

The Effect of Annual National Unemployment Rate on Major Declarations at Reed College

I. Introduction

The purpose of this project is to observe the effect of the lagged national average unemployment rate on major declaration at Reed College between 1982 - 2012 by using degrees awarded as an instrument for major choice. This is a topic that is weakly documented in the academic literature. Thus, we sought to investigate this within the context of Reed - a particularly interesting example given Reedies' seeming lack of concern for the practicality of their major choices.

This report specifically looks into the number of conventionally employable majors defined as economics, math-economics, math and the natural sciences (biology, chemistry, and physics). We performed multiple time-series regressions in order to account for the fact that major declarations are more likely to be affected by previous years' unemployment levels rather than present unemployment levels. The lags also accounted for the fact that a student choose a major in their first or second year of college, whereas our data accounts for those who graduated with that major, a lag of two to three years on its own.

We also had to control for any fluctuations that could arise from gender major preferences, seeing as how males are more likely to pick economics, math, or a hard science as a major.^{1, 2} We converted the number of declarations into a percentage of all majors in order to control for class size (larger graduating class sizes will inevitably have more of each major).

II. Data

Unemployment data were obtained from the [United States Department of Labor's Bureau of Labor Statistics](#). We chose to use the average national figure because Reed's student body comes from all across the nation and is not particularly entrenched to any one region

¹ Zafar, Basit. "College Major Choice and the Gender Gap." *Federal Reserve Bank of New York Staff Reports* 364 (2009): n. pag. Feb. 2009. Web.

² Dickson, Lisa M. "Race and Gender Differences in College Major Choice." *Annals of the American Academy of Political and Social Science* 627.1 (2010): 108-24. 4 Jan. 2010. Web.

pre- or post-graduation. Despite its lack of precision, the average national unemployment rate is a good indicator of the general mood of the country regarding job prospects, which is essentially the aim of our study.

Data regarding the number of graduates per major, graduation rate, gender ratio, and graduating class size from 1982-2012 were obtained from data on the number of baccalaureate degrees awarded by department in the Reed College Compendia of Information (and other data available on [Reed's Institutional Research website](#)). For the years 1982 - 1986, these data were obtained from yearly commencement handbooks (from the [Reed College Special Collections Archive](#)). This graduate data was used as an instrument for major declaration. Gender ratios for this period were obtained by interpreting gender using names and IRIS Alumni Directory queries.

There is some concern of students being counted twice on account of double majors being required to write two theses. However, very few students undertake the monumental task of writing two theses in a year and it was not documented well in our data sources, so we did not consider it a big enough concern to warrant any special data cleaning.

Instead of using the number of majors per department in each graduating class, we elected to do it by division. We decided on 4 distinct categories:

- 1) *Employable majors*: defined as economics and economics-affiliated majors plus the Division of Math and Natural Sciences
- 2) *Only economics and economic-affiliated majors*
- 3) *Only math and natural sciences majors*
- 4) *All other majors*

Instead of using raw numbers, we converted these data into ratios with respect to the total class size, allowing us to control for fluctuations in major choice due to changes in class size without sacrificing another degree of freedom.

III. Variables

Data definitions:

YR: Year

EM: Ratio of conventionally employable majors (Economics, Math-Econ, Biology, Physics, Chemistry) in graduating class

ME: Ratio of math and math/econ majors in graduating class

NS: Ratio of natural science majors in graduating class

NEM: 1 - the ratio of employable majors

U: National average unemployment rate by year

- G:** Gender ratio
- GR:** Graduation rate
- CS:** Graduating class size

We identify four main recessions in our data period: the early 1980s, early 1990s, early 2000s and the Great Recession that started in 2007. However, major spikes in unemployment occurred only in the late 1980s and the the late 2000s. Unfortunately, we were unable to incorporate data from the late 2000s due to the fact that the class of 2013 is the first class to graduate that entered in 2009, which is when unemployment really started to spike during the Great Recession.

IV. Our Model

For our final model, we chose a multivariate lagged time series OLS regression that regresses the ratio of Math and Natural Science majors against the average national unemployment rate lagged by four or three years:

$$ns = \beta + \beta_1[L4(u)] + \beta_2[L3(u)]$$

We chose four years because that's when the majority of the graduating class first entered college and three years because Reedies often change majors after their first year of schooling and if the economy were to all of a sudden tank and unemployment were to skyrocket, that would push someone who was on the fence between English and Chemistry towards Chemistry. However, we did not include two, one, or zero lags, because switching into math or a natural science major would be extremely difficult after the sophomore year. We also considered a lag of five years because of Reed's historically low four-year graduation rate, but the rise in graduation rate from four to five years is not so large as to warrant lending it more weight. Furthermore, people choosing a major for its employment prospects would be more likely to graduate in four rather than five years—a less solid but still reasonable assumption to make. Although our regression analysis showed that only the fourth lag had a significant effect, we chose to keep the third lag in our final model for the theoretical reasons stated above.

The economics major at Reed only began to receive credibility and reasonable faculty support in the early 1990s for a two major reasons. First off, there were changes to the external market that were likely to make economics a more prosperous major post-graduation. This benefited strongly from the fall of Communism and its parallel of the students deciding to take economics (fewer political science, anthropology, etc. decided to take economics after Communism's fall, and the introductory courses became less of an

ideological battlefield). Secondly, after the hiring of Professor Jeffrey Parker in 1988, another professor was hired in 1990, with two more professors hired by the end of the 1990s. The stability of the Reed Economics faculty must have aided in these numbers as well³. From Robert Margo's study on the long run trends in Economics degrees, we know that there has been a steady increase in Economics majors since the 1993, after a 20% year on year drop in 1991 and 1992⁴.

We chose to exclude gender ratios because while there was a clear decline in the ratio of males to females over this 30 year time period, the ratio of male to female math/science majors has similarly declined so the total ratio of math/science majors to total number of graduates is not declining as a result of trends in gender ratios. Our regressions confirmed that gender does not have a significant effect:

	ns	ns
g	0.102 (0.131)	0.103 (0.126)
L3.u	0.000 (0.009)	
L4.u	0.013 (0.009)	0.013 (0.006)*
_cons	0.188 (0.053)**	0.188 (0.052)**
R2	0.33	0.33
N	28	28

* p<0.05; ** p<0.01

³ Parker, Jeff. "Economics as a Lucrative Major." Message to the authors. 8 May 2013. E-mail.

⁴ Margo, Robert A., and John J. Siegfried. "Long-Run Trends in Economics Bachelor's Degrees." *The Journal of Economic Education* 28.1 (1997): 326-36. Print.

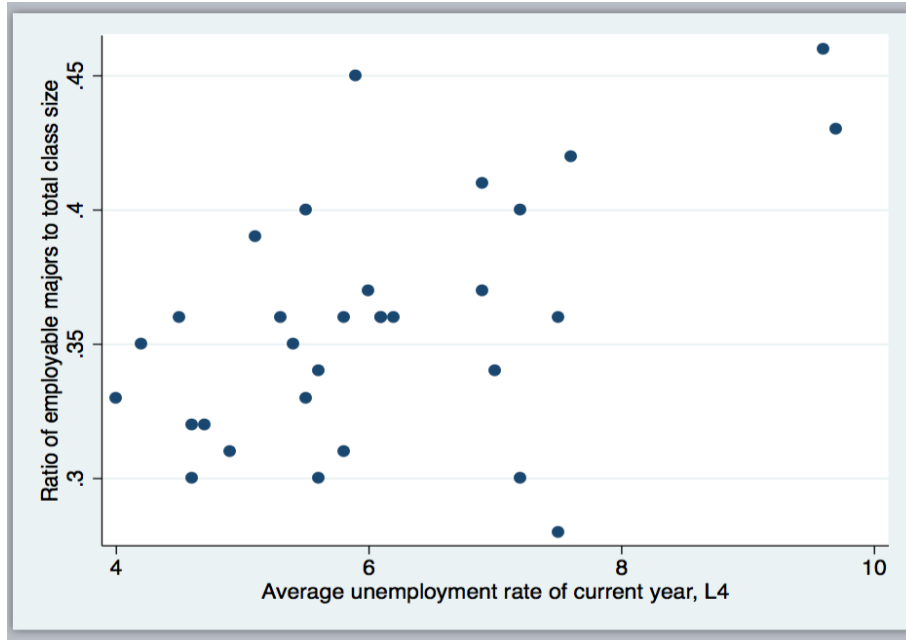
V. Analysis

1. Employable Majors

	em	em	em	em	em	em	em	em
L2.u	0.008 (0.005)				0.004 (0.009)		0.004 (0.009)	
L3.u		0.012 (0.005)*			-0.003 (0.013)	0.004 (0.009)	-0.001 (0.015)	0.002 (0.007)
L4.u			0.016 (0.005)**		0.017 (0.009)	0.008 (0.016)	0.011 (0.017)	0.014 (0.008)
L5.u				0.014 (0.006)*		0.005 (0.012)	0.005 (0.012)	
_cons	0.311 (0.032)**	0.282 (0.032)**	0.259 (0.033)**	0.271 (0.035)**	0.248 (0.039)**	0.248 (0.040)**	0.241 (0.044)**	0.256 (0.034)**
R2	0.07	0.17	0.25	0.19	0.26	0.26	0.26	0.25
N	31	31	31	30	31	30	30	31

* p<0.05; ** p<0.01

We find that significance increases with each additional lag and begins to decrease at the fifth lag. Intuitively, these results can be expected as a fourth lag indicates the unemployment level at the student's first year. The fifth lag can be expected to be slightly less significant than the fourth lag as it accounts for the student's senior year of high school that might have more of an effect on whether and where the student chooses to go to school rather than what she chooses as her major. We find that the first and second lags, which account for the unemployment rate in a student's junior and senior year are not significant. This is because one would already be 'locked in' to a major choice, or limited by the lack of flexibility in Reed's requirements and unable to change one's majors in response to exogenous factors.



This scatter plot of the four-lagged average unemployment rate against the ratio between employable majors versus total class size shows a slight upward trend, indicating a positive relationship between the two variables.

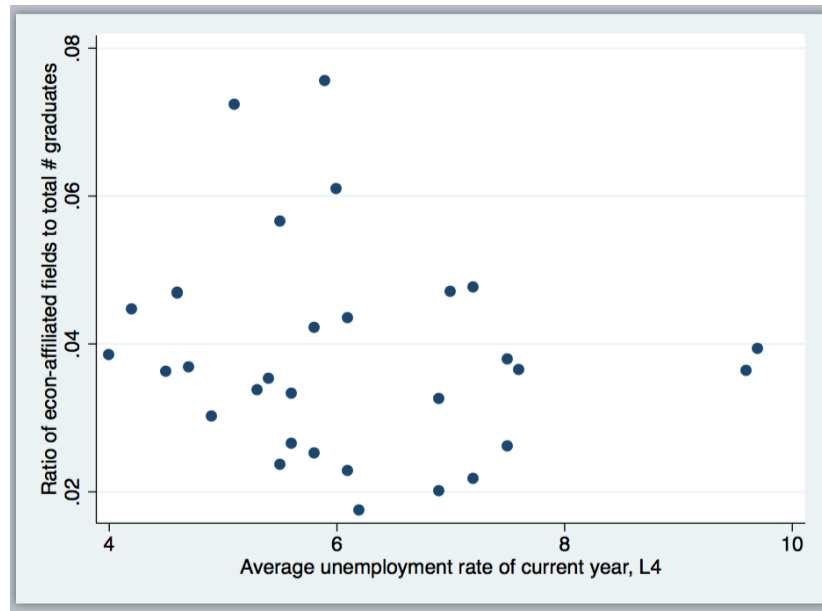
2. Economics-Affiliated Majors

	me	me	me	me	me	me	me	me
L2.u	0.001 (0.002)				0.003 (0.003)		0.003 (0.003)	
L3.u		-0.000 (0.002)			-0.001 (0.005)	0.001 (0.003)	-0.002 (0.005)	0.002 (0.003)
L4.u			-0.002 (0.002)		-0.002 (0.003)	-0.002 (0.006)	-0.000 (0.006)	-0.003 (0.003)
L5.u				-0.002 (0.002)		-0.001 (0.004)	-0.001 (0.004)	
_cons	0.032 (0.010)**	0.041 (0.011)**	0.049 (0.012)**	0.051 (0.012)**	0.041 (0.014)**	0.048 (0.014)**	0.043 (0.015)**	0.046 (0.012)**
R2	0.01	0.00	0.03	0.04	0.07	0.05	0.07	0.04
N	31	31	31	30	31	30	30	31

* p<0.05; ** p<0.01

Economics-affiliated majors (economics and math/economics) show a slightly negative

response to increasing unemployment. However, none of these responses are revealed to be statistically significant. The only indication of significance occurs when we regress both the third and fourth lags against economics-affiliated majors.



As compared to the previous positive-relationship scatter plot, there is no discernable relationship (a very weak negative relationship, if anything) between the four-lagged average unemployment rate and the ratio between econ-affiliated field and the total number of graduates.

3. Math and Natural Sciences (chosen model)

	ns	ns	ns	ns	ns	ns	ns
L2.u	0.007 (0.004)					0.002 (0.008)	
L3.u		0.013 (0.004)**			0.004 (0.007)	0.002 (0.012)	0.001 (0.006)
L4.u			0.018 (0.004)**		0.008 (0.013)	0.009 (0.014)	0.017 (0.007)*
L5.u				0.016 (0.005)**	0.007 (0.009)	0.007 (0.010)	
_cons	0.275 (0.029)**	0.240 (0.028)**	0.212 (0.027)**	0.221 (0.029)**	0.199 (0.033)**	0.196 (0.036)**	0.210 (0.028)**
R2	0.08	0.22	0.36	0.30	0.38	0.38	0.36
N	31	31	31	30	30	30	31

* p<0.05; ** p<0.01

. reg ns l4.u l3.u

Source	SS	df	MS	Number of obs =	31
Model	.017951974	2	.008975987	F(2, 28) =	8.02
Residual	.03132405	28	.001118716	Prob > F =	0.0018
Total	.049276024	30	.001642534	R-squared =	0.3643
				Adj R-squared =	0.3189
				Root MSE =	.03345

ns	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
u						
L4.	.016513	.0066458	2.48	0.019	.0028997	.0301263
L3.	.0013081	.0061358	0.21	0.833	-.0112605	.0138767
_cons	.2100174	.0284257	7.39	0.000	.1517901	.2682448

. estat bgodfrey

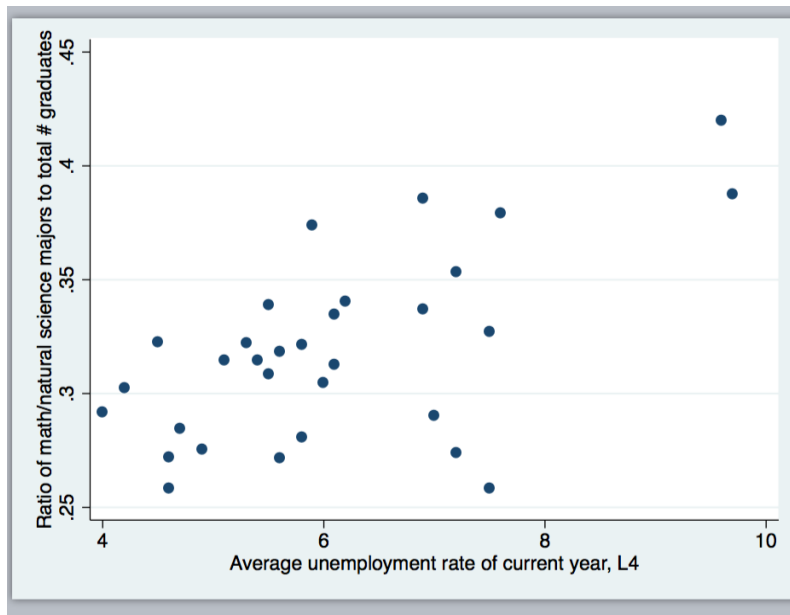
Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	0.001	1	0.9724

H0: no serial correlation

We again find that a lag of four years on unemployment rate affects a student's likelihood to choose a natural science major. A regression that takes into account the unemployment rates of the year a student chooses which college to enter up till the year before he has to write a thesis (lags two to five) yields a result with less significance than simply considering a student's freshman and sophomore year (lags three and four).

We conduct a Breusch-Godfrey test on our preferred regression to check for autocorrelation and, as expected, the test indicates no correlation. This result is expected because it is extremely unlikely that the number of natural science majors at Reed College (or any other major) has an effect on the national unemployment level; there is only a one-way effect of unemployment rate on major choice.



The scatter plot of the four-lagged average unemployment rate against the ratio between math and natural science majors to total number of graduates delineates a positive trend, indicating that the unemployment rate *does* have an effect on the number of students choosing math or natural science majors.

We also used a Breusch-Pagan test to check for heteroskedasticity:

```
. hettest
```

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
```

```
Ho: Constant variance
```

```
Variables: fitted values of ns
```

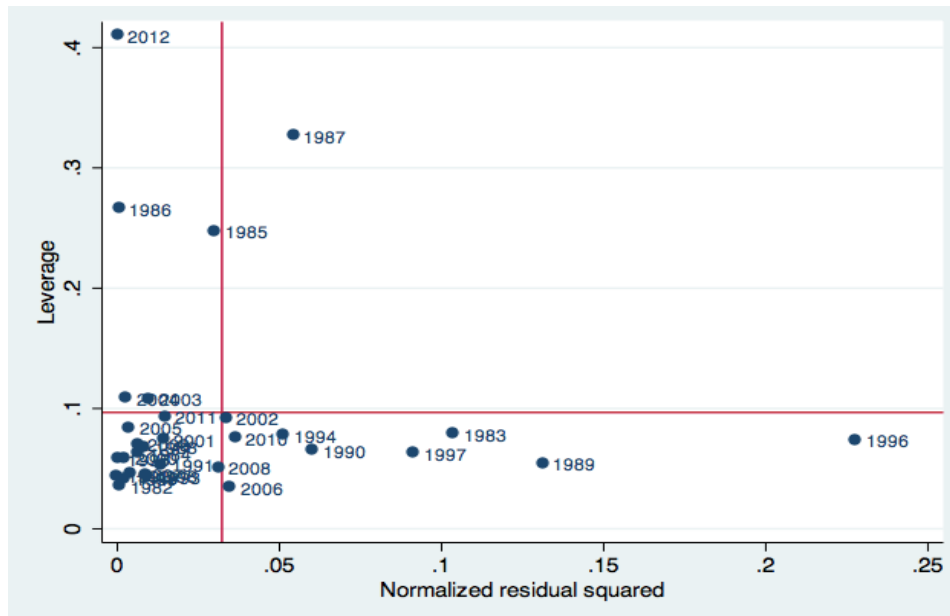
```
chi2(1) = 2.85
```

```
Prob > chi2 = 0.0914
```

We reject the null hypothesis of homoskedasticity at the 10% level but not at the 5% level. We do not feel this is cause for concern because most data are not homoskedastic. This is quite good so we took no further action to correct for it.

4. Leverage

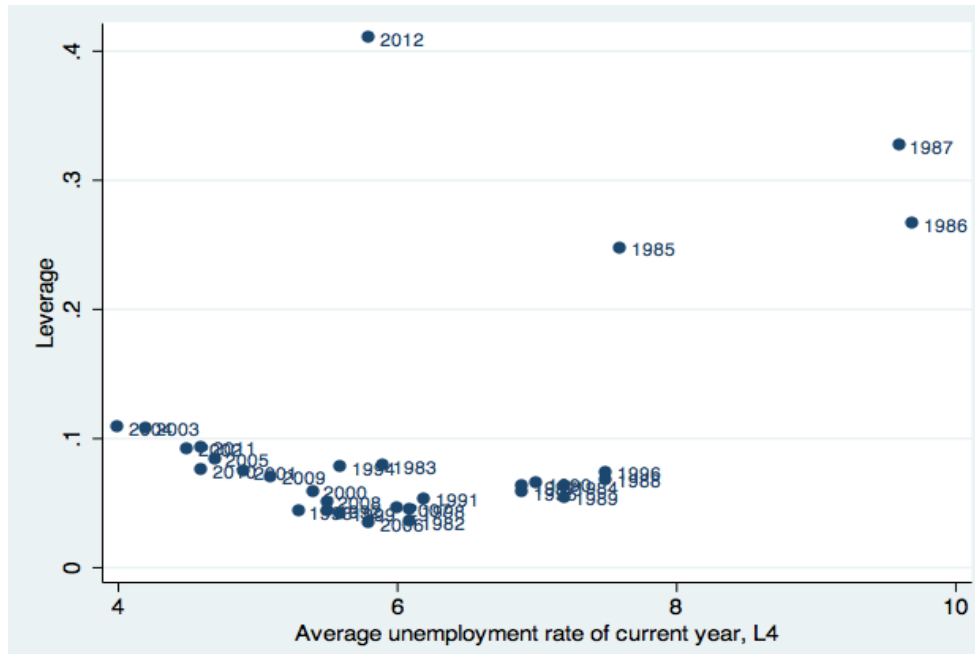
The scatter plot indicates that there are several observations that would likely have high leverage in the regression and generating a leverage plot using the command “lvr2plot, ml(yr)” confirms this suspicion:



It is apparent that in years with high unemployment, there tends to be high leverage. We then used the predict command to generate the leverage and residual data for each observation:

Variable	Obs	Mean	Std. Dev.	Min	Max
res	31	1.31e-10	.0323131	-.0844907	.0570377
lv	31	.0967742	.089521	.0336829	.4099773

Using the command “scatter lv l4.u, ml(yr)” we obtained the following plot:



It is worth noting that it is mostly the years associated with high lagged unemployment that have the highest leverage, which makes intuitive sense, since people would be less compelled to choose or switch to an employable major if job prospects are good regardless.

If we were to eliminate these observations, we would expect the trend line to be much less clear and perhaps less steep. When we did that however, we found the opposite to be true, which we suspect may be due to the 2012 datem pulling the rest of the regression down:

Source	SS	df	MS	Number of obs = 27		
Model	.022086195	2	.011043097	F(2, 24) =	11.15	
Residual	.023779446	24	.00099081	Prob > F =	0.0004	
Total	.04586564	26	.001764063	R-squared =	0.4815	
				Adj R-squared =	0.4383	
				Root MSE =	.03148	

ns	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
u						
L4.	.0202543	.0065581	3.09	0.005	.006719	.0337897
L3.	.0001107	.0059066	0.02	0.985	-.0120799	.0123014
_cons	.1989369	.0272208	7.31	0.000	.1427559	.2551179

But this is not a particularly important hypothetical since the whole point of the project was to study the effects of high unemployment on major choices.

5. Non-employable majors

	nem	nem	nem	nem	nem	nem	nem	nem
L2.u	-0.008 (0.005)				-0.004 (0.009)			-0.004 (0.009)
L3.u		-0.012 (0.005)*			0.003 (0.013)	-0.004 (0.009)	0.001 (0.015)	-0.002 (0.007)
L4.u			-0.016 (0.005)**		-0.017 (0.009)	-0.008 (0.016)	-0.011 (0.017)	-0.014 (0.008)
L5.u				-0.014 (0.006)*		-0.005 (0.012)	-0.005 (0.012)	
_cons	0.689 (0.032)**	0.718 (0.032)**	0.741 (0.033)**	0.729 (0.035)**	0.752 (0.039)**	0.752 (0.040)**	0.759 (0.044)**	0.744 (0.034)**
R2	0.07	0.17	0.25	0.19	0.26	0.26	0.26	0.25
N	31	31	31	30	31	30	30	31

* p<0.05; ** p<0.01

The regression for non-employable majors yields negative coefficients that become increasingly statistically significant with more lags and like our previous regressions shows a decrease in significance once we reach the fifth lag. These results make sense intuitively for two reasons, the first being that the NEM variable was calculated by subtracting the EM variable from 1 (the reciprocal) and the second being that we might expect less students choosing unemployable majors with a high unemployment rate.

6. Results

. reg ns l3.u l4.u

Source	SS	df	MS			
Model	.017951974	2	.008975987	Number of obs =	31	
Residual	.03132405	28	.001118716	F(2, 28) =	8.02	
Total	.049276024	30	.001642534	Prob > F =	0.0018	
				R-squared =	0.3643	
				Adj R-squared =	0.3189	
				Root MSE =	.03345	

ns	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
u						
L3.	.0013081	.0061358	0.21	0.833	-.0112605	.0138767
L4.	.016513	.0066458	2.48	0.019	.0028997	.0301263
_cons	.2100174	.0284257	7.39	0.000	.1517901	.2682448

The results of our preferred regression show that a 1 percent increase in national unemployment in a student's freshman year results in a 1.65 percent increase in math and natural science majors, while the national unemployment rate in a student's sophomore year is uncorrelated with their choice of major. The R-squared value of 0.36 also indicates the highest level of correlation between unemployment and major choice out of any of our other regressions.

VI. Discussion

1. Omitted Variable Bias

As with all econometric studies, our project might suffer from omitted variables. It is difficult to control for factors such as how 'fashionable' a major is or for the varying levels of resources that the college pours into departments over the years. Further, such a variable would be difficult to measure, seeing as how feedback would occur between popular majors and well-funded departments. Another factor to be considered would be the faculty in the department - well-liked professors are very likely to draw students to their department, especially if they teach introductory courses.

Considering Reed's reputation and high proportion of students who go on to earn graduate degrees, a student's undergraduate major choice at Reed might not completely reflect their

eventual career goals. For instance, a student with an intention of attending graduate school for professional degrees like architecture, law or business, might be fully contingent of their employability and career prospects, but choose to major in 'unemployable' fields at Reed.

Finally, we do not consider the salaries and employability of a variety of majors, which may be more of a consideration for students in choosing a major than the unemployment rate. Further, different recessions might have affected the majors differently: the most recent recession might have had a larger negative impact compared to pre-recession on Economics relative to, for example, Chinese. A definition of 'conventionally employable' major might thus be too broad in measuring the effects of individual recessions with their unique characteristics. Of course, we assume that the general unemployment rate is a good proxy for this - that if the official unemployment rate is high, students will migrate towards the majors that are typically better at ensuring jobs or higher salaries after graduation. Nevertheless, there is no way to check this within our realm of capabilities with this project and we must trust our assumption that unemployment rates cover this.

2. Data

This project would have benefited from much more data. Despite having experienced several recessions of varying severity during this time period, there were still only two large spikes in unemployment. To make matters worse, due to our lag structure, we were really only able to utilize one of them because the class that entered in 2009 (when unemployment really peaked during the Great Recession) is only now graduating, so that information is unavailable to us at the time of this writing. One would have to go all the way back to the Great Depression to find another major spike in unemployment.

The fact that Reed is such a small school also poses problems in terms of the type of data available. Math and Natural sciences are certainly more employable than say, Classics or Religion, but not as much as Architecture, or Engineering, which are much more geared towards specific careers. In further researching this topic, one might benefit from analyzing a school with more diverse programs offered and with more students, like a state school.

In considering the major choices of Reedies alongside their post-graduation plans, it would be useful to have data on the post-graduation routes of alumni and their majors at Reed. We would be better able to assess how much Reedies who 'care' about being 'conventionally employed' choose conventionally employable majors, all other variables constant.

3. External Validity

Despite the fact that Reedies are perceived to be unlikely to choose majors based on the job market or on parental pressures, and the fact that Reedies tend to go to pursue postgraduate degrees at a very high rate—both factors that would likely reduce the tendency for job prospects to affect major choice—our preliminary research found a statistically significant (albeit not terribly strong) correlation between the number of graduates in employable majors and the national average unemployment rate. Basically, even the highly-principled Reedie is not completely impervious to potential job prospects (or so we would hope).

Thus, we would expect that schools with students who are less concerned about “the life of the mind” and more concerned about finding employment would have similar, but much stronger correlations.

Further research on larger institutions like state schools would be a good next step to take with these findings. If the findings prove to be robust, it would be helpful to colleges when it comes to hiring. For example, if you’re aware that a high unemployment rate tends to lead to a 4% increase in the number of Chemistry majors, you might hire an extra visiting chemistry professor to better distribute the teaching load.

4. Why this model

If OLS works and is justifiable, the simplest and the one closest to normality should be chosen. A probit model was not used because the choice of major is not something to restrict within a probability of 0 to 1. Technically, we could have restricted each major (or division) within a probability of it being chosen, but that seemed like a step that would beat around the bush.

The nested logit implies a sequence of choices, which our data does not include because it is composed of one decision - the major with which one chooses to graduate.

The multinomial logit model would likewise be inappropriate for our data. This type of model calculates the probabilities of more than two discrete, categorical outcomes. This would have been appropriate if we were interested in the effects of specific business cycles on college major choice category as opposed to the effect of the unemployment rate. However, there were recessions that did not have noticeable changes to the unemployment rates, so using this form of model would have changed the focus of our research.

As stated above, we chose the simplest model because it fit our data and it seemed most appropriate for this research.

VII. Conclusion

Using an OLS time series regression, we find that the unemployment rate is uncorrelated with the number of economics and economics-affiliated majors, slightly positively correlated with the number of math and natural science majors, and slightly negatively correlated with the number of non-employable majors. There was slight heteroskedasticity in the data (but not enough to be of major concern) or autocorrelation with the error term, so an OLS regression fits our data best.

Beyond the omitted variables, we can conclude that the unemployment rate *does*, however slightly, affect students' choice of major at Reed. The effect of the unemployment rate will be expectedly stronger at schools with a student population more concerned with the job prospects of their major after they graduate. Considering that the effect is felt in Freshman year and marginally declines as a Reedie spends more years at Reed, this suggests that Reed might in fact be accomplishing the 'goal' of encouraging students to pursue learning based on interest and knowledge acquisition rather than consideration of employment.

VIII. Works Cited

- Dickson, Lisa M. "Race and Gender Differences in College Major Choice." *Annals of the American Academy of Political and Social Science* 627.1 (2010): 108-24. 4 Jan. 2010. Web.
- "Facts about Reed." *REED COLLEGE BACCALAUREATE DEGREES BY DEPARTMENT*. Reed College Institutional Research, 2012. Web. 09 May 2013.
- Margo, Robert A., and John J. Siegfried. "Long-Run Trends in Economics Bachelor's Degrees." *The Journal of Economic Education* 28.1 (1997): 326-36. Print. <<http://reed.edu/ir/gradbydept.html>>.
- Parker, Jeff. "Economics as a Lucrative Major." Message to the authors. 8 May 2013. E-mail. *Reed College Commencement Pamphlette*. Portland: Reed College Conference and Events Planning, 1982-1985. Print.
- Rivenburg, Jon W., and Darlene Tri. *Reed College Compendium of Information*. Portland: Reed College Institutional Research, 1987-2013. Print.
- United States of America. Bureau of Labor Statistics. Current Population Survey. N.p., n.d. Web. <<http://data.bls.gov/timeseries/LNS14000000>>.
- Zafar, Basit. "College Major Choice and the Gender Gap." *Federal Reserve Bank of New York Staff Reports* 364 (2009): n. pag. Feb. 2009. Web.