

An Introduction to the Wage Records Applications

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In the logician's voice:

An algorithm is

a finite procedure,

written in a fixed symbolic vocabulary,

governed by precise instructions,

moving in discrete steps, 1, 2, 3.....,

whose execution requires no insight, cleverness,

intuition, intelligence, or perspicuity,

and that sooner or later comes to an end.

Front piece to

David Berlinski's

The Advent of the Algorithm

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A Brief Introduction to the Wage Records Applications

In August, 2001 Wyoming hosted a multi-state conference on the applications of the Wage Records (WR) dataset to address Labor Market issues. As a result of this meeting several states agreed to apply methods developed by Wyoming's Research and Planning (R&P) to calculate comparable turnover data within the year. This document is built on several earlier releases¹ and is intended to introduce those unfamiliar with our (Wyoming and the other participating states) past efforts to produce comparable turnover data. Further, R&P will introduce several new concepts and methodologies to address issues of employee Tenure, Retention, and Experience relative to Employers, Industries and Wyoming's Labor Market.

As with the WR Application Project (WRAP), so too, this document is dynamic. There are several avenues of research being explored and as these concepts are solidified this document will be revised. For example, future sections will explore methods currently in development, Wage Records editing methodologies, and those that have been developed and are currently in the revision stage, administrative databases to determine commuting patterns.

We begin this effort by describing WR and the other administrative datasets that we have found useful in exploring Wyoming's Labor Market. To facilitate a general understanding of the concepts we discuss we introduce Hypothetical Pat and Pat's two employers during Pat's relationships to Employers, Industries and Wyoming's Labor Market. While Pat's example is intended as a stand alone, most of the concepts introduced are difficult to understand without further explanation. We proceed to the methodology and definitions of the measures introduced by Pat and provide several completed tables demonstrating the utility of the measures. Lastly, the appendix of this document includes a schematic of the programs created by R&P and each program's code is provided.

Section I: Administrative Databases

Before delving into the resources (data) available to R&P for research purposes we believe it is important to introduce the concept of ethical use of data. Several of R&P's resources are comprised of confidential data about individuals in Wyoming and the best way to demonstrate our policies regarding disclosure of confidential data is by presenting an excerpt of a recent letter to the Director of Driver's Services addressing concerns on the use of the Drivers License Database.

July 23, 2002

*Debra Ornelas
Driver Services Manager
Wyoming Department of Transportation
5300 Bishop Blvd.
Cheyenne, WY 82009*

Subject: Reply to additional questions on Driver License Download

The simple answer to the question of "Is the information distributed to any other departments, organizations or individuals?" No. I will break this question in two parts. First, within office access, and the second, is external distribution. R&P guidelines governing access to data within our office, require that only staff that have an assigned research task have access and only for that period of study. Currently, access to the DL download is restricted to a few individuals who work with the data on assigned projects.

As for the second issue, that of distribution to outside entities, R&P is well aware of privacy and confidentiality requirements surrounding the use of the administrative data. In the case of redisclosure of DL data we cite "Protection of Privacy of Information in State Motor Vehicle Records" and in particular P.L. 103-322, Sec 2721(b)(5) which states a permissible use as "For use in research activities, and for use in producing statistical reports, so long as the personal information is not published, redisclosed, or used to contact the individual." Further, the Department of Employment data collected by our office is governed by W.S. 27-3-603 which briefly states "shall not be disclosed in a manner that reveals the identity of the employing unit or the individual."

Sincerely,

*Tony Glover
Senior Analyst
Wyoming Department of Employment
Research and Planning*

Wage Records

The analysis of Wage Records forms the foundation of the concepts we will discuss. To answer the question of What are Wage Records? we defer to an article published by our office in May of 1995 entitled "Wyoming Unemployment Insurance Wage Record Summary Statistics - A new way to look at Wyoming" written by Wayne M. Gosar.²

Wage records are an administrative database used to calculate UI benefits for employees who have been laid-off through no fault of their own. By law, each employer who has covered employees must submit tax reports to the state showing each employee's wage.

The required information on this tax report includes social security number (SSN) for each covered employee, year, quarter, and wages earned in the quarter. In fact, as you read this article, chances are your employer is in the process of reporting your total wages for first quarter 1995 (January, February, March) to us.

The information on this tax report is then entered into the Department of Employment's mainframe computer. The mainframe computer only maintains the previous six quarters of wage records. For example: at the end of March 1995, the wage record database included data from third quarter 1993 to fourth quarter 1994. When a new quarter is added, the oldest quarter is dropped off the system.

Before the oldest quarter is dropped off the mainframe we "download" the wage record files to a microcomputer. Thus we are able to maintain wage histories for workers in Wyoming over more than six quarters. Previous to our downloads this historic data was lost and no longer available for research.

What Types of Employment Are Not Included In Wage Records?

In last month's Wyoming Labor Force Trends, we published the 1994 Annual Average Civilian Labor Force estimate for Wyoming as calculated by the Local Area Unemployment Statistics (LAUS) program. In 1994, the annual average employment was 250,000 people. If we compare the LAUS estimate to the wage record average social security numbers for 1994, we see that wage records account for approximately 86 percent of the labor force. If wage records do not account for all people in the labor force, who are we missing? The following is a list of typical employment not covered by UI wage records. They are:

*some agricultural employment
independent contracting
self-employed
military employment
federal civilian employment
railroad employment
out-of-state employment
some elected state and local government officials
postsecondary work-study students*

At the time this overview of WR was written we had compiled about two years of WR and only began to explore its applications. Currently, we have ten years of Wyoming's WR archived and have established Memorandum of Understanding (MOU) with numerous other states to capture state to state transitions. We have further explored accessing Federal Government personnel and other entities to capture a portion of the uncovered employment listed above.

Table 1.1: Data Collected in Wyoming's Wage Records

Variable	Description
SSN	Social Security Number
UI	Unemployment Insurance Account Number
YEAR	Year of record
QTR	Quarter of record
WAGES	Wages paid by employer to employee

While Table 1 lists the variables collected by Wyoming's Unemployment Insurance (UI) tax section, there is variation from state to state. For example, Alaska captures an occupational code and Minnesota captures an employer's unit number allowing them to regionalize WR. Lastly, Wyoming has archived ten plus years but many states that we work with have much shorter time spans.

ES-202 / EQUI

As with WR the ES-202 is collected by the UI Tax section and is used to calculate employer's UI and Worker's Compensation taxes. The two datasets, WR and the ES-202, which are collected at the same time, differ on the data captured. Whereas, WR collects information on individuals that were employed in the quarter the ES-202 asks how many jobs the employer had as of the twelfth of each month in the designated quarter.

It is important to distinguish the difference between jobs as reported on the ES-202 and individuals captured in WR. A job is a slot that the employer has and individuals fill that slot and in most cases several individuals may fill the same slot, due to hires and exits, in a given quarter. For example, Eating and Drinking places with the Standard Industrial Classification (SIC) code of 58 had 18,686 jobs (slots) in the third quarter of 2001 which were filled by 24,329 individuals.

Tax rates for employers vary from industry to industry, therefore the ES-202 also captures the following employer descriptors; SIC, North American Industrial Classification (NAICS) and Ownership (Federal, State, Local or Private). Other relevant

variables include the UI account number (which allows us to tie the ES-202 to WR), total wages paid in the quarter, and address information.

Table 1.2: Relevant Data Captured from Wyoming’s ES-202

Variable	Description
UI	Unemployment Insurance Account Number
YEAR	Year of record
QTR	Quarter of record
MO1	Number of jobs as of the 12th in the 1st month of the quarter
MO2	Number of jobs as of the 12th in the 2nd month of the quarter
MO3	Number of jobs as of the 12th in the 3rd month of the quarter
TOTWAGE	Total Wages paid by the employer in the quarter
SIC	Standard Industrial Classification
NAICS	North American Industrial Classification
OWN	Ownership Code
CNTY	County
ADDRESS	Address
CITY	City
STATE	State
ZIP	Zip Code

The ES-202 captures several additional data components and we have only presented the ones relevant to this paper. Of the variables listed above the employer account number and industrial codes are used throughout this paper. The data related to the number of jobs and total wages paid will not be used until Section VII “Wage Records Editing Methods” and the geo-spatial data (address, city, state and zip) until Section VIII “Commuting Patterns from Administrative Databases.”

Driver’s License

R&P recently revised our data request for Driver’s License (DL) downloads, in cooperation with Driver’s Services, to capture a more complete time series from 1988 to present. In the past, we have used DL as our primary source of demographic data. As technology progresses (increased computing capabilities) we have developed the

capacity to address issues revolving around the movement of labor in our state. The DL data is the most readily accessible database that tracks individual’s residences through time.

The historical download was completed a couple of weeks ago and we are currently editing and exploring this rich dataset. Our new DL database downloads are captured in two distinct parts, the Client and the Operator.

The Client data contains all the personal information of those acquiring or renewing a Wyoming DL. At each point in time individual changes any aspect of their personal information a new record is generated and the old record is archived. For example, although weight is not one of the data elements we collect, if an individual’s weight changes we get a revised record and a date the change occurred. The variables captured in our Client side download are listed in Table 1.3.

Table 1.3: Relevant Data Captured from Driver’s License Client Database

Variable	Description
MVID	Motor Vehicle Identification Number (Unique number issued by DS)
DOLCH	Date of Last Change
SSN	Social Security Number
LASTNAME	Last Name
FIRSTNAME	First Name
MDDLNAME	Middle Name
CLYTYPE	Client Type
ADDRESS1	Address 1 of residence
ADDRESS2	Address 2 of residence
CITY	City of residence
STATE	State of residence
ZIP	Zip Code of residence
DOB	Date of Birth
SEX	Sex
AREACODE	Area Code of phone number
PHONE	Phone Number

The Operator data contains all the information on DL issue of those acquiring or renewing a Wyoming DL. At each time an individual is issued or renews an existing DL a new record is generated. The variables captured in our Operator side download are listed in Table 1.4.

Table 1.4: Relevant Data Captured from Driver’s License Operator Database

Variable	Description
MVID	Motor Vehicle Identification Number (Unique number issued by DS)
DOLCH	Date of Last Change
OPERNO	Operator Number
ISSUEDATE	Date Current License is Issued
EXPIRDATE	Date Current License Expires
OPERCLASS	Operator Class
ENDORS	Endorsements

At first glance it appears that the Operator data is not needed to compliment to the Client data. However, the Operator data allows us to track additional changes through time. For example, an individual that renews their DL several times but does not alter their personal (Client) data is only captured in the Client files one time. By combining the two data sets we see that indeed that individual is still in Wyoming and still maintaining their last known residence, phone number, etc.

As with the ES-202 database several of the variables listed in Tables 3 and 4 will not be used until later sections of this document. Those referring to residence information and Date of Last Change will not appear until Section VIII “Commuting Patterns from Administrative Databases.” For now, it is enough to know that the DL database is our primary source of demographic information (i.e. Sex and Date of Birth to calculate age).

Miscellaneous Data Sets

Table 1.5 list other databases archived by R&P. Each database includes their individual set of variables that are relevant to the issue analyzed. We will not go into detail in this

paper, it is just important to note that R&P is often asked to address a variety of issues. For those interested, R&P publishes the results of our analyses in our monthly Wyoming Labor Force Trends and a visit to our website (<http://lmi.state.wy.us>) will answer questions of Why? and How? we use these datasets.

Table 1.5: Miscellaneous Databases and Time Spans

Database	Time Span
Wage Records Colorado	1994 – 2002
Wage Records Nebraska	1996 – 2001
Wage Records Idaho	1995 – 2002
Wage Records South Dakota	1994 – 2002
Wage Records Utah	1998 – 2002
Wage Records Texas	1998 – 2001
Wage Records New Mexico	1998 – 2002
Wage Records Oklahoma	1999 – 2002
Unemployment Insurance Claims	1992 – 2002
Vocational Rehabilitation	1994 – 1999
JTPA	1995 – 1999
WIA	1999 – 2000
Employment Services Applicants	1994 – 1998
University of Wyoming	1995 – 1998
Casper College	1992 – 2002
Central Wyoming College	1997 – 1999, 2001
Eastern Wyoming College	1997 – 1999, 2001
Laramie County Community College	1996 – 2002
Northwest College	1997 – 1999, 2001 – 2002
Sheridan College	1997 – 1999, 2001 – 2002
Western Wyoming Community College	1997 – 1999, 2001
Department of Education (Teacher/Staff)	1992 – 2001
Professional Teaching Standards	1981 – 2001
Wyoming State Board of Nursing	1988 – 2001
Department of Family Services	1996 – 1998
Carl Perkins	1998 – 1999, 2000 – 2001

Section II: Basic Transaction (Turnover) Analysis

Turnover is the general term used to describe the churning that occurs in the Labor Market. Historically turnover has been measured by surveying employers and ascertaining the number of employees that left (Exit) employment in a given time frame. The number Exits was then divided by the number of jobs creating a ratio. For example, a Fast Food place could potentially have 30 Exits and only 15 jobs, in a given month, which would create a ratio of 200 percent.

Measuring **Exit** behavior only captures one aspect of the churning that occurs between employees and the employers. Other activities that occur are Hires (**Entries**), Hire and Exit in the same time frame (**Both**), and those that maintain a Continuous relationship with the employer (**Continuous**). In expanding the number of employee-employer interactions studied we redefine the general term turnover to that of Transactions.

Transactions are operationally defined as the relationship between an employee and an employer at a point in time. Later in Section III we will demonstrate that Transactions can also explore the relationships between Individuals and Industries, Individuals and the Labor Market, and by changing the unit of analysis Employers and the Labor Market.

Conceptual Introduction to Transaction Analysis

To conceptually introduce the Transaction Categories we need a few preliminary definitions. The definition of the term “employed” in this paper is that the individual received wages ($\$ > 0$) from the employer in a given year and quarter. In Tables 2.1 and 2.2 the capitol letter “A” denotes that the individual was employed by Employer A in the

quarter specified and letter “O” means that the individual was not employed with Employer A. Lastly, in Table 2.2 the lower case “a” specifies a quarter in which the individual could have worked for Employer A. The term Reference Quarter (Q0) designates the quarter for which the Transaction Category is to be assigned and Q-1 and Q+1 are the quarters immediately prior and subsequent to the Reference Quarter. For example if we wished to assign a Transaction Category to the employee-employer relationship in 1995q3 (the third quarter of 1995) our Reference quarter is 1995q3, Q-1 is 1995q2, and Q+1 is 1995q4.

Initial inquiry using the prior (Q-1), subsequent (Q+1), and Reference Quarter (Q0) led to the development of four mutually exclusive employee-employer interactions presented in Table 2.1. The definitions for these interactions are each provided three (an attempt to appeal to various learning styles) ways following the Table 2.1.

Table 2.1: Four Mutually Exclusive Individual / Employer Interactions in the Reference Quarter (shaded area).

Turnover Category	Quarter Prior (Q-1)	Reference Quarter (Q0)	Quarter Subsequent (Q+1)
Entry (Hire)	O	A	A
Both (Hire and Exit)	O	A	O
Exit	A	A	O
Continuous	A	A	A

Entry (Hire) (E)

- 1) An Entry is the situation in which and individual is hired by an employer in a specified quarter and maintains that employment in the subsequent quarter.
- 2) The individual was employed with Employer A in the reference quarter (Q0) and the quarter subsequent (Q+1), but was not employed with Employer A the quarter prior (Q-1).
- 3) Of the three quarters in Table 1.

Quarters Employed with Employer A	Quarters Not Employed with Employer A
Q0, Q+1	Q-1

Both (Hire and Exit) (B)

- 1) The Both category is both a Hire and an Exit in a quarter and could be an individual that starts a job and quits or someone who is hired for a temporary position.
- 2) The individual was employed with Employer A in the reference quarter (Q0), but was not employed with Employer A the quarter prior (Q-1) or the quarter subsequent (Q+1).
- 3) Of the three quarters in Table 1.

Quarters Employed with Employer A	Quarters Not Employed with Employer A
Q0	Q-1, Q+1

Exit (X)

- 1) An Exit is an individual that was employed with an employer in the specified and prior quarters but no longer works for the employer in the subsequent quarter.
- 2) The individual was employed with Employer A in the reference quarter (Q0) and the quarter prior (Q-1), but was not employed with Employer A the quarter subsequent (Q+1).
- 3) Of the three quarters in Table 1.

Quarters Employed with Employer A	Quarters Not Employed with Employer A
Q-1, Q0	Q+1

Continuous (C)

- 1) The individual maintains employment with Employer A for all quarters of interest.
- 2) The individual was employed with Employer A in the reference quarter (Q0), the quarter prior (Q-1) and the quarter subsequent (Q+1).
- 3) Of the three quarters in Table 1.

Quarters Employed with Employer A	Quarters Not Employed with Employer A
Q-1, Q0, Q+1	None

Expanded Entry and Both: Newhire and Rehire Definitions

Entry and Both are expanded to include two distinct categories, those that are Newhires and those that are Rehires. In expanding these categories it is necessary to include the four quarters prior (Q-4 to Q-1) to the Reference Quarter (Q0). This time period was deemed appropriate as it would capture Rehires that are a result of seasonal employment. Table 2.2 and the definitions below describe the extended turnover categories.

Table 2.2: Six Mutually Exclusive Individual / Employer Interactions in the Reference Quarter (shaded area).

Variable	Turnover Category	Q-4	Q-3	Q-2	Q-1	Q0	Q+1
E-N	Entry Newhire	O	O	O	O	A	A
E-R	Entry Rehire	a	a	a	O	A	A
B-N	Both Newhire	O	O	O	O	A	O
B-R	Both Rehire	a	a	a	O	A	O
X	Exit	a	a	a	A	A	O
C	Continuous	a	a	a	A	A	A

Entry Newhire (E-N)

- 1) An Entry Newhire is the same as an Entry with the exception that the individual had not worked for the employer in the last year (four consecutive quarters).
- 2) The individual was employed with Employer A in the reference quarter (Q0) and the quarter following (Q+1), but was not employed with Employer A during any of the four quarters prior (Q-4 to Q-1).
- 3)

Quarters Employed with Employer A	Quarters Not Employed with Employer A
Q0 and Q+1	Q-4 and Q-3 and Q-2 and Q-1

Entry Rehire (E-R)

- 1) An Entry Rehire is the same as an Entry with the exception that the individual has worked for the employer for at least one quarter in the prior year, excluding the prior quarter.

- 2) The individual was employed with Employer A in the reference quarter (Q0) and the quarter following (Q+1), was not employed with Employer A in the quarter prior (Q-1), but was employed in at least one of the remaining three quarters prior (Q-4 to Q-2).

3)

Quarters Employed with Employer A	Quarters Not Employed with Employer A	Employed in At Least One of the Following Quarters
Q0, Q+1	Q-1	Q-4, Q-3, Q-2

Both Newhire (B-N)

- 1) A Both Newhire is the same as a Both with the exception that the individual had not worked for the employer in the last year (four consecutive quarters).
- 2) The individual was employed with Employer A in the reference quarter (Q0), not employed the quarter following (Q+1) and was not employed with Employer A during any of the four quarters prior (Q-4 to Q-1).

3)

Quarters Employed with Employer A	Quarters Not Employed with Employer A
Q0	Q-4 and Q-3 and Q-2 and Q-1, Q+1

Both Rehire (B-R)

- 1) A Both Rehire is the same as a Both with the exception that the individual has worked for the employer for at least one quarter in the prior year, excluding the prior quarter.
- 2) The individual was employed with Employer A in the reference quarter (Q0), not employed the quarter following (Q+1), not employed the quarter prior (Q-1) but was employed in at least one of the remaining three quarters prior (Q-4 to Q-2).

3)

Quarters Employed with Employer A	Quarters Not Employed with Employer A	Employed in At Least One of the Following Quarters
Q0	Q-1, Q+1	Q-4, Q-3, Q-2

At this time we have conceptually introduced the six Transaction Categories. We end this part of Section II with an example using Hypothetical Pat. Pat represents one of the multitudes of individuals that have worked in Wyoming's Labor Market in the past.

Table 2.3 shows Pat’s employment history with three employers and the relevant Turnover Categories that are assigned to the relationships Pat has with these employers at each point in time. For all Hypothetical Pat examples to follow the beginning of our WR time span is 1992q1 and the end is 2002q2.

Table 2.3: Hypothetical Pat and Pat’s Three Employers

	1995				1996				1997			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A-OK Construction												
Transaction Category	E-N	C	X		B-R					B-N		
Dandy Do Construction												
Transaction Category			E-N	X		E-R	C	C	C	X		
A-Plus Retail Hardware												
Transaction Category								E-N	C	C	C	X
Pat’s Total Transactions	1	1	2	1	1		1	2	2	3	1	1

The conceptual approach is a good way to visualize what we are trying to do. However, as Pat in Table 2.3 represents three Total Transactions in 1997q2, in reality there are 225,240 unique individuals creating 261,842 Total Transactions in Wyoming in 1997q2. The next part of this section introduces the mathematical approach to calculating Turnover Categories for the multitudes.

Mathematical Introduction to Transaction Analysis

In order to calculate the Turnover Categories mathematically we need to introduce the “fixed symbolic vocabulary” that will be used throughout the remainder of this paper. The terminology below is a three-part definition separated by dashes. The first component designates “Unit” we are analyzing. The second part specifies the “Temporal Activity” we will measure and the third the relative to what or the “Level of

Analysis.” Below we present the simplest scenarios necessary to determine our Transaction Categories to this point. In Section III we will expand the number of Units and Levels of Analysis to include behavior we have not yet explored.

Unit Level

S – SSN or an Individual that works in UI covered employment. By definition the SSN must appear in WR with wages.

Temporal Activity

NW – Next With is defined as the distance in time (quarters) between the current observation and the next occurrence of the same observation.

LW – Last With designates that the observation is the last occurrence in the available data.

PW – Previous With is defined as the distance in time between the current observation and the prior observation.

FW – First With designates that the observation is the first occurrence in the available data.

Level of Analysis

E – Employer represents the UI account.

Combined Definitions – Putting the parts together

S-NW-E – SSN, Next With, Employer = The number of quarters between the current quarter and the next quarter the SSN appears with the same employer. For example, Table 1 shows Hypothetical Pat working for A-OK construction in 1995q2 and 1995q3 and therefore S-NW-E for 1995q2 equals 1. Focusing on 1995q3 the value of S-NW-E equals 2 because Pat worked for A-OK in 1995q3 did not work for A-OK in 1995q4 and re-appears with A-OK in 1996q1.

S-LW-E – SSN, Last With, Employer is a special case of **S-NW-E** which occurs either because the individual separates permanently from the employer or we are at the end of our WR timespan. As an operational definition **S-LW-E** is coded as **S-NW-E** and

always = 0. Referring to Table 1 Pat's last quarter working for A-OK Construction is 1999q3 and **S-NW-E** = 0

S-PW-E – SSN, Previous With, Employer = The number of quarters between the current quarter and the previous quarter the SSN appears with the same employer. For example, Table 1 shows Hypothetical Pat working for A-OK construction in 1995q1 and 1995q2 and therefore **S-PW-E** for 1995q2 equals 1. Focusing on 1996q1 the value of **S-PW-E** equals 2 because Pat worked for A-OK in 1995q3 did not work for A-OK in 1995q4 and re-appears with A-OK in 1996q1.

S-FW-E – SSN, First With, Employer is a special case of **S-PW-E** which occurs either because this is the first quarter the individual worked for the employer or we are at the beginning of our WR time span. As an operational definition **S-FW-E** is coded as **S-PW-E** and always = 0. Referring to Table 1 Pat's first quarter working for A-OK Construction is 1995q1 and **S-PW-E** = 0.

Table 2.4: Hypothetical Pat and Pat's Three Employers and the Combined Definitions

	1995				1996				1997			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A-OK Construction												
S-NW-E	1	1	2		5					0		
S-PW-E	0	1	1		2					5		
Transaction Category	E-N	C	X		B-R					B-N		
Dandy Do Construction												
S-NW-E			1	3			1	1	1	0		
S-PW-E			0	1			3	1	1	1		
Transaction Category			E-N	X			E-R	C	C	X		
A-Plus Retail Hardware												
S-NW-E								1	1	1	1	0
S-PW-E								0	1	1	1	1
Transaction Category								E-N	C	C	C	X
Pat's Total Transactions	1	1	2	1	1		1	2	2	3	1	1

Converting Combined Definitions to Transaction Categories

Converting the above definitions to Transaction Categories relies on the six logical statements listed below.

Entry Newhire (E-N) occurs if the following statement is true:

(1) $(S-PW-E = 0 \text{ or } S-PW-E > 4)$ and $S-NW-E = 1$

Pat either never worked for A-OK Construction or at least Pat has not worked there in the prior 4 quarters and Pat does work for them in the next quarter.

Entry Rehire (E-R) occurs if the following statement is true:

(2) $S-PW-E > 1$ and $S-PW-E < 5$ and $S-NW-E = 1$

Same as (1) with the exception that Pat has worked for A-OK within the last 4 quarters.

Both Newhire (B-N) occurs if the following statement is true:

(3) $(S-PW-E = 0 \text{ or } S-PW-E > 4)$ and $S-NW-E \neq 1$

Pat either never worked for A-OK Construction or at least has not worked there in the prior 4 quarters and Pat does not work for them in the next quarter.

Both Rehire (B-R) occurs if the following statement is true:

(4) $S-PW-E > 1$ and $S-PW-E < 5$ and $S-NW-E \neq 1$

Same as (3) with the exception that Pat has worked for A-OK within the last 4 quarters.

Continuous (C) occurs if the following statement is true:

(5) $S-PW-E = 1$ and $S-NW-E = 1$

Pat worked for A-OK in the prior, current and subsequent quarters.

Exit (X) occurs if the following statement is true:

(6) $S-PW-E = 1$ and $S-NW-E \neq 1$

Pat worked for A-OK in the prior and current quarter but does not work for A-OK in the subsequent quarter.

*** Other State Perspective ***

Wyoming's definitions of Transactions differ from those of Minnesota. I am not entirely sure of the details of their previous work but one aspect comes to mind and may be of future interest. Minnesota divides the Exit Transactions into two distinct types of Exits, similar to the Newhire/Rehire components of Entries

listed above. We therefore offer the following definitions for those interested, which would replace the Both and Exit Transaction Categories above.

Both Newhire Rehire (B-N-R) occurs if the following statement is true:

(3a) $(S-PW-E = 0 \text{ or } S-PW-E > 4) \text{ and } S-NW-E > 1 \text{ and } S-NW-E < 5$

Pat either never worked for A-OK Construction or at least has not worked there in the prior 4 quarters, Pat does not work for them in the next quarter but will return to employment within 4 quarters.

Both Newhire Exit (B-N-X) occurs if the following statement is true:

(3b) $(S-PW-E = 0 \text{ or } S-PW-E > 4) \text{ and } (S-NW-E = 0 \text{ or } S-NW-E > 4)$

Pat has not worked for A-OK within the last 4 quarters and Pat does not return to employment with A-OK in the next 4 quarters.

Both Rehire Rehire (B-R-R) occurs if the following statement is true:

(4a) $S-PW-E > 1 \text{ and } S-PW-E < 5 \text{ and } S-NW-E > 1 \text{ and } S-NW-E < 5$

Pat did not work for A-OK in the prior quarter, has worked for A-OK within the last 4 quarters and Pat does not work for A-OK in the subsequent quarter but returns within four quarters.

Both Rehire Exit (B-R-X) occurs if the following statement is true:

(4b) $S-PW-E > 1 \text{ and } S-PW-E < 5 \text{ and } (S-NW-E = 0 \text{ or } S-NW-E > 4)$

Pat did not work for A-OK in the prior quarter, has worked for A-OK within the last 4 quarters and Pat does not work for A-OK in the following four quarters.

Exit Rehire (X-R) occurs if the following statement is true:

(6a) $S-PW-E = 1 \text{ and } S-NW-E > 1 \text{ and } S-NW-E < 5$

Pat worked for A-OK in the prior, does not work for A-OK in the subsequent quarter but returns within 4 quarters.

Exit Exit (X-X) occurs if the following statement is true:

(6b) $S-PW-E = 1 \text{ and } (S-NW-E = 0 \text{ or } S-NW-E > 4)$

Pat worked for A-OK in the prior and does not work for A-OK in the subsequent 4 quarters.

Table 2.5: Hypothetical Pat and Pat's Three Employers and the Combined Definitions Minnesota Style

	1995				1996				1997				
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
A-OK Construction													
S-NW-E	1	1	2		5						0		
S-PW-E	0	1	1		2						5		
Transaction Category	E-N	C	X-R		B-R-X						B-N-X		
Dandy Do Construction													
S-NW-E			1	3			1	1	1	0			
S-PW-E			0	1			3	1	1	1			
Transaction Category			E-N	X-R			E-R	C	C	X-X			
A-Plus Retail Hardware													
S-NW-E							1	1	1	1	1	0	
S-PW-E							0	1	1	1	1	1	
Transaction Category							E-N	C	C	C	C	X-X	
Pat's Total Transactions	1	1	2	1	1		1	2	2	3	1	1	

We will not discuss Minnesota's methodology for the remainder of this paper but thought it would introduce the flexibility of the methods we are developing.

The Conceptual and Mathematical Applied to Reality

Hypothetical Pat provides a convenient way to display data with time beginning on the left and ending on the right which fits with many peoples perception of the universe. In reality Pat's records as recorded in WR are recorded vertically as in Table 2.6 and records for the quarters for which Pat **did not** work for the specified employer **do not exist**.

A review of Table 2.6 (which should be reviewed relative to Table 2.4) shows that we have added a column for Row Number and a column named Period which was not previously discussed. The first Row Number is simply included to assist you in tracking the discussion following the table. Period is a new variable that we add to our WR data and is simply a numeric representation of time (the Year and Quarter combined). For example our WR data begins in 1992q1 and the value of Period at that time equals 1, 1992q2 = 2, 1992q3 = 3.....1995q1 = 13 2002q2 = 42. Period allows us to easily

calculate S-NW-E and S-PW-E in a large database such as WR that now consists of over 10,000,000 records.

Table 2.6: Hypothetical Pat and Pat's Actual Record Layout in Wage Records

ROW #	SSN	UI ACCOUNT	YEAR	QTR	WAGES	PERIOD	S-NW-E	S-PW-E	TRANSACTION CATEGORY
1	PAT	A-OK Construction	1995	1	1000	13	1	0	E-N
2	PAT	A-OK Construction	1995	2	1000	14	1	1	C
3	PAT	A-OK Construction	1995	3	750	15	2	1	X
4	PAT	A-OK Construction	1996	1	750	17	5	2	B-R
5	PAT	A-OK Construction	1997	2	250	22	0	5	B-N
6	PAT	Dandy Do Construction	1995	3	750	15	1	0	E-N
7	PAT	Dandy Do Construction	1995	4	750	16	3	1	X
8	PAT	Dandy Do Construction	1996	3	500	19	1	3	E-R
9	PAT	Dandy Do Construction	1996	4	250	20	1	1	C
10	PAT	Dandy Do Construction	1997	1	250	21	1	1	C
11	PAT	Dandy Do Construction	1997	2	250	22	0	1	X
13	PAT	A-Plus Hardware	1996	4	500	20	1	0	E-N
14	PAT	A-Plus Hardware	1997	1	500	21	1	1	C
15	PAT	A-Plus Hardware	1997	2	500	22	1	1	C
16	PAT	A-Plus Hardware	1997	3	500	23	1	1	C
17	PAT	A-Plus Hardware	1997	4	500	24	0	1	X

The first step in assigning a Transaction Category to each and every record (which represents an employee-employer observation) is to order your data as shown in Table 2.6. This ordering (SSN ascending, UI ascending, YEAR ascending, QTR ascending) aligns all the observations of Pat with A-OK Construction in a time continuum, as well as, Pat with Dandy Do Construction, and Pat with A-Plus Hardware.

Starting at row 1, recall that our WR time span begins with 1992q1 but the first time Pat occurs in our data is 1995q1, as this is the first quarter which Pat works for A-OK Construction by definition $S-PW-E = 0$. The value of S-NW-E is the product of subtracting the value of PERIOD from ROW 1 from PERIOD in ROW 2. One more time focusing on ROW 4, or Pat with A-OK Construction in 1996q1.

- $S-NW-E = \text{PERIOD (ROW 5)} - \text{PERIOD (ROW 4)} = 5$
- $S-PW-E = \text{PERIOD (ROW 4)} - \text{PERIOD (ROW 3)} = 2$
- and continue through the records until all values of S-NW-E and S-PW-E are assigned.
- Apply the six logical statements in the Mathematical Introduction.

We placed the definition of an Algorithm on the cover of this paper; let's see how many of the criteria we've met at this time.

- ***a finite procedure***, we have in fact outlined a set of rules
- ***written in a fixed symbolic language*** , recall the Mathematical Introduction
- ***governed by precise instructions***, we haven't left anything open to interpretation
- ***moving in discrete steps, 1, 2, 3...***, order records, assign values of S-NW-E and S-PW-E, apply the six logical statements
- ***whose execution requires no insight, cleverness, intuition, intelligence, or perspicuity***, we've done all this for you
- ***and that sooner or later comes to an end***, it ends with the last record in your data, but I never thought this section would.

Section III: Levels of Analysis

So far we have focused only on the SSN-Transactions With-Employers level of analysis. The Table 3.1a shows us what we already have ascertained about Pat's relationship with his employers. We could infer that Pat's relationships with employers in the Construction Industry are patchy at best. In reality we don't know much about Pat, Pat may well be a finish carpenter working spot jobs with the two employers listed, which quite likely satisfies both Pat and the Employers needs. In this section we introduce the concept of there's more than one way to look at Pat, and not all of them are addressed here.

SSN-Transactions With-Industries

In our hypothetical examples we have incorporated the Industry in which Pat is working within the employer's name. For example, both A-OK and Dandy Do are in the Construction Industry and A-Plus is in the Retail Trade Industry. The first step to ascertaining Pat's relationship with Industries is to aggregate (group) Pat to the Industry level. The second section of Table 3.1b shows Pat aggregated relationship to the Construction and Retail Industries.

Things to note in Table 3.1b;

- Employer names are no longer listed as they are not relevant at the Industry level.
- S-NW-E has been changed to S-NW-I and S-PW-E to S-PW-I but they are calculated exactly the same as in the Mathematical Introduction of Section II.
- Regardless of the number of Employers Pat has within an Industry Pat can only have one Transaction at the Industry Level.
- When Pat works in more than one Industry from 1996q4 to 1997q2 Pat has two Total Transactions.

Table 3.1: Hypothetical Pat and Levels of Analysis

	1995				1996				1997			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Part a: SSN-Transactions With-Employer												
A-OK Construction												
S-NW-E	1	1	2		5					0		
S-PW-E	0	1	1		2					5		
Transaction Category	E-N	C	X		B-R					B-N		
Dandy Do Construction												
S-NW-E			1	3		1	1	1		0		
S-PW-E			0	1		3	1	1		1		
Transaction Category			E-N	X		E-R	C	C		X		
A-Plus Retail Hardware												
S-NW-E							1	1	1	1	1	0
S-PW-E							0	1	1	1	1	1
Transaction Category							E-N	C	C	C	C	X
Pat's Total Transactions	1	1	2	1	1		1	2	2	3	1	1
Part b: SSN-Transactions With-Industry												
Construction												
S-NW-I	1	1	1	1	2		1	1	1	0		
S-PW-I	0	1	1	1	1		2	1	1	1		
Transaction Category	E-N	C	C	C	X		E-R	C	C	X		
Retail Trade												
S-NW-I							1	1	1	1	1	0
S-PW-I							0	1	1	1	1	1
Transaction Category							E-N	C	C	C	C	X
Pat's Total Transactions	1	1	1	1	1		1	2	2	2	1	1
Part c: SSN-Transactions With-Market												
Labor Market												
S-NW-M	1	1	1	1	2		1	1	1	1	1	0
S-PW-M	0	1	1	1	1		2	1	1	1	1	1
Transaction Category	E-N	C	C	C	X		E-R	C	C	C	C	X
Pat's Total Transactions	1	1	1	1	1		1	1	1	1	1	1

SSN-Transactions With-Labor Market

The highest level of aggregation we will discuss is SSN-Transactions With-Labor Market. The first step to ascertaining Pat's relationship with Wyoming's Labor Market is to aggregate (group) Pat to the Labor Market level. Table 3.1c shows Pat aggregated relationship to the Labor Market.

Things to note in Table 3.1c;

- Employer and Industry names are no longer listed as they are not relevant at the Labor Market level.
- S-NW-E has been changed to S-NW-M and S-PW-E to S-PW-M but they are calculated exactly the same as in the Mathematical Introduction of Section II.
- Regardless of the number of Employers or Industries within the Labor Market Pat can only have one Transaction at the Labor Market Level.

Combinations on SSN as the Unit of Analysis

SSN-Transactions With-Multi-State Regional Market

SSN-Transactions With-Wyoming's Market

SSN-Transactions With-In State Region

SSN-Transactions With-County

SSN-Transaction With-Industry

SSN-Transactions With-Sub-Industry

SSN-Transactions With-Employers

The list could go on a while when we say that the Level of Analysis could be a combination of any of the above listed. For example, we may be interested in determining the availability and stability of Construction Workers in Campbell County. The Level of Analysis then Becomes SSN-Transactions With-Campbell County Construction Industry.

Section IV: Aggregations and Rate Calculations

We have defined and demonstrated how to assign the proper Transaction Categories (B-N, B-R, E-N, E-R, C, X) and discussed the level of analysis. Tables 4.1 - 4.3 shows what Pat's data files look like at this point for the three levels of analysis. In this section we introduce the operational definitions of several rate calculations and various ways which the data at the differing levels are aggregated.

Table 4.1: Hypothetical Pat and Pat's Actual Record Layout in Wage Records at SSN – Transaction With - Employer Level

SSN	UI ACCOUNT	INDUSTRY	YEA R	QTR	WAGES	PERIOD	S-NW-E	S-PW-E	TRANS CATEGORY
PAT	A-OK Construction	Construction	1995	1	1000	13	1	0	E-N
PAT	A-OK Construction	Construction	1995	2	1000	14	1	1	C
PAT	A-OK Construction	Construction	1995	3	750	15	2	1	X
PAT	A-OK Construction	Construction	1996	1	750	17	5	2	B-R
PAT	A-OK Construction	Construction	1997	2	250	22	0	5	B-N
PAT	Dandy Do Construction	Construction	1995	3	750	15	1	0	E-N
PAT	Dandy Do Construction	Construction	1995	4	750	16	3	1	X
PAT	Dandy Do Construction	Construction	1996	3	500	19	1	3	E-R
PAT	Dandy Do Construction	Construction	1996	4	250	20	1	1	C
PAT	Dandy Do Construction	Construction	1997	1	250	21	1	1	C
PAT	Dandy Do Construction	Construction	1997	2	250	22	0	1	X
PAT	A-Plus Hardware	Retail Trade	1996	4	500	20	1	0	E-N
PAT	A-Plus Hardware	Retail Trade	1997	1	500	21	1	1	C
PAT	A-Plus Hardware	Retail Trade	1997	2	500	22	1	1	C
PAT	A-Plus Hardware	Retail Trade	1997	3	500	23	1	1	C
PAT	A-Plus Hardware	Retail Trade	1997	4	500	24	0	1	X

Table 4.2: Hypothetical Pat and Pat's Actual Record Layout in Wage Records at SSN – Transaction With - Industry Level

SSN	INDUSTRY	YEA R	QTR	WAGES	PERIO D	S-NW-I	S-PW-I	TRANS CATEGORY
PAT	Construction	1995	1	1000	13	1	0	E-N
PAT	Construction	1995	2	1000	14	1	1	C
PAT	Construction	1995	3	1500	15	1	1	C
PAT	Construction	1995	4	750	16	1	1	C
PAT	Construction	1996	1	750	17	2	1	X
PAT	Construction	1996	3	500	19	1	2	E-R
PAT	Construction	1996	4	250	20	1	1	C
PAT	Construction	1997	1	250	21	1	1	C
PAT	Construction	1997	2	500	22	0	1	X
PAT	Retail Trade	1996	4	500	20	1	0	E-N
PAT	Retail Trade	1997	1	500	21	1	1	C
PAT	Retail Trade	1997	2	500	22	1	1	C
PAT	Retail Trade	1997	3	500	23	1	1	C
PAT	Retail Trade	1997	4	500	24	0	1	X

Table 4.3: Hypothetical Pat and Pat's Actual Record Layout in Wage Records at SSN – Transaction With - Market Level

SSN	YEAR	QTR	WAGES	PERIOD	S-NW-M	S-PW-M	TRANS CATEGORY
PAT	1995	1	1000	13	1	0	E-N
PAT	1995	2	1000	14	1	1	C
PAT	1995	3	1500	15	1	1	C
PAT	1995	4	750	16	1	1	C
PAT	1996	1	750	17	2	1	X
PAT	1996	3	500	19	1	2	E-R
PAT	1996	4	750	20	1	1	C
PAT	1997	1	750	21	1	1	C
PAT	1997	2	1000	22	1	1	C
PAT	1997	3	500	23	1	1	C
PAT	1997	4	500	24	0	1	X

In reviewing Tables 4.1 – 4.3 it is apparent at this level of detail the data are difficult to interpret. This is further compounded when you consider that Pat only represents one individual's contact with Wyoming's Labor market. In reality there are between 250,000 and 300,000 unique individuals in any given quarter working with multiple employers and Industries. So our next step is to convert the micro level data to a useable format. We begin by grouping the data on the SSN, Year, Quarter, and Transaction Category then counting the number of times each activity occurs. The results of this process are presented in Table 4.4 for the Retail Trade Industry at both the SSN-Transactions With-Employer and the SSN-Transactions With-Industry levels.

Most of the variables listed (E-N, E-R, B-N, etc.) in Table 4.4 are familiar and we will discuss the Exit Rate, Entry Rate, Cont Rate, and Flow Rate in the next paragraph. The numbers filling the cells of Table 4.4a are the number of employee-employer interactions that met the rules outlined in Section II and the SSN-Transactions With-Employer Level of Analysis from Section III. Similarly, the numbers in Table 4.4b are the employee-industry interactions at the SSN-Transaction With-Industry Level of Analysis. For example, referring to Table 3.1a, if Table 4.4 referred to the Construction Industry the Industry rather than Retail Trade, Pat would have contributed one Exit (X), one Entry Newhire (E-N), and two Total Transactions in 1995q3 to a table similar to 4.4a. Following the same line of thought Pat (referring to Table 3.1b) would have added one Continuous, and one Total Transaction to a table similar to 4.4b.

Table 4.4: Retail Trade Transaction Data at the SSN - Transactions With – Employer and SSN - Transactions With – Industry

	1995				1996				1997			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Part a: SSN - Transactions With – Employer												
B-N	3,470	6,443	7,927	5,512	3,657	5,772	8,254	5,772	3,844	5,834	7,840	5,888
B-R	399	554	621	572	450	735	794	735	515	677	851	670
E-N	6,477	11,332	10,142	7,113	6,030	11,039	10,187	6,811	8,122	11,026	9,815	7,309
E-R	952	1,995	793	784	1,017	2,447	1,068	946	1,465	2,829	963	991
X	7,565	9,588	12,281	10,630	7,558	9,417	13,250	11,670	7,684	9,583	12,323	10,926
C	31,490	29,327	30,354	30,662	30,892	28,536	28,738	28,335	28,511	28,524	30,053	29,904
Total Trans	50,353	59,239	62,118	55,273	49,604	57,946	62,291	54,269	50,141	58,473	61,845	55,688
Exit Rate	22.7%	28.0%	33.5%	30.2%	23.5%	27.5%	35.8%	33.5%	24.0%	27.5%	34.0%	31.4%
Entry Rate	22.4%	34.3%	31.4%	25.3%	22.5%	34.5%	32.6%	26.3%	27.8%	34.8%	31.5%	26.7%
Cont Rate	62.5%	49.5%	48.9%	55.5%	62.3%	49.2%	46.1%	52.2%	56.9%	48.8%	48.6%	53.7%
Flow Rate	-0.3%	6.3%	-2.2%	-4.9%	-1.0%	7.0%	-3.2%	-7.2%	3.8%	7.3%	-2.5%	-4.7%
Part b: SSN - Transactions With – Industry												
B-N	1,493	2,797	3,788	2,534	1,646	2,566	4,073	2,601	1,691	2,522	3,859	2,795
B-R	508	870	1,017	800	612	1,081	1,249	916	666	1,009	1,213	930
E-N	3,753	7,304	5,968	4,118	3,214	7,055	5,919	4,099	3,549	6,886	5,732	4,160
E-R	1,702	3,714	1,958	1,636	1,868	4,130	2,365	1,898	2,405	4,545	2,281	1,878
X	5,634	6,675	9,876	8,457	5,745	6,790	10,609	7,996	5,780	6,888	9,804	8,592
C	34,209	32,989	34,131	33,600	33,609	31,901	32,477	32,765	32,982	32,048	33,675	33,096
Total Trans	47,299	54,349	56,738	51,145	46,694	53,523	56,692	50,275	47,073	53,898	56,564	51,451
Exit Rate	16.1%	19.0%	25.9%	23.1%	17.1%	19.5%	28.1%	22.9%	17.3%	19.3%	26.3%	23.9%
Entry Rate	15.8%	27.0%	22.4%	17.8%	15.7%	27.7%	24.0%	18.9%	17.7%	27.8%	23.1%	19.0%
Cont Rate	72.3%	60.7%	60.2%	65.7%	72.0%	59.6%	57.3%	65.2%	70.1%	59.5%	59.5%	64.3%
Flow Rate	-0.4%	8.0%	-3.4%	-5.3%	-1.4%	8.2%	-4.1%	-4.0%	0.4%	8.4%	-3.2%	-5.0%

Rate Calculations

A Rate is defined in Webster’s Dictionary as “A ratio between two things” and the definition applies to this paper as well. What we are attempting to describe at the end of the process outlined in the first four sections of this paper is some aspect of the activities of masses of individuals relative to Employers, Industries, and Markets. To this end we quantify our data as rates which are more commonly referred to as percents.

Exit Rate

Of our six defined Transaction Categories three describe individuals leaving something (Employers, Industries, or the Market). These are Exits (X), Both Newhires (B-N), and Both Rehires (B-R). Therefore, the percent of Transactions involving individuals leaving employers in Table 4.4a for 1995q1 is $(7,565 (X) + 3,470 (B-N) + 399 (B-R)) / 50,353$ (Total Transactions) which equals 22.7 percent.

Formula 4.1: Exit Rate Calculation Applied to 1995q1 for Tables 4.4a and 4.4b

	Operational Definition	SSN-Transaction With-Employer Level (Table 4.4a)		SSN-Transaction With-Market Level (Table 4.4b)
Exit Rate	$\frac{(X + B-N + B-R)}{\text{Total Transactions}}$	$\frac{(7,565 + 3,470 + 399)}{50,353}$	= 22.7%	$\frac{(5,634 + 1,493 + 508)}{47,299}$
				= 16.1%

Entry Rate

Of our six defined Transaction Categories four describe individuals entering something (Employers, Industries, or the Market). These are Entry Newhires (E-N), Entry Rehires (E-R), Both Newhires (B-N), and Both Rehires (B-R). Therefore, the percent of Transactions involving individuals entering (being hired) by employers in Table 4.4a for 1995q1 is (6,477 (E-N) + 952 (E-R) + 3,470 (B-N) + 399 (B-R)) / 50,353 (Total Transactions) which equals 22.4 percent.

Formula 4.2a: Entry Rate Calculation Applied to 1995q1 for Tables 4.4a and 4.4b

	Operational Definition	SSN-Transaction With-Employer Level (Table 4.4a)		SSN-Transaction With-Market Level (Table 4.4b)
Entry Rate	$\frac{(E-R + E-N + B-N + B-R)}{\text{Total Transactions}}$	$\frac{(6,477 + 952 + 3,470 + 399)}{50,353}$	= 22.4%	$\frac{(3,753 + 1,702 + 1,493 + 508)}{47,299}$
				= 15.8%

Entry Rate can further be decomposed to Entry Newhire Rate (Formula 4.2b) and Entry Rehire Rate (Formula 4.2c).

Formula 4.2b: Entry Newhire Rate Calculation Applied to 1995q1 for Tables 4.4a and 4.4b

	Operational Definition	SSN-Transaction With-Employer Level (Table 4.4a)		SSN-Transaction With-Market Level (Table 4.4b)
Entry Rate	$\frac{(E-N + B-N)}{\text{Total Transactions}}$	$\frac{(6,477 + 3,470)}{50,353}$	= 19.8%	$\frac{(3,753 + 1,493)}{47,299}$
				= 11.1%

Formula 4.2c: Entry Rehire Rate Calculation Applied to 1995q1 for Tables 4.4a and 4.4b

	Operational Definition	SSN-Transaction With-Employer Level (Table 4.4a)		SSN-Transaction With-Market Level (Table 4.4b)
Entry Rate	$\frac{(E-R + B-R)}{\text{Total Transactions}}$	$\frac{(952 + 399)}{50,353}$	= 2.7%	$\frac{(1,702 + 508)}{47,299}$
				= 4.7%

Continuous Rate

Of our six defined Transaction Categories only one that of Continuous describes a continuity of attachment to Employers, Industries, or the Market. Therefore, the percent of Transactions involving individuals maintaining attachment to employers in Table 4.4a for 1995q1 is (31,490 (C)) / 50,353 (Total Transactions) which equals 62.5 percent.

Formula 4.3: Continuous Rate Calculation Applied to 1995q1 for Tables 4.4a and 4.4b

	Operational Definition	SSN-Transaction With-Employer Level (Table 4.4a)		SSN-Transaction With-Market Level (Table 4.4b)	
Cont Rate	= $\frac{C}{\text{Total Transactions}}$	$\frac{31,490}{50,353}$	= 62.5%	$\frac{34,209}{47,299}$	= 72.3%

Flow Rate

Flow Rate is a combination of several Transaction Categories and assesses the difference between Entries and Exits. To this end we subtract the Number of Exits from the number of Entries. Therefore, the Flow Rate for Table 4.4a for 1995q1 is (6,477 (E-N) + 952 (E-R)) – (7,565 (X))) / 50,353 (Total Transactions) which equals -0.3 percent. The Transaction Categories Both Newhire and Both Rehire are self canceling as they are Entries and Exits in the same quarter.

Formula 4.4: Flow Rate Calculation Applied to 1995q1 for Tables 4.4a and 4.4b

	Operational Definition	SSN-Transaction With-Employer Level		SSN-Transaction With-Market Level	
Flow Rate	= $\frac{(E-N + E-R) - X}{\text{Total Transactions}}$	$\frac{(6,477 + 952) - 7,565}{50,353}$	= -0.3%	$\frac{(3,753 + 1,702) - 5,634}{47,299}$	= -0.4%

Aggregations

We just introduced one grouping scheme in Table 4.4, that of Year→Quarter→Retail Trade in Wyoming at both the SSN-Transaction With-Employer and the SSN-Transaction With-Industry levels. Recall, from Section I of this paper that the grouping scheme presented in Table 4.4 is a product of two databases maintained by R&P. The first is Wage Records (WR) and the second, which allows us to tie a Standard Industrial Classification (SIC) number to employer accounts in WR, is the ES-202/EQUI.

Table 4.5 presents a desegregation of Table 4.4. Using the Driver's License data merged to WR on the Social Security Number we are able to break the SSN-Transaction With-Employer data into distinct age groups. Therefore, the aggregation scheme for Table 4.5 becomes Year→Quarter→Retail Trade→Age Group. For brevity sake, we only present the detailed Transaction Categories for Age Groups 00 to 19 and 20-24. The remainder of the Age Groups give the Total Transactions and Total Exits (Exit + Both Newhire + Both Rehire) which is enough data to calculate the Exit Rates presented in Table 4.6. The results are as we expect with declining Exit Rates as Individuals age. The last Age Group specified "Not Available" represents individuals that either came to work in Wyoming for a short period of time or those that have not yet acquired a Wyoming DL.

Table 4.5: Retail Trade Transaction Data by Age Group at the SSN-Transactions With-Employer Level

	1995				1996				1997			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Age Group 00 to 19 Years												
B-N	636	1,509	2,365	1,304	594	1,332	2,304	1,346	519	1,343	2,212	1,385
B-R	81	158	139	95	92	143	176	121	98	130	176	120
E-N	1,467	3,622	3,066	1,801	1,265	3,350	2,973	1,829	1,442	3,365	2,826	1,936
E-R	178	547	162	144	192	619	151	172	232	550	149	153
X	4,177	3,683	4,292	4,891	3,962	3,557	3,981	4,555	3,660	3,461	4,016	4,409
C	1,337	2,137	3,557	2,629	1,278	1,863	3,544	2,552	1,281	1,875	3,360	2,582
Total Trans	7,876	11,656	13,581	10,864	7,383	10,864	13,129	10,575	7,232	10,724	12,739	10,585
Total Exits	2,054	3,804	6,061	4,028	1,964	3,338	6,024	4,019	1,898	3,348	5,748	4,087
Age Group 20 to 24 Years												
B-N	895	1,451	1,590	1,226	855	1,284	1,698	1,244	924	1,376	1,630	1,304
B-R	120	121	143	100	134	180	180	155	150	168	215	117
E-N	1,649	2,573	2,284	1,596	1,480	2,496	2,259	1,560	2,005	2,450	2,203	1,672
E-R	229	484	173	167	264	532	206	193	316	615	181	195
X	5,182	4,673	4,655	4,866	5,170	4,465	4,394	4,352	4,756	4,582	4,603	4,704
C	1,950	2,387	3,071	2,247	1,919	2,452	3,094	2,507	2,026	2,499	3,044	2,283
Total Trans	10,025	11,689	11,916	10,202	9,822	11,409	11,831	10,011	10,177	11,690	11,876	10,275
Total Exits	2,965	3,959	4,804	3,573	2,908	3,916	4,972	3,906	3,100	4,043	4,889	3,704
Age Group 25 to 34 Years												
Total Trans	12,349	13,371	13,551	12,871	12,025	13,009	13,416	12,248	11,777	12,857	12,938	12,160
Total Exits	2,810	3,660	3,951	3,685	2,866	3,590	4,294	3,899	2,894	3,627	3,832	3,606
Age Group 35 to 44 Years												
Total Trans	9,961	10,688	10,884	10,513	9,950	10,831	11,155	10,400	10,180	11,076	11,370	11,049
Total Exits	1,615	2,175	2,271	2,409	1,712	2,234	2,703	2,733	1,831	2,264	2,543	2,601
Age Group 45 to 54 Years												
Total Trans	5,497	5,848	5,844	5,754	5,739	6,071	6,164	5,791	5,881	6,373	6,416	6,200
Total Exits	754	1,007	1,004	1,121	869	1,069	1,336	1,381	911	1,134	1,214	1,350
Age Group 55 to 64 Years												
Total Trans	2,510	2,580	2,564	2,511	2,522	2,697	2,727	2,600	2,701	2,860	2,833	2,727
Total Exits	317	366	360	460	316	415	477	617	351	447	461	548
Age Group 65 and Up Years												
Total Trans	1,036	1,090	1,054	1,022	961	1,040	1,011	979	988	1,011	1,030	983
Total Exits	136	167	190	259	133	180	181	285	161	162	179	224

Age Group Not Available												
Total Trans	1,099	2,317	2,724	1,536	1,202	2,025	2,858	1,665	1,205	1,882	2,643	1,709
Total Exits	783	1,447	2,188	1,179	897	1,182	2,311	1,337	897	1,069	2,148	1,364
All Age Groups												
Total Trans	50,353	59,239	62,118	55,273	49,604	57,946	62,291	54,269	50,141	58,473	61,845	55,688
Total Exits	11,434	16,585	20,829	16,714	11,665	15,924	22,298	18,177	12,043	16,094	21,014	17,484

Table 4.6: Exit Rates of Retail Trade by Age Group at the SSN-Transaction With-Employer Level

Age Group	1995				1996				1997			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
00-19	26.1	32.6	44.6	37.1	26.6	30.7	45.9	38.0	26.2	31.2	45.1	38.6
20-24	29.6	33.9	40.3	35.0	29.6	34.3	42.0	39.0	30.5	34.6	41.2	36.1
25-34	22.8	27.4	29.2	28.6	23.8	27.6	32.0	31.8	24.6	28.2	29.6	29.7
35-44	16.2	20.4	20.9	22.9	17.2	20.6	24.2	26.3	18.0	20.4	22.4	23.5
45-54	13.7	17.2	17.2	19.5	15.1	17.6	21.7	23.9	15.5	17.8	18.9	21.8
55-64	12.6	14.2	14.0	18.3	12.5	15.4	17.5	23.7	13.0	15.6	16.3	20.1
65-Up	13.1	15.3	18.0	25.3	13.8	17.3	17.9	29.1	16.3	16.0	17.4	22.8
N/A	71.3	62.5	80.3	76.8	74.6	58.4	80.9	80.3	74.4	56.8	81.3	79.8
All Ages	22.7	28.0	33.5	30.2	23.5	27.5	35.8	33.5	24.0	27.5	34.0	31.4

Levels of Analysis and Possible Aggregations

All possible combinations would be difficult to list and most have not been explored to date. Below we streamline this section by offering the Level of Analysis and several variables on which the data could be aggregated depending on the desired facet of activity scrutinized.

SSN-Transaction With-Employers

Temporal

Year
Quarter

Demographic

Age
Sex

Unit

SSN
Employer
Sub-Industry
Industry
Ownership

Programmatic/Alternate Data

WIA Participant
Vocational Rehabilitation
Registered Nurse
College Graduate

Spatial

Location of Employment

City
Zip Code
County
Interstate Region
State
Intrastate Region

Location of Residence

City
Zip Code
County
Interstate Region
State
Intrastate Region

Commute Distance

SSN-Transaction With-Industry

Temporal

Year
Quarter

Demographic

Age
Sex

Unit

SSN
Industry
Ownership

Programmatic/Alternate Data

WIA Participant
Vocational Rehabilitation
Registered Nurse
College Graduate
Registered Nurse

Spatial

Location of Employment

City
Zip Code
County
Interstate Region
State
Intrastate Region

Location of Residence

City
Zip Code
County
Interstate Region
State
Intrastate Region

Commute Distance

SSN-Transaction With-Wyoming's Market

Temporal

Year
Quarter

Demographic

Age
Sex

Unit

SSN

Programmatic/Alternate Data

WIA Participant
Vocational Rehabilitation
Registered Nurse
College Graduate
Registered Nurse

Spatial

Location of Employment

City
Zip Code
County
Interstate Region
State
Intrastate Region

Location of Residence

City
Zip Code
County
Interstate Region
State
Intrastate Region

Commute Distance

To conclude this section we present Table 4.7, in which we explore the Exit Rates at the SSN-Transactions With-Employer level for various aggregations. The most important lesson to take from Sections III and IV of this paper is to be specific in annotating the **Level of Analysis** and the **Aggregation** used to create tables. At this time many of the States with which we have worked are only familiar with SSN-Transaction With-Employer, Level of Analysis, Aggregated to Year→Quarter→Industry→Sub-Industry.

Table 4.7: Exit Rates at the SSN-Transaction With-Employer Level for Various Aggregations

	1997				1998				1999			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Year→Quarter→Sex												
Female	15.7	19.7	25.1	21.5	16.1	21.2	26.5	25.0	17.6	23.8	26.0	21.5
Male	16.9	20.7	25.3	24.1	17.4	21.3	24.9	27.1	19.1	22.6	25.0	23.5
N/A	76.1	52.2	75.8	83.5	78.2	61.3	78.7	83.3	78.1	62.9	79.9	82.9
Year→Quarter→Age Group												
00-19	26.2	29.0	52.4	38.9	27.4	30.8	52.6	42.9	30.4	32.9	52.0	38.9
20-24	29.0	31.7	42.7	36.2	30.0	32.0	43.3	38.8	30.9	34.3	43.9	35.9
25-34	19.7	23.6	26.1	26.4	20.3	24.6	26.8	29.5	21.9	26.2	27.1	25.8
35-44	12.9	16.3	17.6	18.1	13.4	17.6	18.2	21.6	15.0	19.6	18.2	18.5
45-54	9.9	13.2	13.5	14.4	10.4	14.2	14.0	17.3	11.9	16.8	14.0	13.8
55-64	11.0	13.7	14.1	15.6	11.1	15.6	15.1	19.2	13.5	17.6	14.7	15.5
65-Up	14.9	17.9	17.8	24.2	15.9	19.9	19.9	28.8	18.2	20.1	20.1	23.5
N/A	76.1	52.2	75.8	83.5	78.2	61.3	78.7	83.3	78.1	62.9	79.9	82.9
Year→Quarter→Quarterly Wage Group												
00,000 to 00,150	54.5	55.8	60.3	67.1	55.5	58.1	61.3	68.7	54.3	57.5	60.0	66.8
00,151 to 03,150	27.4	31.6	42.7	39.5	29.1	34.0	44.7	42.8	31.3	36.2	45.7	40.6
03,151 to 06,150	11.4	15.0	19.0	18.2	13.3	17.0	20.6	22.4	15.0	19.6	21.9	19.8
06,151 to 09,150	7.4	10.0	11.7	11.9	8.2	11.6	12.8	16.4	10.8	14.7	13.8	13.3
09,151 to 12,150	6.4	9.2	8.5	10.0	6.7	10.1	9.4	13.4	8.7	13.3	11.1	10.6
12,151 to 15,150	6.2	7.0	8.2	7.9	5.1	9.5	7.3	11.3	7.8	12.3	9.0	8.4
15,151 to Up	7.7	8.4	11.6	8.9	5.9	9.8	8.9	12.4	10.1	13.4	8.2	9.2
Year→Quarter→Commute Distance in Miles												
Resident (0)	14.6	18.4	21.8	19.6	14.8	19.0	22.2	22.7	16.5	21.3	21.7	18.8
001-050	14.8	19.2	24.1	21.6	15.0	21.0	23.5	24.9	16.5	22.7	23.6	20.9
051-100	23.7	25.5	32.3	30.9	22.6	28.3	31.5	33.2	22.8	26.9	29.2	28.8
101-150	24.8	28.4	34.1	35.6	27.6	29.3	31.1	37.6	25.1	27.9	30.8	31.6
151-200	27.3	30.6	34.8	39.0	28.4	30.2	35.5	41.4	27.9	31.4	33.5	34.3
201-up	29.5	31.1	40.1	35.4	29.8	32.5	39.7	39.2	35.3	33.6	37.8	34.3
Unknown	30.5	31.2	45.2	42.8	31.9	34.4	46.2	44.7	33.5	36.1	46.8	42.1
Year→Quarter→Registered Nurses→Degree Source												
WY Based Education	8.1	11.3	10.6	10.8	9.0	14.8	12.6	12.1	12.2	16.0	11.7	11.9
OS Based Education	8.3	10.2	10.3	8.8	9.5	14.1	11.6	13.6	11.9	16.2	10.4	13.2
Total	8.2	10.7	10.5	9.8	9.2	14.4	12.1	12.9	12.0	16.1	11.0	12.6
Year→Quarter→WIA FY 1999 Completers versus Control Group												
Control	18.9	22.7	31.7	29.6	21.5	25.7	32.7	31.3	22.6	27.9	30.1	26.5
Participant	26.9	32.2	43.4	41.7	36.2	43.2	55.7	47.7	36.7	43.8	43.6	40.1
Total	18.9	22.8	31.8	29.7	21.6	25.8	32.9	31.4	22.7	28.0	30.2	26.6
Year→Quarter→Workforce Development Training Fund(FY 1999) Completers versus Control Group												
Control	21.3	24.4	37.0	32.0	23.5	27.6	38.4	34.3	25.8	29.9	35.5	29.7
Participant	18.8	18.1	36.2	26.9	27.4	28.3	26.0	33.6	22.8	30.7	31.8	19.7
Total	21.2	24.3	37.0	31.9	23.5	27.6	38.2	34.3	25.8	29.9	35.5	29.5

Section VIII: Wage Records Editing Methods

Although this section appears rather late in this publication it presents what is generally considered the first priority in the analysis Wage Records (WR). This section is broken into several parts denoted by stages ranging from errors which are relatively easy to identify and progressing to advanced analysis methodology for detecting UI accounts that diverge from their normal parameters. Lastly, we will introduce methods of error detection that rely upon other than WR datasets, specifically the ES-202 and Unemployment Insurance (UI) Claims. Although we define the activities to be discussed as errors, we would like the reader to keep in mind that the phenomenon discussed are not necessarily errors but rather highly suspect data anomalies requiring subsequent follow-up.

Throughout this section keep in mind that the original intent of the input and maintenance of the WR database was for purposes of UI benefit calculation. In WR capacity as an administrative database WR is a fairly efficient tool as data are extracted only for individuals making a UI claim. At the local claims office if a question of wages earned by a claimant from an employer arises it is quite simple to ask the claimant for verification or to contact the employer against which the claim is filed. As the applications of WR expand to activities related to performance evaluation of federally funded training programs the need for accuracy of reporting is increased. For example, in the case of UI claimants, missing data are self correcting, but in the case of missing employer data for WIA participants the overall performance of the program declines.

Stage 1 Errors – Missing Info and Duplicate Reporting

Stage 1 errors, see Table 8.1, are divided in two types. The first are errors of omission by which the specific record becomes unusable. These omissions include zero filled SSN (Row 1a), zero filled UI Account Number (Row 1b), and zero filled wages (Row 1c). The second type is that of duplicate reporting in the same year and quarter. In this case a unique SSN will have two or more entries in WR corresponding to the same UI Account in the same year and quarter, this error in Wyoming's WR can appear in two

forms. In the first case the wages reported in both entries are exactly the same (Rows 2a and 2b) and in the second the wages are different (Rows 3a and 3b). After discussions with Wyoming’s UI Tax section it was determined that the appropriate fix in the case of duplicate wage reporting is to delete one occurrence of the record, Row 2c replaces Rows 2a and 2b. In the second case, where the wages are different, the fix is to sum the wages and create one record for the SSN-UI Account-Year-Qtr combination, Row 3c replaces Rows 3a and 3b.

Table 8.1: Stage 1 Errors

ROW NUMBER	SSN	YEAR	QTR	UI ACCOUNT	WAGES
Zero Filled Errors or Errors of Omission					
1a	00000000	1995	2	77777777	1000
1b	99999999	1995	2	00000000	1000
1c	99999999	1995	2	77777777	0
Duplicate Reporting Error – Same SSN, UI Account, Year, Qtr, and Wages					
2a	99999999	1995	2	77777777	1000
2b	99999999	1995	2	77777777	1000
2c	99999999	1995	2	77777777	1000
Duplicate Reporting Error – Same SSN, UI Account, Year, Qtr, and Different Wages					
3a	99999999	1995	2	77777777	750
3b	99999999	1995	2	77777777	250
3c	99999999	1995	2	77777777	1000

Program Note on stage1edit.prg

The stage 1 editing program does not fix the problems discussed in this section.

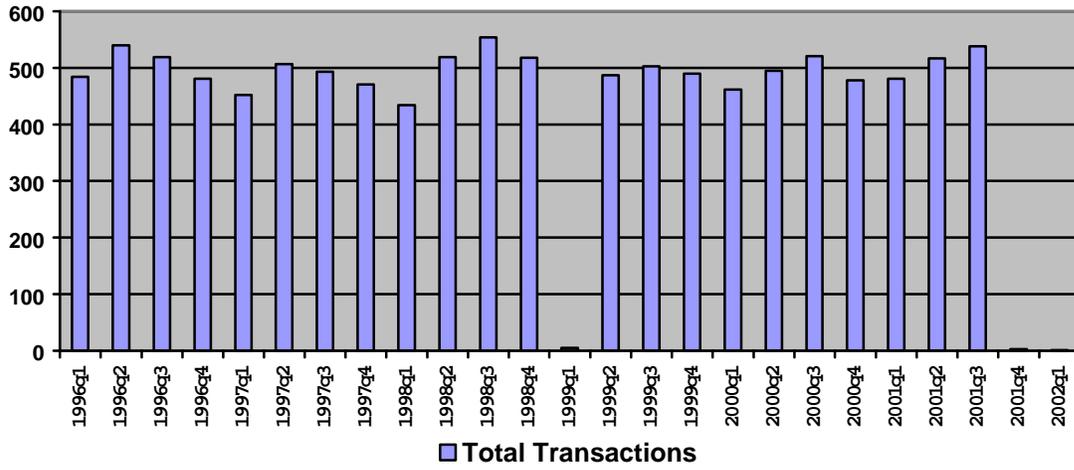
In the case of Zero Filled Errors the data meeting the criteria (i.e. Zero SSN, UI, or Wages) are exported to a table named zero_errors.dbf and subsequently removed from the working.dbf file.

Duplicate Reporting Errors are maintained in the working.dbf file and a list of all such occurrences is exported to a table named dupl_acct_errors.dbf.

Stage 2 Errors - Divergence from Normal UI Account Behavior

The stage 2 errors

An Example of a UI Account with 3 Quarters of Significantly Low Reporting



¹ Cite all past WR documentation

² Gosar article