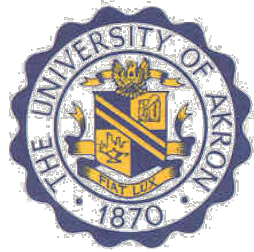


Senior Project
Department of Economics



Cleaning Cobwebs out from Nursing Scrubs:
A Study of the Cobweb Model and Registered Nurses

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Abstract

Using a recursive cobweb model, this study analyzes the responsiveness of nurses to wage changes in the United States between 2004 and 2008. A shortage of registered nurses is predicted to continue for the next 20 years. This is a serious problem, as the registered nurse force ages collectively and retires faster than younger talent enters, and legislation such as the Affordable Care Act greatly increases the demand for healthcare, something must be done. I show that nursing wages are inelastic in the short run and more elastic in the long run. I use state expenditure on healthcare, reported by the Center for Medicare and Medicaid Services, in my demand function to capture demand-shift factors and their impact on nursing wages. This study investigates the impact of wages in an alternate career, elementary school teachers, which are also a majority female, on registered nurse labor supply. My study differs from prior studies on male-dominated occupations. I show that increased nurse wages at the time of admission cause more students to enter school.

I. Acknowledgements

Thank you to Dr. Renna and Dr. Fang for their contributions throughout this study. I appreciate the help I received with finalizing my equations and transitioning research done by Freeman into the study of registered nurses. Dr. Fang has been keeping me enthusiastic since the beginning of this endeavor, and what an endeavor it has become, as Dr. Renna had forewarned. A small hiccup in data transformation threw me for a loop, thanks to Dr. Renna for urging me to slow down and go back through previous models and practices, causing me to obtain the answer that solved my problem.

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II. Introduction

There is an expected shortage of over 260,000 registered nurses by 2025 in the United States. Several factors contribute to this shortage. First, the RN population's average age is increasing, large numbers of RNs will retire quicker than new entrants enter the labor supply. In 2008, over 44 percent of RNs were over the age of 50, compared to 33 percent in 2000. From 2004 to 2008 there was growth of the RN labor supply of 153,806 RNs, with over 291,000 RNs letting their licenses expire, signifying an increase in retirement¹. I expect that legislation such as the Affordable Care Act will continue to increase demand for healthcare and add to the nursing shortage. More than 40 percent of RNs obtain their education through a Bachelor's degree, on which this study focuses. Over 54 percent of RNs work at least 2,000 hours per year, making it difficult to pull more work from current nurses. However, there is a faculty shortage at the same time. Since 2008, there has been a response shown due to the expected shortage of nurses, as RNs graduating between 2000 and 2008 made up more than 22 percent of the entire RN workforce². The question I answer is what kind of responsiveness do nurses show with respect to wages and other market factors? I expect an increased nursing wage during college admission to positively affect graduates, along with an increased alternate wage decreasing the quantity of nursing graduates.

¹ NSSRN, 2008.

² <http://bhpr.hrsa.gov/healthworkforce/rnsurveys/rnsurveyfinal.pdf>

III. Literature Review

Pashigan (1970) wrote an article on rational expectations pertaining to the cobweb theory that was based off Nerlove's 1958 article, *Adaptive Expectations*. Cobweb research attempts to explain why there are price changes within a market where this is a time delay between planting and marketing. The simplest way to look at a cobweb model is to use a two-period price cycle where the period is simply the time to produce a finished product, such as 4 years for a Bachelor's degree. Both authors so far mention that one criticism of the cobweb model is that the predicted model is shorter than the actual observed price cycle in a market where the cobweb model could otherwise be used to predict changes in future pricing.

I have based most of my research on Richard Freeman's (1976) two articles applying a form of the cobweb model and how it explains the market for lawyers and engineers. The cobweb model is applicable due to the time lag in education within a professional field, such as becoming an engineer, lawyer, or a nurse. It has been adapted from the cobweb model explaining crop yields and price fluctuations. Both articles showed that the long run supply in each of these professional fields is responsive to salaries and other states of the market prior to the date of observation, such as inputs similar to state expenditure on healthcare that I use. Salaries and other economic conditions were found to cause changes in the decisions of students to begin education in a professional field, affecting the labor force in their respective profession. If a large number of students graduate, wages decrease, causing less people to enter education, and the trend keeps reversing. My research is based on Freeman (1976) and his study of how wages affect the market for lawyers and engineers. Freeman (1975) found the grad coefficient on wage to be -0.09 and spending to be 0.41 using OLS. He also found that effect of a lawyer's salary on

grads is 0.10 and the alternative salary's coefficient on grads is -0.17 using OLS. Freeman (1976) found that wage coefficients are smaller for grads than admissions.

Link and Chiha (2003) agree with Freeman's (1976) former models, stating that wages are important since they determine the amount of people who begin education into nursing. Link and Chiha (2003), along with Freeman (1976) have concluded that a change in wages showed inelastic short run supply but a more elastic long run supply for engineers and lawyers. They had found that the effect of wages on RN labor force participation is negligible, but still an important influence in causing students to enter RN education. Chiha and Link (2003) linked inadequate nurse staffing to 24 percent of injury or death claims in hospitals.

Staiger, Auerbach, and Buerhaus (2012) further acknowledged that some of the key factors to entering the field of nursing are the population size of people who can become nurses, attractiveness to other careers (alternative wage), and capacity of nursing education programs. Shortages in faculty and training programs have increased the shortage of possible nurses. Many studies suggest that a substitution effect dominates the RN market, that rising wages are positively associated with increased participation in the long run but not in the short run. In 2007, the same group stated that RN numbers rose until 2003, then declined in 2004 until 2005. Over 74 percent of chief nursing officers perceived a nursing shortage where they work. Wage increase is ineffective in increasing the short run supply, just as Link and Chiha found in 2003. Interestingly enough, during a recession, more nurses work. As the recessions fades, so do nurses from the labor market.

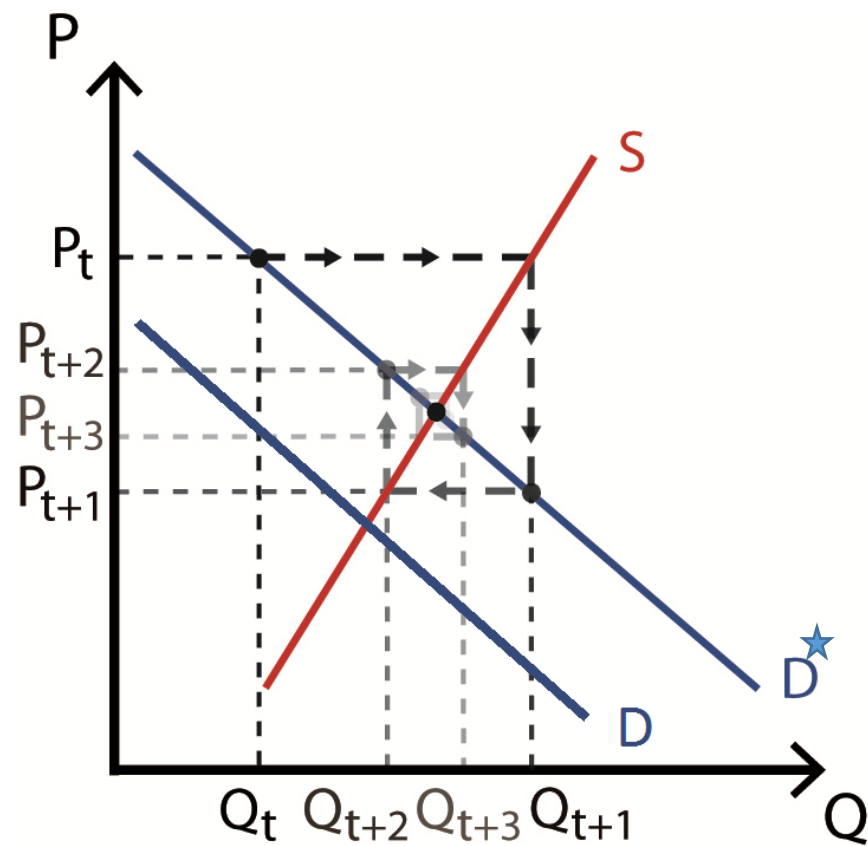
IV. Theoretical Model Development

The cobweb model can be applied to markets where there is a lag in production and noticeable price deviations caused by a short run supply shortage that cannot immediately be filled. An inelastic short run causes supply to be a function of past market conditions. There are inelastic wages and an inelastic supply in the short run, since you cannot immediately become a nurse. Wages are still elastic in the long run and determine the number of entrants into nursing education. The typical model captures the difference between years where the beginning and end of a cycle are measurable and noticed, explaining why I chose to use data from 2004 and 2008 to capture Bachelor's degree education for nurses. Since there is a length of time between the decision to enroll in the field of nursing and actually entering the labor market, this can be noticed by using a cobweb model as an explanatory tool for supply. Long run supply is dependent on past conditions, short run supply is dependent on current conditions, making the cobweb model and its cyclical movements measureable within a field that requires several years of education.

Demand will shift, with an inelastic supply due to a time lag there will be a shortage. This shortage will cause higher wages and in turn more entrants into nursing at the higher wage.

Assuming a surplus is created, wage will decrease and cause less entrants into nursing education.

This will lead to another shortage. Assume that demand is increasing always and another demand shift happens which causes the cycle to repeat itself again.



V. Data

The main source of my data is the National Sample Survey of Registered Nurses for the years 2004 and 2008, this time frame is consistent with a four year time delay of a Bachelor's degree in nursing, I controlled for Bachelor's students only. Also, I used the 2004 data to obtain my lagged variables and then merged my results with 2008 data to obtain the noticeable changes. Over 32,000 individual observations were used for the long run supply (table 2) and were merged into state-level aggregate variables (table 3) to obtain the wage equation due to the significance of state expenditure being weighted by the number of nurses in that state in the survey, I did this in order to have one observation for each state (observations = 50). All data pertaining to teachers came from the Bureau of Labor Statistics. Nursing graduate data came from the Health Resources and Services Administration, and state expenditure on healthcare came from Centers for Medicare and Medicaid Services.

VI. Model Specifications and Results

I operate under the assumption that personal healthcare expenditure is the most efficient predictor of demand for nursing. I assume this since nurses are the largest part of labor in our healthcare system and a change in expenditure would directly result in a wage change in the short run for nurses.

Demand Function:

$$Q_d = f(StateExp)$$

Q_d = Quantity demanded in nursing.

$StateExp_t$ = Used as the determinant for nursing demand. Expected to be positive and always increasing. Demand-shift factors such as age, population, utilization of healthcare. Nurses are the largest professional group in the healthcare industry.

In order to determine the wage equation of nurses, I use the log of nurse wages in 2008 as a function of the number of graduates in 2008 and the personal expenditure by state on healthcare in 2008. Graduates and the state expenditure model a constant flow of nurses in determination of nursing wages by linking the long run supply and the demand to the current wage.

Wage Equation:

$$LNurseWage_t = \beta_0 + \beta_1 LGrads_t + \beta_2 LStateExp_t + \epsilon \quad (1)$$

$LNurseWage_t$ = Nurse average wage in 2008. Logged. Dependent variable used to explain how wages respond to graduates and state expenditure on health.

$LGrads_t$ = Number of Bachelor's nursing graduates in 2008. Logged. Expected to affect the nursing wage in the same year negatively.

$LStateExp_t$ = Average personal healthcare expenditure in 2008. Used as the determinant for nursing demand changes. Logged. Expected to affect the nursing wage positively.

ϵ = Error term.

The long run supply is determined by the number of graduates in time 2008 explained by variables from time 2004. The number of graduates being a function of an alternative wage and nursing wage at the time of admission to college, along with the number of students admitted. Graduates are the actual flow into the nursing supply, and with a four year time lag they are also the dependent variable to predict the wage elasticity of nurses in the long run.

Long Run Supply:

$$LGrads_t = \beta_0 + \beta_1 LLagTWage_{t-4} + \beta_2 LLagNWage_{t-4} + \beta_3 LagAdmissions_{t-4} + \epsilon \quad (2)$$

$LGrads_t$ = Number of Bachelor's nursing graduates in 2008. Logged. Dependent variable used to explain long run supply of nurses.

$LLagTWage_{t-4}$ = Wage of elementary school teachers in 2004. Logged. Expected to affect nursing graduates in 2008 negatively. Alternative wage.

$LLagNWage_{t-4}$ = Wage of registered nurses in 2004. Logged. Expected to affect nursing graduates in 2008 positively.

$LagAdmissions_{t-4}$ = Number of Bachelor's nursing admissions in 2004. Expected to affect nursing graduates in positively.

ϵ = Error term.

VII. Interpretation of Results

For the short run supply where the dependent variable is the log of nurse wages in 2008, OLS results are shown in table 4. Variables were logged to determine percent changes and elasticities. For a one percent increase in 2008 graduates, the nurse wage is predicted to decrease by 0.27 percent. For a one percent increase in 2008 healthcare expenditure, the nurse wage in 2008 is expected to increase by 0.29 percent. This shows my assumption for state expenditure being a large determinant on nursing wages, even with an inelastic nurse wage in the short run due to the lag of education. See table 4.

The long run supply equation I measure with graduates being the dependent variable. For a one percent increase in the 2004 teacher wage, the number of 2008 graduates will decrease by 0.58 percent. For a one percent increase in the 2004 nurse wage, the number of 2008 nursing graduates will increase by 0.18 percent. This is interesting that the effect on nursing graduates is stronger for a female dominated alternative occupation with a similar time delay. The coefficient for the nurse wage being significantly higher than changes in the short run shows the increased elasticity in the long run. For a one person increase in 2004 admissions there is an expected increase in 2008 graduates of 0.07 percent. See table 4.

VIII. Conclusion and Suggestions

I have succeeded in adding evidence to the responsiveness of wage effects on supply for registered nurses, where a lag is noticed between the time to enter education and the time to enter the workforce. My results have been related to a cobweb model of any professional market with a significant time difference and fluctuations of price and quantity that converge towards equilibrium are noticed. Wages at the time of choosing to enter education to become a nurse is important for both the nursing field and an alternate. An increase in state expenditure causes an immediate increase in nursing wages. Coincidentally, grads at the same time cause a decrease in wages of nearly the same coefficient. Results are similar to Freeman's (1976) studies on engineers and lawyers, my alternative field of teaching was slightly higher than his alternative. Unfortunately, data from the 2012 National Sample Survey of Registered Nurses was not available at the time of this study. It would be interesting to see how the Affordable Care Act and its large increase in demand for healthcare has affected the supply of nurses. Some positive policy recommendations would be to increase subsidies for nursing students in order to make alternative education more costly and increase net wage by subtracting education costs, along with an increase in grants for schools to retain educators.

IX. References

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X. Appendix

Table 1: Variable Definitions and Sources

Variable	Definition	Source
LNurseWage_t	Wage of registered nurses in 2008. Logged.	National Sample Survey of Registered Nurses, 2008.
LGrads_t	Number of Bachelor's nursing graduates in 2008. Logged.	Health Resources and Services Administration
LStateExp_t	Average personal healthcare expenditure in 2008. Logged.	Centers for Medicare and Medicaid Services
LLagTWage_{t-4}	Wage of elementary school teachers in 2004. Logged.	Digest of Education Statistics
LLagNWage_{t-4}	Wage of registered nurses in 2004. Logged.	National Sample Survey of Registered Nurses, 2004.
LagAdmissions_{t-4}	Number of Bachelor's nursing admissions in 2004	Health Resources and Services Administration

Table 2: Descriptive Statistics (N = 25,179)

Variable	Mean	Standard Deviation	Min	Max
NurseWage_t	\$30.47	\$10.85	\$4.05	\$192.49
LagNWage_{t-4}	\$27.11	\$3.02	\$21.76	\$34.82
LagTWage_{t-4}	\$29.69	\$4.82	\$21.80	\$43.60
Grads_t	994	839	51	3,070
Admissions_{t-4}	1,439.3	1,214.45	74	4,443
StateExp_t	\$54,430,278,645	\$53,477,253,297	\$3,630,000,000	\$220,099,000,000
N = 25,179				
t = 2008				
t - 4 = 2004				

Table 3: Descriptive Statistics (N = 50)

Variable	Mean	Standard Deviation	Min	Max
NurseWage_t	\$29.96	\$3.25	\$24.76	\$39.59
LagNWage_{t-4}	\$26.57	\$2.89	\$21.76	\$34.82
LagTWage_{t-4}	\$28.72	\$4.59	\$21.80	\$43.60
Grads_t	760	705	51	3,070
Admissions_{t-4}	1,100	1,020	74	4,443
StateExp_t	\$39,827,560,000	\$43,108,030,476	\$3,630,000,000	\$220,000,000,000
N = 50				
t = 2008				
t - 4 = 2004				

Table 4: OLS Results

Dependent:

	Wage	Grads
Intercept	-1.9526	6.7418
	(0.62)***	(0.09)***
Grads	-0.2729	
	(0.03)***	
StateExp	0.2942	
	(0.03)***	
LagTWage	-----	-0.5795
		(0.027)***
LagNWage	-----	0.1845
		(0.037)***
Admissions	-----	0.00076
		(0.000002)***
Adj. R2	0.60	0.80
Est. Tech.	OLS	OLS

S.E. in parentheses

*** Denotes significance at the 99% level

SAS Code:

N=25,179

```

DATA RN08_State_data ;

    INFILE "E:\RN08_State_data.DAT" TRUNCOVER LRECL=2500;

PROC PRINT DATA=RN08_State_data;
RUN;
DATA RN08_State_data_lag_exp;
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if Q59State = "AZ" then LagNurseWage = 27.34;
if Q59State = "AR" then LagNurseWage = 23.89;
if Q59State = "CA" then LagNurseWage = 34.82;
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if Q59State = "CT" then LagNurseWage = 31.77;
if Q59State = "DE" then LagNurseWage = 27.78;
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if Q59State = "ME" then LagNurseWage = 25.71;
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if Q59State = "PA" then LagNurseWage = 26.87;
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if Q59State = "UT" then LagNurseWage = 26.07;
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if Q59State = "KY" then TeachWage = 23.94;
if Q59State = "LA" then TeachWage = 24.31;
if Q59State = "ME" then TeachWage = 22.37;
if Q59State = "MD" then TeachWage = 31.42;
if Q59State = "MA" then TeachWage = 33.36;
if Q59State = "MI" then TeachWage = 28.66;
if Q59State = "MN" then TeachWage = 25.97;
if Q59State = "MS" then TeachWage = 22.25;
if Q59State = "MO" then TeachWage = 22.12;
if Q59State = "MT" then TeachWage = 22.21;
if Q59State = "NE" then TeachWage = 22.48;
if Q59State = "NV" then TeachWage = 25.03;
if Q59State = "NH" then TeachWage = 24.94;
if Q59State = "NJ" then TeachWage = 31.56;
if Q59State = "NM" then TeachWage = 22.88;
if Q59State = "NY" then TeachWage = 34.56;
if Q59State = "NC" then TeachWage = 24.32;
if Q59State = "ND" then TeachWage = 20.83;
if Q59State = "OH" then TeachWage = 27.33;
if Q59State = "OK" then TeachWage = 21.92;
if Q59State = "OR" then TeachWage = 27.04;
if Q59State = "PA" then TeachWage = 28.62;
if Q59State = "RI" then TeachWage = 29.20;
if Q59State = "SC" then TeachWage = 23.71;
if Q59State = "SD" then TeachWage = 17.54;
if Q59State = "TN" then TeachWage = 22.77;
if Q59State = "TX" then TeachWage = 23.58;
if Q59State = "UT" then TeachWage = 21.17;
if Q59State = "VT" then TeachWage = 23.94;
if Q59State = "VA" then TeachWage = 24.18;
if Q59State = "WA" then TeachWage = 26.28;
if Q59State = "WV" then TeachWage = 22.35;
if Q59State = "WI" then TeachWage = 25.56;
if Q59State = "WY" then TeachWage = 27.30;

if Q59State = "AL" then TeachSalary = 46879;
if Q59State = "AK" then TeachSalary = 58395;
if Q59State = "AZ" then TeachSalary = 46358;
if Q59State = "AR" then TeachSalary = 47472;

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if Q59State = "CA" then TeachSalary = 68093;
if Q59State = "CO" then TeachSalary = 48487;
if Q59State = "CT" then TeachSalary = 63152;
if Q59State = "DE" then TeachSalary = 56667;
if Q59State = "FL" then TeachSalary = 46921;
if Q59State = "GA" then TeachSalary = 52879;
if Q59State = "HI" then TeachSalary = 55733;
if Q59State = "ID" then TeachSalary = 45178;
if Q59State = "IL" then TeachSalary = 61344;
if Q59State = "IN" then TeachSalary = 49569;
if Q59State = "IA" then TeachSalary = 48638;
if Q59State = "KS" then TeachSalary = 46401;
if Q59State = "KY" then TeachSalary = 47875;
if Q59State = "LA" then TeachSalary = 48627;
if Q59State = "ME" then TeachSalary = 44731;
if Q59State = "MD" then TeachSalary = 62849;
if Q59State = "MA" then TeachSalary = 66712;
if Q59State = "MI" then TeachSalary = 57327;
if Q59State = "MN" then TeachSalary = 51938;
if Q59State = "MS" then TeachSalary = 44498;
if Q59State = "MO" then TeachSalary = 44249;
if Q59State = "MT" then TeachSalary = 44426;
if Q59State = "NE" then TeachSalary = 44957;
if Q59State = "NV" then TeachSalary = 50067;
if Q59State = "NH" then TeachSalary = 49872;
if Q59State = "NJ" then TeachSalary = 63111;
if Q59State = "NM" then TeachSalary = 45752;
if Q59State = "NY" then TeachSalary = 69118;
if Q59State = "NC" then TeachSalary = 48648;
if Q59State = "ND" then TeachSalary = 41654;
if Q59State = "OH" then TeachSalary = 54656;
if Q59State = "OK" then TeachSalary = 43846;
if Q59State = "OR" then TeachSalary = 54085;
if Q59State = "PA" then TeachSalary = 57237;
if Q59State = "RI" then TeachSalary = 58407;
if Q59State = "SC" then TeachSalary = 47421;
if Q59State = "SD" then TeachSalary = 35070;
if Q59State = "TN" then TeachSalary = 45549;
if Q59State = "TX" then TeachSalary = 47157;
if Q59State = "UT" then TeachSalary = 42335;
if Q59State = "VT" then TeachSalary = 47884;
if Q59State = "VA" then TeachSalary = 48365;
if Q59State = "WA" then TeachSalary = 52567;
if Q59State = "WV" then TeachSalary = 44701;
if Q59State = "WI" then TeachSalary = 51121;
if Q59State = "WY" then TeachSalary = 54602;

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if Q59State = "AL" then LagTeachWage = 25.33;
if Q59State = "AK" then LagTeachWage = 35.05;
if Q59State = "AZ" then LagTeachWage = 22.91;
if Q59State = "AR" then LagTeachWage = 24.97;
if Q59State = "CA" then LagTeachWage = 35.62;
if Q59State = "CO" then LagTeachWage = 28.48;
if Q59State = "CT" then LagTeachWage = 36.67;
if Q59State = "DE" then LagTeachWage = 31.6;

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if Q59State = "FL" then LagTeachWage = 30;
if Q59State = "GA" then LagTeachWage = 29.51;
if Q59State = "HI" then LagTeachWage = 29.10;
if Q59State = "ID" then LagTeachWage = 29.07;
if Q59State = "IL" then LagTeachWage = 33.57;
if Q59State = "IN" then LagTeachWage = 29.28;
if Q59State = "IA" then LagTeachWage = 23.02;
if Q59State = "KS" then LagTeachWage = 23.37;
if Q59State = "KY" then LagTeachWage = 26.28;
if Q59State = "LA" then LagTeachWage = 24.67;
if Q59State = "ME" then LagTeachWage = 26.24;
if Q59State = "MD" then LagTeachWage = 32.14;
if Q59State = "MA" then LagTeachWage = 34.16;
if Q59State = "MI" then LagTeachWage = 35.31;
if Q59State = "MN" then LagTeachWage = 29.46;
if Q59State = "MS" then LagTeachWage = 24.61;
if Q59State = "MO" then LagTeachWage = 26.31;
if Q59State = "MT" then LagTeachWage = 22.77;
if Q59State = "NE" then LagTeachWage = 26.62;
if Q59State = "NV" then LagTeachWage = 24.40;
if Q59State = "NH" then LagTeachWage = 28.96;
if Q59State = "NJ" then LagTeachWage = 35.74;
if Q59State = "NM" then LagTeachWage = 26.46;
if Q59State = "NY" then LagTeachWage = 43.6;
if Q59State = "NC" then LagTeachWage = 24.39;
if Q59State = "ND" then LagTeachWage = 24.27;
if Q59State = "OH" then LagTeachWage = 31.81;
if Q59State = "OK" then LagTeachWage = 22.25;
if Q59State = "OR" then LagTeachWage = 29.41;
if Q59State = "PA" then LagTeachWage = 31.87;
if Q59State = "RI" then LagTeachWage = 34.60;
if Q59State = "SC" then LagTeachWage = 26.37;
if Q59State = "SD" then LagTeachWage = 21.80;
if Q59State = "TN" then LagTeachWage = 25.42;
if Q59State = "TX" then LagTeachWage = 27.11;
if Q59State = "UT" then LagTeachWage = 27.18;
if Q59State = "VT" then LagTeachWage = 28.60;
if Q59State = "VA" then LagTeachWage = 34.07;
if Q59State = "WA" then LagTeachWage = 30.90;
if Q59State = "WV" then LagTeachWage = 24.78;
if Q59State = "WI" then LagTeachWage = 28.79;
if Q59State = "WY" then LagTeachWage = 26.99;

if Q59State = "AL" then LagTeachSalary = 40530;
if Q59State = "AK" then LagTeachSalary = 56091;
if Q59State = "AZ" then LagTeachSalary = 36659;
if Q59State = "AR" then LagTeachSalary = 39966;
if Q59State = "CA" then LagTeachSalary = 57007;
if Q59State = "CO" then LagTeachSalary = 45578;
if Q59State = "CT" then LagTeachSalary = 58686;
if Q59State = "DE" then LagTeachSalary = 50562;
if Q59State = "FL" then LagTeachSalary = 48006;
if Q59State = "GA" then LagTeachSalary = 47228;
if Q59State = "HI" then LagTeachSalary = 46560;
if Q59State = "ID" then LagTeachSalary = 46515;
if Q59State = "IL" then LagTeachSalary = 53712;
if Q59State = "IN" then LagTeachSalary = 46851;

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if Q59State = "IA" then LagTeachSalary = 36842;
if Q59State = "KS" then LagTeachSalary = 37403;
if Q59State = "KY" then LagTeachSalary = 42059;
if Q59State = "LA" then LagTeachSalary = 39477;
if Q59State = "ME" then LagTeachSalary = 41994;
if Q59State = "MD" then LagTeachSalary = 51437;
if Q59State = "MA" then LagTeachSalary = 54657;
if Q59State = "MI" then LagTeachSalary = 56498;
if Q59State = "MN" then LagTeachSalary = 47142;
if Q59State = "MS" then LagTeachSalary = 39388;
if Q59State = "MO" then LagTeachSalary = 42099;
if Q59State = "MT" then LagTeachSalary = 36441;
if Q59State = "NE" then LagTeachSalary = 42596;
if Q59State = "NV" then LagTeachSalary = 39050;
if Q59State = "NH" then LagTeachSalary = 46346;
if Q59State = "NJ" then LagTeachSalary = 57194;
if Q59State = "NM" then LagTeachSalary = 42345;
if Q59State = "NY" then LagTeachSalary = 69809;
if Q59State = "NC" then LagTeachSalary = 39034;
if Q59State = "ND" then LagTeachSalary = 38839;
if Q59State = "OH" then LagTeachSalary = 50904;
if Q59State = "OK" then LagTeachSalary = 35604;
if Q59State = "OR" then LagTeachSalary = 47060;
if Q59State = "PA" then LagTeachSalary = 50996;
if Q59State = "RI" then LagTeachSalary = 55374;
if Q59State = "SC" then LagTeachSalary = 42205;
if Q59State = "SD" then LagTeachSalary = 34894;
if Q59State = "TN" then LagTeachSalary = 40682;
if Q59State = "TX" then LagTeachSalary = 43388;
if Q59State = "UT" then LagTeachSalary = 43497;
if Q59State = "VT" then LagTeachSalary = 45766;
if Q59State = "VA" then LagTeachSalary = 54519;
if Q59State = "WA" then LagTeachSalary = 49448;
if Q59State = "WV" then LagTeachSalary = 39662;
if Q59State = "WI" then LagTeachSalary = 46074;
if Q59State = "WY" then LagTeachSalary = 43188;

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if Q59State = "AL" then Grads = 919 ;
if Q59State = "AK" then Grads = 51;
if Q59State = "AZ" then Grads = 760;
if Q59State = "AR" then Grads = 459;
if Q59State = "CA" then Grads = 3070;
if Q59State = "CO" then Grads = 512;
if Q59State = "CT" then Grads = 352;
if Q59State = "DE" then Grads = 130;
if Q59State = "FL" then Grads = 2046;
if Q59State = "GA" then Grads = 802;
if Q59State = "HI" then Grads = 154;
if Q59State = "ID" then Grads = 169;
if Q59State = "IL" then Grads = 1473;
if Q59State = "IN" then Grads = 1104;
if Q59State = "IA" then Grads = 560;
if Q59State = "KS" then Grads = 503;
if Q59State = "KY" then Grads = 739;
if Q59State = "LA" then Grads = 615;
if Q59State = "ME" then Grads = 179;

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if Q59State = "MD" then Grads = 639;
if Q59State = "MA" then Grads = 902;
if Q59State = "MI" then Grads = 1330;
if Q59State = "MN" then Grads = 792;
if Q59State = "MS" then Grads = 465;
if Q59State = "MO" then Grads = 923;
if Q59State = "MT" then Grads = 107;
if Q59State = "NE" then Grads = 317;
if Q59State = "NV" then Grads = 219;
if Q59State = "NH" then Grads = 176;
if Q59State = "NJ" then Grads = 794;
if Q59State = "NM" then Grads = 271;
if Q59State = "NY" then Grads = 2621;
if Q59State = "NC" then Grads = 1070;
if Q59State = "ND" then Grads = 122;
if Q59State = "OH" then Grads = 2140;
if Q59State = "OK" then Grads = 617;
if Q59State = "OR" then Grads = 354;
if Q59State = "PA" then Grads = 1933;
if Q59State = "RI" then Grads = 150;
if Q59State = "SC" then Grads = 594;
if Q59State = "SD" then Grads = 191;
if Q59State = "TN" then Grads = 828;
if Q59State = "TX" then Grads = 2458;
if Q59State = "UT" then Grads = 395;
if Q59State = "VT" then Grads = 84;
if Q59State = "VA" then Grads = 959;
if Q59State = "WA" then Grads = 673;
if Q59State = "WV" then Grads = 333;
if Q59State = "WI" then Grads = 848;
if Q59State = "WY" then Grads = 96;

if Q59State = "AL" then TotalNurses = 45666;
if Q59State = "AK" then TotalNurses = 5605;
if Q59State = "AZ" then TotalNurses = 50841;
if Q59State = "AR" then TotalNurses = 27415;
if Q59State = "CA" then TotalNurses = 274722;
if Q59State = "CO" then TotalNurses = 43480;
if Q59State = "CT" then TotalNurses = 37555 ;
if Q59State = "DE" then TotalNurses = 10380 ;
if Q59State = "FL" then TotalNurses = 167476;
if Q59State = "GA" then TotalNurses = 75976;
if Q59State = "HI" then TotalNurses = 9357;
if Q59State = "ID" then TotalNurses = 10527;
if Q59State = "IL" then TotalNurses = 120203;
if Q59State = "IN" then TotalNurses = 63655 ;
if Q59State = "IA" then TotalNurses = 33378;
if Q59State = "KS" then TotalNurses = 28556;
if Q59State = "KY" then TotalNurses = 44755;
if Q59State = "LA" then TotalNurses = 42856;
if Q59State = "ME" then TotalNurses = 16153 ;
if Q59State = "MD" then TotalNurses = 55944 ;
if Q59State = "MA" then TotalNurses = 80725;
if Q59State = "MI" then TotalNurses = 89445;
if Q59State = "MN" then TotalNurses = 57639;
if Q59State = "MS" then TotalNurses = 29016;
if Q59State = "MO" then TotalNurses = 63756 ;

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if Q59State = "MT" then TotalNurses = 11172;
if Q59State = "NE" then TotalNurses = 22260 ;
if Q59State = "NV" then TotalNurses = 19428 ;
if Q59State = "NH" then TotalNurses = 13860;
if Q59State = "NJ" then TotalNurses = 75269;
if Q59State = "NM" then TotalNurses = 15701;
if Q59State = "NY" then TotalNurses = 196189;
if Q59State = "NC" then TotalNurses = 90663;
if Q59State = "ND" then TotalNurses = 7702;
if Q59State = "OH" then TotalNurses = 126582;
if Q59State = "OK" then TotalNurses = 29366 ;
if Q59State = "OR" then TotalNurses = 32113 ;
if Q59State = "PA" then TotalNurses = 140077 ;
if Q59State = "RI" then TotalNurses = 12744 ;
if Q59State = "SC" then TotalNurses = 42254 ;
if Q59State = "SD" then TotalNurses = 10076 ;
if Q59State = "TN" then TotalNurses = 67159;
if Q59State = "TX" then TotalNurses = 186573 ;
if Q59State = "UT" then TotalNurses = 18771 ;
if Q59State = "VT" then TotalNurses = 6528;
if Q59State = "VA" then TotalNurses = 64268 ;
if Q59State = "WA" then TotalNurses = 56607 ;
if Q59State = "WV" then TotalNurses = 19220;
if Q59State = "WI" then TotalNurses = 60813;
if Q59State = "WY" then TotalNurses = 4296;

if Q59State = "AL" then TotalTeach = 27193;
if Q59State = "AK" then TotalTeach = 4111;
if Q59State = "AZ" then TotalTeach = 39077;
if Q59State = "AR" then TotalTeach = 19656;
if Q59State = "CA" then TotalTeach = 206996;
if Q59State = "CO" then TotalTeach = 27679;
if Q59State = "CT" then TotalTeach = 31808;
if Q59State = "DE" then TotalTeach = 4093;
if Q59State = "FL" then TotalTeach = 75396;
if Q59State = "GA" then TotalTeach = 72537;
if Q59State = "HI" then TotalTeach = 6058;
if Q59State = "ID" then TotalTeach = 7951;
if Q59State = "IL" then TotalTeach = 93183;
if Q59State = "IN" then TotalTeach = 34007;
if Q59State = "IA" then TotalTeach = 19603;
if Q59State = "KS" then TotalTeach = 16957;
if Q59State = "KY" then TotalTeach = 21609;
if Q59State = "LA" then TotalTeach = 34573;
if Q59State = "ME" then TotalTeach = 10881;
if Q59State = "MD" then TotalTeach = 34396;
if Q59State = "MA" then TotalTeach = 46585;
if Q59State = "MI" then TotalTeach = 37702;
if Q59State = "MN" then TotalTeach = 27327;
if Q59State = "MS" then TotalTeach = 15891;
if Q59State = "MO" then TotalTeach = 34870;
if Q59State = "MT" then TotalTeach = 6182;
if Q59State = "NE" then TotalTeach = 12403;
if Q59State = "NV" then TotalTeach = 11283;
if Q59State = "NH" then TotalTeach = 10649;
if Q59State = "NJ" then TotalTeach = 53374;
if Q59State = "NM" then TotalTeach = 13473;
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if Q59State = "NY" then TotalTeach = 105446;
if Q59State = "NC" then TotalTeach = 56823;
if Q59State = "ND" then TotalTeach = 5132;
if Q59State = "OH" then TotalTeach = 54741;
if Q59State = "OK" then TotalTeach = 22386;
if Q59State = "OR" then TotalTeach = 20886;
if Q59State = "PA" then TotalTeach = 61395;
if Q59State = "RI" then TotalTeach = 5386;
if Q59State = "SC" then TotalTeach = 33282;
if Q59State = "SD" then TotalTeach = 5791;
if Q59State = "TN" then TotalTeach = 44397;
if Q59State = "TX" then TotalTeach = 163514;
if Q59State = "UT" then TotalTeach = 11658;
if Q59State = "VT" then TotalTeach = 3333;
if Q59State = "VA" then TotalTeach = 35233;
if Q59State = "WA" then TotalTeach = 26775;
if Q59State = "WV" then TotalTeach = 9452;
if Q59State = "WI" then TotalTeach = 28622;
if Q59State = "WY" then TotalTeach = 3646;

if Q59State = "AL" then LagTotalTeach = 37330;
if Q59State = "AK" then LagTotalTeach = 5368;
if Q59State = "AZ" then LagTotalTeach = 34523;
if Q59State = "AR" then LagTotalTeach = 13561;
if Q59State = "CA" then LagTotalTeach = 216293;
if Q59State = "CO" then LagTotalTeach = 22604;
if Q59State = "CT" then LagTotalTeach = 25348;
if Q59State = "DE" then LagTotalTeach = 3914;
if Q59State = "FL" then LagTotalTeach = 67460;
if Q59State = "GA" then LagTotalTeach = 63677;
if Q59State = "HI" then LagTotalTeach = 5805;
if Q59State = "ID" then LagTotalTeach = 7351;
if Q59State = "IL" then LagTotalTeach = 76438;
if Q59State = "IN" then LagTotalTeach = 31947;
if Q59State = "IA" then LagTotalTeach = 22503;
if Q59State = "KS" then LagTotalTeach = 14451;
if Q59State = "KY" then LagTotalTeach = 23980;
if Q59State = "LA" then LagTotalTeach = 34367;
if Q59State = "ME" then LagTotalTeach = 11196;
if Q59State = "MD" then LagTotalTeach = 32214;
if Q59State = "MA" then LagTotalTeach = 29832;
if Q59State = "MI" then LagTotalTeach = 70818;
if Q59State = "MN" then LagTotalTeach = 26163;
if Q59State = "MS" then LagTotalTeach = 14989;
if Q59State = "MO" then LagTotalTeach = 33711;
if Q59State = "MT" then LagTotalTeach = 6801;
if Q59State = "NE" then LagTotalTeach = 13598;
if Q59State = "NV" then LagTotalTeach = 10779;
if Q59State = "NH" then LagTotalTeach = 10497;
if Q59State = "NJ" then LagTotalTeach = 46654;
if Q59State = "NM" then LagTotalTeach = 12419;
if Q59State = "NY" then LagTotalTeach = 93036;
if Q59State = "NC" then LagTotalTeach = 55206;
if Q59State = "ND" then LagTotalTeach = 4828;
if Q59State = "OH" then LagTotalTeach = 80452;
if Q59State = "OK" then LagTotalTeach = 19952;

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if Q59State = "OR" then LagTotalTeach = 11689;
if Q59State = "PA" then LagTotalTeach = 52307;
if Q59State = "RI" then LagTotalTeach = 8371;
if Q59State = "SC" then LagTotalTeach = 32703;
if Q59State = "SD" then LagTotalTeach = 5551;
if Q59State = "TN" then LagTotalTeach = 42571;
if Q59State = "TX" then LagTotalTeach = 146012;
if Q59State = "UT" then LagTotalTeach = 10813;
if Q59State = "VT" then LagTotalTeach = 3367;
if Q59State = "VA" then LagTotalTeach = 40518;
if Q59State = "WA" then LagTotalTeach = 26120;
if Q59State = "WV" then LagTotalTeach = 9909;
if Q59State = "WI" then LagTotalTeach = 40981;
if Q59State = "WY" then LagTotalTeach = 3158;

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if Q59State = "AL" then STATE = 1;
if Q59State = "AK" then STATE = 2;
if Q59State = "AZ" then STATE = 3;
if Q59State = "AR" then STATE = 4;
if Q59State = "CA" then STATE = 5;
if Q59State = "CO" then STATE = 6;
if Q59State = "CT" then STATE = 7;
if Q59State = "DE" then STATE = 8;
if Q59State = "FL" then STATE = 9;
if Q59State = "GA" then STATE = 10;
if Q59State = "HI" then STATE = 11;
if Q59State = "ID" then STATE = 12;
if Q59State = "IL" then STATE = 13;
if Q59State = "IN" then STATE = 14;
if Q59State = "IA" then STATE = 15;
if Q59State = "KS" then STATE = 16;
if Q59State = "KY" then STATE = 17;
if Q59State = "LA" then STATE = 18;
if Q59State = "ME" then STATE = 19;
if Q59State = "MD" then STATE = 20;
if Q59State = "MA" then STATE = 21;
if Q59State = "MI" then STATE = 22;
if Q59State = "MN" then STATE = 23;
if Q59State = "MS" then STATE = 24;
if Q59State = "MO" then STATE = 25;
if Q59State = "MT" then STATE = 26;
if Q59State = "NE" then STATE = 27;
if Q59State = "NV" then STATE = 28;
if Q59State = "NH" then STATE = 29;
if Q59State = "NJ" then STATE = 30;
if Q59State = "NM" then STATE = 31;
if Q59State = "NY" then STATE = 32;
if Q59State = "NC" then STATE = 33;
if Q59State = "ND" then STATE = 34;
if Q59State = "OH" then STATE = 35;
if Q59State = "OK" then STATE = 36;
if Q59State = "OR" then STATE = 37;
if Q59State = "PA" then STATE = 38;
if Q59State = "RI" then STATE = 39;
if Q59State = "SC" then STATE = 40;
if Q59State = "SD" then STATE = 41;
if Q59State = "TN" then STATE = 42;

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if Q59State = "TX" then STATE = 43;
if Q59State = "UT" then STATE = 44;
if Q59State = "VT" then STATE = 45;
if Q59State = "VA" then STATE = 46;
if Q59State = "WA" then STATE = 47;
if Q59State = "WV" then STATE = 48;
if Q59State = "WI" then STATE = 49;
if Q59State = "WY" then STATE = 50;

if Q59State = "AL" then admissions = 1330;
if Q59State = "AK" then admissions = 74;
if Q59State = "AZ" then admissions = 1100;
if Q59State = "AR" then admissions = 664;
if Q59State = "CA" then admissions = 4443;
if Q59State = "CO" then admissions = 741;
if Q59State = "CT" then admissions = 509;
if Q59State = "DE" then admissions = 189;
if Q59State = "FL" then admissions = 2962;
if Q59State = "GA" then admissions = 1161;
if Q59State = "HI" then admissions = 223;
if Q59State = "ID" then admissions = 245;
if Q59State = "IL" then admissions = 2133;
if Q59State = "IN" then admissions = 1599;
if Q59State = "IA" then admissions = 811;
if Q59State = "KS" then admissions = 728;
if Q59State = "KY" then admissions = 1070;
if Q59State = "LA" then admissions = 890;
if Q59State = "ME" then admissions = 260;
if Q59State = "MD" then admissions = 924;
if Q59State = "MA" then admissions = 1305;
if Q59State = "MI" then admissions = 1925;
if Q59State = "MN" then admissions = 1147;
if Q59State = "MS" then admissions = 673;
if Q59State = "MO" then admissions = 1336;
if Q59State = "MT" then admissions = 155;
if Q59State = "NE" then admissions = 458;
if Q59State = "NV" then admissions = 317;
if Q59State = "NH" then admissions = 254;
if Q59State = "NJ" then admissions = 1149;
if Q59State = "NM" then admissions = 392;
if Q59State = "NY" then admissions = 3794;
if Q59State = "NC" then admissions = 1548;
if Q59State = "ND" then admissions = 177;
if Q59State = "OH" then admissions = 3097;
if Q59State = "OK" then admissions = 894;
if Q59State = "OR" then admissions = 512;
if Q59State = "PA" then admissions = 2798;
if Q59State = "RI" then admissions = 217;
if Q59State = "SC" then admissions = 859;
if Q59State = "SD" then admissions = 277;
if Q59State = "TN" then admissions = 1198;
if Q59State = "TX" then admissions = 3558;
if Q59State = "UT" then admissions = 572;
if Q59State = "VT" then admissions = 121;
if Q59State = "VA" then admissions = 1389;
if Q59State = "WA" then admissions = 974;
if Q59State = "WV" then admissions = 481;
```

```
if Q59State = "WI" then admissions = 1228;
if Q59State = "WY" then admissions = 138;

if Q59State = "AL" then totalnurses = 49780;
if Q59State = "AK" then totalnurses = 5883;
if Q59State = "AZ" then totalnurses = 55001;
if Q59State = "AR" then totalnurses = 26096;
if Q59State = "CA" then totalnurses = 277575;
if Q59State = "CO" then totalnurses = 47805;
if Q59State = "CT" then totalnurses = 42215;
if Q59State = "DE" then totalnurses = 10547;
if Q59State = "FL" then totalnurses = 186349;
if Q59State = "GA" then totalnurses = 84489;
if Q59State = "HI" then totalnurses = 12061;
if Q59State = "ID" then totalnurses = 12922;
if Q59State = "IL" then totalnurses = 136213;
if Q59State = "IN" then totalnurses = 69672;
if Q59State = "IA" then totalnurses = 38208;
if Q59State = "KS" then totalnurses = 32165;
if Q59State = "KY" then totalnurses = 46473;
if Q59State = "LA" then totalnurses = 41863;
if Q59State = "ME" then totalnurses = 19249;
if Q59State = "MD" then totalnurses = 55276;
if Q59State = "MA" then totalnurses = 89434;
if Q59State = "MI" then totalnurses = 105222;
if Q59State = "MN" then totalnurses = 67551;
if Q59State = "MS" then totalnurses = 30801;
if Q59State = "MO" then totalnurses = 72698;
if Q59State = "MT" then totalnurses = 10373;
if Q59State = "NE" then totalnurses = 20501;
if Q59State = "NV" then totalnurses = 17902;
if Q59State = "NH" then totalnurses = 15468;
if Q59State = "NJ" then totalnurses = 89314;
if Q59State = "NM" then totalnurses = 18949;
if Q59State = "NY" then totalnurses = 203597;
if Q59State = "NC" then totalnurses = 96864;
if Q59State = "ND" then totalnurses = 8566;
if Q59State = "OH" then totalnurses = 138743;
if Q59State = "OK" then totalnurses = 32522;
if Q59State = "OR" then totalnurses = 37170;
if Q59State = "PA" then totalnurses = 169352;
if Q59State = "RI" then totalnurses = 12887;
if Q59State = "SC" then totalnurses = 41371;
if Q59State = "SD" then totalnurses = 11591;
if Q59State = "TN" then totalnurses = 68660;
if Q59State = "TX" then totalnurses = 189823;
if Q59State = "UT" then totalnurses = 19200;
if Q59State = "VT" then totalnurses = 8290;
if Q59State = "VA" then totalnurses = 70499;
if Q59State = "WA" then totalnurses = 63795;
if Q59State = "WV" then totalnurses = 19456;
if Q59State = "WI" then totalnurses = 66229;
if Q59State = "WY" then totalnurses = 5008;
```

```

if TOTRNHRS_YR<1000 then delete;
if TOTRNHRS_YR>3500 then delete;
if Q30<10000 then delete;
if Q30>200000 then delete;
if q59state=-8 then delete;
RUN;
DATA RN08_State_data_lag_exp_logged;
  set RN08_State_data_lag_exp;
  NurseWage=Q30/TOTRNHRS_YR;
  LogTotalNurses=log(totalnurses);
  LogNurseWage=log(NurseWage);
  LogLagNurseWage=log(LagNurseWage);
  LogTeachWage=log(TeachWage);
  LogLagTeachWage=log(LagTeachWage);
  LogNurseSalary=log(Q30);
  LogHouseIncome=log(houseincome);
  LogLagNurseSalary=log(LagNurseSalary);
  LogTeachSalary=log(TeachSalary);
  LogLagTeachSalary=log(LagTeachSalary);
  LogTOTRNHRS_YR=log(TOTRNHRS_YR);
  LogGrads=log(grads);
  LogFemLabor=log(femlaborforce);
  LogStateExp=log(StateExp);
  LogTotalNurses=log(TotalNurses);
  LogTotalTeach=log(TotalTeach);
  LogLagTotalNurses=(LagTotalNurses);
  LogLagTotalTeach=log(LagTotalTeach);
  stateexppercapita=stateexp/totalnurses;
  logstateexppercapita=log(stateexppercapita);
  logadmissions=log(admissions);
  run;
  proc sort data=RN08_State_data_lag_exp_logged
out=RN08_State_data_lag_exp_logged;
  by q59state;
run;

ods rtf file = 'E:\LongRunRETEST.rtf';
proc reg;
  model LogGrads = LogLagNurseWage LogLagTeachWage admissions;
  run;
  ods rtf close;
ods rtf file = 'E:\ShortRunRETEST.rtf';
proc reg;
model lognursewage = loggrads logstateexp;
run;
ods rtf close;

N = 50

proc import datafile="E:\newnurse.csv"
  out=Nurses

```



```

        dbms=csv
        replace;
        getnames=yes;
        run;

data nurses;
set nurses;
lognursesalary=log(nursesalary);
logteachersalary=log(teachersalary);
loglagnursesalary=log(lagnursesalary);
logstateexp=log(stateexp);
loglagnursehours=log(lagnursetotalhours);
loglagteachersalary=log(lagteachersalary);
loggrads=log(grads);
logadmit=log(lagbsnadmissions);
lognursewage=log(nursewage);
loghours=log(nursetotalhours);
loglagnursewage=log(lagnursewage);
logteachwage=log(teachwage);
loglagteachwage=log(lagteachwage);
logtotalnurses=log(totalnurses);
run;
ods rtf file = 'E:\Long Run.rtf';
proc reg data=nurses;
model loggrads = loglagteachwage loglagnursewage lagbsnadmissions;
run;
ods rtf close;
ods rtf file = 'E:\Short Run.rtf';
proc reg data=nurses;
model lognursewage = loggrads logstateexp;
run;
ods rtf close;
ods rtf file = 'E:\Means.rtf';
proc means data=nurses;
var nursewage lagnursewage teachwage lagteachwage grads lagbsnadmissions
stateexp;
run;
ods rtf close;

proc import datafile="E:\newnurse.csv"
        out=Nurses
        dbms=csv
        replace;
        getnames=yes;
        run;

data nurses;
set nurses;
lognursesalary=log(nursesalary);
logteachersalary=log(teachersalary);
loglagnursesalary=log(lagnursesalary);
logstateexp=log(stateexp);
loglagnursehours=log(lagnursetotalhours);
loglagteachersalary=log(lagteachersalary);
loggrads=log(grads);
logadmit=log(lagbsnadmissions);
lognursewage=log(nursewage);
loghours=log(nursetotalhours);
loglagnursewage=log(lagnursewage);

```

```
logteachwage=log(teachwage);
loglagteachwage=log(lagteachwage);
logtotalnurses=log(totalnurses);
run;
ods rtf file = 'E:\Long Run.rtf';
proc reg data=nurses;
model loggrads = loglagteachwage loglagnursewage lagbsnadmissions;
run;
ods rtf close;
ods rtf file = 'E:\Short Run.rtf';
proc reg data=nurses;
model lognursewage = loggrads logstateexp;
run;
ods rtf close;
ods rtf file = 'E:\Means.rtf';
proc means data=nurses;
var nursewage lagnursewage teachwage lagteachwage grads lagbsnadmissions
stateexp;
run;
ods rtf close;
```