CYCLICAL EMPLOYMENT AND UNEMPLOYMENT FLOWS IN THE U.S.

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ABSTRACT

Unemployment in the U.S. has risen dramatically since the start of the recession in December 2007, going from about 6.8 million people in May 2007 to over 14.6 million in June 2010. This is often spoken of as "losing 7.8 million jobs," but this is a terribly misleading view of the issue. The reality is that flows of people and jobs each month are huge – it would be more correct to say that 4-6 million jobs were lost *each month*, with a comparable (just slightly lower) number found each month. This paper examines some of the data regularities in the monthly gross flows published by the Bureau of Labor Statistics. The methodology is to analyze the transition rates and implied steady-state levels of employment and unemployment. This is an approach that, while not commonly used, does provide valuable insights. For example, declines in employment have been largely due to decreased probability of finding a job, with little net impact from changes in the probability of losing a job. Furthermore, in spite of a fall in the u→e transition contributing significantly to falling employment, the flow from unemployment to employment actually increased. As another example, changes in the probability of moving between unemployment and not in the labor force (NLF) look like an "anti-discouraged worker" effect – during the recession people are more likely to move from NLF to unemployment and less likely to move from unemployment to NLF.

Keywords: Job flows, employment fluctuations, labor force, employment dynamics, worker flows

JEL Classifications: E32, E24, J63, J64, C82

1. INTRODUCTION AND SUMMARY

Employment and unemployment are dynamic, with large gross flows each month. The Bureau of Labor Statistics (BLS) has, since 2007, published monthly estimates of the flows between employment, unemployment, and not in the labor force (NLF). These measure the number of people who move from, say, employed in March to unemployed in April. These flows are large, surprisingly large to most people. The flow out of employment (to unemployment and NLF) is on the order of 4-6 million people *each month*, with a comparable number flowing in. These flows determine the levels of employment and unemployment, in the same way that the volume of a bathtub with the drain left open would be determined by the flow in from the spigot and out through the drain.

Given the importance of flows in determining the levels of employment and unemployment, it is somewhat surprising that more attention is not devoted to analyzing the flows and their impact on the levels. This paper aims to summarize some of the empirical observations regarding flows and their impact on levels. We focus on the transition rates or conditional probabilities of moving from one state to another, and examine the impact of changes in those transition rates on implied steady-state levels of employment and unemployment.

The major conclusions are:

- **Dynamics**: Employment and unemployment are hugely dynamic, with large flows in and out even during the current severe recession.

- **Employment**: Declines during the recession have been largely due to decreased probability of finding a job. There has been very little impact from changes in the probability of losing a job.

- **Unemployment**: Increases have been, not surprisingly, largely due to lower probability of finding a job and higher probability of losing a job to unemployment.

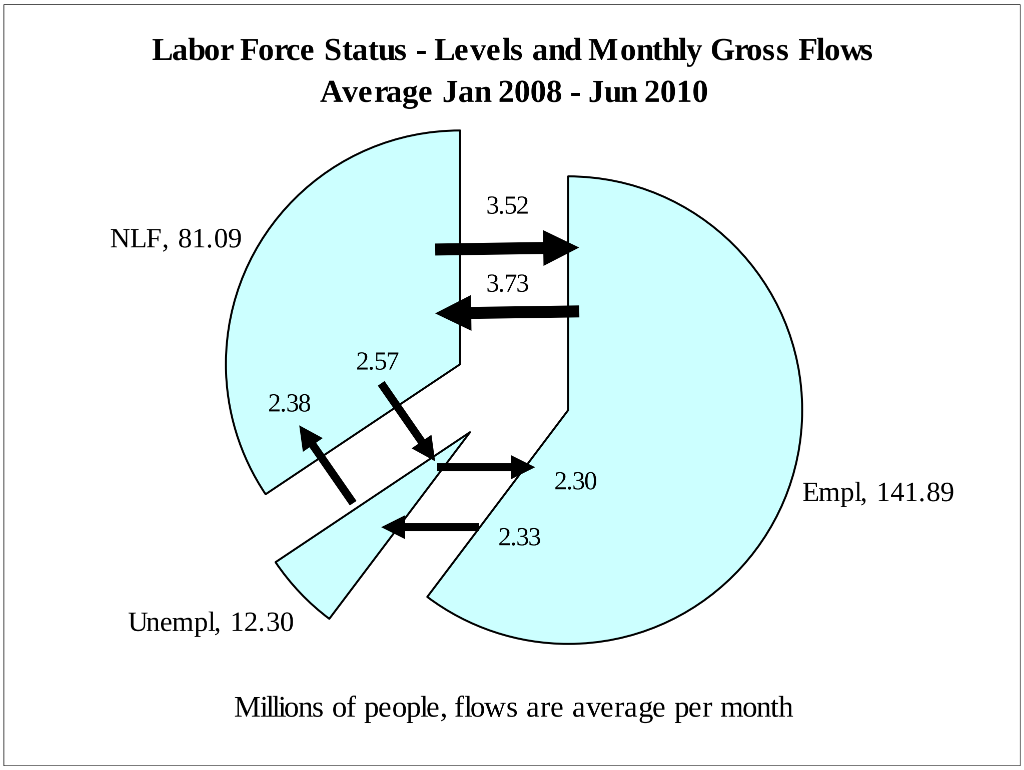
- **NLF**: Not in the labor force (NLF) is enormously important. First, the monthly flows in and out of NLF are large. Second, higher propensity to move from NLF to unemployment is a significant contribution to higher unemployment and, surprisingly, contributes to an *increase* in employment (that partially offsets the overall decline). The changes in probability of moving between unemployment and NLF seem to look like an “anti-discouraged worker” effect – during the recession people are more likely to move from NLF to unemployment and less likely to move from unemployment to NLF.

- **Current Recession**: The dynamics of employment and unemployment during the current recession do not appear qualitatively different from the recessions of the early 1990s and 2000s – the effects are significantly larger but qualitatively the same.

Figure 1 shows basic observations about employment and unemployment from the CPS (Current Population or household Survey). The pie represents the average level of employment, unemployment, and not in the labor force (NLF), number of people in millions for January 2008 through Jun 2010. The arrows represent the average of monthly flows.

The first thing to note is the large size of these flows. Consider unemployment. Figure 1 shows there were roughly 4.9 million people *each month* entering unemployment and roughly 4.7 million leaving, or almost 40% of the number unemployed. Employment is the same story. Flows in and out of employment according to figure 1 were about 6 million per month – even during the worst US recession in over 75 years. Unfortunately, there were more jobs lost than found each month, but this focuses our attention where it should be – what influences the flows in and out and how those flows determine the levels. Finally, the flows to and from not in the labor force (NLF). The size of the flows argue that the distinction between unemployed and NLF is somewhat artificial (many new employees come directly from NLF). We will see below that the economic significance of changes in NLF flows means we must account for NLF behavior to understand changes in employment and unemployment.

Figure 1 – Gross Labor Force Flows



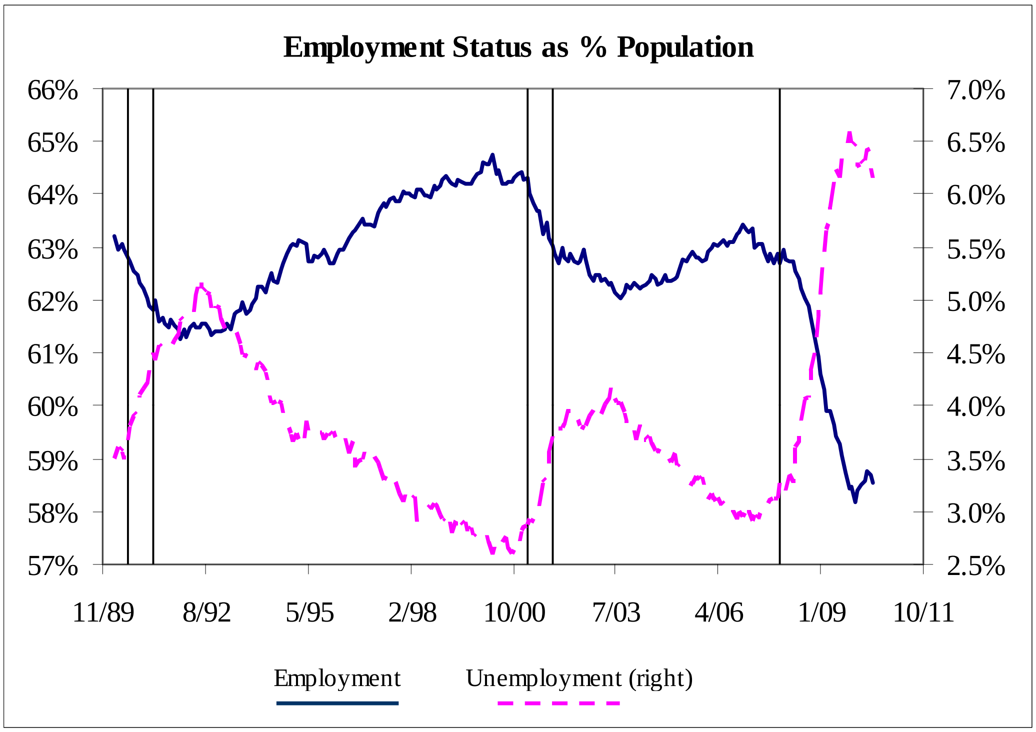
Note: The data are from the Bureau of Labor Statistics "Research series on labor force status flows from the Current Population Survey," http://www.bls.gov/cps/cps_flows.htm. The level data show the number employed, unemployed, and not in the labor force (NLF) and are the same as reported in the monthly unemployment reports from the Current Population (household) Survey. The flows show the number moving from one state to another each month. All data are seasonally adjusted and averaged for the period stated.

There are reasons to think the data shown in figure 1 over-estimate the monthly flows. The evidence is that the over-estimation might be something like 5-20% for flows between employment and unemployment and 30-50% for flows in and out of NLF. Even allowing for such over-estimation, however, the flows are large, economically significant, and critical to understanding changes in employment and unemployment. Even allowing for over-estimation the flows in and out of unemployment are on the order of 3 million plus each month, and more than 4 million new jobs *each month*. In the end, whether the exact number of new jobs is 4.5 million or 5.8 million is irrelevant to the larger point – a significant number of people flow between labor force states each month.

As a mental model of unemployment we often use what I might call the "lump of proletariat" model of changing unemployment. Unemployment is like a bucket full of lumps of proletariat. Each month a lump is either added (unemployment goes up) or removed (unemployment goes down). In reality a better mental picture is the bathtub model – unemployment as a tub of water with an open spigot pouring water in and a pump briskly draining water out. The volume goes up by five gallons not because five gallons are added – it goes up because 115 gallons are added but only 110 are removed. The approach to understanding the bathtub is very different than understanding the bucket of proletariat. With the bucket we focus on the lump or the change in unemployment – how and why did 200,000 people come into unemployment this month? With the bathtub we focus on how many new entrants become unemployed compared with how many leave. We recognize that the tub is fuller by 200,000 people because 4.9 million entered but only 4.7 million left. We focus on why only 4.7 million left and where they went – we focus on the *rate* of entry and exit as the determinants of the level.

Figure 2 shows the history of employment and unemployment levels since 1990 (measured as a ratio to population to adjust for growth in population). The effect of the late 2000s recession is obvious: unemployment rose about 3.5 percentage points and employment fell about 5.2 percentage points.[1]

Figure 2 – Employment and Unemployment as Ratio to Population
Monthly March 1990 – June 2010



Note: The data source is given in figure 1. Employment and unemployment are displayed here as the ratio to population. Vertical lines show recessions (the recession that started December 2007 has not officially been declared as finished).

The monthly flows (as in figure 1) are what determine the levels of employment and unemployment. The flow data contain valuable information and insight into what drives the changes in employment and

[1] This is for the period March 2007 to December 2009. This corresponds roughly to the trough-to-peak for unemployment, and starts somewhat before the official start of the recession in December 2010. Unemployment rose from 2.9% to 6.4% and employment fell from 63.4% to 58.2%.

unemployment.[2] The flows, however, can also provide a few surprises. For example, the flow u→e (from unemployment to employment) generally *rises* during a recession. Naively one might think that this means lower job-finding rates do not contribute to lower employment or higher unemployment, but as we will see shortly, the opposite is true.[3]

In analyzing the flows we need to look at the *conditional* flows or probabilities rather than the gross flows themselves. The conditional probabilities are the economically relevant variables. The flows are determined by people making individual decisions and we need to normalize by how many people there are making those decisions. [4] From figure 1 we see there are six flows:

- *u→e*: an unemployed person finds a job
- *n→e*: a person not in the labor force (NLF) finds a job
- *e→u*: an employed person loses a job and goes to unemployment
- *e→n*: an employed person loses a job and goes to NLF
- *u→n*: an unemployed person moves to NLF
- *n→u*: an NLF person moves to unemployed

To decompose changes in employment and unemployment we analyze the steady-state levels implied by the conditional probabilities. Steady-state levels depend only on the conditional probabilities, so concentrating on the steady-state isolates the effect of changes in conditional probabilities. What makes focusing on steady-state useful is that the steady-state time-series matches the actual levels closely (particularly for unemployment), giving confidence that conclusions we draw from analysis of the steady-state apply to changes in observed levels.

Figure 3 shows the decomposition of changes in employment and unemployment for the recent recession due to changes in the conditional probabilities. The decomposition is only approximate (discussed more in the next section and the appendix) but it does provide a useful view into what drives the changes in employment and unemployment. The figure shows the total change in unemployment and employment (+3.5 and -5.2 percentage points) together with an approximate decomposition resulting from changes in the probabilities of moving between states. For example "u->e" shows the effect resulting from changes in the probability of finding a job conditional on being unemployed (moving *u* to *e*).

Employment fell by 5.2 percentage points

- A fall in the probability of finding a job (u→e and n→e) was the biggest contributor. The impact from n→e (probability of finding a job when NLF) was slightly bigger than the impact from u→e
- The probability of losing a job had almost no net impact. The probability of going to unemployment increased but the probability of losing a job to NLF decreased and these two offset.
- Most intriguingly, changes in the probability of moving between unemployment and NLF contributed positively to employment. The probability of moving unemployed to NLF (u→n) decreased and the probability of moving NLF to unemployed (n→u) increased. These increased the level of unemployment relative to NLF; the higher probability of finding a job from unemployment (instead of NLF) increases the level of employment.

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[2] As mentioned above the flows are probably over-estimated. I continue to focus on the unadjusted flows because there is no ideal or generally-accepted method for adjusting the flows. In the detailed discussion below I do apply one method of adjustment, and find that the results do not change significantly.

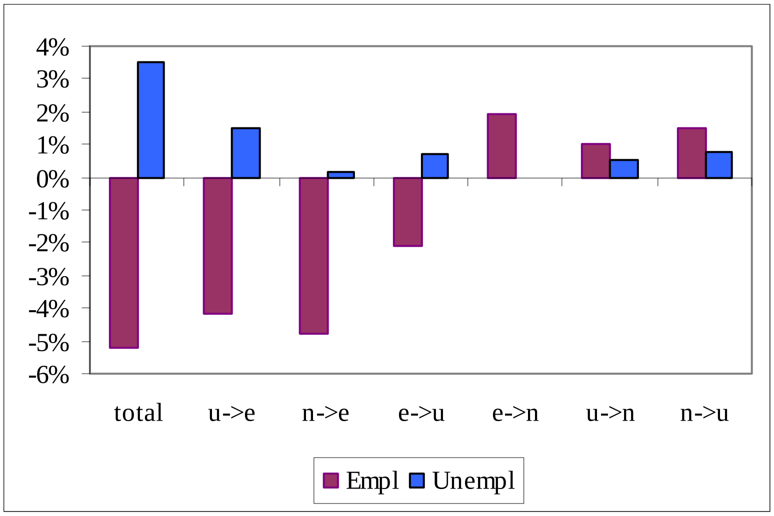
[3] The flow u->e goes up because the conditional probability u->e goes down but the level of unemployment goes up so much that the flow u->e actually rises.

[4] The conditional probability of moving from one state to another is the actual flow (number of people) divided by the number of people starting in the original state – for example the number moving from employed to NLF (e→n) divided by the number starting in employment.

Unemployment rose 3.5 percentage points.

- The biggest contributor was the fall in the probability of getting a job if unemployed (u→e)
- The second biggest contributor was the increased probability of losing a job (e→u).
- A fall in the probability of moving unemployed to NLF (u→n) and a rise in the probability of moving NLF to unemployed (n→u) both contributed, as mentioned above.

Figure 3 – Change in Employment and Unemployment and Approximate Decomposition, March 2007 – December 2009



Note: Employment and Unemployment are both measured as ratio to population. The change is in percentage points (-5.2% means the employment to population ratio changed from 63.4% to 58.2%). The decomposition is for the steady-state employment and unemployment ratios but this provides an approximate decomposition to the observed ratios, as discussed below.

The changes to and from NLF had important effects:

- The probability u→n went down and n→u went up, and this contributed positively to unemployment.
- The fall in u→n and rise in n→u contributed *positively* to employment. The effect seems to be that unemployed job seekers work harder to find a job than do NLF job seekers. More unemployed people partially offsets the lowered probability of finding a job.
- I interpret this as something of an "anti-discouraged worker" effect. Prior to the recession an NLF job-seeker might have found a job without searching hard and thus not reported themselves as unemployed. With the recession such a person is forced to search hard and thus are reported as unemployed.

This pattern of changes in flows during the 2007-2009 recession, and their impact on levels of employment and unemployment, matches well with that of the recessions of 1990-1992 and 2000-2003. All three periods exhibited the same pattern of changes in probabilities and the effect of these changes on employment and unemployment levels. What distinguishes the 2007-2010 recession is the magnitude of the changes, not their pattern. (Furthermore, adjusting the flows for possible over-estimation does not change these conclusions substantively.)

2. DATA OVERVIEW

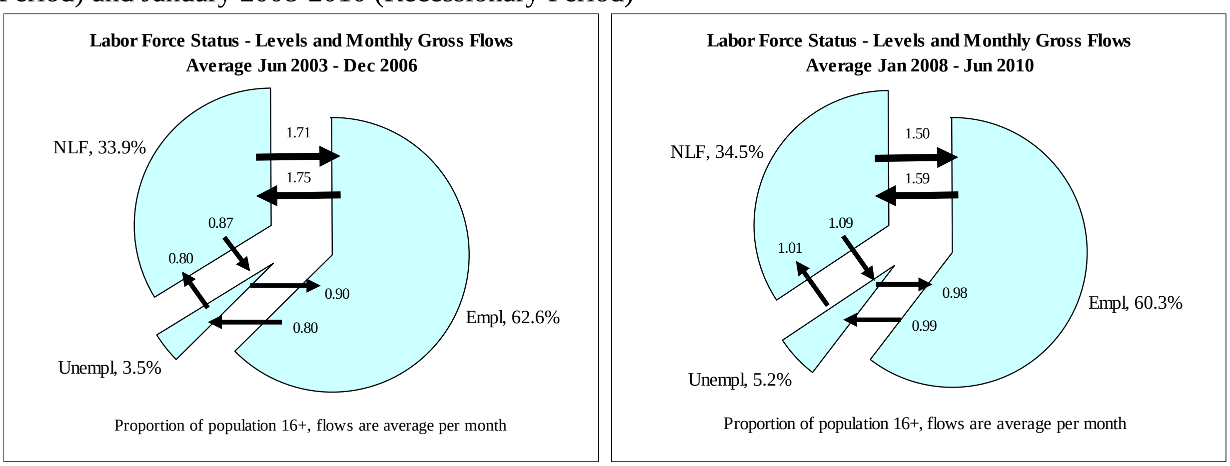
The Bureau of Labor Statistics started publishing labor force flows on a regular basis in 2007. Historical data are available back to 1990. The three labor force states are employed, unemployed, and not in the labor force (NLF). The data are from the same household survey (Current Population Survey) as used to produce the monthly unemployment rate. The data are reported as estimates of the number of people moving between each of the three states, thus filling the nine elements of the following matrix:[5]

$$= \begin{bmatrix} no.e_0 \to e_1 & no.u_0 \to e_1 & no.n_0 \to e_1 \\ no.e_0 \to u_1 & no.u_0 \to u_1 & no.n_0 \to u_1 \\ no.e_0 \to n_1 & no.u_0 \to n_1 & no.n_0 \to n_1 \end{bmatrix}$$

Frazis, Robison, Evans and Duff (2005) discuss the data in more detail.

The flows between labor forces sates (employment, unemployment, and not in the labor force or NLF) are shown in figure 1 above, measured in millions of people. Figure 4 (right panel below) shows the flows from figure 1 as ratios to population, a better way to display flows from different periods. The left panel is an average for January 2008 – June 2010, a severe recession. The left panel shows June 2003 – December 2006, a period of growth and low unemployment. The data are also shown in tables 1 and 2.

Figure 4 – Gross Labor Force Flows as Ratio to Population for June 2003-December 2006 (Growth Period) and January 2008-2010 (Recessionary Period)



Note: The data are from the Bureau of Labor Statistics "Research series on labor force status flows from the Current Population Survey," http://www.bls.gov/cps/cps_flows.htm. The level data show the number employed, unemployed, and not in the labor force (NLF) as a ratio to the civilian noninstitutional population. The flows show the number moving from one state to another each month. All data are seasonally adjusted and averaged for the period stated.

As mentioned above there are a number of striking observations:

- Employment and unemployment are hugely dynamic. This is true both during a recession and a growth period. Flows have changed but not by a large amount.

[5] This is not exactly correct. There are small flows in and out of the sample which are not shown in this matrix. See the appendix for details.

- Unemployment is particularly dynamic. Not surprisingly, flows into unemployment increased during the recession. What is surprising is that flows out also increased during the recession. The average flow from unemployment to employment was actually higher during the recession than during the earlier non-recessionary period (0.98% for 2008-2010 versus 0.93% for 2003-2006, as a percent of population).

- Not in the labor force (NLF) is particularly important. There are more people taking jobs from NLF than there are from unemployment (and more leaving jobs to go to NLF than to unemployment). This is true for both the recessionary and growth periods.[6]

Table 1a – Labor Force Flows, Ratio to Population, Average June 2003 – December 2006

State this month	State last month e	u	n	o	Sum - this mth
e	59.97%	0.90%	1.71%	0.04%	62.62%
u	0.80%	1.77%	0.87%	0.01%	3.45%
n	1.75%	0.80%	31.23%	0.14%	33.92%

Source: as in figure 4

Table 1b – Labor Force Flows, Ratio to Population, Average January 2008 – June 2010

State this month	State last month e	u	n	o	Sum - this mth
e	57.82%	0.98%	1.50%	0.03%	60.32%
u	0.99%	3.13%	1.09%	0.01%	5.22%
n	1.59%	1.01%	31.72%	0.14%	34.46%

Source: as in figure 4

These flows are for *people* between *labor force states*. That is to say, these are not *job* flows in the sense of jobs being created or destroyed. There can be labor force flows with no change in jobs. For example, person *1* could quit a job at firm *A* (moving to NLF), while person *2* could move from unemployment to that same job at firm *A*. This would involve labor force flows but no change in jobs. Alternatively, person *3* could move from a job at firm *B* to a job at firm *C*, showing up as employed in both months and generating no labor force flow but with one old job disappearing from firm *B* and a new job appearing at firm *C*.

The BLS publishes two data-sets that focus more specifically on employment and jobs: the Job Openings and Labor Turnover Survey (JOLTS) and the Business Employment Dynamics (BED) data. JOLTS, like the CPS gross flows discussed in this paper, focuses on employees and movements in and out of jobs.

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[6] A perceptive reader might note that the flows are *monthly* and that any person showing up as NLF in month 0 and employed in month 1 might actually have gone n→u and then u→e *during* the month. In other words the monthly flow n→e might be hiding daily flows n→u→e, and there might be no direct n→e transitions. The size of the flows make this highly unlikely. J. Coleman (1964) and Singer and Spilerman (1976a, 1976b) discuss the problem of inferring a continuous-time Markov transition matrix from a discrete-time matrix. The matrixes here generally satisfy the sufficient conditions discussed in Singer and Spilerman, and show continuous-time transition rates not very different from the discrete-time rates. The problem here is non-stationary so the analysis of J. Coleman and Singer and Spilerman do not really apply; nonetheless it seems clear that there are truly direct n→e transitions.

BED, in contrast, focuses on jobs. The BED data measure the change in jobs over a quarter, in other words the number of new jobs created at new and expanding firms, and the number of disappearing jobs at closing and contracting firms.

Examining both employee flows and job flows is important for a full understanding of the labor market. The current paper restricts attention to worker flows (flows of people) alone. Boon, Carson, Faberman, and Ilg (2008) describe in detail the variety of data and sources for both worker and job flows available from the BLS. Burgess, Lane and Stevens (2000, 2001) and Abowd and Vilhuber (2010) examine both job and worker flows. One important finding of Burgess, Lane, and Stevens (200, 2001) and Abowd and Vilhuber (2010) is that worker flows are higher than job flows.[7]

3. ACTUAL AND STEADY-STATE EMPLOYMENT AND UNEMPLOYMENT

The gross flow data are available back to 1990 which allows us to perform some simple analysis. Figure 2 (reproduced from above) shows the actual employment to population and unemployment to population ratios. This tells the story we all know – unemployment went up during the recessions of the early 1990s (peaking June 1992), early 2000s (peaking June 2003), and late 2000s (possibly peaking October 2009).

Analyzing the flows will help us understand the forces that have produced the changes shown in figure 3. As shown in the appendix employment status this month is a function of the flows from last month to this (with re_1 denoting the ratio of employment to population for period 1, this month, and rue_1 denoting the flow from u last month to e this month as a ratio of period 1 population):

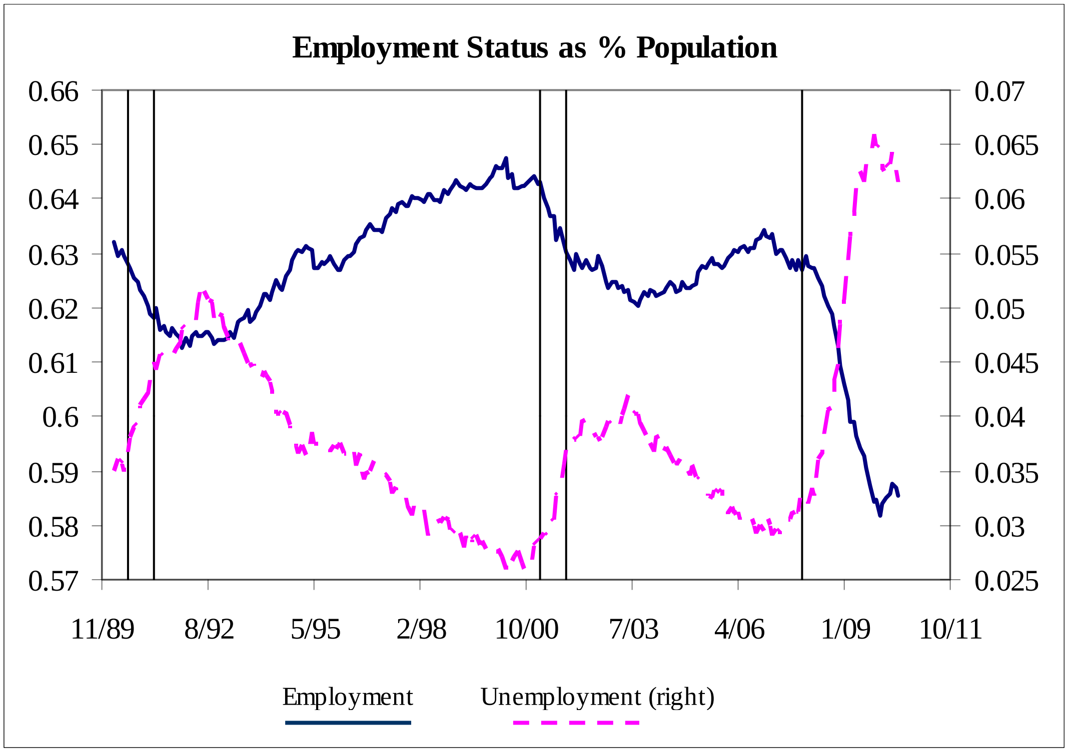
(1)
$$\begin{bmatrix} re_1 \\ ru_1 \\ rn_1 \end{bmatrix} = \begin{bmatrix} ree_1 + rue_1 + rne_1 + roe_1 \\ reu_1 + ruu_1 + rnu_1 + rou_1 \\ ren_1 + run_1 + rnn_1 + ron_1 \end{bmatrix}$$

These flows are interesting and useful, but the conditional transition probabilities and transition matrixes (see appendix for definitions) provide more insight into the economic forces at play. The transition matrix relates employment and unemployment to population ratios last period to those this period:

(2)
$$\begin{bmatrix} re_1 \\ ru_1 \\ rn_1 \end{bmatrix} = \begin{bmatrix} acee & acue & acne \\ aceu & acuu & acnu \\ acen & acun & acnn \end{bmatrix} \cdot \begin{bmatrix} re_0 \\ ru_0 \\ rn_0 \end{bmatrix} \quad \text{or} \quad r_1 = C \cdot r_0 \ .$$

[7] The excess of worker flows over job flows is called "churning." This terminology is slightly unfortunate since it confers a negative connotation to worker flows in excess of job flows. There are at least two sound economic reasons workers may move in-and-out of jobs at a higher rate than jobs are created or disappear. First, individuals may move for life-cycle reasons (moving geographically or changing firms to progress along a career path). Second, job-search and job-matching may mean that workers will try a number of jobs before finding a good match, implying that workers will move from one job to another.

Figure 2 – Employment and Unemployment as Ratio to Population, Monthly March 1990 – June 2010



Note: The data source is given in figure 1. Employment and unemployment are displayed here as the ratio to population.

If the conditional transition matrix *C* remains constant then the long-run or steady-state employment to population ratios are completely determined by the elements of *C*. In this sense *C* contains much more economically useful information than do the elements reu_1, etc., above, which combine both the conditional transition probabilities and the current employment levels.

The transition matrixes *C* change over time as we would expect. Nonetheless we can extract economically useful information by the following trick. For any *C* we can calculate the steady-state employment, unemployment, and NLF levels by solving

$$r = C \cdot r$$

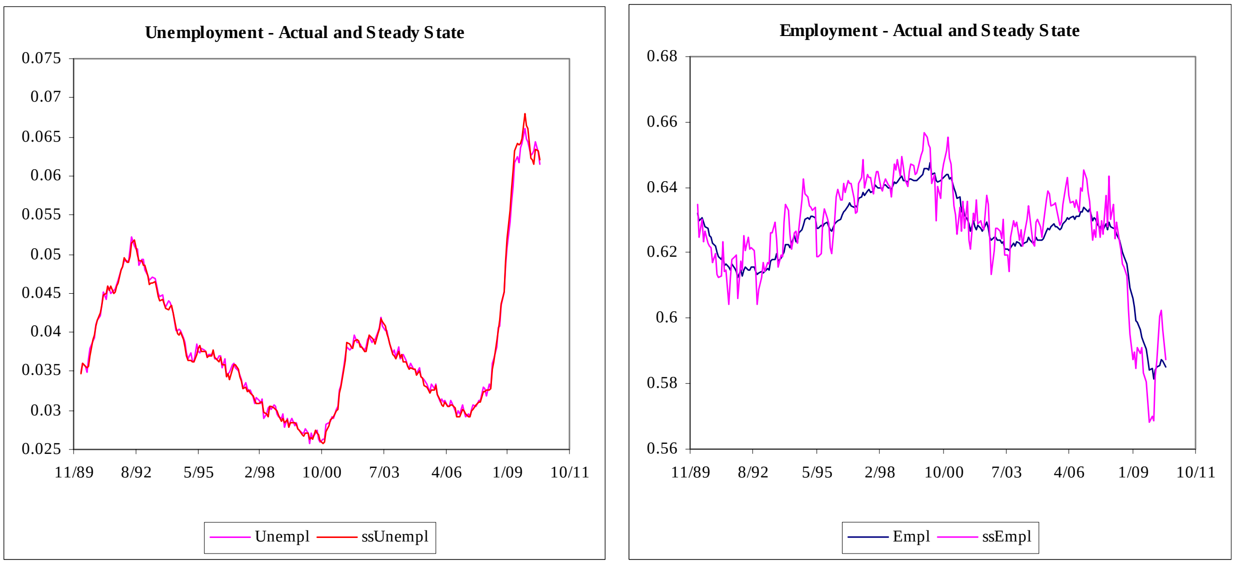
as detailed in the appendix. Each month we can calculate a matrix, *C*t, and thus each month we can calculate implied steady-state ratios by solving:

$$r_t = C \cdot r_t \ .$$

This gives us a time-series of implied steady-state ratios that depend only on the transition probabilities or flows. If the implied steady-state ratios are close to the actual we can have some confidence that the transition probabilities can provide economically interesting information.

The left panel of figure 5 shows the actual and implied steady-state unemployment to population ratio (using a 3-month moving average for the transition matrixes).[8] The correspondence is remarkably close. The right panel shows the same for employment. The steady-state ratios follow the general pattern but with reasonable month-to-month variability.

Figure 5 – Actual and Implied Steady-State (Moving Average) Unemployment and Employment, 1990-2010



Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes.

4. STEADY-STATE DECOMPOSITION

We can calculate a decomposition of the change in steady-state ratios as described in the appendix:

$$r_2 - r_1 \approx \sum (\partial r / \partial \alpha) \cdot \mathrm{d}\alpha$$

where the parameters α are the six independent parameters of the transition matrix C:

$$C = \begin{bmatrix} 1 - aceu - acen & acue & acne \\ aceu & 1 - acue - acun & acnu \\ acen & acun & 1 - acne - acnu \end{bmatrix} .$$

In other words we can decompose the change in the steady-state ratio as due to the following probabilities:

- *acue*: an unemployed person will find a job
- *acne*: a person not in the labor force (NLF) will find a job
- *aceu*: an employed person loses a job and goes to unemployment
- *acen*: an employed person loses a job and goes to NLF

[8] The transition matrixes used are 3-month moving averages. The monthly flow data are noisy. The correspondence between the actual and steady-state for employment using monthly matrixes is good over the long-term but quite noisy month-to-month. (The correspondence for unemployment, however, is very good even for monthly matrixes.)

- *acun*: an unemployed person moves to NLF
- *acnu*: an NLF person moves to unemployed

Table 2 shows the average transition matrixes for the two periods January 2008 – June 2010 and June 2003 – December 2006.

Table 2a – Transition Matrix – Conditional Probabilities, Average June 2003 – December 2006

State this month	State last month		
	e	u	n
e	95.91%	26.05%	5.05%
u	1.29%	50.95%	2.58%
n	2.80%	23.00%	92.37%

Source: as in figure 4 with calculations as detailed in the appendix

Table 2b – Transition Matrix – Conditional Probabilities, Average January 2008 – June 2010

State this month	State last month		
	e	u	n
e	95.74%	20.34%	4.39%
u	1.63%	59.56%	3.13%
n	2.63%	20.10%	92.47%

Source: as in figure 4 with calculations as detailed in the appendix

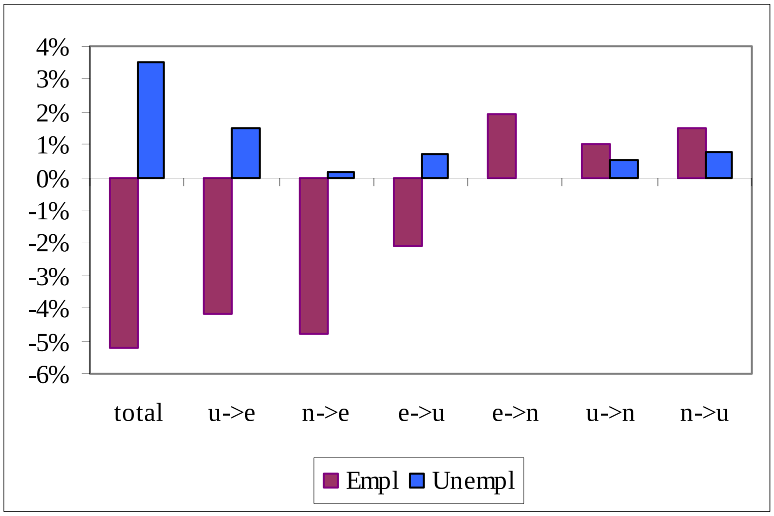
Table 3 shows the decomposition for the recessionary March 2007 – December 2009, which is roughly the period from the low to high for unemployment. Figure 3, reproduced here, shows the same graphically. The total change in unemployment was 3.5 percentage points (from 2.91% to 6.44%). The largest contributor was the lower probability of finding a job, with a higher probability that those NLF will enter unemployment contributing second. Higher layoff rates (probability employment to unemployment) only contributes third. The significant contribution of higher probabilities of moving NLF to unemployed is a little surprising, as is the contribution of the lower probability of going from unemployed to NLF. Taken together these look a little like an "anti-discouraged worker" effect. During the recession people have a higher probability of looking hard for a job (moving NLF to unemployed), and a lower probability of dropping out.

Table 3 – Approximate Decomposition of Change in Employment and Unemployment Ratios, March 2007 – December 2009

	Total	u->e	n->e	e->u	e->n	u->n	n->u
Change in transition probability		-13.7%	-1.3%	0.5%	-0.3%	-5.3%	1.1%
Change in Empl and decomp	-5.2%	-4.2%	-4.8%	-2.1%	1.9%	1.0%	1.5%
Change in Unempl and decomp	3.5%	1.5%	0.1%	0.7%	0.0%	0.5%	0.8%

Source: as in figure 4 with calculations as detailed in the appendix

Figure 3 – Change in Employment and Unemployment and Approximate Decomposition, March 2007 – December 2009



Note: Employment and Unemployment are both measured as ratio to population. The change is in percentage points (-5.2% means the employment to population ratio changed from 63.4% to 58.2%). The decomposition is for the steady-state employment and unemployment ratios but this provides an approximate decomposition to the observed ratios.

The decomposition for employment is much more surprising. A higher probability of losing a job to unemployment contributed substantially to lower employment, but that was almost completely offset by a lower probability of leaving from employment to NLF. Net, there was almost no impact due to increased probability of losing a job. Most interestingly, there was a positive contribution to employment resulting from moves into unemployment from NLF – the higher level of unemployment meant more employment than would have otherwise been the case. Also, interestingly, the flow from unemployment to employment increased even though the conditional probability fell, as the higher level of unemployment led to higher flows from unemployment to employment.

Table 4 shows the same decomposition, together with the recessions of 1990-1992 and 2000-2003. The pattern is the same across all three episodes:

- Employment:
  - Largest contributor to falling employment was lower probability of finding a job
  - Changing probability of losing / quitting a job contributed little

- Unemployment:
  - Largest or near-largest contributor was lower probability of finding a job

- NLF:
  - Movements between unemployment and NLF contributed to the increase in unemployment but offset some of the fall in employment
  - These movements seem to be something "anti-discouraged worker" effect, with people more likely to stay or move into unemployment rather than go to NLF.

Table 4 – Approximate Decomposition of Change in Employment and Unemployment Ratios for Three Recessionary Periods

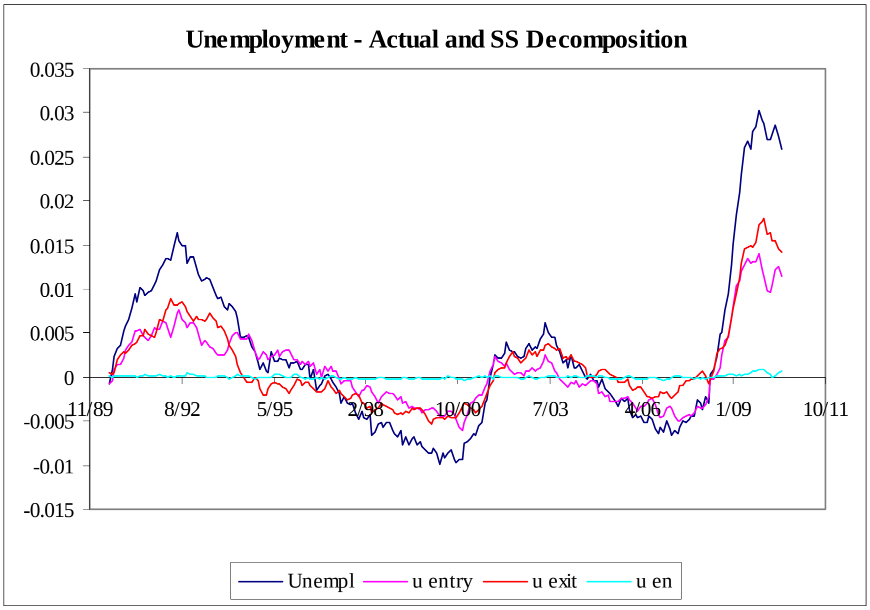
	Actual ch	SS ch	u->e	n->e	e->u	e->n	u->n	n->u
Average Probability			26.4%	4.8%	1.4%	2.7%	21.8%	2.7%
Ch in Probability Mar-07-Dec-09			-13.7%	-1.3%	0.5%	-0.3%	-5.3%	1.1%
Change in Empl and decomp	-5.2%	-6.7%	-4.2%	-4.8%	-2.1%	1.9%	1.0%	1.5%
% decomposition			-62%	-72%	-31%	28%	15%	23%
Change in Unempl and decomp	3.5%	3.6%	1.5%	0.1%	0.7%	0.0%	0.5%	0.8%
% decomposition			42%	4%	20%	-1%	15%	22%
Ch in Probability Jun-90-Sep-92			-5.5%	-0.5%	0.2%	-0.2%	-2.3%	0.7%
Change in Empl and decomp	-1.5%	-0.8%	-1.4%	-1.7%	-0.7%	1.4%	0.5%	1.1%
% decomposition			-172%	-200%	-81%	168%	57%	128%
Change in Unempl and decomp	1.6%	1.5%	0.5%	0.0%	0.2%	0.0%	0.2%	0.5%
% decomposition			38%	2%	17%	-2%	13%	31%
Ch in Probability Dec-00-Jun-03			-7.8%	-0.4%	0.4%	-0.1%	-1.8%	0.7%
Change in Empl and decomp	-2.0%	-2.1%	-1.6%	-1.5%	-1.2%	0.8%	0.3%	1.1%
% decomposition			-75%	-70%	-58%	38%	15%	50%
Change in Unempl and decomp	1.6%	1.6%	0.6%	0.0%	0.4%	0.0%	0.1%	0.4%
% decomposition			37%	2%	27%	-2%	8%	28%

Source: as in figure 4 with calculations as detailed in the appendix

Figure 6 shows the decomposition for unemployment by month, with the six probabilities grouped according to whether they affect entry, exit, or neither:

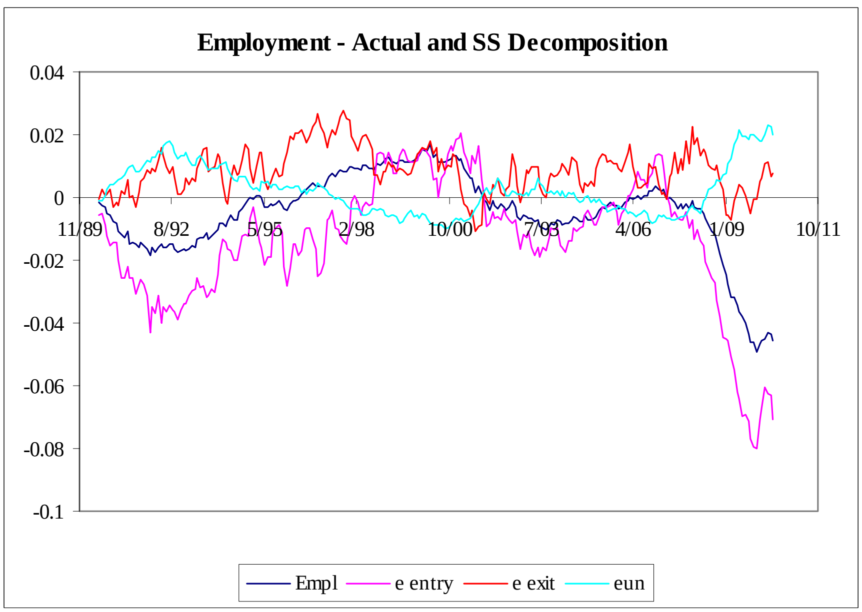
- Entry:
  - *aceu*: an employed person goes to unemployment
  - *acnu*: an NLF person moves to unemployed
- Exit:
  - *acue*: an unemployed person will find a job
  - *acun*: an unemployed person moves to NLF
- Neither:
  - *acne*: a person not in the labor force (NLF) will find a job
  - *acen*: an employed person loses a job and goes to NLF

Figure 6



Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes. Vertical units are change from May 1990.

Figure 7



Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes. Vertical units are change from May 1990.

Figure 7 shows the decomposition for employment by month, with the six probabilities grouped according to whether they affect entry, exit, or neither:

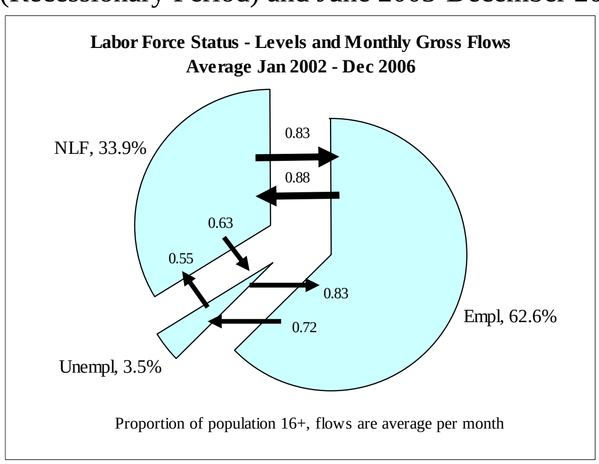
- Entry:
  - *acue*: an unemployed person will find a job
  - *acne*: a person not in the labor force (NLF) will find a job
- Exit:
  - *aceu*: an employed person goes to unemployment
  - *acen*: an employed person loses a job and goes to NLF
- Neither:
  - *acun*: an unemployed person moves to NLF
  - *acnu*: an NLF person moves to unemployed

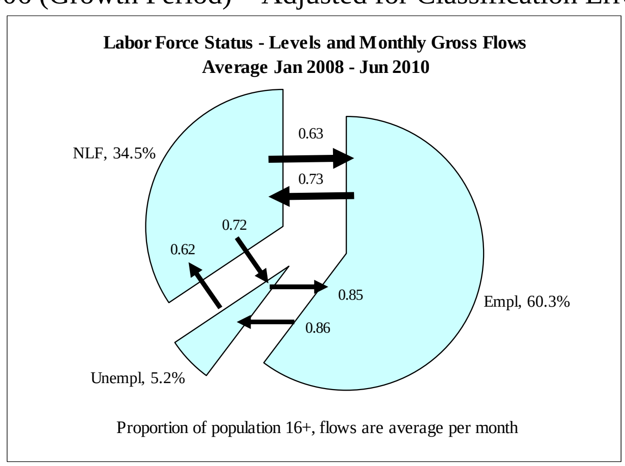
5. ADJUSTED FLOWS

As mentioned above there is reason to believe the flows shown in figures 1 and 4 above over-estimate the actual monthly flows, particularly due to classification errors. The flows are estimated by matching respondents who are in the CPS in two successive months. There will be classification errors where a person is incorrectly reported in a labor force state, say a person is reported in the survey as employed when they are actually not in the labor force (NLF). When these classification errors are independent from one month to the next such errors will produce upwardly-biased estimates of the flows (but no bias in the levels of employment, unemployment, and NLF – see for example Frazis, Robison, Evans and Duff 2005).

Abowd and Zellner (1985) and Poterba and Summers (1986) are two classic studies that examined such classification errors, using reinterview data to measure the error rates. They produced a methodology for adjusting the flows to correct for classification errors. Figure 6, corresponding to figure 4, shows the flows adjusted using Abowd and Zellner's parameters.[9] The adjusted flows are indeed lower, particularly for flows in and out of the labor force. Nonetheless they remain large – flows into and out of employment on the order of 1.5% of population and 2.5% of employment. And although the flows are different between an expansionary and a recessionary period, the differences are smaller than one might expect given the changes in levels of employment and unemployment. And surprises remain. As mentioned above the flow u→e actually increases during the recession. The increase shown by the adjusted data is small but still an increase.

Figure 8 – Adjusted Gross Labor Force Flows as Ratio to Population for January 2008-2010 (Recessionary Period) and June 2003-December 2006 (Growth Period) – Adjusted for Classification Error



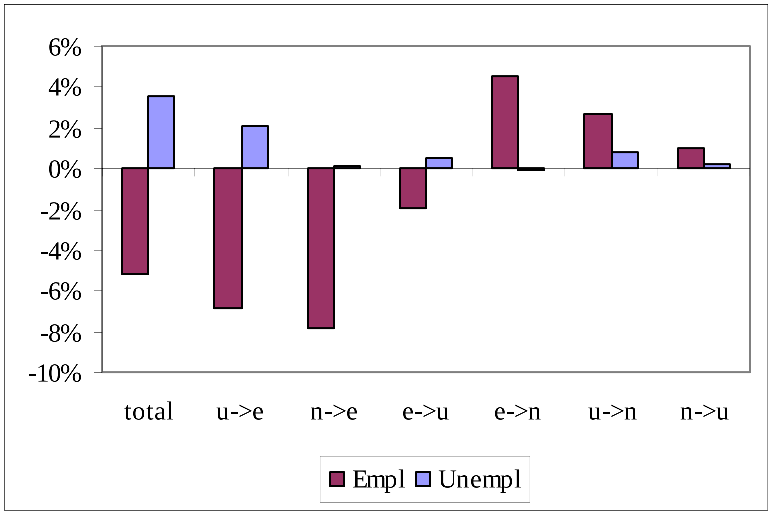


[9] Summers and Poterba's parameters produce adjustments that appear too large – see discussion in the appendix.

Note: Source as in figure 4 except that the data are adjusted for classification error using the Abowd and Zellner adjustment matrix discussed in the appendix.

The correspondence between actual and implied steady-state levels of employment, unemployment, and NLF remains. The conclusions of the steady-state decomposition remain largely unchanged. Figure 9, corresponding to figure 3 above, shows the decomposition for unemployment and unemployment for the 2008-2009 recession. The major difference is the increased importance of flows in and out of NLF for changes in employment.[10]

Figure 9 – Change in Employment and Unemployment and Approximate Decomposition, March 2007 – December 2009, Adjusted Flows



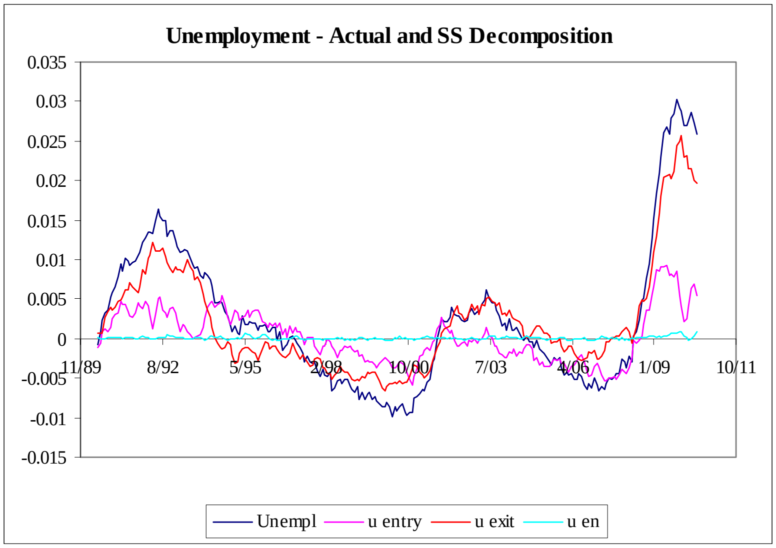
Note: Employment and Unemployment are both measured as ratio to population. The change is in percentage points (-5.2% means the employment to population ratio changed from 63.4% to 58.2%). The decomposition is for the steady-state employment and unemployment ratios but this provides an approximate decomposition to the observed ratios, as discussed below.

Figures 10 and 11 show the monthly decomposition of unemployment and employment, corresponding to figures 6 and 7 above. For unemployment the data show that conditional probabilities for exit from unemployment (u→e and u→n) are most important, with conditional probabilities for entry now less important. For employment, figure 10 shows that conditional probabilities of entry (u→e and n→e) are now much more important, with probabilities of exit (e→u and e→n) now actually partially offsetting the decline in employment.[11]

[10] Flows in and out of NLF are lowered the most by the adjustment for classification error. One might think that the substantially smaller flows would imply lower contributions from probabilities u→n and n→u, but although the flows are smaller the magnitude of the derivatives of the steady-state levels are larger.

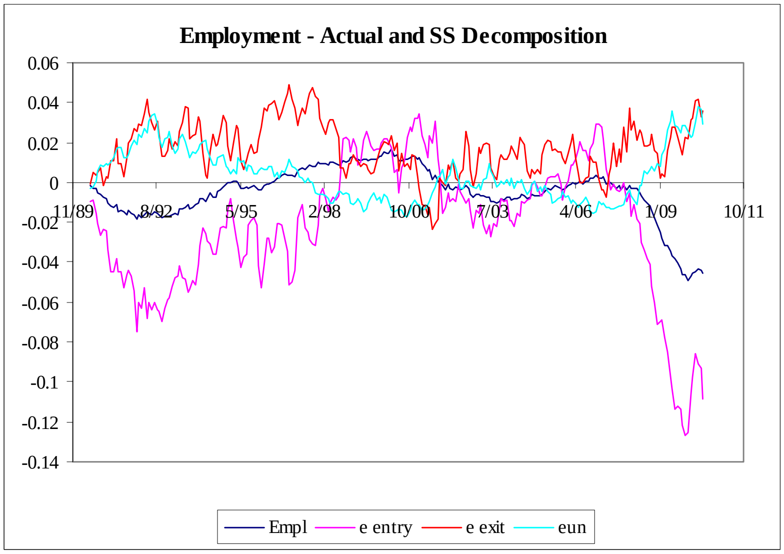
[11] As with the unadjusted data, both conditional entry probabilities u→e and n→e contribute to a decline in employment, while for exits the conditional probability e→u contributes to declining employment but is offset by changes in probability e→n. Also as with the unadjusted data, changes in transition rates between unemployment and NLF (probabilities u→n and n→u) look something like an “anti-discouraged worker” effect and offset some of the fall in employment.

Figure 10 – Gross Flow Data Adjusted for Classification Errors



Note: Source for actual data as in figure 4 except that the data are adjusted for classification error using the Abowd and Zellner adjustment matrix discussed in the appendix. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes. Vertical units are change from May 1990.

Figure 11 – Gross Flow Data Adjusted For Classification Errors



Note: Source for actual data as in figure 4 except that the data are adjusted for classification error using the Abowd and Zellner adjustment matrix discussed in the appendix. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes. Vertical units are change from May 1990.

6. 2008-2009 RECESSION, CONDITIONAL TRANSITION RATES, AND DYNAMICS

This section focuses on the period since 2006, particularly the recession that started December 2007. The goal is to provide a closer analysis of the changes in employment and unemployment and their likely causes. In doing so we will examine the differences between conditional probabilities (transition rates) and flows, and briefly examine the dynamics of changes in employment and unemployment.

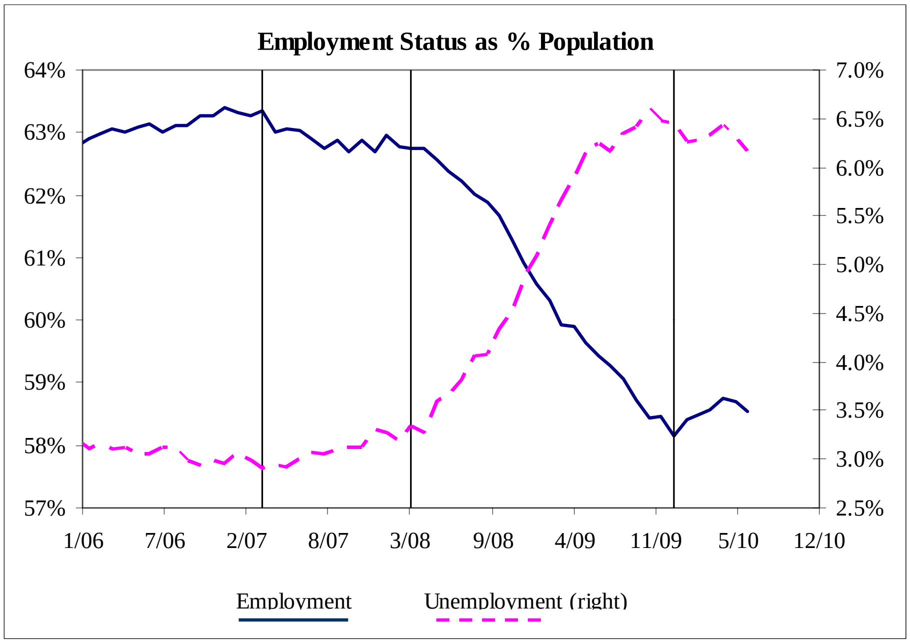
Figure 12 shows employment and unemployment as ratio to population for the period 2006 through June 2010 (same as shown in figure 2 but for a shorter period). The vertical lines show three dates that demark episodes in the recent story of employment and unemployment:

- March 2007 – the low for unemployment and high for employment. This was about nine months prior to the official start of the recession (December 2007)

- March 2008 – the start of a period when changes accelerated for unemployment and employment

- December 2009 – the low of employment and roughly high of unemployment

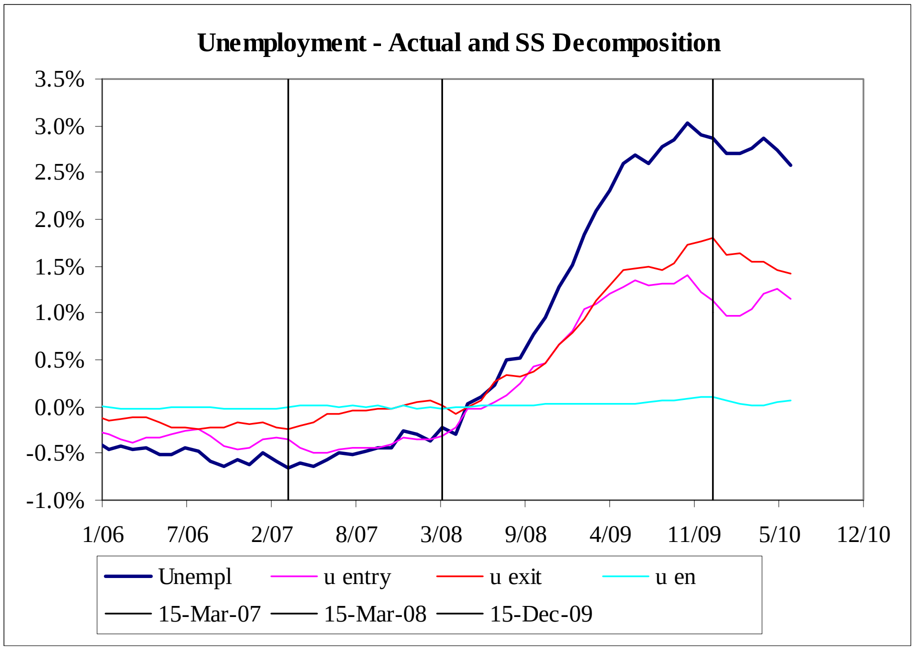
Figure 12 – Employment and Unemployment as Ratio to Population
Monthly January 2006 – June 2010



Note: The data source is given in figure 1. Employment and unemployment are displayed here as the ratio to population. Vertical lines show March 2007, March 2008, December 2009.

Figures 13 and 14 show unemployment and employment together with the changes in steady-state (decomposition) implied by the monthly transition matrixes. For unemployment (figure 13) changes in entry and exit probabilities both contributed to the substantial rise in the level of unemployment. This is the same as shown in figure 3 and tables 3 and 4. The period from March 2007 to March 2008 showed a modest increase in unemployment, with the increase accelerating after March 2008. There are no substantial surprises here and we will not focus on unemployment further.

Figure 13 – Unemployment and Steady-State Decomposition
Monthly January 2006 – June 2010

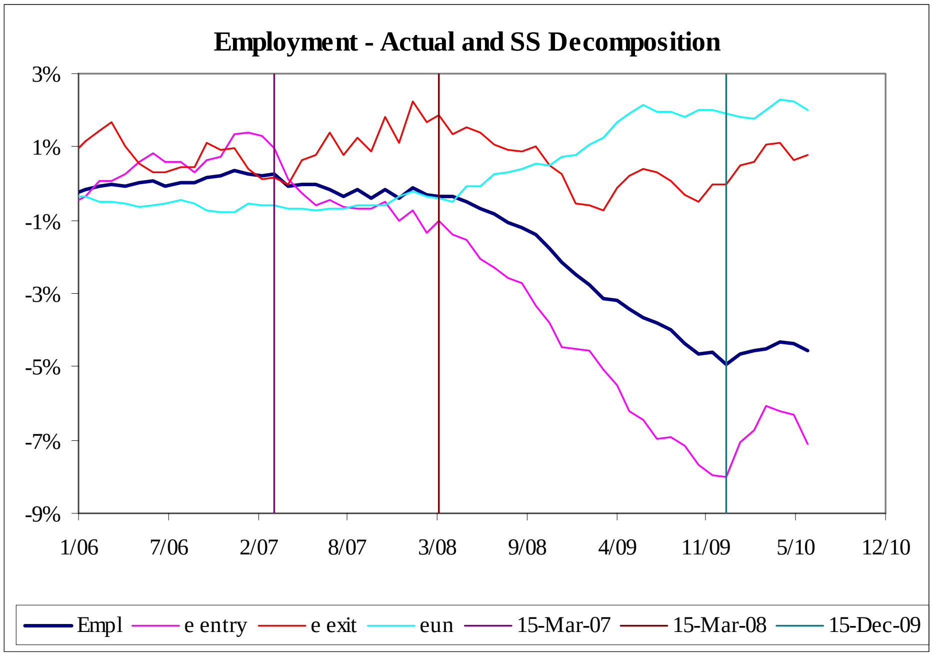


Note: Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes. Vertical units are change from May 1990. Vertical lines show dates March 2007, March 2008, December 2009.

For employment (figure 14) the picture is more involved, and the period splits naturally into the two periods 3/07-3/08 and 3/08-12/09.

- Overall, changes in entry probabilities or transition rates contributed most to the fall in employment.
- For March 2007 to March 2008
  - Employment fell only modestly (by 0.6 percentage points).
  - Entry rates contributed to a fall in employment
  - Exit probabilities partially offset and contributed to a rise in employment (due to a fall in the e→n transition rate – a fall in quits to NLF).
- For March 2008 to December 2009
  - Employment fell much more dramatically, by 4.6 percentage points (from 62.74% to 58.16%).
  - Entry rates contributed most to this fall in employment.
  - Exit rates contributed somewhat to the fall, but the negative contribution for 3/08-12/09 was roughly the same in magnitude as the positive contribution from 3/07-3/08, so the net effect for 3/07-12/09 was roughly nil.
  - Changes in transition rates between unemployment and NLF contributed positively to employment.

Figure 14 – Employment and Steady-State Decomposition
Monthly January 2006 – June 2010



Note: Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes. Vertical units are change from May 1990. Vertical lines show dates March 2007, March 2008, December 2009.

Flows are the product of transition rates and prior month levels. It is often more fruitful to think of transition rates (conditional probabilities) as the starting point, and changes in levels and flows as the result of variations in transition rates. Conditional probabilities are the closest we can get (with aggregate data) to measuring individual economic decisions and circumstances. For that reason I think they provide insight that cannot be obtained by considering gross flows themselves.

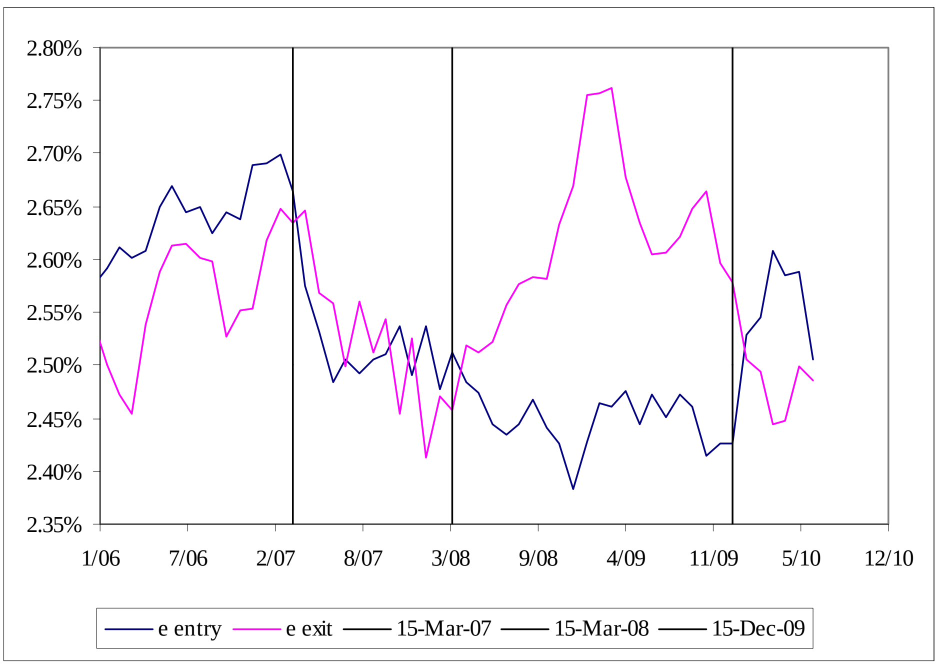
I start from the assumption that the individual is the appropriate unit for studying the labor force. Levels of *e*, *u*, *n* are a function of the flows, and flows depend on individuals' decisions and circumstances. For example:

- The current level of unemployment depends on past flows in and out (this is a trivial fact, not an assumption)
- The flows out of unemployment depend on individuals' decisions such as level of search intensity, and circumstances such as availability of jobs (frequency of job offers from firms), how many other job-seekers are competing for those jobs, and the value of alternative NLF opportunities.
    - If we want to consider unemployed *individuals'* decisions and circumstances we need to look at the monthly u→e and u→n flows normalized by the number unemployed – that is the conditional probability of exiting unemployment
- The flows into unemployment from, say, employment, depend on individual decisions and circumstance such as whether to quit and search for a better job, or whether an individual is layed-off or the value of alternative NLF opportunities.
    - Once again, since we are focusing on employed individuals we should normalize the monthly e→u flow by the number employed - the conditional probability e→u.
- The levels then are a result of flows, but the flows themselves depend on the individual decisions / circumstances (conditional probabilities) and the current stock or number in the state.

Levels and changes in flows are not a reliable indicator of how and why the level of employment or unemployment changes. Remember that, in the long run, inflow and outflow rates have to be equal (otherwise the employment-to-population ratio would go to 1.0 or 0.0). This means that in steady-state, lower employment can result from either higher or lower flows. If the entry rate u→e goes down then steady-state employment will go down and flows into and out of employment will go *down*. If the exit rate e→u goes up then steady-state employment will go down and flows in and out of employment will go *up*.

The gross flows for the period 3/07-12/09 provide a nice example of exactly how and why transition rates (conditional probabilities) can provide insight that the flows themselves mask. The gross flows for the period 3/07-12/09 seem to give a different picture from the transition rates discussed above and shown in figure 14, implying that employment outflows have the largest impact on the employment level. Figure 15 shows the flows in and out of employment. The period 3/07-3/08 is somewhat hard to pin down, as both flows in and flows out fell relative to the earlier period.[12] The period 3/08-12/09, however, seems to tell a clear story: flows out rose dramatically, particularly 3/08-3/09, and flows in fell much less. This would seem to imply that the fall in employment was due to rising outflows rather than lower inflows. This is not, however, the case; outflows rose so much because, over the short-term, outflows are much more responsive to a rise in exit rates (e→u) than inflows are to a fall in entry rates (u→e and n→e).

Figure 15 – Flows In and Out of Employment
Monthly January 2006 – June 2010



Note: Source for actual data as in figure 4. Flow is 3-month moving average, measured as ratio to population. Vertical lines show dates March 2007, March 2008, December 2009.

[12] However, as Frazis and Ilg (2009) point out, the inflow fell more than the outflow relative to the six months prior (i.e. comparing 3/07-3/08 versus 9/06-2/08) so that it would be reasonable to ascribe the fall in employment to falling inflows.

Let us consider the period 3/08-3/09, when the employment outflow increased dramatically. First we will look at changes in implied steady-states. Table 5 shows the beginning and ending transition rates (conditional probabilities) for the two dates and the change for the period. The last three columns of table 5 show the change in the implied steady-state flows and levels (change from the steady-state implied by the average transition matrix for 3/07-3/08). Note that all changes in transition rates imply a fall in employment, but the change in the exit rate (e→u) implies a large rise in flows while changes in entry rates (u→e and n→e) imply a (smaller) fall in flows.

The change in the exit rate e→u implies a fall in employment of 2.3 percentage points and a rise in outflows and inflows (by 0.290 percentage points). The falls in the entry rates (u→e and n→e) imply a fall in employment and a fall in flows (combined fall in employment 3.5 percentage points, fall in flows 0.141 points). Note that the fall in employment due to the rise in exit rate (2.3 percentage points) is less than the combined effect of the fall in exit rates (3.5 percentage points), but that the rise in flows due to rising exit rates is almost twice the fall in flows due to falling entry rates (0.290 versus -0.141).

Table 5 – Transition Rate Changes and Implied Changes in Steady-State

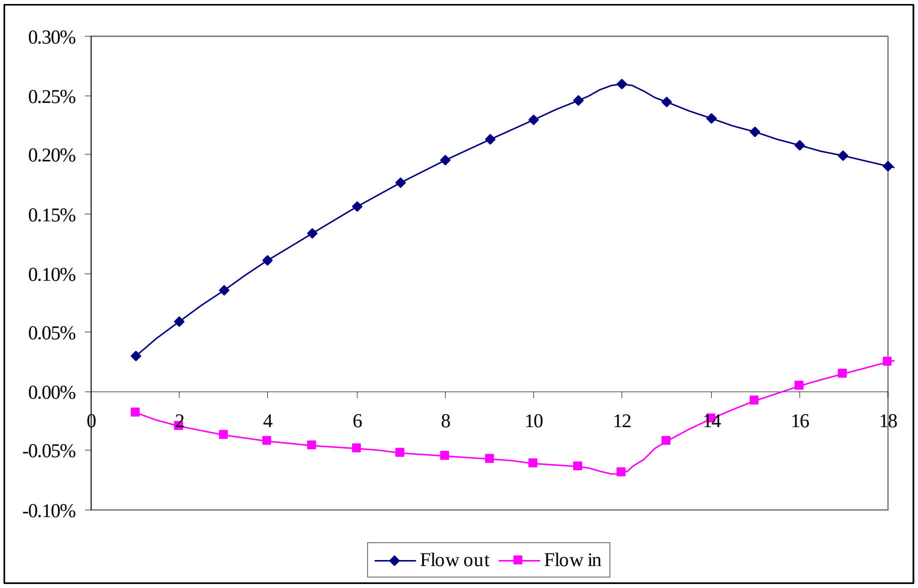
					Change in steady-state		
		3/08	3/09	Change	flow	e	u
Exit rate	e->u	0.0126	0.0189	0.0063	0.290%	-2.3%	0.8%
Entry rate	u->e	0.2628	0.1865	-0.0763	-0.068%	-1.7%	0.6%
Entry rate	n->e	0.0490	0.0442	-0.0048	-0.073%	-1.8%	0.0%

Note: Source for actual data as in figure 4. The exit and entry rates are the transition rates (conditional probabilities) using 3-month moving averaged transition matrixes. Implied steady-state ratios are calculated as described in the appendix. The initial steady-state is that implied by the transition matrix averaged over 3/07-3/08. The change in the steady-state is that implied by the change in the transition rate for that row.

The bottom line is that employment goes down whether the flow rises or falls. Whether the flow goes up or down, however, and by how much, depends on which transition rate changes. For the changes in transition rates shown in table 5, the fall in steady-state employment will be more due to falling entry rates, but nonetheless the steady-state flows will increase.

The analysis around table 5 is for steady-state. If we investigate the dynamics the conclusions are no different. Say that we assume the changes shown in table 5 occur equally over 12 months (and say that we start from the steady-state implied by the average transition matrix for 3/07-3/08). In month one we perturb the transition matrix by $1/12^{th}$ of the changes shown in table 5. In month two we perturb by an additional $1/12^{th}$. After 12 months the transition matrix is kept fixed, at what is now the new matrix implied by the changes shown in table 5.

Figure 16 – Implied Flows In and Out of Employment
Perturbed Transition Matrix for 12 Months
Fixed Transition Matrix for 6 Months



Note: These are the flows implied by starting from the steady-state implied by the average 3/07-3/08 transition matrix. For 12 months the transition matrix is perturbed by 1/12th of the changes shown in table 5. The following 6 months the transition matrix is left fixed at the final level.

The result is shown in figure 16. The employment outflow grows dramatically during the initial 12 months. In fact after 12 months the outflow has grown substantially above the steady-state level. The outflows overshoot the eventual steady-state flow and when changes in the transition rates cease the flow starts to fall back towards the steady-state. Nonetheless, by construction, exit rates contribute substantially (more than half) of the fall in employment. Note also that this mimics the pattern seen in figure 15 for 3/08-3/09. My conclusion is that the level and changes in the outflow versus inflow are not reliable guides to the underlying origin of the change in the level of employment; using transition rates or conditional probabilities can provide useful insight that the gross flows themselves may not.

For the 2007-2009 recession both the entry transition rates (u→e and n→e) and the entry flows fell. In other words the effect of rising e→u exit rates on the u→e flows was not large enough to cause the u→e flows themselves to increase. This was not the case in the 2000 recession. From 12/00-6/03 (the trough-to-peak for unemployment) the transition rates u→e and n→e both fell and both contributed to a fall in employment. In contrast the entry flow (u→e plus n→e) rose, not because the *entry* transition rates rose but because the *exit* transition rate rose and offset what would otherwise have been a fall in the entry flow. In this sense the behavior during the 2007-2009 recession matches both the early 2000s and early 1990s.[13]

A further example of the difficulty interpreting flows is in the rise in flows from unemployment to employment during the recent recession. Figure 17 shows the flows into employment from 2006, and starting in about June 2007the flow into employment from unemployment actually *increased*. This does not mean, however, the finding a job became easier, or that increased rates of job-finding contributed to higher employment – quite the contrary.

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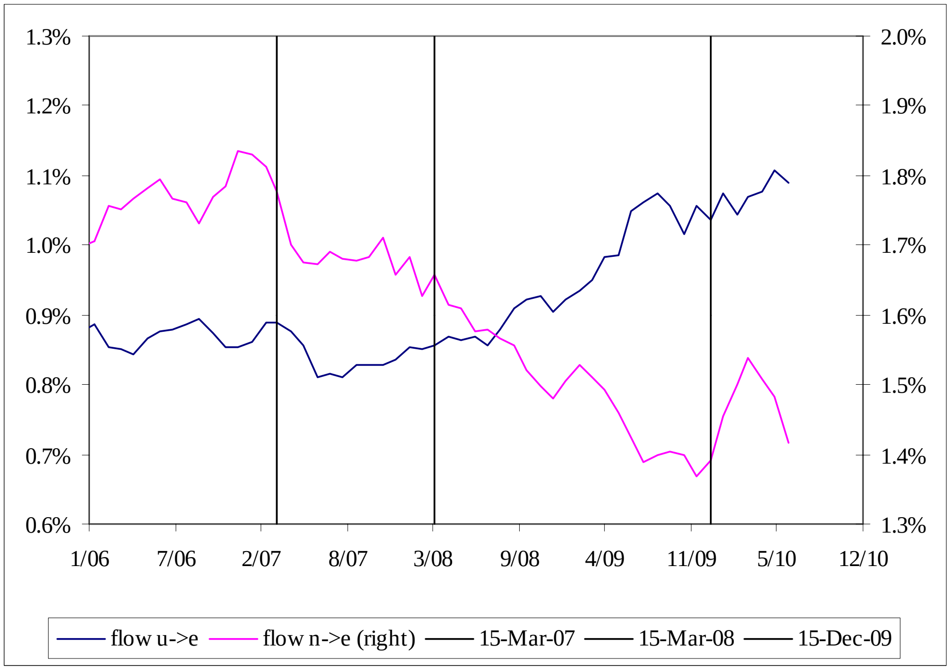
[13] This contrasts with the conclusion of Frazis and Ilg (2009), and is primarily due to the different methodology – focusing on conditional transition rates rather than flows.

Figure 18 shows the transition rates or conditional probabilities of finding a job, from unemployment and NLF. Both declined. It became harder for an unemployed individual to find a job (in the sense that the probability of a randomly-chosen unemployed individual would find unemployment during a month declined). Analysis of the steady-state level of employment shows that this unambiguously contributed to a decline in employment.

Figure 17 – Flows Into Employment
Monthly January 2006 – June 2010

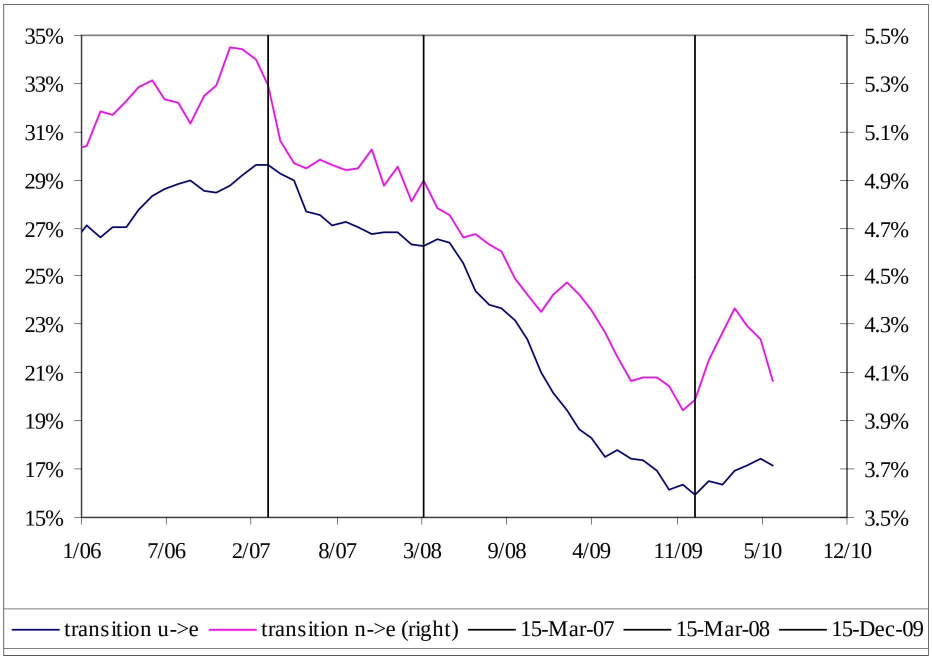


Note: Source for actual data as in figure 4. Flow is 3-month moving average, measured as ratio to population. Vertical lines show dates March 2007, March 2008, December 2009.

The reason for the apparent anomaly is related to the change in flows resulting from a change in the e→u transition. The transition rate u→e declined during the recession, which has the effect of pushing up unemployment and pulling down the flow u→e. If this were all that happened we would indeed see a lower flow u→e. But also during the transition rate e→u increased, and this pushed *up* the flow u→e considerably. This simply points out that the u→e flow will depends on all the transition rates, and in particular the u→e flow is quite sensitive to increases in the e→u transition rate.[14]

[14] A rise in e→u transition of .001 and a fall in u→e transition of 0.02 will have roughly the same effect on employment and unemployment, but

Figure 18 – Transition Rates Into Employment
Monthly January 2006 – June 2010



Note: Source for actual data as in figure 4. Flow is 3-month moving average, measured as ratio to population. Vertical lines show dates March 2007, March 2008, December 2009.

APPENDIX

A.1 – DATA

Introduction

The Bureau of Labor Statistics (BLS) reports monthly the number of people employed, unemployed, or not in the labor force. The estimates are commonly referred to as the household survey data, formally the Current Population Survey (CPS). These data are one of the most important macroeconomics statistics on the US economy and are the basis for calculation of the unemployment rate.[15]

The CPS is structured is such a way that about 75% of respondents can be tracked from one month to the following. This allows the BLS to estimate the number of people who move from one state to the other, say from employed to unemployed, from one month to the next. These data are termed gross flow or labor status flow data.

The level data are familiar, widely used, and among the most widely disseminated of macroeconomic statistics. The labor force status flows are not widely known or used. The BLS has long calculated the flow data but did not regularly publish them until about 2005.[16] The reason is simple: the flow data and the sampling scheme used to produce them have some inherent problems. A research program instituted by the BLS has led to improved estimates with the data now published on a regular basis. The methodology behind the improved estimates is discussed in Frazis, Robison, Evans and Duff (2005).[17]

The flow data can be visualized as a 4×4 transition matrix:

$$\text{(A.1)} \qquad \begin{bmatrix} ne_0 \rightarrow e_1 & nu_0 \rightarrow e_1 & nn_0 \rightarrow e_1 & no_0 \rightarrow e_1 \\ ne_0 \rightarrow u_1 & nu_0 \rightarrow u_1 & nn_0 \rightarrow u_1 & no_0 \rightarrow u_1 \\ ne_0 \rightarrow n_1 & nu_0 \rightarrow n_1 & nn_0 \rightarrow n_1 & no_0 \rightarrow n_1 \\ ne_0 \rightarrow o_1 & nu_0 \rightarrow o_1 & nn_0 \rightarrow o_1 & -- \end{bmatrix} \Rightarrow \begin{bmatrix} ne_1 \\ nu_1 \\ no_1 \\ no_1 \end{bmatrix}$$

$$\Downarrow$$

$$\begin{bmatrix} ne_0 & nu_0 & nn_0 & no_0 \end{bmatrix}$$

The rows sum to the number in state in period 1 (this month) and the columns sum to the number in state in period 0 (last month). The meaning of the terms is

$nu_0 \rightarrow e_1$ = number of people going from unemployment (*u*) in period 0 to employment (*e*) in period 1
ne_1 = number of people in employment in period 1
etc.

Special mention is necessary for the flows involving the "other" state *o*:

---

[15] The unemployment rate is the number unemployed divided by the number employed plus unemployed:
unemployment rate = #u / (#e + #u) .
For a variety of reasons, mainly because of the large flows to an from the not in the labor force state, I focus instead on the number unemployed divided by population, termed the unemployment to population ratio:
unemployment-to-population ratio = #u / (#e + #u + #n) .

[16] The BLS published data prior to 1952, and has made data available for research periodically. Marston (1976) (summarizing data from Charles C. Holt et al. 1975??) and Abowd and Zellner (1985) are two papers that used flow data. Coleman (1985) used the data from Marston and Abowd and Zellner.

[17] Data are available from the BLS at http://www.bls.gov/cps/cps_flows.htm .

$no_0 \rightarrow e_1$ = number of people moving from not in the sample (“other”) in period 0 to employment in period 1

$ne_0 \rightarrow o_1$ = number of people in the sample and employed in period 0 who dropped out of the sample in period 1

no_1 = number of people not-in-sample (status “other”) in period 1. This causes a decrease in the population; those who were in the sample in period 0 but dropped out (through death, aging out of the population, emigration, etc.)

no_0 = number of people not-in-sample (status “other”) in period 0. This causes an increase in the population; those who were not in the sample in period 0 but came in (through turning 16, immigration, etc.)

The populations in period 0 and period 1 are:

$$pop_0 = ne_0 + nu_0 + nn_0 \qquad pop1 = ne_1 + nu_1 + nn_1$$

and the change in population is:

$$pop1 - pop0 = no_0 - no_1 \; .$$

The flows for May 2010 to June 2010 are shown in table A.1. The rows sum to the number in state this month and the columns sum to the number in state last month.[18]

Table A.1 – Labor Force Flows and Number in State for May 2010 (“last month”) to June 2010 (“this month”) – thousands of people

State this month	State last month				Sum - this mth
	e	u	n	o	
e	133,499	2,459	3,133	28	139,119
u	2,248	9,436	2,925	14	14,623
n	3,632	3,075	76,854	387	83,948
o	41	3	195		239
Sum - last mth	139,420	14,973	83,107	429	

Data Relations

The basic relation we need to used is that the number of people in state *e*, *u*, *n* at time 1 is given by the number flowing into that state (dropping the $\rightarrow$ and time subscripts and writing *nue* instead of $nu_0 \rightarrow e_1$):

$$\text{(A.2)} \qquad \begin{bmatrix} ne_1 \\ nu_1 \\ nn_1 \end{bmatrix} = \begin{bmatrix} nee + nue + nne + noe \\ neu + nuu + nnu + nou \\ nen + nun + nnn + non \end{bmatrix}$$

[18] Note that the published data do not report the fourth row, the flows $ne_0 \rightarrow o_1$, etc., but these can be inferred by the fact that the columns sum to the number in state last month.

To adjust for changing population, and for easier understanding, we measure everything as a ratio to population rather than raw numbers. For the flows between states we can write:

$$\text{(A.3)}\quad \begin{bmatrix} ne_1 \div p_1 \\ nu_1 \div p_1 \\ nn_1 \div p_1 \end{bmatrix} = \begin{bmatrix} re_1 \\ ru_1 \\ rn_1 \end{bmatrix} = \begin{bmatrix} (nee + nue + nne + noe) \div p_1 \\ (neu + nuu + nnu + nou) \div p_1 \\ (nen + nun + nnn + non) \div p_1 \end{bmatrix} = \begin{bmatrix} ree_1 + rue_1 + rne_1 + roe_1 \\ reu_1 + ruu_1 + rnu_1 + rou_1 \\ ren_1 + run_1 + rnn_1 + ron_1 \end{bmatrix}$$

This normalizes by population at period 1 (p_1). Table A.2 shows these flows for May 2010 to June 2010. The final column shows the employment, unemployment, and NLF to population ratios. By definition these sum to 1.00 or 100% of the population. The row labeled "Col sum" is the column sum. This does not equal the employment to population ratio for last month because of population changes, and must be adjusted by the factor (pop_1/pop_0).

Table A.2 – Labor Force Flows as a Ratio to Population, May 2010 to June 2010

State this month	State last month				Sum - this mth
	e	u	n	o	
e	56.16%	1.03%	1.32%	0.01%	58.53%
u	0.95%	3.97%	1.23%	0.01%	6.15%
n	1.53%	1.29%	32.33%	0.16%	35.32%
o	0.02%	0.00%	0.08%		
Col sum	58.66%	6.30%	34.96%		
Pop adj	58.70%	6.30%	34.99%		

A.2 – TRANSITION RATES AND STEADY-STATE

Conditional Transition Matrix

These gross flows are very useful but may obscure some of the underlying economic influences. Let us focus on the flows out of employment:

Flows out of employment: $reu_1 + ren_1 + reo_1$.

The flows out of employment will be determined by individual firm decisions regarding layoffs and worker decisions about whether to quit. To isolate and investigate the individual decision variables we need to consider the flow per employed person, the conditional probability of leaving employment – we need to divide the flows out of employment by the level of employment last period. The economically interesting variable is the conditional probability of leaving rather than the flow itself. The individual decisions may of course depend on other economic variables (say on macroeconomic growth) but the point is that the flow depends on the individual decisions and we need to consider the conditional probabilities, which are the probabilities that individuals face. Reverting for now to flows in numbers, we should therefore look at the flows out of employment as:

Flows out of employment: $neu_1 + nen_1 + neo_1 = [(neu_1 + nen_1) / ne_0] \cdot ne_0 + neo_1$

$= (ceu + cen) \cdot ne_0 + neo_1$.

Writing this as ratios to population introduces the growth in population (p_0 / p_1):

Flows out of employment: $reu_1 + ren_1 + reo_1 = (p_0 / p_1) \cdot (ceu + cen) \cdot re_0 + reo_1$.

For all three states we can write the conditional probabilities as: [19]

$$\begin{bmatrix} ne_1 \\ nu_1 \\ nn_1 \end{bmatrix} = \begin{bmatrix} (nee/ne_0)\cdot ne_0 + (nue/nu_0)\cdot nu_0 + (nne/nn_0)\cdot nn_0 \\ (neu/ne_0)\cdot ne_0 + (nuu/nu_0)\cdot nu_0 + (nnu/nn_0)\cdot nn_0 \\ (nen/ne_0)\cdot ne_0 + (nun/nu_0)\cdot nu_0 + (nnn/nn_0)\cdot nn_0 \end{bmatrix} + \begin{bmatrix} noe \\ nou \\ non \end{bmatrix}$$

$$= \begin{bmatrix} cee & cue & cne \\ ceu & cuu & cnu \\ cen & cun & cnn \end{bmatrix} \cdot \begin{bmatrix} ne_0 \\ nu_0 \\ nn_0 \end{bmatrix} + \begin{bmatrix} noe \\ nou \\ non \end{bmatrix} .$$

For rates we need to adjust by the change in population:

$$\text{(A.4)} \qquad \begin{bmatrix} re_1 \\ ru_1 \\ rn_1 \end{bmatrix} = \frac{p_0}{p_1} \begin{bmatrix} cee & cue & cne \\ ceu & cuu & cnu \\ cen & cun & cnn \end{bmatrix} \cdot \begin{bmatrix} re_0 \\ ru_0 \\ rn_0 \end{bmatrix} + \begin{bmatrix} roe_1 \\ rou_1 \\ ron_1 \end{bmatrix} .$$

Table A.3 shows the conditional transition matrix for May 2010 to June 2010. Note that the column rows do not add to 100% because of the flows out of sample.

Table A.3 – Conditional Flows, May 2010 to June 2010

State this month	State last month		
	e	u	n
e	95.68%	16.41%	3.77%
u	1.61%	62.97%	3.52%
n	2.60%	20.52%	92.40%
Col sum	99.89%	99.90%	99.69%

Steady State

Equation (A.4) determines the evolution of states. This is almost but not quite a Markov chain. The columns do not add to 1.0 (as seen in table A.3) and there are entries into the sample represented by roe_1, etc. The goal here is to examine the steady-state rather than the exact monthly evolution, so we do not do too much damage by making two somewhat ad-hoc adjustments:

- Ignore entry into the sample, i.e. the roe_1 terms.
- Force the columns to sum to 1.0 by dividing by the original sum

[19] See Coleman (1985) for a search-theoretic model of labor supply that builds the conditional probabilities from a worker's optimization problem.

We thus end with

(A.5)
$$\begin{bmatrix} re_1 \\ ru_1 \\ rn_1 \end{bmatrix} = \begin{bmatrix} acee & acue & acne \\ aceu & acuu & acnu \\ acen & acun & acnn \end{bmatrix} \cdot \begin{bmatrix} re_0 \\ ru_0 \\ rn_0 \end{bmatrix}$$

where *acee* is the adjusted conditional probability:

$$acee \;=\; (p_0/p_1) \cdot cee \,/\, (cee + ceu + cen) \;.$$

Writing this in matrix notation:

(A.5′)
$$r_1 \;=\; C \cdot r_0 \;\;.$$

The steady-state is:

(A.6)
$$r \;=\; C \cdot r \qquad \text{or} \qquad (C - I) \cdot r = 0 \;\;.$$

That is we need to calculate the eigenvalues and eigenvectors of the matrix *C*. The largest eigenvalue will be 1.0 and the smaller eigenvalues will tell us the rate of convergence to the steady-state. The largest eigenvector will be proportional to the stead-state. We will need to use = $re_1 + ru_1 + rn_1 = 1$.

Alternatively we can use

$$re_1 + ru_1 + rn_1 = 1$$

and

$$acee = 1 - aceu - acen, \qquad acuu = 1 - acue - acun, \qquad acnn = 1 - acne - acnu,$$

to write:

(A.7)
$$\begin{bmatrix} -aceu - acen - acne & acue - acne \\ aceu - acnu & -acue - acun - acnu \end{bmatrix} \cdot \begin{bmatrix} re \\ ru \end{bmatrix} = \begin{bmatrix} -acne \\ -acnu \end{bmatrix}$$

or

(A.7′)
$$A \cdot z \;=\; b\,, \qquad z \;=\; A^{-1} \cdot b \;\;.$$

Derivatives

Derivatives of the steady-state employment and unemployment to population ratios (with respect to the elements *aceu*, etc.) can be found from (A.7′) by:

$$(\mathrm{d} / \mathrm{d}\alpha)\!: \;\; (\partial A/\partial\alpha)\cdot z + A\cdot(\partial z/\partial\alpha) = (\partial b/\partial\alpha)$$

which gives:

(A.8) $$(\partial z/\partial \alpha) = A^{-1}\cdot[(\partial b/\partial \alpha) - (\partial A/\partial \alpha)\cdot z\,]\ .$$

The matrixes $(\partial A/\partial \alpha)$ and the vectors $(\partial b/\partial \alpha)$ will be:

(A.9)
$$acue\quad \begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad acnu\quad \begin{bmatrix} 0 & 0 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$acne\quad \begin{bmatrix} -1 & -1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} \qquad acen\quad \begin{bmatrix} -1 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$aceu\quad \begin{bmatrix} -1 & 0 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad acun\quad \begin{bmatrix} 0 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Decomposition of Changes in Steady State

Consider two transition matrixes, A_1 and A_2. These will generate two steady states from (A.7):

$$A_1\cdot z_1 = b_1, \qquad A_2\cdot z_2 = b_2\ .$$

We can approximately decompose the difference into contributions from changes in the parameters *acue*, etc., by:

$$z_2 - z_1 \approx \sum (\partial z/\partial \alpha)\cdot \mathrm{d}\alpha\ .$$

(We might want to use the average of the derivatives calculated from the A_1 and A_2 matrixes.)

Non Steady-State Analysis

Ideally we would like to decompose changes in employment and unemployment into the actual components due to changes in particular transition rates, not simply use the steady-state analysis as a proxy. Doing so is not easy however.

From equations (A.4) or (A.5) we have that the ratio (proportion in employment, etc. as a ratio to population) is given by:

(A.10) $$r_1 = C_1\cdot r_0\ .$$

We can write the transition matrix C_1 as the period-zero transition matrix plus changes:

$$C_1 = H_1 + C_0\ .$$

Equation (A.10) then becomes:

(A.10′) $$r_1 = (C_0 + H_1)\cdot r_0$$

and the change in levels becomes:

(A.11) $$r_1 - r_0 = (H_1 + C_0 - I)\cdot r_0\ .$$

This can be continued as:

$$\text{(A.11}'\text{)}\qquad r_n - r_{n-1} = (H_n + H_{n-1} + \ldots + C_0 - I) \cdot (H_{n-1} + H_{n-2} + \ldots + C_0)$$

$$\cdot (H_{n-2} + H_{n-3} + \ldots + C_0) \cdot \ldots \cdot (H_1 + C_0) \cdot r_0 \; .$$

This will involve terms such as $H_n \cdot C_0$, that will be large, terms such as H_1^n, that will be small, and terms such as C_0^n that will look like the steady-state. The net effect is that the influence of r_0 and H_1 will decrease as *n* gets large, so that the influence of past changes in transition rates will fade. The expressions, however, will not be simple.

A.3 – FLOWS – ARE THEY REALLY AS LARGE AS GROSS FLOWS INDICATE?

There is reason to believe the flows shown in figures 1 and 4 above over-estimate the actual monthly flows. The evidence indicates that the true flows are between 10% and 50% lower than shown. More specifically the over-estimation might be something like 5-20% for flows between employment and unemployment and 30-50% for flows in and out of NLF. There appears little doubt, however, that the flows between labor force states are large and that the gross flows, while maybe over-stimates by 10-50%, are correct as to order-of-magnitude.

First we examine classification error as a natural source for over-estimation of flows and methods to adjust for classification error. These adjustments do indeed imply lower flows, but flows that are still large. Second we examine other data sources for flow data. We can cross-check the reasonableness of CPS gross flows by comparing again other data. Unemployment flows can be cross-checked against the monthly CPS "unemployment duration" question for the currently unemployed and, less easily, the annual CPS "unemployment experience" survey that reports individuals' unemployment experience during a year. Employment flows can be cross-checked against the payroll or establishment survey data on new hires and separations (the Job Openings and Labor Turnover Survey or JOLTS).

Gross Flows, Classification Error, and Adjustment

The CPS gross flows discussed here are estimated by matching respondents who are in the CPS in two successive months. There will be classification errors where a person is incorrectly reported in a labor force state, say a person is reported in the survey as employed when they are actually not in the labor force (NLF). When these classification errors are independent from one month to the next such errors will produce no bias in the levels of employment, unemployment, and NLF but will produce upwardly-biased estimates of the flows (see Frazis, Robison, Evans and Duff 2005).

Abowd and Zellner (1985) and Poterba and Summers (1986) are two classic studies that examined such classification errors, using reinterview data to measure the error rates. They wrote down the observed flow (F) as a function of the true flow (F^*) and the error-rate probabilities (Q) (see Poterba and Summers 1986 p. 1327 and Meyer 1988):

$$F = Q' \cdot F^* \cdot Q \qquad \Rightarrow \qquad F^* = (Q^{-1})' \cdot F \cdot Q^{-1} \quad .$$

Abowd and Zellner found that adjustments to the flows ranged from 3.6% for u→e flows to 46% for n→e flows. The exact reductions in flows that Abowd and Zellner found, for 1977-1982, are as shown in table A.4

Table A.4 - Reductions in Gross Flows Due to Correction of Classification Error, Abowd and Zellner 1977-1982

	e	u	n
e	e->e	u->e	n->e
u	e->u	u->u	n->u
n	e->n	u->n	n->n

	e	u	n
e	2.4%	-3.6%	-46.3%
u	-8.3%	27.9%	-24.6%
n	-41.6%	-31.2%	1.0%

Note: This is from Abowd and Zellner (1985) table 4, and represents the change in the relevant flow (average 1977-1982) due to classification error correction, their entry "Classification & Margin Error to Margin Error Only". The matrix is transposed from Abowd and Zellner.

Poterba and Summers found substantially larger reductions (as high as 86% for the n→e flows) but these appear unreasonably large when compared against other data.[20]

We can use this approach and the estimates from Abowd and Zellner to adjust the current gross flows. This is not ideal because Abowd and Zellner's matrix *Q* of error rates was estimated from data roughly 30 years old, but it does provide at least an adjustment with theoretical and empirical justification.[21] The adjustment applied to recent data produces the reductions in flows shown in table A.5. The adjustments are slightly larger than for the 1977-1982 data because the levels of labor force states are different. (The classification error is estimated by labor force status so that the exact adjustment depends on the level of the flow.)

Table A.5 - Reductions in Gross Flows Due to Correction of Classification Error, Data 2002-2006

	e	u	n
e	e->e	u->e	n->e
u	e->u	u->u	n->u
n	e->n	u->n	n->n

	e	u	n
e	1.6%	-8.2%	-51.7%
u	-10.3%	17.7%	-28.0%
n	-49.7%	-31.7%	3.6%

Note: This is from the application of the Abowd and Zellner (1985) error classification adjustment matrix *Q* to recent data (January 2002 – December 2006, average of monthly data), and represents the change in the relevant flow due to classification error correction.

Cross-Checking Unemployment Flows

The CPS is the source of the monthly unemployment level, in addition to the flow data. As part of the monthly survey respondents who are unemployed are asked to report how many weeks they have been unemployed. This question about weeks unemployed is independent of the flow estimates. Note, however, that those who report "less than 5 weeks" are newly unemployed, would not have shown up in the prior month as unemployed, and thus provide an estimate of new monthly flows into unemployment, an estimate separate from the gross flow data. Although the CPS is the source of both the unemployed weeks and the flow data, the question about weeks unemployed is separate from the matching used to

[20] First, when applied to current (2010) data they produce negative flows. Second, they imply new flows into unemployment substantially lower than those reported from the "Unemployed duration" section of the CPS survey, discussed below.

[21] Abowd and Zellner discuss both margin and classification error adjustment. I am focusing on only the classification adjustment. They do not publish the *Q* matrix directly but they do publish both *F* (their "Margin error only" correction and F^* (their "Classification and Margin Error") in table4, allowing one to back out the implied *Q*. I use the Abowd and Zellner adjustment matrix rather than Poterba and Summers's because, as noted above, Poterba and Summers's adjustments appear unreasonably large when cross-checked against other data. After the classification adjustment via the Abowd / Zellner *Q* matrix the flows must be re-adjusted to match the prior and current month's marginals. This is done via "raking," using code from the Alaska Department of Labor and Workforce Development, 2008, at http://www.demog.berkeley.edu/~eddieh/ (Matrix raking is originally due to Deming and Stephan 1940, it is also called iterative proportional fitting, bipropotional fitting, matrix scaling, or the RAS algorithm.)

estimate flows into unemployment. As pointed out above, classification errors that are independent across months will not bias the levels and independent classification errors should not bias the "weeks unemployed" question. Thus, while not completely independent pieces of data, comparing the flow implied by "unemployment duration" versus the gross flows provides a valuable cross-check.

Abowd and Zellner's flows are average 1977-1982. We can also calculate the "less than 5 weeks" proportion for 1977-1982 from the unemployment duration data. Abowd and Zellner's flows (as percent of unemployment), together with the "unemployment duration" measure are:

Abowd and Zellner unadjusted	45%
Abowd and Zellner adjusted	34%
CPS "unemployment duration" new flow	43%

This indicates that Abowd and Zellner's classification adjustments are, if anything, too large.[22]

The same comparison can be performed for more recent data. For average the average of 2002-2006 monthly data, the comparison is:

CPS gross flow, unadjusted	48%	(re-check these calcs)
CPS gross flow, adjusted using A&Z matrix	38%	
CPS "unemployment duration" new flow	34%	

This indicates that the gross flow data are indeed too high, and that the adjustment produces more reasonable flows.

The second data comparison for unemployment flows involves the CPS unemployment experience data. Every spring CPS respondents are asked about their employment and unemployment experience during the prior year: were they unemployed at all during the year, and if so how many weeks during the year and how many spells did they experience. Note the important distinction between the data collected from the annual experience data and the monthly unemployment duration data. Both produce data labeled "weeks unemployed" but for the former this is the weeks during a fixed 52-week window (and cannot exceed 52 weeks) and may be the result of multiple spells, while for the latter it is the number of weeks so far experienced by a currently-unemployed person (and so may range upwards without limit) and refers to a single spell of unemployment.[23]

The annual unemployment experience data do not provide a direct measure of the flow into or out of unemployment and so are not immediately comparable with the gross flow or monthly unemployment duration data. Indeed the observed experience data result from a multi-state transition process and individuals may have zero, one, two, or more spells of unemployment during a year. Sattinger (1985, p. 64 ff) derives the density and distribution functions for the time spent unemployed as one state of a two-state Markov process. Coleman (1989) uses this, accounting for the the densities by spells, to estimate a sequence of transition models for the 1984 experience data (using unpublished detail on weeks by spell).

[22] Poterba and Summers's adjustment seems too large. Their corresponding figures are:

Unadjusted	46%
Adjusted	27%

[23] Clark and Summers (1979) is an oft-quoted paper that analyzes (among various data sources) the unemployment experience data. Clark and Summers fail to note the distinction between the annual unemployment experience data and the monthly unemployment duration data, and consequently their analysis of the annual unemployment experience data is invalid.

Unfortunately we have only the estimates for 1984 (which does not correspond to either of the periods for which we have gross flow data) but we can compare the "unemployment duration" versus the "unemployment experience" data. Using the estimates for 1984 we can calculate the new flow into unemployment implied by the experience data (and assuming steady-state).

CPS "unemployment duration" new flow for 1984	39%
New flow implied by "unemployment experience"	24%

The unemployment experience data imply a lower flow than do the unemployment duration data.

Cross-Checking Employment Flows

Starting in 2002 the BLS began releasing flow data for employment from the Job Opening and Labor Turnover Survey (JOLTS – see Boon et al. 2008). This survey focuses on establishments (firms) instead of people and counts the number of new hires and separations. The survey sample about 16,000 establishments (firms) and is benchmarked against the Current Employment Statistics (CES) survey, commonly referred to as the "establishment" or "payroll" survey.

JOLTS provides estimates of hires, or all additions to the payroll during a month, and separations, or all subtractions from payroll.[24] These are flows in and out of employment. The flow in (new hires) may be from unemployment, from NLF, or from employment at another firm. The flow out (separations) may be to unemployment, to NLF, or to another firm. The important point at the moment is that this is a source of data on employment flows from a survey entirely separate from the CPS and gross flow data.

The flows from JOLTS, measured as a percent of employment, averaged 3.9% (hiring) and 3.8% (separation) for the period monthly June 2003-2006. Averaging the CPS gross flow data for the same period (calculating the flows into and out of employment as a percent of the level of employment) we find flows in of 4.2% and flows out of 4.1% for unadjusted flows and 2.7% and 2.6% for adjusted flows. The unadjusted are slightly higher than the JOLTS flows while the adjusted flows are substantially lower. There is an important data issue that arises here. The CPS gross flow data measure transitions for people while the JOLTS measures jobs. Thus if an individual is employed at firm *A* in month 0 and then firm *B* in month 1, this *will not* show as a flow in or out for the CPS but *will* show as a flow out (separation for firm *A*) and a flow in (hire for firm *B*). This means that the CPS gross flows in and out of employment should be lower than the JOLTS flows.

JOLTS provides data by industry (and region) that the CPS gross flow data do not. Hiring rates (and separation rates) vary substantially by industry, as one might expect. Leisure and Hospitality, Construction, and Retail Trade are at the high end with hiring rates of 6.5%, 5.6%, and 4.5%. Government, Manufacturing, and Financial Activities are at the low end, but still show monthly rates of 1.5%, 2.3%, and 2.3% of the level of employment (all average for 2001-2006).

Summary of Cross-Checking Evidence

My conclusion from cross-checking the unemployment and employment flows is two-fold. First, there is not good quantitative agreement from different sources on the exact magnitude of the monthly flows to or from unemployment or employment. On the other hand there is good evidence from multiple sources that the flows are large – for unemployment somewhere on the order of 20-40% of the level of unemployment and for employment somewhere on the order of 3-4% of the level of employment. Consider the different strands of evidence:

[24] Although it does not matter for present purposes, separations are categorized as quits (generally voluntary), layoffs and discharges, and other (e.g. transfers and retirement).

- Gross flows, when adjusted for classification error, still show large flows – on the order of 30% of the level of unemployment and 2.5% of the level of employment
- Single-spell "unemployment duration" data show new flows into unemployment on the order of 25-40% of the level of unemployment (with substantial variation over time)
- CPS "unemployment experience" data for 1984 imply flow into unemployment just under 25% of the level of unemployment
- JOLTS show flows into and out of employment about 3.8% of the level of employment (for the period June 2003-2006) while the CPS gross flows are about 4.1% or 10% larger (unadjusted) and 2.6% or 30% lower (adjusted for classification error). The CPS flows should be lower than JOLTS because CPS does not report flows from one job to another (an individual moving from one firm to another while remaining employed) while JOLTS does.

Flows as Repeated Spells vs. Episodic Experience
There is a very important question that none of the flow data address: how much of the flows are repeat offenders versus episodic experience. To fix ideas consider flows from employment to unemployment. One prototype would be that everyone is identical and those going e→u were randomly chosen to be fired or quit and just happened to be unlucky. Their experience of unemployment would be episodic in the sense that, when they eventually found another job they would be no more likely to become unemployed again. The other extreme is that those going e→u are different from those who keep their jobs – they are repeat job-losers who, when they eventually find another job, will quickly lose it again. They will suffer multiple spells of unemployment and employment.

This gets into questions about how much of a month's flow is "good" labor force mobility (say new firms starting up and old ones closing, individuals moving geographically or progressing along a career path) versus "bad" labor force mobility (say workers moving in and out of dead-end jobs flipping burgers at McDonalds). Such questions may be more political and emotive than empirical and economic, but nonetheless the question remains – how much of the monthly flows are due to a small number of individuals with repeated spells, versus episodic experience for the population as a whole.

The CPS gross flow and the JOLTS flow data do not address this question. The CPS work experience data, however, do provide some insight. The data indicate that there are too many multiple spells of unemployment to be consistent with a homogeneous, Markovian population. There must be some subset of the population that has high probability of coming back into unemployment quickly when they leave, and this subset, though small, accounts for a disproportionate fraction of the monthly flow.[25]

The work experience or unemployment experience survey asks how many weeks of unemployment and how many spells were experienced during the prior year. Not all respondents provide data on the number of spells, but from those who do we observe that there are a large number of repeated spells. Coleman (1989, table 1b) shows that 33% of those with spell data reported 2 or more spells. The joint distribution of weeks unemployed and number of spells cannot be fit well with a homogeneous Markov model (one that assumes all individuals have the same entry and exit rates and no duration dependence). By fitting various models of heterogeneity (high vs. low entry rates, high vs. low exit rates) it appears that variation in the entry rates into unemployment is far more important than variation in exit rates from unemployment in fitting the number of spells. A simple two-group heterogeneity model fits reasonably well. The two groups, together with some steady-state characteristics, are shown in table A.6

[25] To be accurate, strong duration dependence could probably account for the observations as well as heterogeneity. It is very difficult to distinguish between duration dependence and population heterogeneity. Nonetheless, I suspect that population heterogeneity is the more likely primary cause.

Table A.6 - Steady-State Characteristics for Two-Group Heterogeneity Fitted to 1984 CPS Work Experience Data

		Pop wt	Group unempl	Cont'n to unemp	Unemp flow	Cont'n to flow
Group 1	Low entry	93.8%	1.40%	1.31%	0.38%	0.36%
Group 2	High entry	6.2%	40.43%	2.51%	9.97%	0.62%
Population				3.82%		0.98%

Note – From Coleman (1989) table 4, model 1 heterogeneity, and calculations. The parameters are: group 1 entry rate 0.004518, group 2 entry rate 0.2162, both exit rates 0.3185 (all rates continuous-time transition rates).

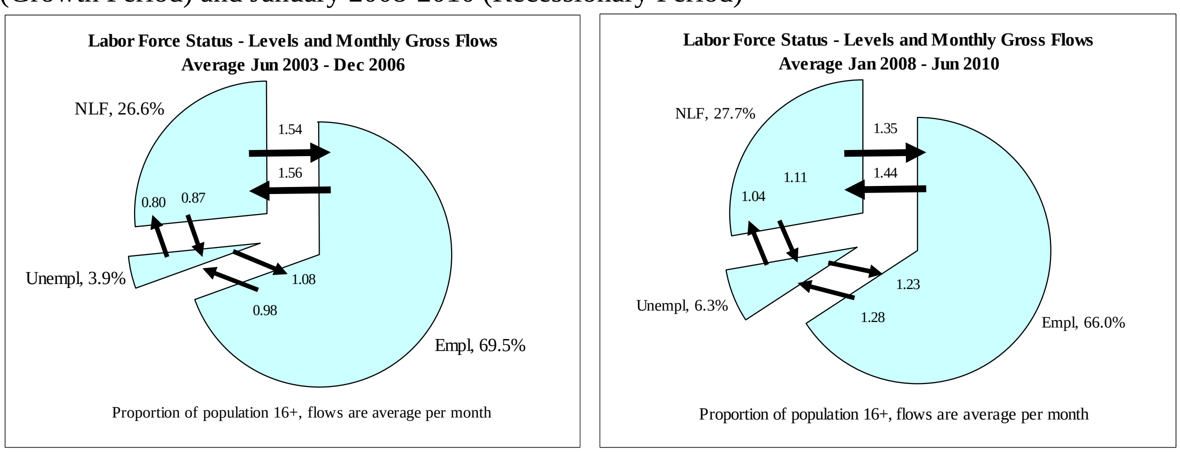
This shows that group 2, although a small fraction of the population, contributes are very large share of the overall unemployment rate and the monthly flow.

A.4 – ANALYSIS OF MEN AND WOMEN

The analysis discussed in the body of the paper is for both sexes. The BLS also publishes gross flows separately for men and women. The differences between men and women are largely related to labor force participation. Men have higher labor force participation and transitions rates to and from NLF have less impact on employment. Women have lower participation and NLF transition rates have more impact on employment.

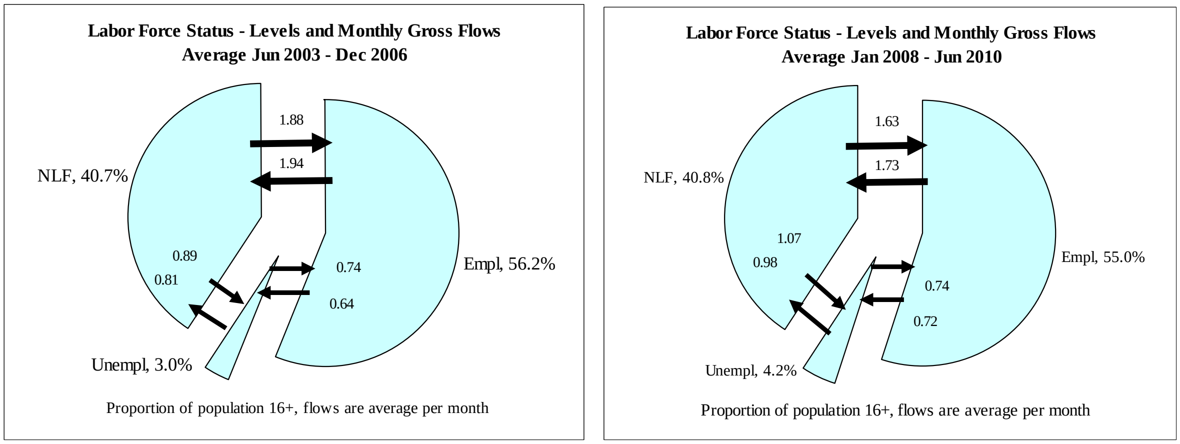
Figures A.1 and A.2 show the gross flows for men and women.

Figure A.1 – Gross Labor Force Flows for Men as Ratio to Population for June 2003-December 2006 (Growth Period) and January 2008-2010 (Recessionary Period)



Source for data as in figure 4.

Figure A.2 – Gross Labor Force Flows for Women as Ratio to Population for June 2003-December 2006 (Growth Period) and January 2008-2010 (Recessionary Period)

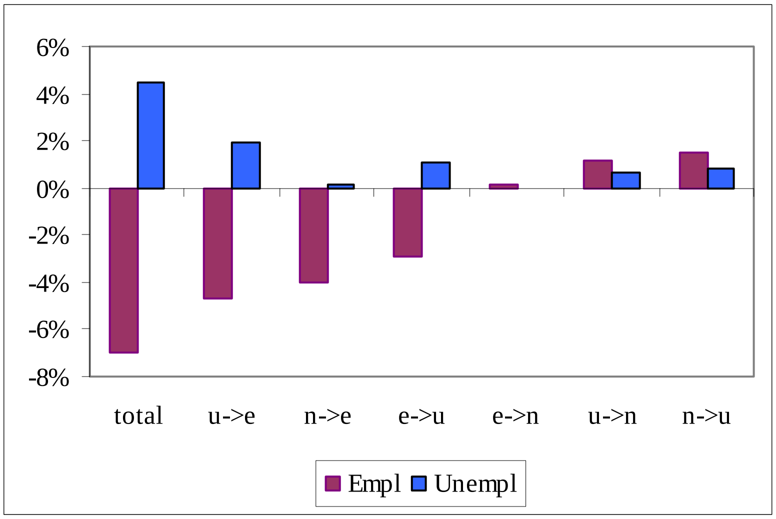


Source for data as in figure 4.

The decomposition of changes in employment and unemployment during the 2007-2009 recession is shown in figures A.3 and A.4, corresponding to figure 3 in the main text. For men entry rates have the largest impact, but exit rates also contribute. Unlike for both sexes combined (or women) changes in the entry rate n→e has little impact. Changes in rates between unemployment and NLF (u→n and n→u) still look something like an "anti-discouraged worker" effect, contributing positively to employment.

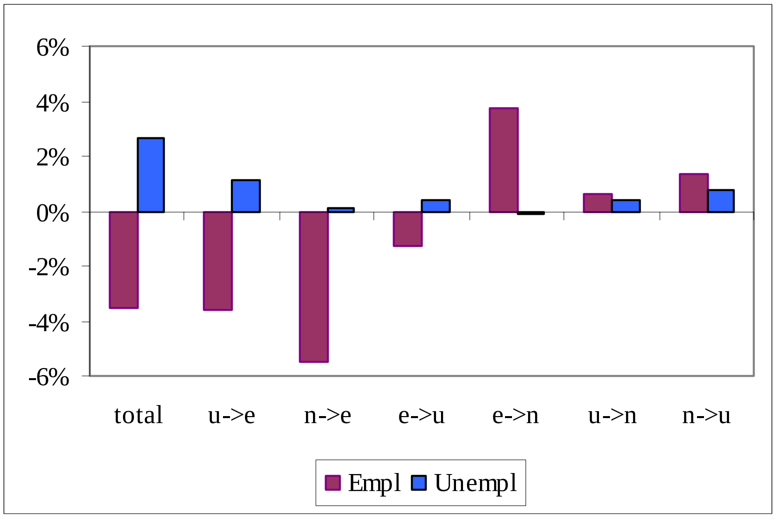
The most important difference between men and women is in the impact of changes in transition rates between employment and NLF: falling entry and exit rates (n→e and e→n) have a big impact with falling entry (n→e) pulling down employment and falling exit rates (e→n) pushing up employment.

Figure A.3 – Change in Employment and Unemployment and Approximate Decomposition, March 2007 – December 2009, Men



Note: Employment and Unemployment are both measured as ratio to population. The change is in percentage points (-7.0% means the employment to population ratio changed from 70.2% to 63.2%). The decomposition is for the steady-state employment and unemployment ratios but this provides an approximate decomposition to the observed ratios, as discussed above.

Figure A.4 – Change in Employment and Unemployment and Approximate Decomposition, March 2007 – December 2009, Women



Note: Employment and Unemployment are both measured as ratio to population. The change is in percentage points (-3.5% means the employment to population ratio changed from 56.9% to 53.4%). The decomposition is for the steady-state employment and unemployment ratios but this provides an approximate decomposition to the observed ratios, as discussed above.

Table A.7 and A.8 show the decomposition for the three recessionary periods in tabular form.

Table A.7 – Approximate Decomposition of Change in Employment and Unemployment Ratios for Three Recessionary Periods, Men

	Actual ch	SS ch	u->e	n->e	e->u	e->n	u->n	n->u
Average Probability			27.9%	5.6%	1.6%	3.3%	18.3%	2.1%
Ch in Probability Mar-07 - Dec-09			-14.3%	-1.4%	0.7%	0.0%	-5.4%	1.3%
Change in Empl and decomp	-7.0%	-8.8%	-4.7%	-4.0%	-2.9%	0.1%	1.1%	1.5%
% decomposition			-54%	-45%	-33%	2%	13%	17%
Change in Unempl and decomp	4.5%	4.7%	2.0%	0.2%	1.1%	0.0%	0.6%	0.8%
% decomposition			42%	4%	23%	0%	13%	17%
Ch in Probability Jun-90 - Sep-92			-5.9%	-0.4%	0.3%	0.0%	-0.9%	1.0%
Change in Empl and decomp	-2.3%	-1.7%	-1.6%	-0.9%	-0.9%	0.3%	0.3%	1.2%
% decomposition			-95%	-54%	-54%	17%	15%	72%
Change in Unempl and decomp	2.0%	1.8%	0.8%	0.0%	0.4%	0.0%	0.1%	0.5%
% decomposition			43%	1%	23%	0%	5%	29%
Ch in Probability Dec-00 - Jun-03			-8.7%	-0.4%	0.4%	0.0%	-1.5%	1.1%
Change in Empl and decomp	-3.0%	-3.2%	-1.9%	-1.1%	-1.5%	-0.2%	0.3%	1.2%
% decomposition			-58%	-35%	-46%	-7%	9%	36%
Change in Unempl and decomp	1.9%	2.0%	0.8%	0.0%	0.6%	0.0%	0.1%	0.5%
% decomposition			38%	2%	29%	0%	6%	25%

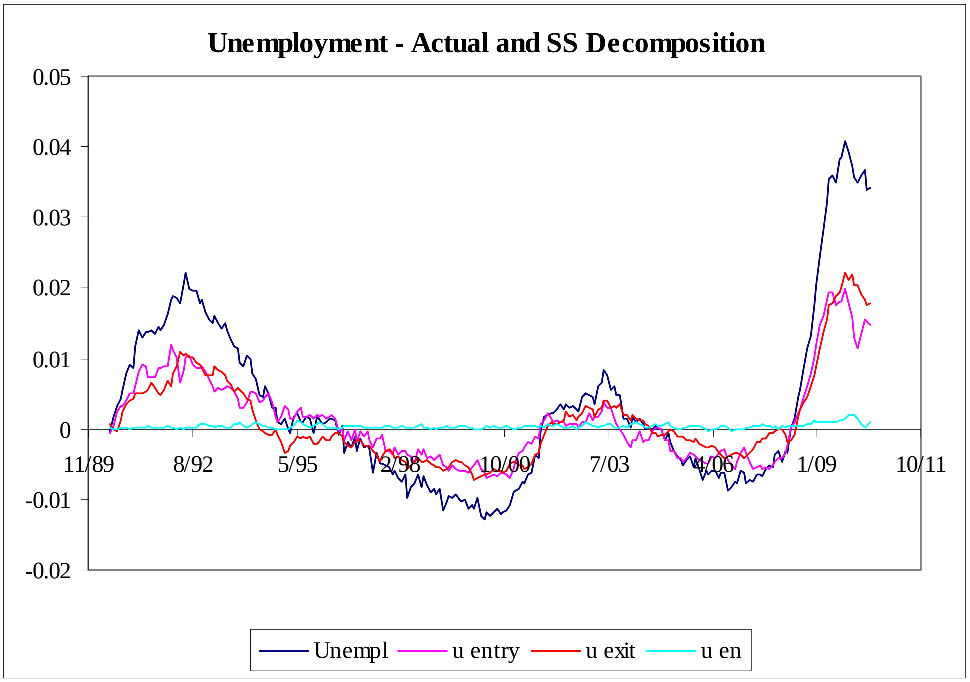
Source: as in figure 4 with calculations as detailed in the appendix

Table A.8 – Approximate Decomposition of Change in Employment and Unemployment Ratios for Three Recessionary Periods, Women

	Actual ch	SS ch	u->e	n->e	e->u	e->n	u->n	n->u
Average Probability			24.7%	4.4%	1.2%	2.3%	26.2%	3.4%
Ch in Probability Mar-07 - Dec-09			-13.3%	-1.2%	0.3%	-0.6%	-4.4%	0.9%
Change in Empl and decomp	-3.5%	-4.7%	-3.6%	-5.5%	-1.3%	3.7%	0.6%	1.4%
% decomposition			-77%	-118%	-28%	80%	14%	29%
Change in Unempl and decomp	2.6%	2.7%	1.1%	0.1%	0.4%	-0.1%	0.4%	0.7%
% decomposition			42%	5%	15%	-3%	14%	27%
Ch in Probability Jun-90 - Sep-92			-5.2%	-0.5%	0.1%	-0.4%	-3.4%	0.5%
Change in Empl and decomp	-0.7%	-0.1%	-1.2%	-2.4%	-0.4%	2.5%	0.5%	0.8%
% decomposition			-824%	-1630%	-275%	1735%	354%	539%
Change in Unempl and decomp	1.2%	1.1%	0.4%	0.1%	0.1%	-0.1%	0.2%	0.4%
% decomposition			33%	5%	11%	-5%	22%	34%
Ch in Probability Dec-00 - Jun-03			-7.0%	-0.5%	0.3%	-0.3%	-1.8%	0.5%
Change in Empl and decomp	-1.2%	-1.1%	-1.3%	-1.9%	-0.9%	1.9%	0.3%	0.9%
% decomposition			-116%	-166%	-83%	167%	23%	75%
Change in Unempl and decomp	1.2%	1.2%	0.4%	0.0%	0.3%	0.0%	0.1%	0.4%
% decomposition			36%	3%	25%	-4%	8%	31%

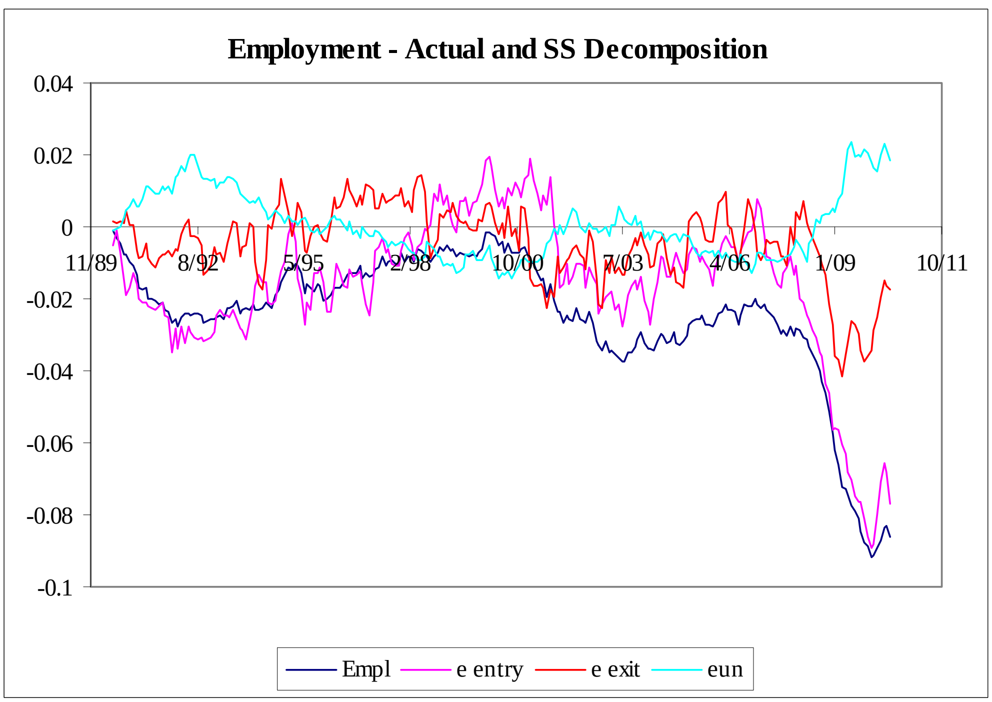
Source: as in figure 4 with calculations as detailed in the appendix

Figure A.5 - Men



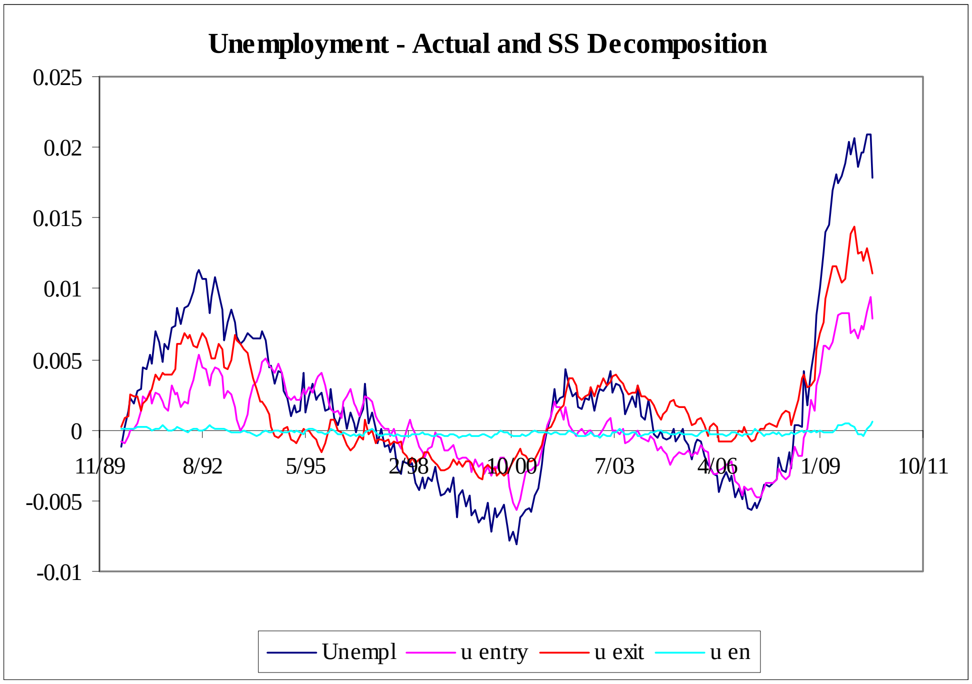
Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes.

Figure A.6 - Men



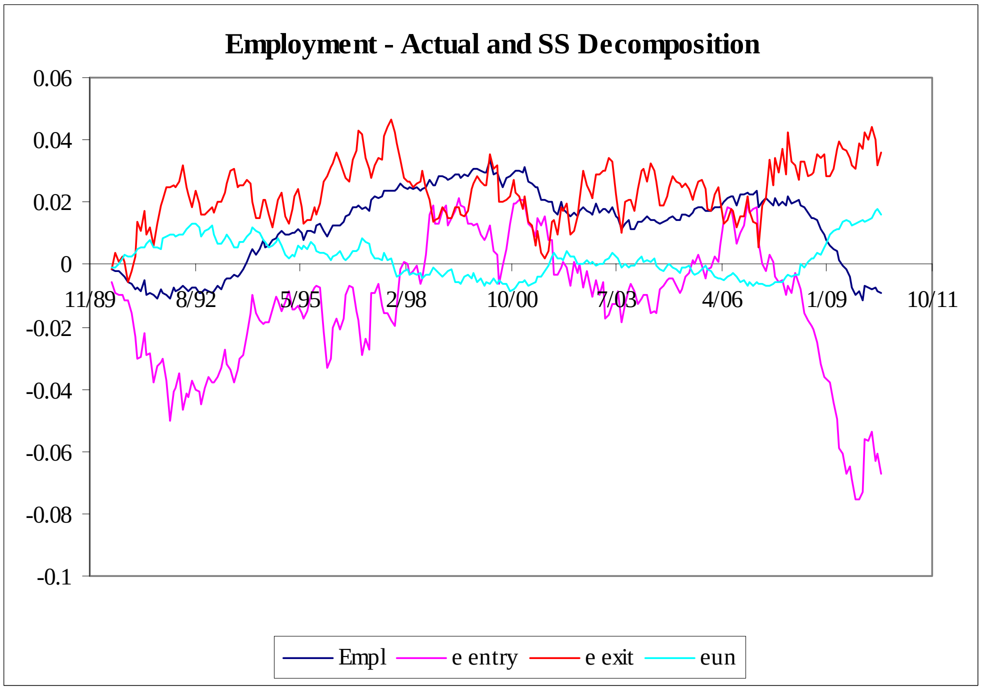
Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes.

Figure A.7 - Women



Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes.

Figure A.8 - Women



Source for actual data as in figure 4. Implied steady-state ratios are calculated as described in the appendix, using 3-month moving averaged transition matrixes.

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