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Abstract

Even after the close of the first decade of the 21st century, there is still significant gender bias in labor market composition and compensation. As the events of the last two years have proven, even drastic efforts of monetary and fiscal policy have not tamed the business cycle. Previous research has reached no definite conclusions on the effect of business cycle trends on the gender wage gap. Over the period from 1979:1 to 2009:3, it is found that increases in the growth rate of GDP yield decreases in women's earnings relative to men's, and it is also found that increases in the unemployment rate yield increases in female earnings relative to male. It is hypothesized that these significant differences in compensation over the trend of the business cycle correspond to inherent differences in the labor supply curves of men and women.

Keywords

income gap, gender inequality, female wages, business cycle

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Abstract

Even after the close of the first decade of the 21st century, there is still significant gender bias in labor market composition and compensation. As the events of the last two years have proven, even drastic efforts of monetary and fiscal policy have not tamed the business cycle. Previous research has reached no definite conclusions on the effect of business cycle trends on the gender wage gap. Over the period from 1979:1 to 2009:3, it is found that increases in the growth rate of GDP yield decreases in women's earnings relative to men's, and it is also found that increases in the unemployment rate yield increases in female earnings relative to male. It is hypothesized that these significant differences in compensation over the trend of the business cycle correspond to inherent differences in the labor supply curves of men and women.

I. Introduction

In the post-war period, as women have entered the workforce in the United States in ever greater numbers, they have made substantial gains in earnings relative to their male peers. However, by one metric, women are currently earning only 80% of what men earn (BLS 2009). This can be thought of as a 20% “gender wage gap,” which has varied extensively over the previous fifty years, with a general trend of convergence to a smaller gap. For comparison, the wage gap was around the 35-37% range through the 1960s and early 1970s (O’Neill 1983).

An extensive body of literature exists which investigates the structural composition of this gender wage gap, attributing the differences to skill premiums, sexual discrimination, and various other factors. The goal of this paper is not to analyze the determination of the wage gap,

but to conduct a time-series analysis of the effect of the business cycle in the United States on the gender wage gap.

The reason for conducting this analysis is multifaceted. Foremost, the literature studying the effect of the business cycle on the gender wage gap is inextensive, and outdated. A new paradigm may have indeed developed in labor markets over the past 15 years, since the last substantive review of the impact of the business cycle on the wage gap. The labor market in the US is still suffering from the effects of the 2007-2009 global recession, with the unemployment rate reaching, and only recently declining from, a 10% level. Unemployment rates of this magnitude have not been seen for a quarter century. Additionally, a significant portion of the job loss during this recession has come in the manufacturing, and construction industries, both traditionally industries dominated by men (Kandil 2002).

Given the significant structural shifts in the economy, and dynamic factors in the labor market, there is reason to believe that the gender wage gap may be significantly shifting in the current period. Indeed, with the current unemployment rate for men standing at 10.8%, and the female rate standing at 8.3% (BLS 2009), it is difficult to ignore speculation about the impact of such significant differences in the male and female labor supply on relative compensation.

In the following section I will describe several methods of investigating the changes in the wage gap over the business cycle, specifically with reference to O'Neill, and Kandil and Woods. Section III will detail my methodology for approaching this topic from a new angle. Section IV will discuss in detail the specificities of the data used to conduct this analysis, and section V will present the results of testing the model using the given data. I will then

conclude with a summary and suggestions for policy and further research.

II. Literature Review

As aforementioned, the existing literature discussing the problem at hand is thorough, but outdated, and differing in specifics from the planned approach herein. Two main streams of thought, emerging from two specific papers, have emerged from the work on the gender wage gap trend. First, and most outdated, is the idea that business cycle fluctuations adversely affect women in terms of wages. Several authors have conversely found that male and female labor supply curves are becoming more similar over time, resulting in a general convergence of the wage gap; this wage gap convergence is exaggerated by the business cycle.

June O'Neill, publishing "The Trend in the Male-Female Wage Gap in the United States," conducted a time-series analysis, focusing on the effects of cyclical changes in

unemployment in the wage gap. She theorized that business cycle fluctuations in unemployment may affect the wage rates of men and women differently for two reasons: (1) women's wages are less likely to be covered by union wage agreements than men's, which makes them more flexible, which would increase female employment stability but *widen* the wage gap during a recession (and opposite during an expansion); (2) within industries and occupations, women have less specific training, which results in greater vulnerability during layoffs for female employees (O'Neill 1985). O'Neill found results that matched her expectations: specifically that an increase in the unemployment rate caused a decrease in the female-to-male earnings level, at a statistically significant level.

Magda Kandil and Jeffrey Woods sought in 2002 to extend the work of O'Neill in their work "Convergence of the gender gap over the business cycle: a sectoral

investigation,” with sectoral wage data from 1979:1 to 1993:4, and different theory. The authors theorize that men do indeed have a relatively inelastic labor supply curve, due to significant investment in training because of long-term labor force obligations. This incentivizes men to endure wage relative to employment fluctuations over time. Females, who invest fewer years of experience and tenure in the labor force relative to men, are caused to endure more employment compared to wage fluctuations over the business cycle. Given this framework, the authors expected that the wage gap would widen significantly during expansions, and shrink during contractionary periods (Kandil 2002). These expectations are contrary to those of O’Neill.

Empirically, Kandil and Woods found evidence of wage convergence with the business cycle in a majority of the eight sectors. The gap between men’s and women’s wages appears to be shrinking over time, due to a decline in

responses of the hourly wage gap for males relative to females during expansionary and contractionary demand shocks. The authors assert that the labor supply curves of the two genders are become more similar over time, resulting in wage convergence over the business cycle (Kandil 2002).

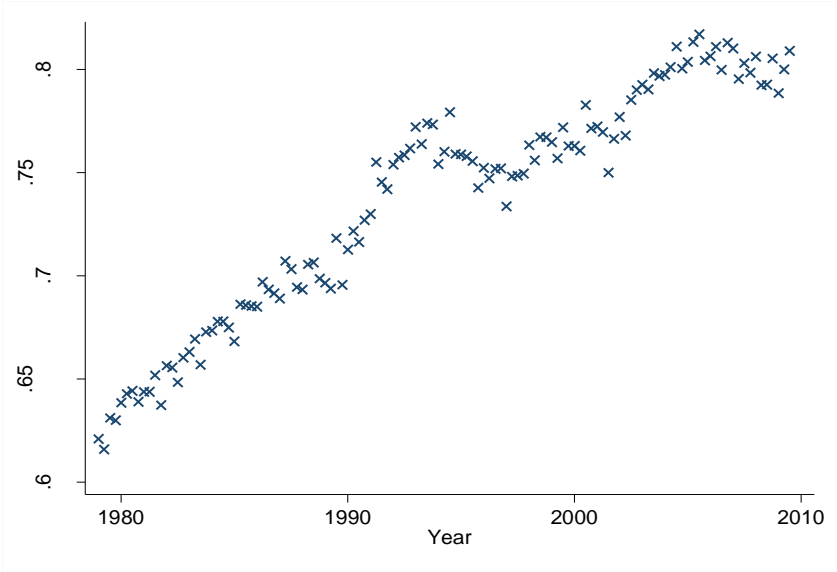
Two additional international studies, one by Aller and Arce in 2001, and one by Gupta, Oaxaca, and Smith in 2006 find similar empirical results, using similar theory to that of the Kandil and Woods study.

III. Methodology

This econometric analysis seeks to answer the following question: does the female-to-male earnings differential expand or contract during business cycles? More specifically, how do fluctuations in the growth rate of GDP, and fluctuations in the unemployment rate affect the female-to male earnings differential?

Theory, as discussed, shows conflicting evidence for the composition of the male-female earnings differential over time as affected by the business cycle. Indeed, a brief investigation of a scatter plot of the differential over time (Figure 1) can show just how variable the wage gap has been since 1979.

Figure (1): The Gender Wage Gap over Time (Quarterly Observations)
US Bureau of Labor Statistics



This time series trend of the wage differential will be used as a dependent variable in an OLS regression designed to measure the impact of fluctuations in aggregate demand and supply and labor demand and supply on the wage differential. Specifically, the model will take the form of Equation (1), below:

$$Y = \beta_1 + \beta_2 \Delta GDP_t + \beta_3 \Delta GDP_{t-1} + \beta_4 \Delta GDP_{t-2} + \beta_5 U_t + \beta_6 U_{t-1} + \beta_7 U_{t-2} + \beta_8 t + \beta_9 t^2 + \varepsilon$$

Where Y is the female-to-male wage differential, GDP is the real level of GDP in the current quarter, U is the current nominal unemployment rate, t is a time trend, and ε is a stochastic error term. The current quarter in time is represented by t , and previous quarters are represented by $t - n$. In addition to the CLRM OLS regression that will be conducted, the Prais-Winsten (Cochrane-Orcutt) iterated autoregression will be utilized to correct for autocorrelation in the error term.

Theory suggests that wages are sticky, such that, aggregate demand and supply shocks will not immediately affect worker wages due to worker bargaining agreements. This is the rationale for including lagged terms for the change in GDP, as it is unreasonable to assume that GDP growth in the current quarter determines the level of wages in the current quarter. By similar reasoning, the current unemployment rate will not influence the labor supply curve and effect wages contemporaneously.

An augmented Dickey-Fuller test for stationarity on the dependent variable leads to non rejection of the null hypothesis of a unit root contained in the dependent variable. The wage differential does not follow a stationary process. Because of the non-stationarity of the dependent variable, two time trends are included in the model: a linear term, and a quadratic term. Results from the Dickey-Fuller test are available in Table (1).

Table (1). Dickey Fuller Test for Stationarity of the Female-to-Male Wage Differential.

Dickey-Fuller test for unit root		Number of observations = 122	
----- Interpolated Dickey-Fuller -----			
Test	1% Critical	5% Critical	10% Critical
Statistic	Value	Value	Value

Z(t)	-1.672	-3.503	-2.889

MacKinnon approximate p-value for Z(t) = 0.4454			

The model of the female-to-male wage differential is designed to specifically analyze the impact of aggregate economic shocks on it. These shocks are specifically limited to aggregate demand, in the form of GDP growth, and labor supply, in the form of the unemployment rate. Two time trends are included to break the trends in the dependent variable. Theory suggests two possibilities for empirical results: namely, that the female-to-male wage differential could *increase* during contractions (as empirically shown by O'Neill), or that the female-to-male wage differential could *decrease* during contractions (as empirically shown by

Kandil and Woods). Notably, O'Neill did not include measures of shocks to aggregate demand and supply, only the unemployment rate as a measure of the business cycle. Kandil and Woods did not include unemployment rates in their analysis, only proxies for aggregate demand and supply. Furthermore, the results of the most recent study only date to 1993, resulting in an additional sixteen years of time series data being available for study in regards to the composition of the wage gap. In the next section, changes in that data since 1993 will be discussed as they pertain to the analysis.

Simultaneity bias is not an issue for the regressions at hand; theory does not suggest that the wage gap's nominal size has a causation effect on the growth rate of GDP or the unemployment rate. There is no need for instrumentation or two stage OLS correction of the model in its current functional form.

IV. Data

Ideal data for this time series regression would date back to the second world war, when women began to enter the “official” workforce in significantly greater numbers. By the nature of the gender wage gap itself, constructing data for this analysis presents problems, as noted earlier in the discussion of the non-stationarity of the wage gap dependent variable. Because the rate of female participation in the labor force has fluctuated greatly over time, results in any given period may be significantly different from another. Furthermore, the feminist movement, equal pay legislation, and shifting cultural attitudes obviously have significant (and difficult to quantify) effects on the wage differential. Given these issues, a practical aggregate measure of wages was selected.

The data on the gender wage gap was constructed from the Bureau of Labor Statistic’s Current Population

Survey. Two time series dating back to 1979:1 and ranging to 2009:3 were obtained, the seasonally adjusted median usual weekly earnings (averaged by quarter), for each sex. This series applies only to full-time workers, removing bias of ratios of each sex that work part time to full time. From these two series, the dependent variable in the model, the female-to-male earnings ratio, was constructed. This was done by dividing female earnings in each quarter by the corresponding level of male earnings. Figure (1) in section III illustrates the composition of the dependent variable over time. As shown, the average wage differential, by quarter, over the time period 1979:1 to 2009:3, was equal to 73.6%, interpreted as women making that percentage of what men make, on average. The values for the differential vary widely over the 30 year period, ranging from nearly 60% to above 80%.

The first independent variable in the equation is the growth rate in GDP. The time series for this was obtained from the Federal Reserve Bank of St. Louis' FRED online database. The data takes the form of the seasonally adjusted continuously compounded annual rate of change in real gross domestic product. Two lagged terms of this variable were created, dating back one quarter, and two quarters, respectively.

Additionally, the unemployment rate is included as an independent variable in the regression. This data was obtained from the BLS's online database, consisting of the seasonally adjusted quarterly unemployment rate, ranging from 1979:1 to 2009:3. Two lagged terms were also created for this variable. A table of summary statistics for all included model variables is available below, in Table (2).

Table (2): Variable Summary Statistics

Variable	Mean	Std. Dev.	Min	Max	# Obs
Y	.736	.055	.615	.817	123
ΔGDP_t	2.622	3.039	-8.3	8.9	123
ΔGDP_{t-1}	2.622	3.039	-8.3	8.9	123
ΔGDP_{t-2}	2.615	3.050	-8.3	8.9	122
U_t	6.148	1.484	3.9	10.7	123
U_{t-1}	6.148	1.484	3.9	10.7	123
U_{t-2}	6.120	1.456	3.9	10.7	122
t	62	35.651	1	123	123
t^2	5104.667	4653.386	1	15129	123

V. Empirical Results

The following, Table (3) presents the results for the OLS regression on Equation (1), as detailed in section III.

There are no statistical modifications to this model.

Table (3).

Time-Series OLS Regression of the Gender Wage Gap,
1979:1 – 2009:3

	Y	
	Coefficient	Absolute value of t-statistic
ΔGDP_t	-0.001	(2.50)*
ΔGDP_{t-1}	-0.002	(3.12)*
ΔGDP_{t-2}	-0.001	(1.49)
U_t	-0.014	(2.34)*
U_{t-1}	0.001	(0.07)
U_{t-2}	0.018	(3.08)*
t	0.003	(19.92)*
t^2	-0.000	(9.71)*
Constant	0.591	(63.19)*
Observations	121	
R-squared	0.96	
* significant at 5%		
Durbin- Watson Statistic	.911	

When interpreting this regression it is first necessary to note the presence of positive autocorrelation in the error term, as evidenced by the Durbin-Watson statistic being of lower value than its lower bound. This suggests a statistical correction will be necessary for more robust results.

Furthermore, a Breusch/Pagan test for heteroskedasticity yields a p-value of .9283, indicating no rejection of the null hypothesis of constant variance of the error term. However, the regression coefficients can still be interpreted.

The Ramsey RESET test yielded a p-value of 0.000, allowing rejection of the null hypothesis that there are omitted independent variables of a squared or polynomial form in the model specification. This result is consistent with the structure of theoretical model of the behavior of the wage gap, and it also fits with the inclusion of only a squared term for time in the model. Investigation of the variance inflation factors, seen below in Table (4), necessitates some discussion. There is some issue with multicollinearity in the regression, especially due to the time series inclusion of lags on macroeconomic variables. Furthermore, there is significant multicollinearity between a variable and its squared values. However, theory suggests that the inclusion

of these variables is necessary, even given the high multicollinearity; dropping any variables would lead to specification bias.

Table (4): Variance Inflation Factors									
Vari	ΔGDI	ΔGDP_t	ΔGDP_t	U_t	U_{t-1}	U_{t-2}	t	t^2	Me
able									<i>an</i>
VIF	2.3	2.40	1.76	74.	168	67.	25.	23.	45.
	1			85	.93	63	82	38	89

The coefficient value on GDP and its one period lag were both found to be statistically significant in difference from zero, and negative. This supports the empirical results of Kandil and Woods (2002), which also discovered that an increase in GDP corresponds to an increase in the percentage value of the female-male wage differential (i.e. the female-to-male wage ratio would decrease).

The coefficients on the current value of unemployment, and the two-period lag value of unemployment were both found to be statistically significant in difference from zero. However, they took opposite signs, with the current value of unemployment's coefficient yielding a positive sign, suggesting that an increase in unemployment will increase the value of the female-male wage differential (as above with GDP). This supports the empirical results of O'Neill, 1985, who found the same. However, as the coefficient on the two-period lag in unemployment is also statistically significant in difference from zero, it must be interpreted. It suggests that an increase in unemployment, two quarters previously, will decrease the value of the wage differential, which supports the conclusions of Kandil and Woods, and Aller and Arce (2001), which both found that the gender wage gap contracts during recession.

As predicted by the non-stationarity of the wage gap over time, the included variables of time and time squared both had statistically significant coefficients. This time-series significance explains the high r^2 value of the regression, which is of little use for interpretation of the model in this case. To correct for potential error, mostly due to the detection of autocorrelated errors, the Prais-Winsten iterated autoregressive estimates of the same regression equation will be calculated. This regression will also utilize robust standard errors, autocorrelation issues in the error term. The results from this regression are presented below, in Table (5).

Table (5).

Prais-Winsten Autoregression of the Gender Wage Gap,
1979:1 – 2009:3, with robust errors

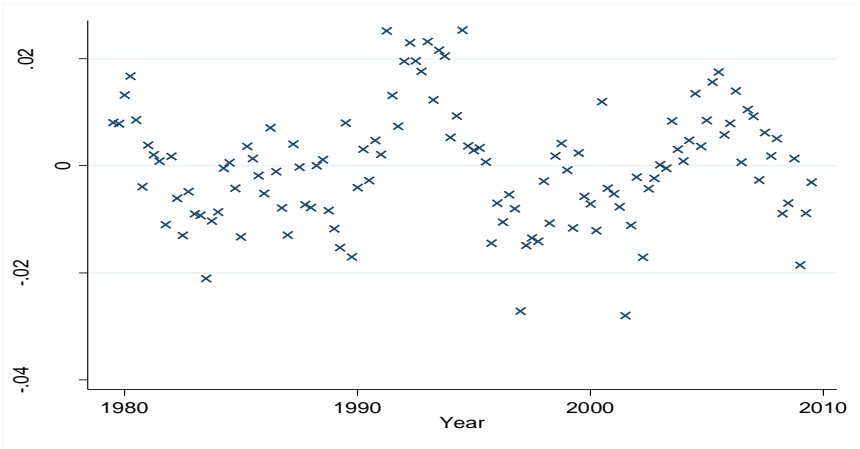
	Y	
	Coefficient	Absolute value of t-statistic
ΔGDP_t	-0.0004	(1.23)
ΔGDP_{t-1}	-0.0009	(2.38)*
ΔGDP_{t-2}	-0.0002	(0.76)
U_t	-0.0066	(1.57)
U_{t-1}	0.0000	(0.02)
U_{t-2}	0.0108	(2.53)*
t	0.0028	(11.84)*
t^2	-0.0000	(5.45)*
Observations	121	
R-squared	0.91	
* significant at 5%		
Durbin-Watson Statistic	2.31	

First notable in the results of the AR(1) model is the transformed Durbin-Watson statistic, which is not proof of no autocorrelation, but significantly close to its upper bound of no autocorrelation as to assume that autocorrelation is not an issue here (especially when compared to the original statistic of .91). Another method of testing for autocorrelation is the runs test for patterns in the sign of the

error term. The runs test on the errors from the AR model yields a rejection of the null hypothesis of non serially random errors, indicating that autocorrelation is still present (the runs can actually be seen in Figure (2)).

Investigation of the behavior of the residuals for the AR(1) regression over the time period is still warranted, and this can be observed in the scatter plot in Figure (2), below.

Figure (2). AR(1) Regression Residuals.



The error term for the autoregressive does not appear to be entirely stochastic in nature. At a quick glance, the residuals appear to reflect the business cycle, to some extent. However, although there appears to be a slight pattern in the error term, the Durbin-Watson statistic does not yield definite conclusions about autocorrelation. Further investigation into this problem suggested utilizing differencing of the dependent variable with the current RHS variables: however, this method garnered no statistical significance from zero of any RHS coefficient.

Accepting the issues with this regression as given, interpretations of the coefficients can be made. For the GDP coefficients, in this regression, only the one-quarter lagged coefficient on GDP is deemed to have an effect statistically significant in difference from zero, taking a negative value, matching the results of the OLS model and supporting the evidence from Kandil and Woods (2002). These results

suggest that when there is a positive increase in the growth rate of GDP in the previous quarter of one percent, there is a .0004 increase in the percentage value of the gender wage gap (i.e. it would increase from 20% to 20.0004%, or, in terms of the regression model, the percentage of men's wages women earn would drop from 80% to 79.9994%), holding the influence of other included variables constant. While the t-score on the non-lagged component of GDP's coefficient has dropped, its sign has not changed, so conclusions from the previous section about the impact of GDP on the wage differential are not changed.

The only coefficient on unemployment that remains statistically significant is the two-period lagged value, which takes a positive coefficient again, as in the OLS regression. This coefficient predicts a .0028% decrease in the value of the gender wage gap for each increase in the unemployment rate of 1%, holding the influence of other included variables

constant. This supports the empirical work of Kandil and Woods, and Arce and Aller, who found the gender wage gap to contract during a recession. The negative coefficient on the current value of unemployment is no longer statistically significant in difference from zero, which indicates that the results of O'Neill are not supported by the autocorrelation corrected regression. The coefficients on the time variables remain statistically significant in difference from zero, as predicted by theory.

VI. Conclusions

This investigation focused on the behavior of the female-to-male wage differential in the aggregate US economy over the period 1979:1 to 2009:3. An estimation of the true gender wage gap was created from Current Population Survey data, using median weekly earnings of full time workers. The historical time series data shows

significant variance in the wage gap over time. Stationarity of the wage gap series was rejected.

Using traditional OLS methods, and autoregressive methods, the wage gap was regressed on GDP growth and its lags over two quarters, and the unemployment rate and its lags over two quarters. Empirical evidence was found that the gender wage gap expands during business cycle expansions and contracts during recessions. Specifically: when the growth rate of GDP is positive in previous quarters, the value of female earnings decreases relative to men's; when the unemployment rate increases in previous quarters, the value of female earnings relative to men's increases. Some of this empirical evidence conflicts with previous time series analysis, however, this investigation includes an additional 15 years of data compared to the most recent US study.

This evidence is at large consistent with theory regarding the nature of the labor supply curves of women and men. The greater experience, tenure, and bargaining positions men hold due to their longer commitment on average to the workforce (and possibly sex bias), compared to their female peers, puts them in a position which enables more wage gains during expansions (Blau 1997).

This paper was written to conduct further analysis of an important topic that had not recently been studied. It can be observed that the gender wage gap has been increasing during the current recession (Figure 1). The empirical findings of this paper, however, do not support the current fluctuations in the data. The empirical findings suggest that the large increases in the unemployment rate and decreases in the GDP growth rate should have led to a decreased gender wage gap; the data shows that the gender wage gap has increased. However, the empirical findings do support

the notion that it is crucial for women to increase their work experience, and positions in labor agreements, in order to hold the kind of wage bargaining power that men do.

Further investigation into this topic should undertake a sectoral analysis of wages, similar to the study by Kandil and Woods (2002), in order to analyze the different components of the labor market. Although the results of this paper support previous research, the current situation of the wage gap does not reflect what has been empirically shown. Additional time and data may be necessary in future years to show the true effect of the 2007-2009 recession on the composition of the gender wage gap.

VII. References

Aller, R., & Ullibarri Arce, M. (2001, March). Explaining the Reduction in the Gender Wage Gap during the 1990-94 Economic Recession in Spain. *Atlantic Economic Journal*, 29(1), 63-74. Retrieved September 20, 2009, from EconLit database.

Blau, F., & Kahn, L. (1997, January). Swimming Upstream: Trends in the Gender Wage Differential in the 1980s.

Journal of Labor Economics, 15(1), 1-42. Retrieved October 10, 2009, from EconLit database.

Bureau of Labor Statistics – Current Population Survey (2009). Retrieved October 2009. From Bureau of Labor Statistics Web Site: <http://www.bls.gov>

Datta Gupta, N., Oaxaca, R., & Smith, N. (2006, August). Analysing Trends in US and Danish Gender Wage Gaps in the 1980s and 1990s. *Applied Economics Letters*, 13(10), 643-647. Retrieved September 20, 2009, from EconLit database.

Federal Reserve Bank of St. Louis – Economic Research (2009). Retrieved October 2009. From Federal Reserve Bank of St. Louis Economic Research Web Site: <http://research.stlouisfed.org/fred2/>

Kandil, M., & Woods, J. (2002, May). Convergence of the Gender Gap Over the Business Cycle: A Sectoral Investigation. *Journal of Economics and Business*, 54(3), 271-292. Retrieved September 20, 2009, from EconLit database.

O'Neill, J. (1985, July). The Trend in the Male-Female Wage Gap in the United States. *Journal of Labor Economics*, 3(10), 91-116. Retrieved October 10, 2009, from EconLit database.

O'Neill, J., & Polachek, S. (1993, January). Why the Gender Wage Gap Narrowed in the 1980s. *Journal of Labor Economics*, 11(1), 205-228. Retrieved October 10, 2009, from Econlit database.