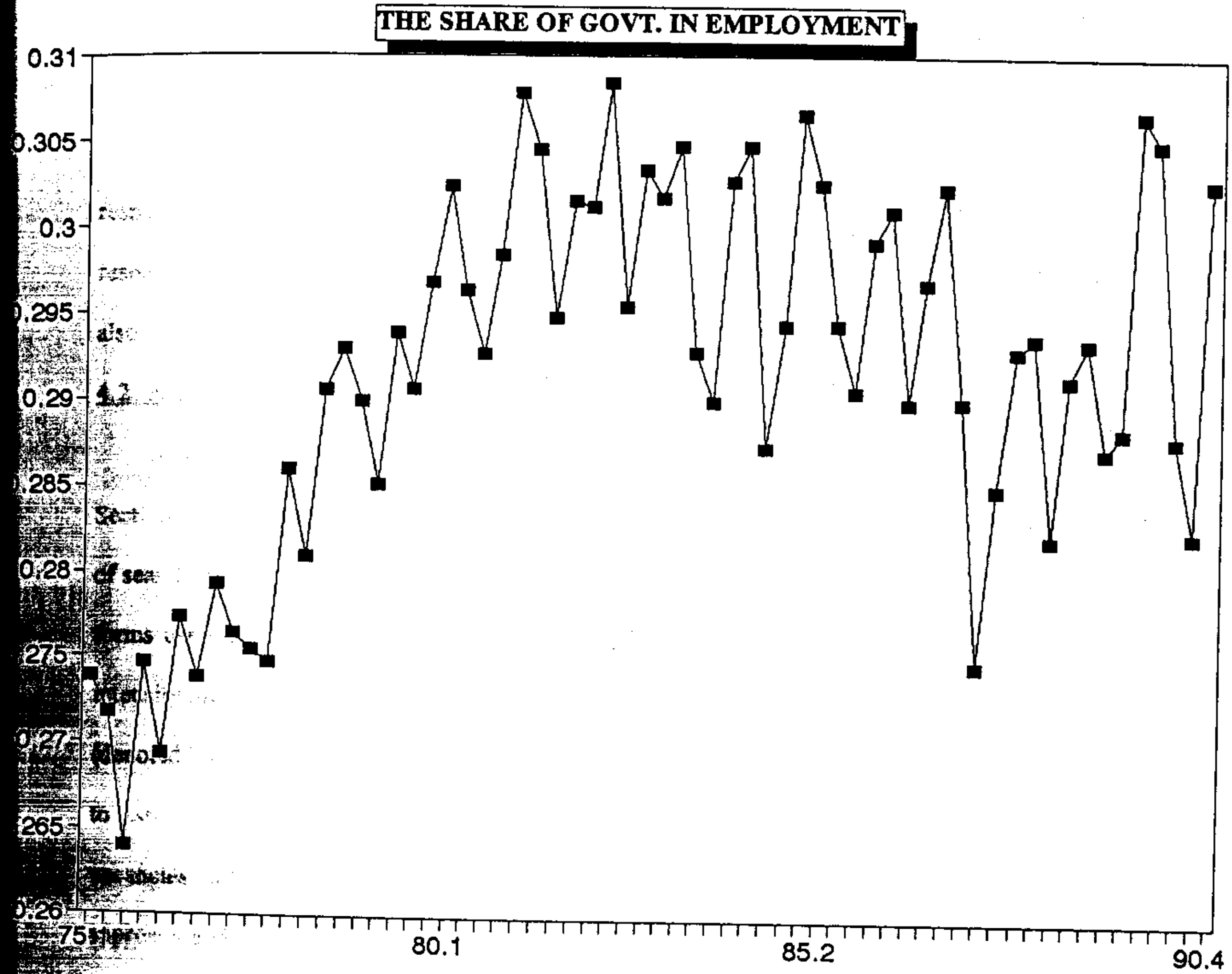

UNEMPLOYED SEVEN MONTHS AND MORE
THE SHARE IN TOTAL UNEMPLOYMENT
0.305
0.3
80.1
85.2
90.4

Figure 7



THE SHARE OF GOVT. IN EMPLOYMENT
0.31
0.305
0.3
0.295
0.29
0.285
0.28
0.275
0.27
0.265
0.26
75
80.1
85.2
90.4

as an explanatory variable. This specification is analogous to matching function formulations which have been widely used in empirical work[7]. We test several alternatives within this formulation: stocks and flow+stock measures of unemployment and vacancies (as discussed above); OLS and TSLS estimation methods; and v on u as well as u on v. The results are presented in Table 2.

Table 2

The elasticity estimates lie within a wide range: between 0.82 and 1.42 for unemployment with respect to vacancies for the alternative specifications and between 0.63 and 0.90 for vacancies with respect to unemployment across the different specifications. The regressions employing stock measures also exhibit serial correlation.

4.2. A Richer Specification

The regressions reported in Table 2 should serve only as a benchmark. The model discussed in Section 2 allows for a richer specification of the Beveridge relation. In particular it considers the effects of search intensity, the separation rate and labor supply factors. Evidently the relation may take on many forms depending upon the specification of the functional forms for the matching function (m), search intensity (denoted c in the above model, which is a function of various variables) and labor force growth (denoted $\hat{L}$ above, which is a function of various labor supply variables). The standard approach has been to estimate a log-log or a semi-log relation between unemployment as the dependent variable and vacancies and potentially other economic factors as the independent variables. Here we try the standard approach under several alternatives (stocks vs. stocks+flows; OLS vs.TSLS; u as dependent variable vs. v as dependent variable) as well as a second-order Taylor approximation. We thus run the following three

[7] Such estimation runs the log of hires on the logs of u and v and on time. See Berman (1993) for estimates of the Israeli case, Blanchard and Diamond (1989) for the U.S. and Burda and Wyplosz (1994) for four European economies.

Table 2

The Beveridge Curve: A Benchmark Specification
Period: 1975:1 - 1990:3

Dep / Indep Var	Ln u	Ln u	Ln twsr	Ln twsr	Ln v	Ln tvr
constant	-8.95 (0.28)	-8.77 (0.28)	-6.16 (0.36)	-6.96 (0.50)	-8.05 (0.54)	-4.59 (0.44)
Ln v	-0.94 (0.05)	-1.00 (0.06)				
Ln tvr			-0.82 (0.13)	-1.42 (0.21)		
Ln u					-0.92 (0.05)	
Ln twsr						-0.63 (0.08)
Time	-0.01 (0.004)	-0.02 (0.005)	-0.01 (0.005)	-0.03 (0.006)	-0.02 (0.005)	-0.02 (0.003)
$Time^2$	0.0006 (0.00006)	0.0007 (0.00007)	0.0003 (0.00006)	0.0005 (0.00007)	0.0007 (0.00006)	0.0003 (0.00004)
Adjusted R^2	0.97	0.97	0.87	0.84	0.93	0.85
Durbin -Watson	0.99	1.07	1.29	1.79	1.09	1.78
Estimation Methodology	OLS	TSLS	OLS	TSLS	TSLS	TSLS
Instruments:		Ln v(-1)		Ln tvr(-1)	ln u(-1)	ln twsr(-1)

<u>Note</u>: Standard errors, corrected for heteroscedasticity [see White (1980)], are in parantheses.

<u>Notation</u>:
u = unemployment rate (stock)
v = vacancy rate (stock)
twsr = unemployment rate (stock + flow)
tvr = vacancy rate (stock +flow)

See Appendix for full details.

equations:

1. A hybrid log-log semi-log specification:

$$\ln u_t = \delta_0 + \delta_1 \ln v_t + \delta_2\, wp_t + \delta_3\, z_t + \delta_4\, sevenp_t + \delta_5\, femprt_t + \delta_6 \ln govprt_t + \delta_7\, s_t \tag{16}$$

where u and v are the unemployment and vacancy rates respectively; wp is the real wage; z denotes real unemployment benefits; sevenp is the share of unemployed seven months and more; femprt is the female participation rate; govprt is the share of employees in the public sector; and s is the separation rate (see Section 3 and the Appendix for full details).

2. The "reverse" regression:

$$\ln v_t = \delta_0 + \delta_1 \ln u_t + \delta_2\, wp_t + \delta_3\, z_t + \delta_4\, sevenp_t + \delta_5\, femprt_t + \delta_6 \ln govprt_t + \delta_7\, s_t \tag{17}$$

3. A Taylor approximation[8].

$$\ln v_t = \delta_0 + \delta_1\, u_t + \eta\, u_t^2 + \delta_2\, wp_t + \delta_3\, z_t + \delta_4\, sevenp_t + \delta_5\, femprt_t + \delta_6 \ln govprt_t + \delta_7\, s_t \tag{18}$$

Based on the discussion in Section 2 we consider the following hypotheses: the coefficient of vacancies in the unemployment regressions and the coefficient of unemployment in the vacancies

[8] This is derived as follows: if we write equation (12) in Cobb-Douglas form as follows:

$$c^{\alpha}\, u^{\alpha}\, v^{\beta} = (1-u)(\hat{L}+s)$$

and then take logs of both sides of the equation and do a second-order Taylor approximation for the expressions involving u we get:

$$\ln v = \frac{\gamma_0}{\beta} + \frac{\gamma_1}{\beta}u + \frac{\gamma_2}{\beta}u^2 - \frac{\alpha}{\beta}\ln c + \frac{1}{\beta}\ln(\hat{L}+s)$$

where the γ parameters are a function of α. Assuming that c and $\hat{L} + s$ are exponential functions of their determinants we get equation (18).

regressions should be negative; the variables that affect labor force growth - female labor force participation and the government share in total employment - are expected to shift the Beveridge curve (out, for the former variable and in, for the latter); likewise variables that affect search intensity - real wages, unemployment benefits and unemployment duration (proxied by the share of the long-term unemployed) are expected to shift the curve: whenever real wages decline, benefits increase or duration increases we expect the curve to shift out. Finally the rate of separation should have a positive coefficient.

As many of the independent variables may be subject to simultaneity problems we report TSLS results for all regressions using lagged values as instruments in addition to OLS. The results are reported in Tables 3a and 3b.

Tables 3a and 3b

4.3 Discussion

For the large part the hypotheses are corroborated. The following major conclusions emerge:

a. Relative to the benchmark specification reported in Table 2 the elasticity estimates of unemployment with respect to vacancies are lower in absolute value: for the unemployment stock they are around 0.7 compared to 0.9 - 1 under the "naive" specification; for the unemployment stock+ flow measure they are 0.3 to 0.5 compared to 0.8 to 1.4; for the vacancy stock regressions it is around 0.8 compared to 1.1; for the vacancy stock+ flow regressions it is 1 compared to 1.7. Thus the benchmark case is biased towards a higher elasticity, implying a larger reduction in unemployment for a given increase in vacancies.

b. Search intensity factors play the expected role: decreases in the real wage, increases in

<u>**Table 3a**</u>

The Beveridge Curve: Equation (12)
Period: 1975:1 - 1990:3

Dep / Indep Var	Ln u	Ln u	Ln twsr	Ln twsr
constant	-9.41 (0.43)	-9.57 (0.52)	-5.06 (0.34)	-5.32 (0.47)
Ln v	-0.68 (0.04)	-0.69 (0.05)		
Ln tvr			-0.33 (0.09)	-0.52 (0.11)
wp	-0.008 (0.002)	-0.01 (0.006)	-0.05 (0.002)	-0.008 (0.004)
z	0.01 (0.009)	0.02 (0.01)	-0.001 (0.006)	0.007 (0.008)
sevenp	0.04 (0.008)	0.04 (0.009)	0.01 (0.005)	0.01 (0.006)
femprt	0.10 (0.02)	0.11 (0.02)	0.02 (0.01)	0.02 (0.01)
govprt	-7.00 (1.96)	-7.32 (2.20)	-1.33 (1.09)	-2.59 (1.36)
s	30.51 (5.84)	27.49 (6.72)	34.12 (3.18)	29.43 (3.94)
Adjusted R^2	0.98	0.98	0.95	0.95
Durbin -Watson	0.95	1.00	1.66	1.85
Estimation Methodology	OLS	TSLS	OLS	TSLS

<u>Notes</u>:

1. Standard errors, corrected for heteroscedasticity [see White (1980)], are in parantheses.
2. All estimation is in TSLS with lagged values of the endogenous variables as instruments.

<u>Notation:</u>

u = unemployment rate (stock)
v = vacancy rate (stock)
twsr = unemployment rate (stock + flow)
tvr = vacancy rate (stock +flow)
wp = real wage
z = real unemployment benefits
sevenp = share of unemployed seven months and more
femprt = female participation ratio
govprt = share of employed in public sector
s = separation rate
See Appendix for full details.

Table 3b

The Beveridge Curve: Equation (12)
Period: 1975:1 - 1990:3

Dep / Indep Var	Ln v	Ln v	Ln tvr	Ln tvr	Ln v	Ln v
constant	-10.72 (0.89)	-12.09 (1.07)	-4.25 (0.71)	-6.22 (1.35)	-3.56 (0.72)	-5.59 (1.45)
Ln u	-1.15 (0.07)	-1.24 (0.09)				
u					-106.78 (8.22)	-115.04 (13.44)
u^2					1942.12 (176.67)	1990.88 (280.81)
Ln twsr			-0.60 (0.14)	-1.02 (0.27)		
wp	-0.01 (0.004)	-0.02 (0.02)	-0.01 (0.003)	-0.02 (0.005)	-0.01 (0.005)	-0.05 (0.02)
z	0.02 (0.01)	0.04 (0.02)	0.01 (0.008)	0.02 (0.01)	0.03 (0.02)	0.07 (0.03)
sevenp	0.05 (0.01)	0.04 (0.01)				
femprt	0.13 (0.02)	0.16 (0.04)	0.02 (0.01)	0.03 (0.02)	0.13 (0.02)	0.24 (0.07)
govprt	-13.92 (2.09)	-12.54 (2.23)	-6.35 (1.12)	-5.68 (1.31)	-16.56 (2.60)	-14.78 (3.28)
s	26.92 (6.86)	30.84 (12.49)	5.26 (7.93)	24.28 (13.51)		
Adjusted R^2	0.91	0.89	0.85	0.80	0.87	0.73
Durbin -Watson	1.16	1.31	1.44	1.74	1.19	1.61
Estimation Methodology	OLS	TSLS	OLS	TSLS	OLS	TSLS

Notes:
1. Standard errors, corrected for heteroscedasticity [see White (1980)], are in parantheses.
2. All estimation is in TSLS with lagged values of the endogenous variables as instruments.

Notation:
u = unemployment rate (stock)
v = vacancy rate (stock)
twsr = unemployment rate (stock + flow)
tvr = vacancy rate (stock +flow)
wp = real wage
z = real unemployment benefits
sevenp = share of unemployed seven months and more
femprt = female participation ratio

govprt = share of employed in public sectors = separation rate

See Appendix for full details.

unemployment benefits and increases in duration[9] reduce search intensity and thus increase unemployment. Particularly interesting in this context is the coefficient of the real wage which is negative, i.e. increases in the real wage **lower** unemployment. Running unemployment solely on the real wage yields a positive coefficient; but when adding vacancies and the female participation rate the coefficient becomes negative. The reason is as follows: increases in the real wage lower vacancies and raise the participation rate thus operating to increase unemployment. When these effects are controlled for by the inclusion of the vacancy and particpation rates in the regression the marginal effect which remains is the positive effect on search intensity.

c. The labor supply variables also operate as expected: increases in the female participation rate increases unemployment and so does a decline in the government share of employment.

d. The separation rate affects the unemployment rate positively.

e. The different specifications basically convey the same picture: generally the differences between the OLS and TSLS estimates are small, though the latter do tend to produce more precise estimates of the coefficients.

5. The Role of Growth and Business Cycles

In a wider macroeconomic context, a series of papers have recently examined the channels through which the Beveridge curve is affected by growth and business cycles. These papers employ models that use variations and extensions of the model presented in Section 2. In what follows we shall present the essential implications of these models for modelling unemployment. These implications shall enable us to specify an estimating equation for unemployment which caters for the effects of growth and

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[9] In four regressions where unemployment is an explanatory variable - as reported in Table 3b - there is substantial collinearity between the duration variable and the rate of unemployment. Thus its coefficient is insignificant and it was dropped from those regressions. A similar argument applies to the separation rate for two regressions in that table.

business cycles on vacancy creation and on the separation rate.

Each of the different models in the recent literature specifies an optimization condition for the firm guiding its creation of vacancies in accordance with the market structure assumed. Basically these are all conditions along the lines of equation (5) above, equating the marginal benefit from vacancy creation with its marginal cost, taking into account the probability of filling a vacancy.

Growth may play a role in the following ways: Pissarides (1990, chapter 2) introduces labor-augmenting technical progress into the model. An increase in the growth rate raises the present discounted value of profits and leads to more vacancy creation. This may be termed a "capitalization effect." A similar effect is at play in the endogenous growth model of Aghion and Howitt (1994), where growth arises from the introduction of new technologies[10]. In this model, the separation rate is the frequency of innovations which drive growth. Firms lay off old workers as they absorb a new technology, looking for new workers to work with the innovations in the production process. If old workers adapt to the new technology then the rate of layoffs depends on the adaptability of old workers to this new technology. When adaptation is not complete, an increase in the growth rate will increase the rate of separation. Thus, in the Aghion-Howitt framework there is also a negative effect on vacancy creation to the increase in the rate of growth. As faster growth is due to a faster rate of innovation, it reduces the duration of each job-worker match and hence its profitability to the firm. This negative effect is termed by the authors an "indirect creative destruction" effect. In their model the capitalization effect dominates. Mortensen and Pissarides (1993) examine a similar problem allowing for stochastic arrival times of innovation. They find that the relative strength of these effects depend on the channels through which the new technology affects production. In particular if innovations affects productivity in all jobs more or less equally the capitalization effect will dominate. But when all technical progress is embodied in new jobs, the creative

[10] Some empirical corroboration of this notion was recently given by Caballero and Jafee (1993) who found a positive correlation between the growth rate of a smoothed labor productivity series and a rate of patenting series, proxing for the rate of technological innovation.

destruction effect dominates.

Business cycles may affect vacancy creation and the rate of separation through cyclical fluctuations in profitability[11]. Mortensen and Pissarides (1994) analyze the effects of cycles in a model that distinguishes between aggregate conditions that follow the business cycle and firm-specific conditions. They show that an increase in demand in booms (reflected in their framework in higher prices) leads to more vacancy creation due to higher profitability. This cyclicality is reduced by the anticipation of the downturn which will follow the boom. As to job destruction, the following cyclical pattern emerges: in a boom, when prices have increased, firms hold on to more jobs after unfavorable firm-specific shocks, thus decreasing the rate of job destruction; in a recession, when prices have decreased, there is a rise in the reservation productivity leading to immediate job destruction and firms are more likely to destroy jobs when hit by negative firm-specific shocks. Thus there is asymmetric countercyclicality in the rate of job destruction.

6. Quantifying the Role of Growth and Business Cycles

The foregoing discussion implies that vacancies (v) and the rate of separation (s) are influenced by growth and cycles. In order to quantify through estimation the role of these factors on the evolution of unemployment we employ the following strategy: we look at several real activity series and decompose them - using the Hodrick-Prescott filter - into growth and cycle components (6.1). We then use some transformations of these decompositions, as well as other variables, to explain the evolution over time

[11] Davis and Haltiwanger (1990, 1993) and Blanchard and Diamond (1990) present evidence according to which job destruction (engendering layoffs) is intensified during recessions, possibly because firms use recessions to reorganize. On the other hand quits are pro-cyclical: they are low during recessions. Job creation is mildly procyclical or even acyclical. One would expect that the (pro) cyclical fluctuations in job creation would dominate the (counter) cyclical fluctuations in job destruction due to this moderating effects of quits. However, for U.S data the amplitude of fluctuations in job destruction over the cycle is larger than fluctuations in job creation. Boeri (1993) and Contini and Revelli (1993) report similar patterns, though not to the same extent, for European economies.

of the rate of vacancies and the rate of separation (6.2). Based on the findings of the latter estimation we insert the relevant variables in place of the rates of vacancies and separation in the Beveridge equation (6.3). We discuss the implications of the results in 6.4.

6.1 Real Activity Variables and Their Decomposition

In light of the discussion in the preceding section we should consider variables that are likely to affect firms' decisions with respect to job creation and job destruction. We examined eight series: real GDP, real business sector GDP, productivity (derived from real GDP), business sector productivity, industrial production, non-durables consumption, current consumption (non durables excluding sevices) and the Bank of Israel index of co-incident indicators series. We found that the first four series - which are highly correlated - to be problematic: the quarterly data seems to be prone to substantial measurement error. The GDP and productivity series are also theoretically dubious given the large share of government in GDP. We thus make use of the other four series which pertain entirely to the private sector.

We decompose the natural log of each series into a stochastic growth component and a cyclical component using the Hodrick-Prescott filter [for a discussion of the propeties of this filter see King and Rebelo (1993)]. Table 4 reports GMM estimates of the second moment of the differenced growth series and the cycle series for all four variables.

Table 4

Comparing these estimates to the ones reported for output measures for OECD countries in the post-war period by Backus and Kehoe (1992) we find these to be reasonable.

6.2 The Determinants of the Rates of Vacancies and Separation

Based on the various theoretical arguments put forth by Aghion and Howitt (1994) and Mortensen and Pissarides (1993, 1994) and discussed in the preceding section, we proceed to estimate the following two specifications for the rate of vacancies and the rate of separation:

Table 4

Properties of Real Activity Variables
Period: 1975:1 - 1990:3

Notation: $Y = Y^G + Y^C$
Y = A real activity variable
Y^G = Hodrick - Prescott stochastic growth component
Y^C = Hodrick - Prescott cyclical component

Log of Variable (Y)	Standard Deviation of Differenced Stochastic Growth (ΔY^G)	Standard Deviation of Cycle (Y^C)
Industrial Production (tpr1d)	0.21 (0.03)	2.87 (0.44)
BOI Index of Co-Incident Indicators (inds)	0.09 (0.08)	3.94 (0.75)
Non Durables Consumption (rcn)	0.22 (0.49)	4.60 (0.36)
Current Consumption (rcc)	0.13 (0.34)	4.15 (0.33)

Notes: 1. Estimation of standard deviation by GMM [see Ogaki (1993, sec 8)].
2. Moments and their standard errors are in percentage terms.
3. Standard errors of moments are in parentheses.

$$\ln v_t = \delta_0 + \delta_1 DGROWTH_t + \delta_2\ CYCLE_t + \delta_3\ wp_t + \delta_4\ r_t \tag{19}$$

where $DGROWTH_t = GR_t - GR_{t-1}$ and GR is the growth component of the relevant real activity series, CYCLE is its cyclical component and r is the real interest rate derived from deflating commercial banks lending rate by CPI inflation.

Based on the foregoing discussion we expect the two components of real activity to have a positive coefficient and the price of labor (wp, the real wage) and of capital (r, the rate of interest) to have a negative effect on vacancy creation. Note that we are postulating that it is the **change** in growth which should affect the **rate** of vacancies; for a given growth rate we expect the vacancy rate to stay constant.

Similarly for the rate of separation we estimate the following specification under different variants:

$$s_t = \delta_0 + \delta_1 DGROWTH_t + \delta_2\ CYCLE_t + \delta_3\ wp_t + \delta_4\ z_t + \delta_5\ r_t \tag{20}$$

Here we expect an increase in the rate of growth to increase the rate of separation through faster job destruction, a countercyclical behavior of the rate of separation (assuming layoffs are more important than quits) and a positive effect of unemployment benefits on this rate as it may induce more quits. If indeed layoffs dominate quits, increases in the real wage and in the rate of interest should lower firm profitability and increase layoffs and thus the rate of separation.

We report the results of estimation for equation (19) in Table 5. We use both OLS and TSLS, the four real activity series discussed above and stocks and stocks+flows measures of vacancies.

Table 5

Table 5

The Vacancy Rate: Equation(19)
Period: 1975:1 - 1990:3

Dep / Indep Var	Ln v	Ln tvr	Ln v	Ln tvr	Ln tvr	Ln tvr
constant	-5.43 (0.61)	-3.11 (0.50)	-6.10 (0.95)	-3.38 (0.69)	-3.01 (0.25)	-2.63 (0.16)
Dgrowth	85.08 (37.71)	23.51 (25.59)	152.09 (65.19)	49.21 (40.43)	47.19 (15.34)	24.53 (10.69)
Cycle	5.35 (1.99)	4.65 (1.22)	4.27 (1.10)	2.18 (0.44)	0.87 (0.45)	3.20 (0.59)
wp	-0.008 (0.004)	-0.01 (0.004)	-0.01 (0.005)	-0.01 (0.004)	-0.02 (0.002)	-0.02 (0.002)
r	-4.07 (2.25)	-5.22 (2.89)	-5.03 (2.36)	-5.28 (2.29)	-2.83 (0.88)	-3.92 (1.41)
Real Activity Vars	Industrial Production (tpr1d)	Industrial Production (tpr1d)	BOI Index of Co-Incident Indicators (inds)	BOI Index of Co-Incident Indicators (inds)	Non Durables Consumption (rcn)	Current Consumption (rcc)
Adjusted R^2	0.37	0.60	0.39	0.60	0.69	0.55
Durbin - Watson	0.37	1.78	0.36	1.52	1.31	1.87

Note: 1. All estimation is done in TSLS. Instruments are lagged values of the endogenous variables.
2. Standard errors, corrected for heteroscedasticity [see White (1980)], are in parantheses.

Notation:
Dgrowth = GR_t-GR_{t-1}, where GR is stochastic growth component of real activity variable..
Cycle = cyclical componenet of real activity variable in first row.
wp = real wage
r = the real rate of interest
See Appendix for full details.

We report the results of estimation for equation (20) in Table 6.

Table 6

The results are in line with our hypotheses.

6.3 A Modified Unemployment Equation

The results of Table 5 and 6 lead us to replace v and s in equation (16) and run the unemployment equation without these variables but with their determinants, including the change in growth and the cycle:

$$\ln u_t = \delta_0 + \delta_1 DGROWTH_t + \delta_2\ CYCLE_t + \delta_3\ wp_t + \delta_4\ z_t + \delta_5\ sevenp_t + \delta_6\ femprt_t + \delta_7\ govprt_t + \delta \qquad \textbf{(21)}$$

We report the results in Table 7 for both stock and stock+flow measures of unemployment, after elimination of those variables in (21) that were found to be statistically insignificant.

Table 7

6.4. Discussion

Table 7 conveys the following picture:

(i) Increases in growth lower unemployment; i.e. the positive effect of growth on vacancy creation dominates the negative effect of increased seperations.

(ii) Unemployment is countercyclical: as can be seen in Tables 5 and 6, in a recession vacancy creation decreases and the rate of seperation increases so unemployment increases.

Table 6

The Rate of Seperation: Equation(20)
Period: 1975:1 - 1990:3

Dependent Variable: s (the rate of seperation)

Activity Vars	Industrial Production (tpr1d)	BOI Index of Co-Incident Indicators (inds)	NonDurables Consumption (rcn)	Current Consumption (rcc)
constant	-0.05 (0.008)	-0.06 (0.01)	-0.05 (0.01)	-0.03 (0.005)
Dgrowth	1.56 (0.47)	2.16 (0.68)	1.46 (0.66)	0.81 (0.23)
Cycle	-0.07 (0.02)	-0.09 (0.008)	-0.05 (0.01)	-0.11 (0.01)
wp	0.0003 (0.0001)	0.0003 (0.0001)	0.0003 (0.0001)	0.0002 (0.00008)
z	0.001 (0.0003)	0.001 (0.0004)	0.0006 (0.0004)	0.009 (0.0002)
r	0.13 (0.03)		0.12 (0.04)	-0.04 (0.03)
Adjusted R^2	0.71	0.83	0.60	0.79
Durbin -Watson	1.48	1.22	1.04	1.24

Note: 1. All estimation is done in TSLS. Instruments are lagged values of the endogenous variables.

2. Standard errors, corrected for heteroscedasticity [see White (1980)], are in parantheses.

Notation:

Dgrowth = $GR_t - GR_{t-1}$, where GR is stochastic growth component of real activity variable.
Cycle = cyclical componenet of real activity variable in first row.
wp = real wage
z = real unemployment benefit
r = the real rate of interest
See Appendix for full details.

Table 7

Unemployment: Equation(21)

Period: 1975:1 - 1990:3

Dep / Indep Var	Ln u	Ln twsr	Ln u	Ln twsr	Ln u	Ln twsr	Ln u	Ln twsr
constant	-4.88 (1.16)	-5.31 (0.63)	-5.10 (1.26)	-4.97 (0.63)	-6.94 (0.96)	-6.00 (0.54)	-3.29 (1.33)	-3.55 (0.65)
Dgrowth	-153.79 (24.52)	-28.48 (11.78)	-220.91 (50.61)	-50.90 (28.79)	-92.54 (21.29)	-31.21 (17.67)	-77.14 (21.34)	-32.15 (9.66)
Cycle	-7.90 (1.44)	-4.34 (0.62)	-2.22 (0.93)	-2.28 (0.50)	-1.66 (0.89)	-0.78 (0.42)	-5.62 (1.02)	-2.78 (0.54)
wp	-0.02 (0.008)	-0.007 (0.004)	-0.01 (0.008)	-0.01 (0.005)	-0.01 (0.008)	-0.013 (0.005)		-0.006 (0.003)
z				0.02 (0.009)	0.06 (0.02)	0.02 (0.01)	0.10 (0.02)	0.03 (0.008)
sevenp	0.13 (0.02)	0.05 (0.01)	0.13 (0.02)	0.05 (0.01)	0.10 (0.02)	0.05 (0.008)	0.13 (0.01)	0.06 (0.007)
femprt	0.07 (0.04)	0.07 (0.02)	0.10 (0.02)	0.07 (0.01)	0.09 (0.03)	0.09 (0.02)		0.06 (0.02)
govprt							-7.49 (4.35)	-6.81 (1.56)
r			5.36 (1.64)		3.39 (1.35)		5.05 (1.88)	
Activity Vars	Industrial Production (tpr1d)	Industrial Production (tpr1d)	BOI Index of Co-Incident Indicators (inds)	BOI Index of Co-Incident Indicators (inds)	Non Durable Consumption (rcn)	Non Durable Consumption (rcn)	Current Consumption (rcc)	Current Consumption (rcc)
Adjusted R^2	0.91	0.91	0.88	0.93	0.86	0.86	0.90	0.94
Durbin - Watson	1.25	1.48	1.74	1.32	1.00	1.11	1.99	1.87

1. All estimation is done in TSLS
2. Standard errors, corrected for heteroscedasticity [see White (1980)], are in parantheses.

on:

th = GR_t-GR_{t-1}, where GR is stochastic growth component of real activity variable (see row 11).
= cyclical componenet of real activity variable (see row 11).
eal wage
unemployment benefit
= share of unemployed seven months and more
= female participation ratio
= share of employed in public sector
eal rate of interest
endix for full details.

(iii) The real wage has again a negative (marginal) effect on unemployment. It is persumably the result of its positive effect on search intensity (see the discussion following Tables 3a and 3b above). In the same vein, increases in unemployment benefits or in long term unemployment (proxying for duration) lead to a fall in search intensity and to an increase in unemployment.

(iv) Labor supply factors continue to play the role reported in Section 4, though here the coefficient on the government's share in employment is insignificant for most of the equations.

(v) Increases in the real rate of interest lower vacancy creation and increase the rate of seperation engendering higher unemployment.

7. A Structural VAR Analysis

The foregoing analysis calls for a natural extension in the form of a dynamic analysis. We do so by running a structural VAR of unemployment, vacancies and the labor force. We impose structural restrictions derived from theoretical considerations pertaining to a stochastic, dynamic formulation of the model presented in Section 2. Our methodology is akin to the one proposed by Bernanke (1986) and Sims (1986) and in a related context by Blanchard and Diamond (1989, 1990). In Section 7.1 we present the structural model and in 7.2 we report and discuss the results of estimation. In sub-section 7.3 we re-run the VAR using a real activity variable instead of vacancies; we discuss the rationale for this substitution and its implications.

7.1 The Structural Model and Identifying Restrictions

Basically we think of three equations, representing the dynamic form of the model presented in Section 2:

1. The motion of unemployment is due to labor force growth, separation from jobs and matching:

$$U_t = U_{t-1} + sN_{t-1} - [m(cU_{t-1}, V_{t-1}) + \epsilon_{m_t}] + L_t - L_{t-1} \tag{22}$$

We assume that there is a stochastic innovation operating in matching(ϵ_m) and that matching at period t is defined over the stocks of the previous period.

2. Optimal vacancy creation by firms:

$$F_N + \epsilon_{F_t} - w_t - \frac{\gamma V_{t-1}}{m(cU_{t-1}, V_{t-1})} + \frac{1}{1+r_t} E_t \frac{\gamma(1-s_t) V_t}{m(cU_t, V_t) + \epsilon_{m_t}} = 0 \tag{23}$$

This is the discrete time, stochastic, dynamic version of the firm's F.O.C [see equation (5) above]. We assume a productivity innovation (ϵ_F) as well as the afore-mentioned innovation to the matching function.

3. Labor force growth is given by:

$$L_t = L_0 * e^{gt} * e^{\epsilon_{L_t}} \tag{24}$$

Here there is a labor force innovation (ϵ_L).

We model these three equations in VAR form as follows [following the terminology and notation in Bernanke (1986)]:

The "structural" model - following the above three equations - is:

$$Y_t = \sum_{i=0}^{l} B_i Y_{t-i} + A \underline{\epsilon_t} \tag{25}$$

where Y = [ln u, ln v, ln l] and $\underline{\epsilon}$ is the vector of structural innovations in matching (ϵ_m), in productivity (ϵ_F) and in the labor force (ϵ_L). We assume that these are serially uncorrelated and that E ($\underline{\epsilon_t}\ \underline{\epsilon'_t}$) = Σ is a diagonal matrix.

We can re-write it in regular VAR form as:

$$Y_t = \sum_{i=1}^{l} C_i Y_{t-i} + y_t \tag{26}$$

With $C_i = (I - B_0)^{-1} B_i$, and the unrestricted VAR residuals y satisfying:

$$y_t = By_t + A\epsilon_t \tag{27}$$

where

$$\underline{\epsilon}_t = \epsilon_m \quad \epsilon_f \quad \epsilon_l \tag{28}$$

By imposing constraints on A and B in (25) we are able to identify (27) and estimate it using maximum likelihood estimation.

We impose the following structure, as derived from equations (22) - (24):

$$(I - B_0) = \begin{matrix} 1 & 0 & \beta_1 \\ \beta_2 & 1 & 0 \\ 0 & 0 & 1 \end{matrix} \tag{29}$$

The intuition here is that vacancies do not affect unemployment contemporaneously as matching is defined over the previous period's stocks; the size of the labor force does not affect the vacancy creation decision; and the labor force is not affected contemporaneously by unemployment and vacancies.

$$(A) = \begin{matrix} \alpha_1 & 0 & 0 \\ \alpha_2 & \alpha_3 & 0 \\ 0 & 0 & \alpha_4 \end{matrix} \tag{30}$$

The intuition here is that only matching innovations enter directly into the unemployment dynamics equation; only labor force innovations affect the labor force directly; and vacancy creation is affected by both matching and productivity innovations. Note however that this formulation allows for indirect and lagged effects of the structural innovations.

We then estimate the following:

$$G\, y_t = \underline{\epsilon}_t \tag{31}$$

where

$$G = [(I - B_0)^{-1} A]^{-1} = \begin{bmatrix} \frac{1}{\alpha_1} & 0 & \frac{\beta_1}{\alpha_1} \\ \frac{\alpha_1\beta_2 - \alpha_2}{\alpha_1\ \alpha_3} & \frac{1}{\alpha_3} & \frac{-\alpha_2\beta_1}{\alpha_1\alpha_3} \\ 0 & 0 & \frac{1}{\alpha_4} \end{bmatrix} \tag{32}$$

We normalize the diagonal elements of G to equal one. The order condition for estimation of this system is that the number of parameters will not exceed the number of distinct covariances in the variance-covariance matrix of y. The latter number is 6; we thus estimate the three free parameters in (32) and the three diagonal elements of Σ.

7.2 Estimation Results

We report the results of estimation[12] in three forms: impulse responses, these same responses of unemployment and vacancies shown in Beveridge curve space (figures 8 and 9) and variance decompositions (table 8). We differentiate between the short-run (up to 3 years) shown in Figure 8 and the long-run (up to 15 years) shown in Figure 9:

Figures 8 and 9

[12] We use the BERNANKE procedure in RATS version 4.1. After testing for lag length - using a likelihood ratio test - we use 3 lags (with quarterly data).

Figure 8a

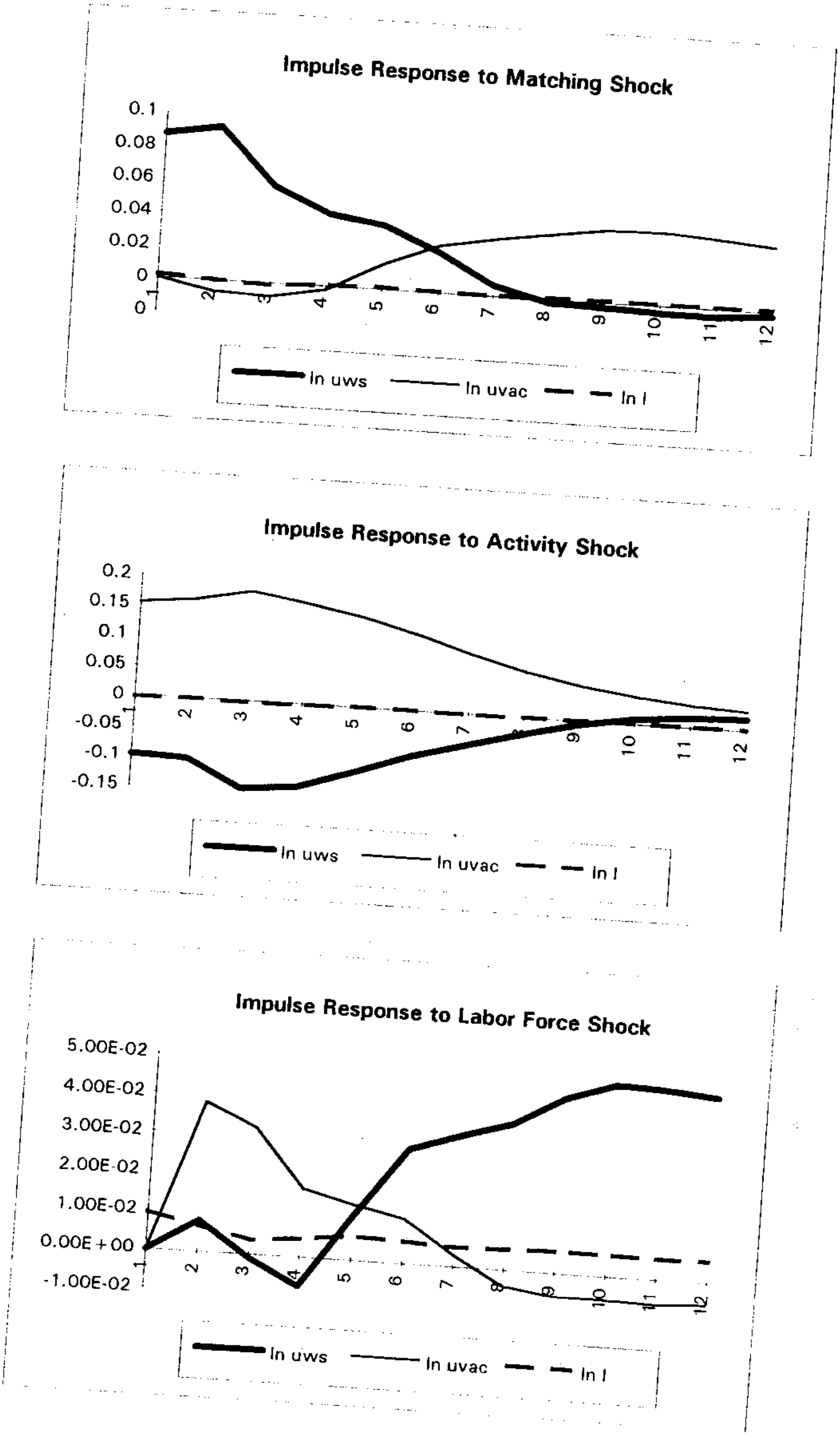

Impulse Response to Matching Shock
0.1
0.08
0.06
0.04
0.02
0
0
1 2 3 4 5 6 7 8 9 10 11 12
ln uws
ln uvac
ln l
Impulse Response to Activity Shock
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1 2 3 4 5 6 7 8 9 10 11 12
ln uws
ln uvac
ln l
Impulse Response to Labor Force Shock
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
-1.00E-02
1 2 3 4 5 6 7 8 9 10 11 12
ln uws
ln uvac
ln l

Figure 8b

Effects of Shocks on Beveridge Curve

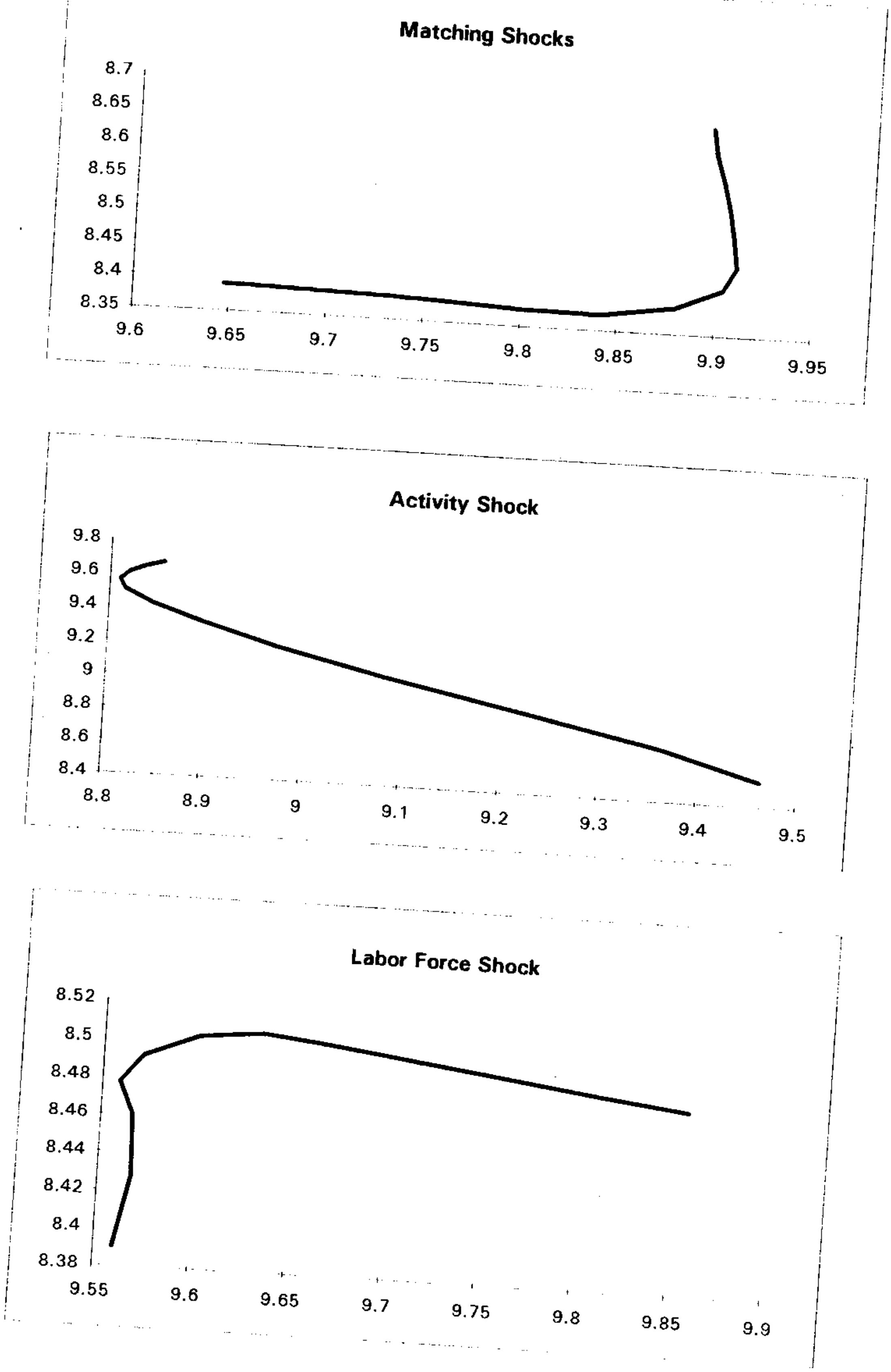
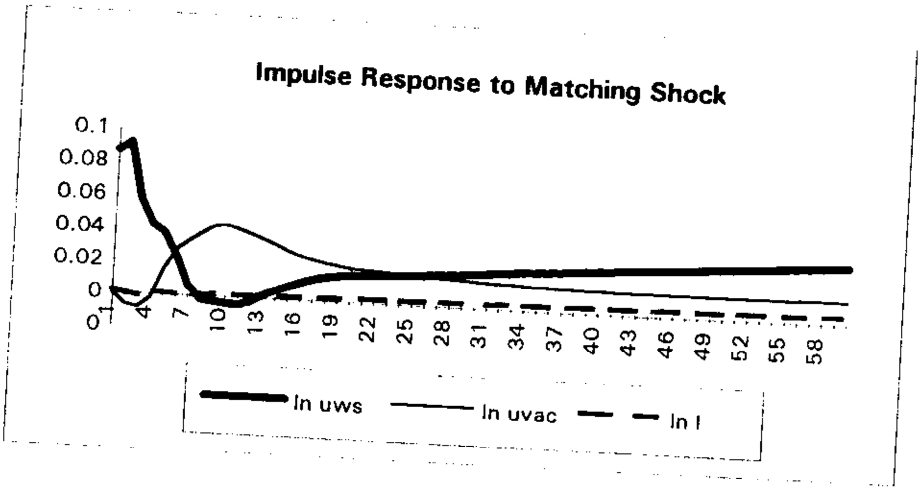
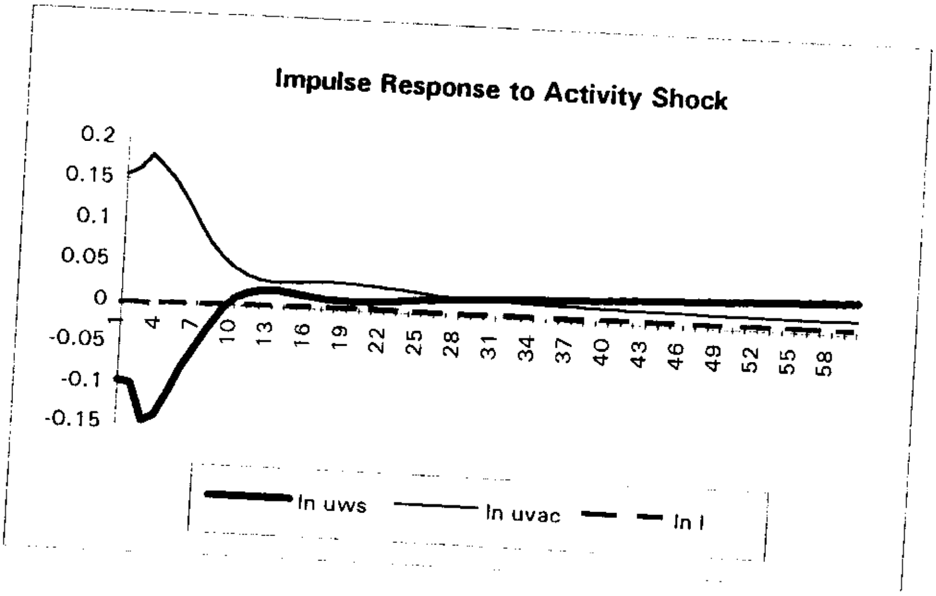


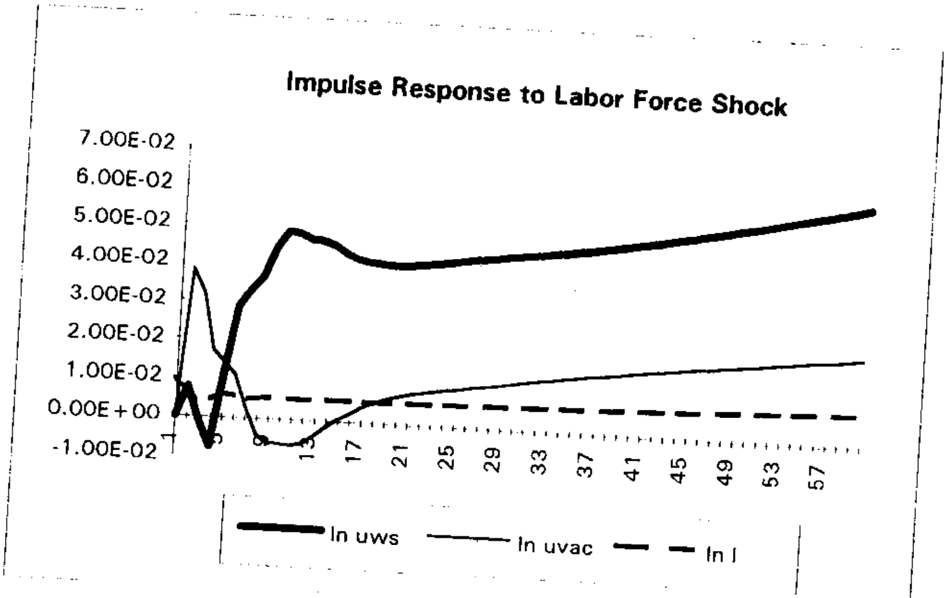
Figure 9a



Impulse Response to Matching Shock
0.1
0.08
0.06
0.04
0.02
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
ln uws
ln uvac
ln l



Impulse Response to Activity Shock
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
ln uws
ln uvac
ln l



Impulse Response to Labor Force Shock
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
-1.00E-02
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
ln uws
ln uvac
ln l

Figure 9b

Effects of Shocks on Beveridge Curve

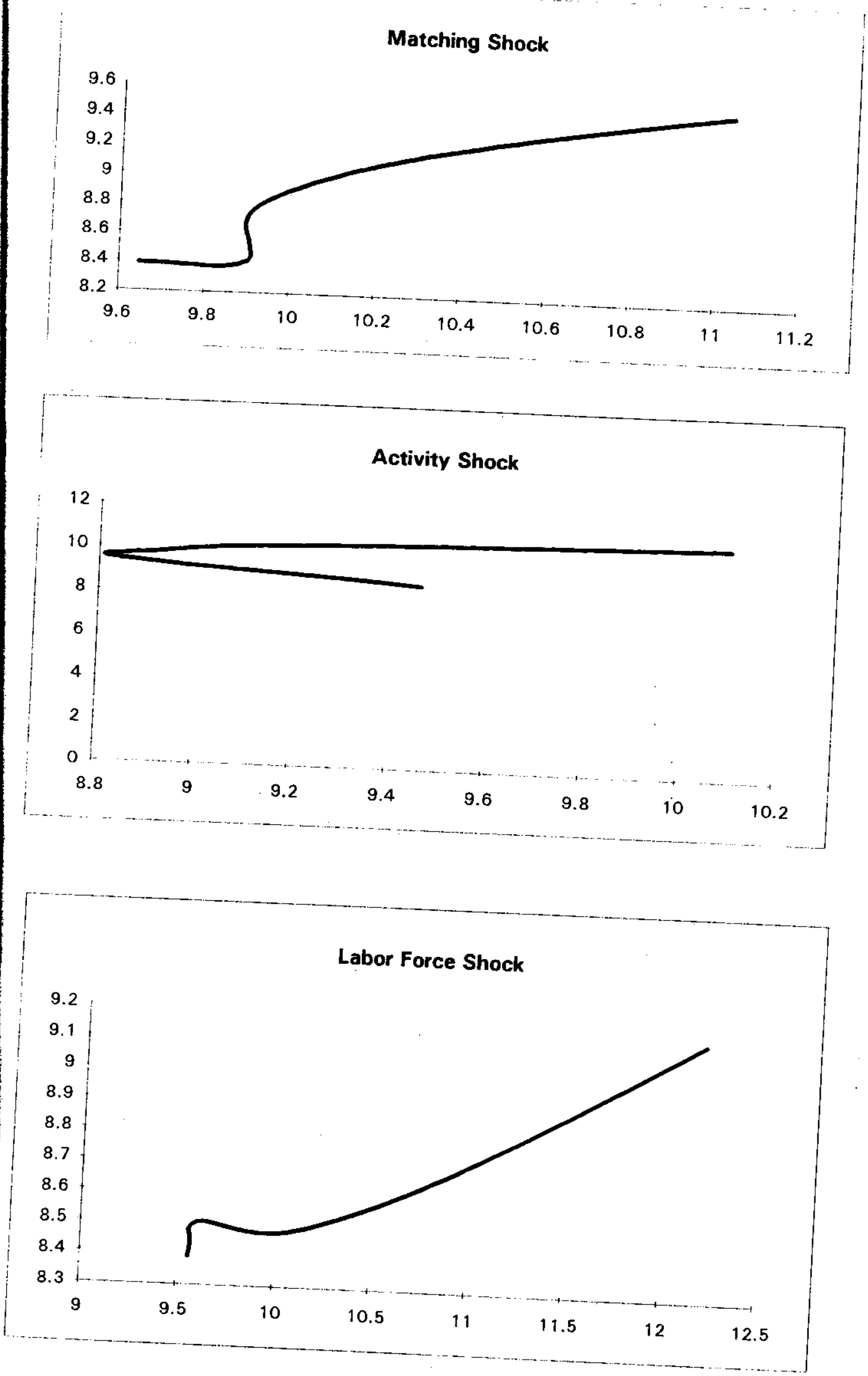


Table 8

From the figures it is apparent that there is a significant difference between the short-run and long run effects of shocks. The results can be summarized as follows:

Negative matching shocks increase unemployment quickly in the short-run, then subside for a time and cause a further increase in the long run; vacancies respond more slowly, beginning to increase only after a year but subsequently exhibit a steady increase. This generates the expected movement to the North-East in u-v space. These innovations do not account for a large proportion of the variance of the three variables except in the very short run. Thus they account for 45% of the variance of unemployment in the first two quarters but by the second year their effect goes down to around 20%. With respect to vacancies and the labor force they play an even smaller role.

Positive activity shocks cause an immediate large increase in vacancies and decrease in unemployment. Their effect diminishes after about three years but does not die out. In u-v space this is represented as a movement to the North-West in the short-run and subsequently as a movement towards higher unemployment and slightly higher vacancies. These shocks account for a very significant portion of the variation in unemployment and for most of the variation in vacancies at all horizons.

Positive labor force shocks operate as expected to increase both unemployment and vacancies, generating movements in u - v space akin to matching shocks. However they have a greater impact on unemployment than on vacancies and affect both of these variables differentially across time (thus generating a very different picture in Beverdige curve space in the short-run and in the long-run). Note in particular that at long horizons they explain a very large proportion of the variation in unemployment (around 40%).

7.3. Real Activity and Unemployment

In Section 6 we have seen that we can replace vacancies with measures of real activity and get

Table 8

Variance Decomposition

Proportion of Variance due to Shocks (in %)

ln uws

Quarters	Matching Shock	Activity Shock	Labor Force Shock
4	26.46	73.40	0.15
20	18.33	61.59	20.07
40	17.57	47.71	34.72
60	18.00	38.97	43.03

ln uvac

Quarters	Matching Shock	Activity Shock	Labor Force Shock
4	0.10	97.46	2.44
20	8.49	89.80	1.71
40	10.37	86.67	2.96
60	11.29	82.76	5.96

ln l

Quarters	Matching Shock	Activity Shock	Labor Force Shock
4	3.94	6.15	89.92
20	6.88	5.76	87.36
40	12.89	13.70	73.42
60	16.00	18.48	65.51

meaningful results with respect to the evolution of unemployment. We therefore ran the same structural VAR using the Bank of Israel index of co-incident indicators (in logs) instead of vacancies. We report the results in the same fashion in Figures 10 and 11 and in Table 9.

Figures 10-11

Table 9

Negative matching shocks generate similar effects to the ones discussed for the previous VAR system, except that here unemployment and vacancies move in a more monotone fashion. The major difference here is that they account for larger share of variation in unemployment (around 60% at short horizons and 45% at long horizons).

Activity shocks generate very similar impulse responses compared to the previous case. In response to shocks, the log of the Bank of Israel index of co-incident indicators displays a time profile that is very similar to the one exhibited by the log of vacancies. The main difference is that the effect of the shock diminishes more rapidly. Here again activity shocks are important in explaining the variation in unemployment (though less than under the previous case) and constitute the large part of fluctuations in activity.

For **labor force shocks** the results are similar again, generating the North-East movement in Beveridge curve space. Here the main difference lies in the finding that they do not account for as large a part of unemployment variation (24% in the long run) but play a significant role in explaining variation in vacancies (around 40% at long horizons).

These results lead us to conclude that while replacing vacancies by real activity changes both the nature of the activity shocks and the interaction between the variables, it nonetheless generates a picture that is broadly consistent with regular Beveridge curve analysis.

Figure 10a

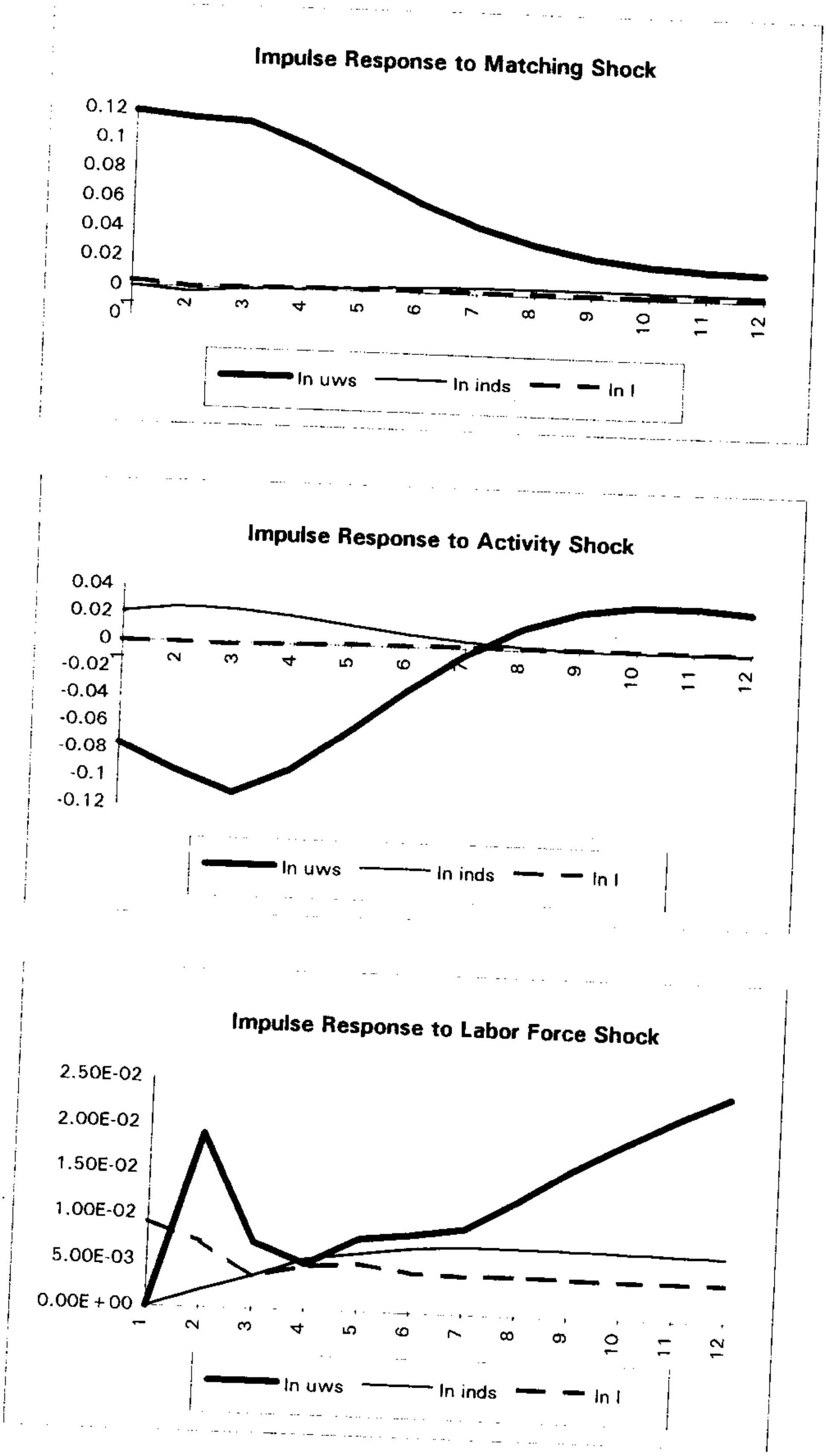
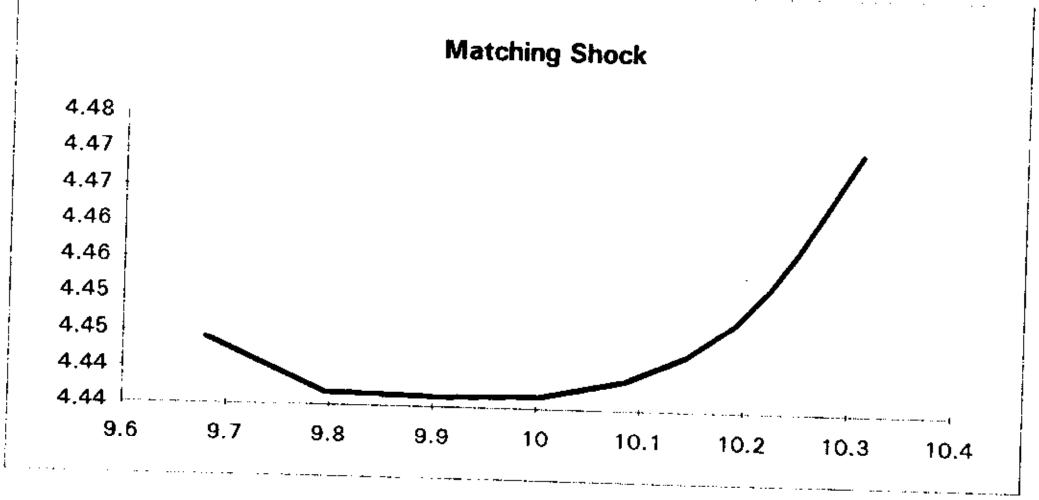
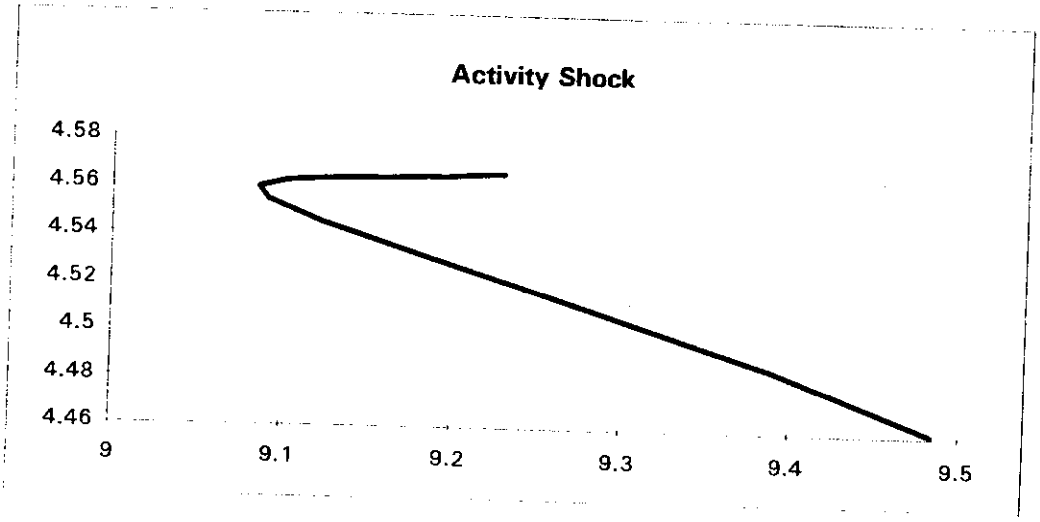

Impulse Response to Matching Shock
0.12
0.1
0.08
0.06
0.04
0.02
0
0
1
2
3
4
5
6
7
8
9
10
11
12
ln uws
ln inds
ln l
Impulse Response to Activity Shock
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
1
2
3
4
5
6
7
8
9
10
11
12
ln uws
ln inds
ln l
Impulse Response to Labor Force Shock
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
1
2
3
4
5
6
7
8
9
10
11
12
ln uws
ln inds
ln l

Figure 10b

Effects of Shocks on Modified Beveridge Curve





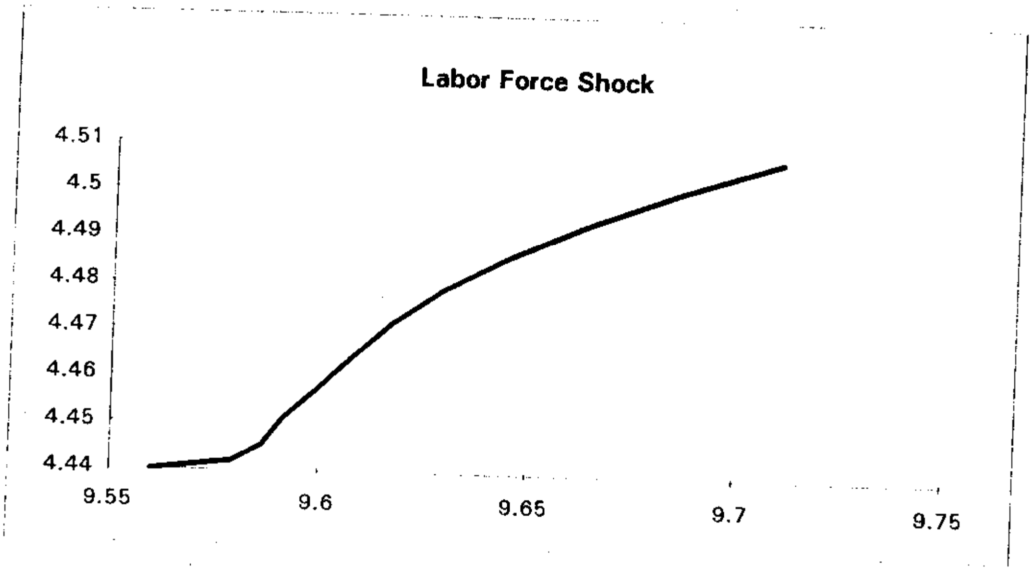


Figure 11a

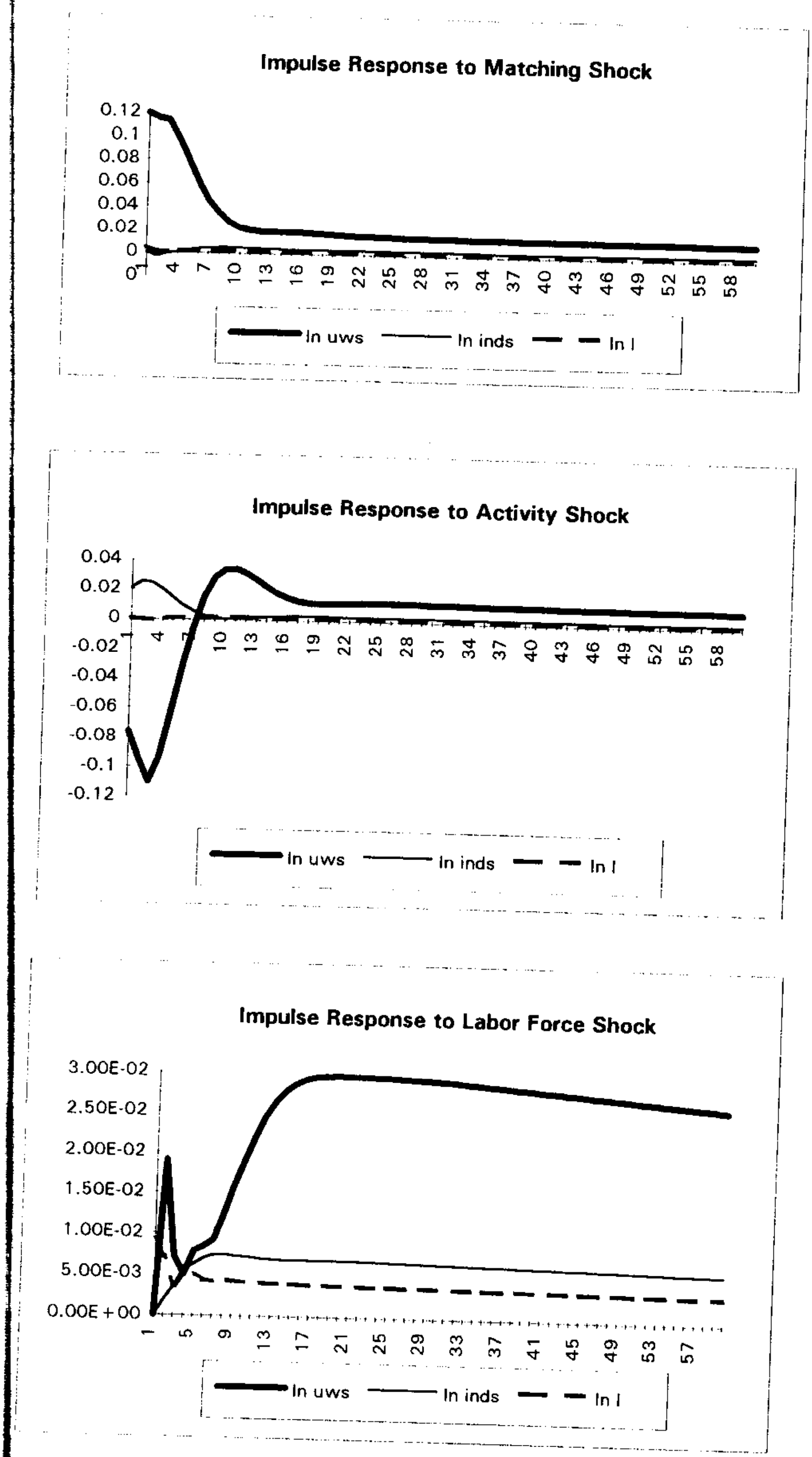
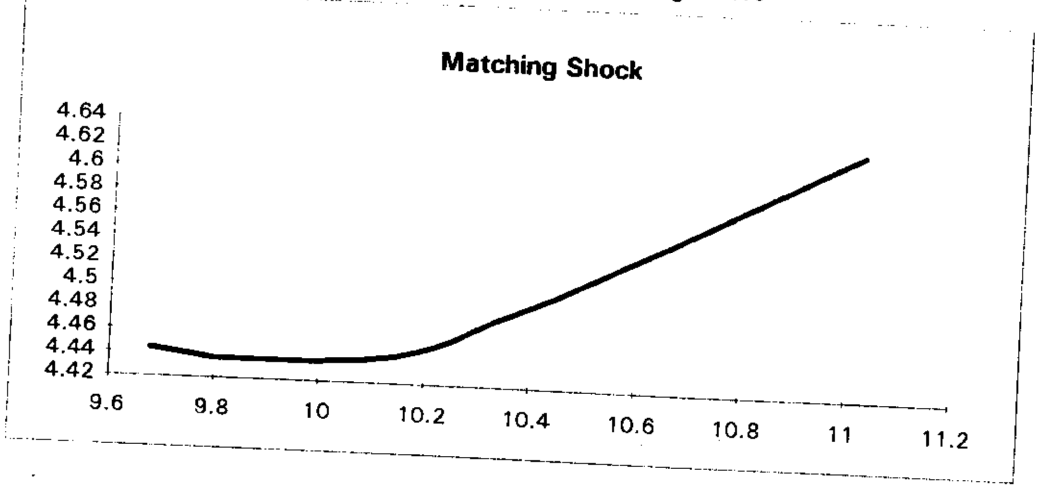
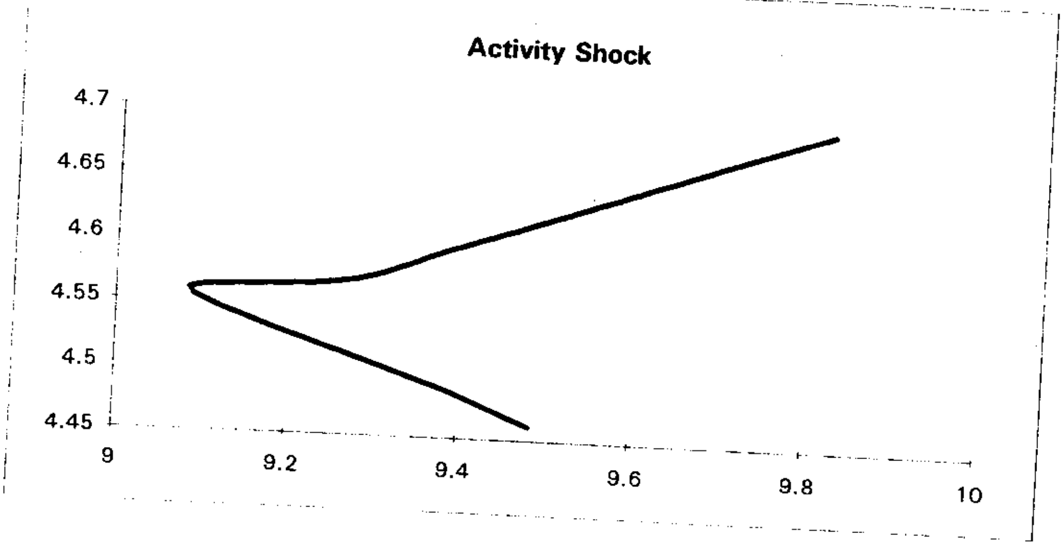

Impulse Response to Matching Shock
0.12
0.1
0.08
0.06
0.04
0.02
0
ln uws
ln inds
ln l
Impulse Response to Activity Shock
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
ln uws
ln inds
ln l
Impulse Response to Labor Force Shock
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
ln uws
ln inds
ln l

Figure 11b

Effects of Shocks on Modified Beveridge Curve





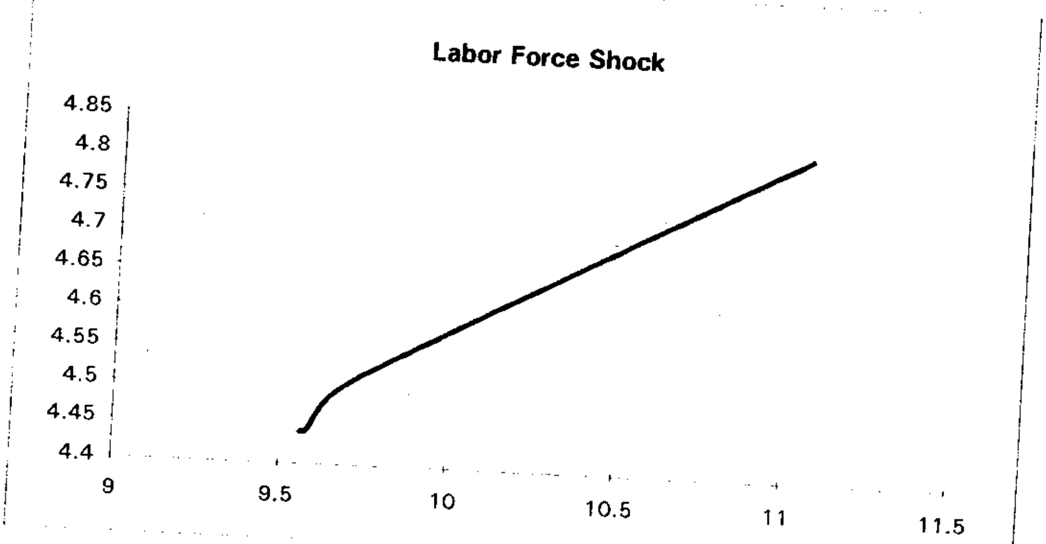


Table 9

Variance Decomposition

Proportion of Variance due to Shocks (in %)

ln uws

Quarters	Matching Shock	Activity Shock	Labor Force Shock
4	58.22	41.27	0.51
20	54.48	38.16	7.36
40	48.56	33.89	17.56
60	44.75	31.18	24.08

ln inds

Quarters	Matching Shock	Activity Shock	Labor Force Shock
4	0.52	97.28	2.20
20	7.47	69.33	23.20
40	10.15	54.44	35.41
60	11.54	46.69	41.78

ln l

Quarters	Matching Shock	Activity Shock	Labor Force Shock
4	10.44	0.53	89.02
20	12.19	6.90	80.90
40	14.42	8.96	76.62
60	15.28	9.74	74.98

8. Conclusions

Two fundamental conclusions regarding the causes of the rise in unemployment emerge from the analysis:

(i) Both growth and cyclical factors play a significant role in the evolution of unemployment. This role is manifested through their effects on vacancy creation and destruction. In particular unemployment increases when growth declines. Such a decline indeed occurred in both European countries and Israel beginning in the early 1970s.

(ii) Search intensity and labor force supply factors account for the rightward shift of the Beveridge curve. This is attested by both the direct estimation of the curve and the movements in Beveridge curve space generated by matching and labor force shocks in the structural VAR analysis.

Our analysis has demonstrated the usefulness of certain variables in accounting for movements in unemployment. Among these are private sector real activities variables which should be decomposed in the appropriate way to account for the differential role of growth and cycles and variables that affect search intensity: the real wage, unemployment benefits and the share of long-term unemployment.

Several extensions are called for: a non-linear estimation of the main relations, including the dynamic specification; a more detailed analysis of the role of growth; and finally, using the results of Section 5, a further study of the possibility to replace vacancy series (which in some economies are problematic) by appropriate real activity measures. These issues are the subject of current research.

Appendix

Definitions and Sources of the Data

Variable Symbol	Description	Mathematical Definition of Transformed Variables	Source
tv	Total Vacancies - total number of vacancies available to be filled over a given month		ES
tws	Total Work Seekers - total number of work seekers who registered over the month[1]		ES
uvac	Unfilled Vacancies - the number of vacancies out of tv that remained unfilled at the end of the month		ES
uws	Unreferred Work Seekers - the number of work seekers out of tws not referred to a job during the month		ES
femprt	Female Participation Rate - the feamle participation rate reported in the LFS		CBS
l	The Labor Force		CBS
N	Total number of employed persons		CBS
tote	Total number of Employee posts		NIA
emp	Total number of Employees[2]		CBS

[1] a work seeker is an individual who registered at least once a month in the employment exchange in application for work.

[2] This is the total number of employed persons minus the self-employed.

Variable	Description	Mathematical Definition of Transformed Variables	Source
gov	Total number of employees in the public sector		CBS
wp	Real Wages - nominal employee wages as computed by the CBS divided by the CPI	W/CPI	CBS
z	Unemployment Insurance - real unemployment insurance payments		NIA
fd	Demand for Unemployment Insurance - by the newly unemployed		NIA
r	Real Interest Rate		CBS
sevenp	Long term Unemployment - the share of workseekers who were unemployed for 7 or more months out of total workseekers		ES
rcn	Non Durables private consumption		CBS
rcc	Current Private Consumption [3]		CBS
tpr1d	Industrial Production Index		CBS
v	The rate of unfilled vacancies out of the labor force	uvac/(uws+emp)	CBS
u	The rate of unreferred work seekers out of the labor force	uws/(uws+emp)	CBS
tvr	The rate of total vacancies out of the labor force	tv/(tws+emp)	ES
twsr	The rate of total work seekers out of the labor force	tws/(tws+emp)	ES
s	Rate of Separation	fd_t/emp_{t-1}	NIA

[3] Total private consumption without durables and services

govprt	Goverment Employment Share - The ratio of employees in the public sector.	gov/N	CBS

Notation:

Ln *variable* = Ln(variable), e.g: Ln v=Ln(v)

variable(-1) = variable_{t-1}, e.g: Lv(-1)=Lv_{t-1}

Sources:

Data is available from the following sources:

CBS- the Central Bureau of Statistics which conducts a quarterly Labor Fource Survey (LFS)

ES- the Employment Service, affiliated with the Ministry of Labor, which complies data series based on the reports of its exchanges.

NIA - the National Insurance Agency

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