Chapter 10

Unemployment

The study of unemployment is usually cast as the study of workers. Several theories seek to explain why the labor market might not clear at a particular wage. Among these are "search" models, in which unemployed people are in the process of looking for work. One such model is presented in Chapter 10 of the Barro textbook. More-sophisticated theories attempt to explain unemployment as the breakdown in a matching process between workers and jobs. Public discussions of unemployment often conflate the two.

In this chapter we will discuss some exciting new research on the statistical characteristics of jobs and employment in the United States. We will not attempt to provide theoretical explanations for the observed statistical patterns; rather, we will concentrate on the statistics themselves. The primary source for the material in this chapter is *Job Creation and Destruction*, by Davis, Haltiwanger, and Schuh.[1] Hereafter, we will refer to this book simply as "DHS". The book synthesizes research based on some important data sets regarding jobs and employment. This chapter can provide only a very broad outline of the book, and the interested reader is strongly encouraged to obtain his or her own copy. The book is short, accessible, and every page contains something worth knowing.

The authors use two previously untapped sets of data regarding manufacturing employment in the United States. They present evidence that the main statistical regularities of their data sets are also present in service industries and across countries. The data sets give them the number of *jobs* (defined as filled employment positions) at different *establishments* (roughly, factories) over time. Most importantly, they are able to track *gross* job flows over time, i.e., how many jobs are created and how many are destroyed at each establishment. Standard measures track only *net* job flows, i.e., the difference between the number created and the number destroyed. It turns out that net flows conceal an enormous amount. For

[1] The complete citation is: Davis, Steven J., John C. Haltiwanger, and Scott Schuh. *Job Creation and Destruction*. Cambridge, Mass.: MIT Press. 1996.

example, if we knew that the number of jobs in the U.S. grew 3% from 1998 to 1999, from say 100 million to 103 million, we would know the net change in jobs, but nothing about the gross changes in jobs. How many jobs were created? How many destroyed? Until DHS, there were simply no good answers to those questions.

The authors find that in a typical year 10% of jobs are created and that a roughly equal number are destroyed. The authors are also able to track job creation and destruction over the business cycle, and they find that job creation falls slightly during recessions, whereas job destruction grows strongly. Their data sets contain information about the nature of the establishments, so they are able to track job creation and destruction by employer and by factory characteristics. They convincingly explode one of the shibboleths of modern American political discourse: the myth of small-business job creation. It turns out that most jobs are created (and destroyed) by large, old plants and firms. This insight alone makes the book worth reading.

We begin with a primer on the notation used in DHS and then turn to a brief overview of the main conclusions of the book.

10.1 Job Creation and Destruction: Notation

Basic Notation

Variables in DHS can take up three subscripts. For example, the total number of filled employment positions at a plant is denoted X_{est}, where e denotes the *establishment* (that is, the plant), s denotes the *sector* (for example, the garment industry) and t denotes the *time period* (usually a specific year). If you find this notation confusing, ignore the differences among the first two subscripts e and s and just think of them as denoting the same thing: establishments. Capital letters will denote levels and lower-case letters will denote rates. The words "plant" and "establishment" mean the same thing. A *job* is defined as a filled employment position; no provision is made for considering unfilled positions.

Jobs are *created* when a plant increases the number of jobs from one period to the next, while jobs are *destroyed* when a plant decreases the number of jobs from one period to the next. *Gross job creation* is the sum of all new jobs at expanding and newly-born plants, while *gross job destruction* is the sum of all the destroyed jobs at shrinking and dying plants. Let X_{est} denote the number of jobs at establishment e in sector s at time t, and let S_t^+ be the set of establishments that are growing (i.e., hiring more workers) between periods $t-1$ and t. Then gross job creation is:

$$C_{st} = \sum_{e \in S_t^+} \Delta X_{est},$$

where Δ is the difference operator:

$$\Delta X_{est} \equiv X_{est} - X_{es,t-1}.$$

In words, C_{st} is the total number of new jobs at expanding and newly born plants in sector s between periods $t-1$ and t. Next we turn to job destruction. Let S_t^- be the set of establishments that are shrinking between periods $t-1$ and t. Then gross job destruction is:

$$D_{st} = \sum_{e \in S_t^-} |\Delta X_{est}|.$$

In words, D_{st} is the total number of all the jobs lost at shrinking and dying plants in sector s between periods $t-1$ and t. The absolute-value operator guarantees that D_{st} will be a positive number.

Next, we need a measure for the size of a plant. DHS use the average number of jobs between the current period and the last. For some establishment e in sector s at time t, DHS define its *size* Z_{est} as follows:

$$Z_{est} \equiv \frac{1}{2}\left(X_{est} + X_{es,t-1}\right).$$

Notice that the size in period t contains employment information for both periods t and $t-1$.

Suppose we discover that ten-thousand jobs were created in the mining sector in 1996. In our notation, we would write that as: $C_{m,1996} = 10{,}000$, where m is for "mining". This information would be more useful if compared with some measure of the number of jobs already present in the mining sector, which is what we call a *rate*. Then we could say, for example, that the gross rate of job creation in the mining sector was 10% in 1996.

The rate of employment growth at the plant level is defined as:

$$g_{est} = \frac{\Delta X_{est}}{Z_{est}}. \tag{10.1}$$

Let Z_{st} be the sum of all the plant sizes in sector s. Then the rate of job creation in a sector is defined as:

$$c_{st} = \frac{C_{st}}{Z_{st}}. \tag{10.2}$$

The rate of job destruction is defined similarly:

$$d_{st} = \frac{D_{st}}{Z_{st}}. \tag{10.3}$$

Notice that if some plant i dies between $t-1$ and t (so that $X_{i,t-1} > 0$ but $X_{it} = 0$), then the growth rate of the plant will be $g_{it} = -2$, while if plant i is born in t (so that $X_{i,t-1} = 0$ and $X_{it} > 0$), then the growth rate of the plant will be $g_{it} = 2$.

A Simple Example

Consider an economy with only one sector and three plants, P_1, P_2, and P_3. The following tables list the total employment figures for these three plants as well as: the gross levels of job creation and destruction at the plant level, average plant size, and gross rates of job creation and destruction.

Year	$X_{P_1,t}$	$X_{P_2,t}$	$X_{P_3,t}$	Total
1991	200	100	0	300
1992	0	300	200	500

Plant i	P_1	P_2	P_3	Total
$Z_{i,1992}$	100	200	100	400
$\Delta X_{i,1992}$	-200	200	200	200
$C_{i,1992}$	0	200	200	400
$D_{i,1992}$	200	0	0	200
$g_{i,1992}$	-2.0	1.0	2.0	

Notice that plant P_1 died between 1991 and 1992, so its growth rate was -2, the same as it would have been for any plant that died. Plant P_3 was born between 1991 and 1992, so its growth was 2, the same as it would have been for any plant that was born. This is because of the somewhat non-standard definition of plant size chosen by DHS. (See equation (10.1).) The economy went from 300 jobs in 1991 to 500 jobs in 1992, so it added 200 net jobs. However, two plants expanded, adding 200 jobs each, while one plant contracted, destroying 200 jobs. Thus gross job creation was 400 jobs, and gross job destruction was 200 jobs.

In 1992 the sizes $Z_{i,1992}$ of the three plants were 100, 200, and 100 jobs, respectively, so the aggregate plant size Z_{1992} was 400. Recall, S^+_{1992} is the set of plants that were growing between 1991 and 1992, so $S^+_{1992} = \{2, 3\}$. The rate of job creation c_{1992} for this economy was:

$$c_{1992} = \frac{C_{1992}}{Z_{1992}} = \frac{\sum_{i \in S^+_{1992}} \Delta X_{i,1992}}{Z_{1992}} = \frac{200 + 200}{400} = 1.$$

Now, recall that S^-_{1992} was the set of plants that were shrinking between 1991 and 1992. Using the same formulation, we can calculate the economy-wide rate of job destruction as:

$$d_{1992} = \frac{D_{1992}}{Z_{1992}} = \frac{\sum_{i \in S^-_{1992}} |\Delta X_{i,1992}|}{Z_{1992}} = \frac{|-200|}{400} = 0.5.$$

Job Reallocation, Net Job Creation, and Persistence

Let R_{st} be the sum of the number of jobs created and the number of jobs destroyed in sector s between periods $t-1$ and t. We call R_{st} the *level of job reallocation* in sector s at time t. Formally:

$$R_{st} = C_{st} + D_{st}.$$

Note that R_{st} is an upper bound for the number of workers who have to switch jobs to accommodate the redistribution of employment positions across plants.

We define the *employment status* of a citizen to be: "employed", "unemployed", or "not in the workforce". With that in mind, consider the previous example. For that one-sector economy, 600 jobs were reallocated. Imagine that all of the 400 newly created positions were filled with workers just entering the workforce and that none of the workers at the 200 destroyed jobs found employment. Then 600 workers changed employment status. Of course, if some of the workers at the 200 destroyed jobs had been hired to fill the newly created jobs, then the number of workers changing employment status would have been lower.

As before, we convert the level of job reallocation into a rate by dividing by our measure of plant size Z_{st}. Formally, the rate of job reallocation in sector s at time t is defined as:

$$r_{st} \equiv \frac{R_{st}}{Z_{st}} = \frac{C_{st} + D_{st}}{Z_{st}} = c_{st} + d_{st}.$$

Let NET_{st} be the difference between the gross levels of job creation and destruction in sector s at time t:

$$\mathrm{NET}_{st} = C_{st} - D_{st}.$$

This is the net level of job creation. Note that when job destruction is greater than job creation, NET_{st} will be negative. In the simple example above, $\mathrm{NET}_{1992} = 200$. Let net_{st} be the net rate of job creation in sector s at time t. Formally:

$$\mathrm{net}_{st} = c_{st} - d_{st}.$$

Now we are interested in creating a measure of the persistence of the changes in employment levels at establishments. We will first define a simple counting rule for determining how many of the new jobs created at a plant are still present after j periods, where j is an integer greater than or equal to one. Consider some plant i in year $t-1$ with $X_{i,t-1} = 100$ and $X_{it} = 110$. Thus $C_{it} = 10$, i.e., ten jobs were created (in gross) at plant i in year t.

Now consider the future year $t+j$. If employment $X_{i,t+j}$ at plant i in the year $t+j$ is 105, we say that five of the new jobs created at plant i in the year t have survived for j periods. If $X_{i,t+j} \leq 99$, we say that zero of the new jobs have survived. If $X_{i,t+j} \geq 110$, we say that all ten of the new jobs have survived.

Let $\delta_{it}(j)$ be the number of new jobs created at plant i in year t that have survived to year $t + j$, using the counting rule defined above. The *level of job persistence* $P^c_{it}(j)$ at plant i between periods t and $t + j$ is defined as the number of jobs created in year t that exist in all of the periods between t and $t + j$. Formally:

$$P^c_{it}(j) = \min \left\{ \delta_{it}(1), \delta_{it}(2), \ldots, \delta_{it}(j) \right\}.$$

The rate of job persistence can be calculated by summing over all new and expanding establishments at time t and dividing by gross job creation at t. Using the fact that we have defined S^+_t to be the set of growing plants, we formally define the rate of job persistence as follows:

$$p^c_t(j) = \sum_{i \in S^+_t} \frac{P^c_{it}(j)}{C_{st}}.$$

Now we work through an example in order to fix ideas. The following chart gives employment levels for a firm between 1990 and 1995. X_t denotes the number of jobs at the plant in the year t, where all other subscripts have been dropped for convenience, and $\delta_{1991}(j)$ gives the number of jobs created in 1991 that still exist in the period $t + j$.

Year	Employment	Persistent jobs from 1991
1990	$X_{1990} = 100$	—
1991	$X_{1991} = 110$	—
1992	$X_{1992} = 109$	$\delta_{1991}(1) = 9$
1993	$X_{1993} = 108$	$\delta_{1991}(2) = 8$
1994	$X_{1994} = 107$	$\delta_{1991}(3) = 7$
1995	$X_{1995} = 108$	$\delta_{1991}(4) = 8$

We see that for this plant there were seven jobs that were created in 1991 and were also present in all periods from 1991 to 1995. Accordingly, $P^c_{1991}(4) = 7$. The subtle point is that one of the jobs of the 108 in 1995 was not one of those created in 1991.

Worker Reallocation and Excess Job Reallocation

We define the *level of worker reallocation* WR_t at time t to be the number of workers who change employment status or place of employment between periods $t - 1$ and t. There is no way to extract WR_t precisely from the data, since the data concentrate on jobs, not workers. However, we can provide upper and lower bounds on WR_t from the data on jobs.

Our job reallocation measure R_t may overstate the number of workers who change status or position. Consider a worker whose job is destroyed and then finds employment later within the sample period at a newly created job. This worker is counted twice in calculating

R_t. Only in the special case that all fired workers fail to find reemployment in the survey period would WR$_t$ = R_t. Hence R_t provides an upper bound on WR$_t$.

The minimum bound on WR$_t$ is max$\{C_t, D_t\}$. That is, if 75 jobs were created economy-wide and 50 were destroyed, we know that at least 75 workers had to change employment status or place of employment. Imagine that all 50 workers whose jobs were destroyed found employment at the newly created jobs. Then 25 other workers would have had to be drawn in to fill the remaining 25 new jobs. Hence the 50 fired workers changed place of employment and the 25 new workers changed employment status, moving from unemployed to employed.

10.2 Job Creation and Destruction: Facts

In this section we sketch briefly only the high points of the results in DHS. To answer the exercises at the back of this chapter, you will need to consult the text directly.

Over the sample period 1973-1988, the net manufacturing job creation rate ($c_t - d_t$) averaged -1.1%. This basic fact obscures the variation of job creation and destruction over the business cycle, by industry and by plant characteristic. In this section, we hit some of the high points.

The average annual rate of job destruction d_t in manufacturing was 10.3%, and the average rate of job creation c_t was slightly lower at 9.1%, so the average rate of job reallocation was 19.4%. The rate of job creation hit a peak of 13.3% in the recovery year of 1984, while the rate of job destruction peaked at 14.5% and 15.6% in the recession years of 1982-83. This points to the striking cyclical nature of job creation and destruction: in recessions job destruction spikes well above its mean, while job creation does not fall that much. Moreover, most of the job creation and destruction is concentrated in plants that open or close, rather than in plants that change size.

When DHS look at gross job flows across industries, they find that rates of job reallocation are uniformly high, i.e., all industries create and destroy lots of jobs. However, high-wage industries tend to have smaller gross job flows than low-wage industries. Finally, they find that the degree to which an industry faces competition from imports does not significantly affect job destruction. (For your information, imports make up less than 13% of the market for 80% of U.S. industries.)

Examining gross job flows by employer characteristics reveals that most jobs are not created by small business but rather by large, old firms. The pervasive myth of small-business job creation is fed by bureaucratic self-interest and by some elementary statistical errors. Understanding these errors is an instructive exercise in its own right and one of the most interesting parts of the DHS book.

Variable	Definition
X_{est}	Number of filled employment positions (jobs) at plant e, sector s, period t
S_t^+	Set of plants that grew between periods $t-1$ and t
S_t^+	Set of plants that shrunk between periods $t-1$ and t
C_{st}	Gross job creation
D_{st}	Gross job destruction
Z_{est}	Size of employment of plant e, sector s, period t
g_{est}	Plant-level rate of employment growth
c_{st}	Rate of job creation
d_{st}	Rate of job destruction
R_{st}	Level of job reallocation
r_{st}	Rate of job reallocation
NET_{st}	Net jobs created in sector s at time t
net_{st}	Net rate of creation of jobs in sector s at time t
$P_t^c(j)$	The number of jobs created in period t still present j periods later
$p_t^c(j)$	Rate of the persistence of job creation
WR_t	Level of worker reallocation

Table 10.1: Notation for Chapter 10

Finally, we touch on one last insight. Well-diversified plants tend to be more likely to survive recessions than single-output plants. This makes sense, since by producing a portfolio of products, a plant can spread the risk that a recession will completely stop demand for all of its output.

Exercises

Exercise 10.1 (Moderate)
Answer: True, False, or Uncertain, and explain.

1. "Did you know that America's 22 million small businesses are the principal source of new jobs?" (Source: Web page of the Small Business Administration.)
2. "In the next century, 20% of the population will suffice to keep the world economy

going.... A fifth of all job-seekers will be enough to produce all the commodities and to furnish the high-value services that world society will be able to afford" the remaining 80% will be kept pacified by a diet of "Tittytainment". (Source: Martin, Hans-Peter and Harald Schumann. *The Global Trap.* New York: St Martin's Press. 1996.)

Exercise 10.2 (Easy)
The plant-level rate of employment growth is defined as:

$$g_{est} = \frac{\Delta X_{est}}{Z_{est}},$$

where:

$$\Delta X_{est} = X_{est} - X_{es,t-1}.$$

That is, ΔX_{est} is the change in employment at plant e in sector s from $t-1$ to t. Show that $g_{est} = 2$ for all plants that are born between $t-1$ and t, and show that $g_{est} = -2$ for all plants that die between $t-1$ and t.

Exercise 10.3 (Easy)
Show the following:

$$c_{st} = \sum_{e \in S^+} \left(\frac{Z_{est}}{Z_{st}} \right) g_{est}, \text{ and:}$$

$$\text{net}_{st} = \sum_{e \in S} \left(\frac{Z_{est}}{Z_{st}} \right) g_{est}.$$

Here c_{st} is the average rate of job creation of all plants in sector s. What does the term Z_{est}/Z_{st} mean?

Exercise 10.4 (Moderate)
For the purposes of this exercise, assume that you have data on annual national job creation C_t and job destruction D_t for N years, so $t = 1 \ldots N$. Show that if annual national job reallocation R_t and net job creation NET_t have a negative covariance, then the variance of job destruction must be greater than the variance of job creation. Recall the definition of variance of a random variable X for which you have N observations, $\{x_i\}_{i=1}^N$:

$$\text{var}(X) = \frac{1}{N} \sum_{i=1}^{N} (x_i - \bar{x})^2,$$

where $\bar{x}$ is the mean of X. Similarly, recall the definition of the covariance of two variables X and Y. If there are N observations each, $\{x_i, y_i\}_{i=1}^N$, then:

$$\text{cov}(X, Y) = \frac{1}{N} \sum_{i=1}^{N} (x_i - \bar{x})(y_i - \bar{y}).$$

These definitions and the definitions of NET_t and R_t provide all the information necessary to answer this exercise.

Exercise 10.5 (Easy)
Consider the employment statistics in chart below. Compute each of the following five measures: (i) the economy-wide rate of job creation c_t; (ii) the economy-wide rate of job destruction d_t; (iii) the net rate of job creation net_t; (iv) the upper bound on the number of workers who had to change employment status as a result of the gross job changes; and (v) the lower bound on the number of workers who had to change employment status as a result of the gross job changes for each each of the years 1991, 1992, 1993, 1994, and 1995.

Year	$X_{1,t}$	$X_{2,t}$	$X_{3,t}$	c_t	d_t	net_{st}	UB	LB
1990	1000	0	500					
1991	800	100	800					
1992	1200	200	700					
1993	1000	400	600					
1994	800	800	500					
1995	400	1200	600					
1996	200	1400	600					
1997	0	2000	500					

Exercise 10.6 (Moderate)
For each of the following statements, determine if it is true, false or uncertain and why. If possible, back your assertions with specific statistical evidence from DHS.

1. Foreign competition is destroying American manufacturing jobs.
2. Robots and other capital improvements are replacing workers in factories.
3. Most job creation occurs at plants that grow about 10% and most job destruction occurs at plants that shrink about 10%.
4. Diversified plants are better able to withstand cyclical downturns.
5. Every year, high-wage manufacturing jobs are replaced by low-wage manufacturing jobs.