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Brooke Whetstone
blynnwhetstone@gmail.com

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Cover Page Footnote

I would like to thank the Olivet Honors Program for enabling me to complete a research project during my undergraduate experience. I would also like to thank my fiancé for his support. I would also like to thank my project mentor, Dr. Koch, for sharing his expertise during this process. Finally, I would like to thank the other five remaining members of Cohort 10 of the Honors Program. These women have been an incredible support system as we walked through the process together.

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ABSTRACT

Background
Contractionary monetary policy has long-term effects on inequality (Feldkircher & Kakamu, 2018). However, other forms of monetary policy do not have a clear effect on income inequality. Central banks defend the position that other factors are the driving forces behind income inequality (Powell, 2018).

Methodology
This investigation utilized ANOVA regression analysis to determine if income inequality, as measured by wage growth by sector, is related to interest rates in the United States and Spain. If applicable, slopes of the regression lines for each sector were compared to see if they were significantly different in a statistical sense.

Results
At interest rates above 0.4 percent in the United States, the Federal Funds Rate has asymmetric effects on the sectors studied. In Spain, there is no clear relationship between the European Central Bank (ECB) rate of discount and wage growth, so tests of the slope were not relevant.

Conclusion
In the United States, higher, or contractionary, rates of interest appear to have an impact on income inequality. This is in line with the results of previous studies.

Keywords: income inequality, monetary policy, United States, Spain

REVIEW OF LITERATURE

One of the major sources of economic policy is a nation's central bank. Central banks intervene in an economy through monetary policy. Monetary policy refers to the actions of central banks to steer the direction of the economy by adjusting the money supply and interest rates. Contractionary monetary policy occurs when central banks increase interest rates or decrease the money supply to slow economic growth. Expansionary monetary policy refers to a decrease in interest rates or increase of the money supply in order to spur economic growth. Some of economists' major historic indicators of a recession are now considered unreliable, due to the intervention of central banks. For example, the Phillips Curve, a model that shows the tradeoff between unemployment and inflation, has flattened, meaning low unemployment no longer seems to put upward pressure on the average price level. As of 2019, the United States economy was operating with low unemployment and low inflation. According to the traditional Phillips Curve, this should not be possible. The flattening of the Phillips Curve, according to current and previous chairs of the Federal Reserve, may be the result of the Federal Reserve's ability to anchor inflation expectations (Sheiner, 2018). As economists try to navigate an economic state that is theoretically impossible, concerns surrounding the effects of adjusting the economy through monetary policy have arisen following the 2007 global financial crisis.

Central banks defend monetary policy

One such concern is the impact central banks have on income inequality. Income inequality is defined as a relative disparity in income or consumption (Bourguignon et al., 2010). Income inequality is generally addressed by means of fiscal policy, government intervention in the economy through taxes, and government spending. The impact of monetary policy on income inequality was first investigated by Romer and Romer (1999) through the process of multicollinearity. Romer and Romer saw rising income inequality as a cause of higher poverty rates. Their investigation sought to determine if monetary policy could have positive distributive effects to help the poor, individuals earning incomes below the poverty line (Romer & Romer, 1999). However, their model was based upon the dual mandate. The dual mandate refers to the Congress mandated focus of the Federal Reserve on unemployment and inflation. Thus, using unemployment and inflation indicators as determinants of poverty, they investigated the distributional effects of the actions of the Federal Reserve (Romer & Romer, 1999). Given the current state of the Phillips Curve, their model may yield different results today. Since their investigation, further research has been done to investigate the distributive effects of monetary policy. Ben Bernanke, chair of the Federal Reserve Board of Governors from 2006 to 2014, discussed his view on the causes of income inequality on his Brookings Institution blog. Bernanke asserted that income inequality is largely the result of globalization, technological change, demographics, and institutions. He does not attribute the rise in income inequality to changes in monetary policy (Bernanke, 2001). In contrast, Bernanke's successor, Janet Yellen who served as chair from 2014 to 2018, emphasized the importance of monitoring rising income inequality in her 2014 speech. While the heads of the Federal Reserve have had differing opinions on the importance of income inequality, studies within central banks around the world have been conducted to determine if there is a statistical relationship between the two.

Several researchers at the European Central Bank conducted a study on the distributive impacts of monetary policy with specific focus on quantitative easing. Quantitative Easing (QE) refers to large scale liquid asset purchases in order to increase the amount of money in circulation. This became a popular form of monetary policy during the Great Recession despite being controversial due to fears that QE would cause depreciation and rapid inflation. In order to determine the distributional effects of monetary policy, this study analyzed the direct and indirect channels through which interest rate adjustments and asset purchases impact income and wealth inequality. Here, direct impacts were defined as changes in the incentives of households to save and changes in net household financial income. Indirect impacts result from equilibrium changes in the employment level, including wages and prices. The researchers concluded that asset purchases and expansionary interest rate adjustments lead to decreases in distributional inequality. However, on an overall basis, monetary policy has a minimal effect on income inequality (Ampudia et al., 2018). As the indicators defined as indirect channels in this study are easier to measure than the Gini or Theil Indexes, these channels will form the basis for this study.

Research conducted outside of central banks

Despite the assertions of central banks that their policies do not increase income inequality, researchers outside of the institutions have found otherwise. Several studies have been conducted to look at this relationship by investigating the channels through which monetary policy indirectly affects income inequality. For example, Coiboin, Gorodnichenko, Kueng, & Silvia conducted a study in 2016 which suggested that contractionary monetary policy shocks within the United States have significant impacts on long-run inequality, due to their influence on personal consumption and income.

A similar study conducted in Japan used income statistics from the Japanese Family Income and Expenditures Survey. This survey collected income data from a group of 9,000 individuals on a monthly basis. Using this data, Feldkircher and Kakamu (2018) approximated the Gini Index, a measure of income inequality, using a log normal distribution. The researchers in this study were able to estimate Japan's Gini Index through their sample. The Gini Index calculates the area between the current distribution of income held by each percentage of the population and the line of perfect equality. The greater the value of the Gini Index, the higher the level of income inequality is. This estimate was utilized to see if changes in income inequality, as measured by the Gini index, were attributable to monetary policy. This study concluded that monetary tightening does lead to an increase in income inequality in Japan. This study is unique because the researchers had access to a large sample of monthly income statistics. As the Gini Index is only calculated annually, it is difficult to compare it to the monthly measure of interest rates. Feldkircher and Kakuma illustrate that new methods of research are showing greater evidence of a statistical relationship between monetary policy and income inequality, suggesting there is a need for a further investigation into this topic. There has yet to be a notable study that investigates the impact of monetary policy on income inequality in two countries with different central banks.

Even though there are not specific studies that focus on the comparison of monetary policy and income inequality in different countries, there are cross-country comparisons of income inequality. For example, Wang, Caminada, and Goudswaard (2012) compared the Gini Indices of nations that are part of the Organization for Economic Cooperation and Development using data from the Luxemburg Project, which had been adjusted for redistributive tax policies. Alternatively, another study investigates how educational attainment impacts the gap in income inequality between nations using a metric known as the Theil Index (Ahmed, Bussolo, Cruz, Go, & Osorio-Rodarte, 2017). Thus, there is precedence for income inequality comparisons between nations.

Implications of income inequality

The current study was conducted at a time that dignity is becoming a greater concern of ongoing public policy. The American Enterprise Institute, a public policy research organization, or "think tank" in the United States, has launched the Human Dignity Project in an effort to ensure that policy takes the dignity of individuals into account. Similarly, The Brookings Institute is working on the Hamilton Project which seeks to create an economy that benefits more Americans ("The Hamilton Project," n.d.).

The British White Paper issued in November of 1997 mentions that "true progress in poverty reduction cannot be achieved unless all individuals are treated with dignity" (Agola & Awange, 2014). Thus, this investigation will also discuss the impact of the data on human dignity and the future of policy.

Though dignity is making its way to the forefront of public policy, income inequality is not. In general, income inequality has not been a prominent issue in public policy. Cornia and Stewart (2014) discuss the neglect of income inequality in public policy. They largely attribute this trend to the attitude of economists. In this book, attitudes of economists are consistent with that of Willem Butier who said, "Poverty bothers me. Inequality does not. I just don't care" (Cornia & Stewart, 2014, p.99). Cornia and Stewart (2014) consider the attitude to be the result of several economic principles. First, free-market economists argue that competition produces "the optimal functional income distribution" because the market operates efficiently without intervention (p. 111). Second, it is argued that by allowing individuals to keep a larger portion of their income, incentives to work are created and the resultant hard work will benefit the rest of society (Cornia & Stewart, 2014). This sentiment continues to be present, In an interview with Michael Strain, the director of American policy studies at the American Enterprise Institute, he describes concerns about inequality as the manifestation of populist frustration on the political left (Pethokoukis, 2019).

As policy has focused on poverty rather than income inequality, so have the recent dignity projects. However, according the most recent survey by the Bureau of Labor Statistics, income inequality is the highest it has been since they began measuring it five decades ago despite poverty reaching historic lows (Telford, n.d.). Thus, this investigation looks at dignity in the context of income inequality and raises a question regarding the morality of economic policy. If in fact there is a relationship between income inequality and economic policy, what impact does it have on those asymmetrically affected? According to Gronbacher (1998), "the central aim of economic policy" is to increase "the quality of life for individuals and the community in a manner consistent with the dignity of persons." He asserts, it "is impossible [to do this] without regard for economic liberty and private property" (Gronbacher, 1998,p.15). Because human dignity should be something policy makers are concerned about and is, as defined by Gronbacher, a central aim of economic policy, it should be addressed. Thus, dignity must be taken into account even when policy is pursued for the sake of progress.

Ultimately, economic and political systems are evaluated by different criteria from the criteria by which the actions of individuals are evaluated. One such criteria for evaluating economic systems is economic justice. However, how one defines economic justice impacts his or her evaluation of income inequality. The two most common definitions include defining justice as fairness in the process and defining it as equality in opportunity and/or income. For the sake of this investigation, economic justice will be defined as equality in the opportunity and income. Economic opportunity is generally defined in terms of the poverty line.

This investigation seeks to answer the question: *Is there a statistical relationship between monetary policy and income inequality in the United States and Spain when measuring income inequality by employment fluctuations by industry?*

METHODS

The investigation sought to answer the specific question: Is there a statistical relationship between monetary policy and income inequality in the United States and Spain when measuring income inequality with wage growth by sector? In this case, monetary policy will be represented as the level of interest rates.

United States

For the United States, monetary policy is represented as the monthly average of the Federal Funds Rate found on the website of the Federal Reserve Bank of St. Louis (FRED). Wage growth data comes from a monthly survey of Current Employment Statistics (CES) conducted by the Bureau of Labor Statistics. CES provides access to average hourly earnings reports from a variety of specific jobs as well as industries. In order to obtain diverse pay bands, the sectors of retail, manufacturing, financial activities, and professional services were selected. These occupations vary with education attainment and skills required.

Spain

Spain was used in this investigation to see if there is a parallel trend between a nation in a monetary union when compared to a country like the United States in control of its own monetary policy. Out of all of the countries in the Euro Area, Spain was chosen as a case study due to its high rate of youth unemployment. High rates of youth unemployment indicate a possible disparity in the distribution of income by age brackets. For Spain, the analysis uses quarterly ECB discount rates as monetary policy. The quarterly ECB discount rate is also available on FRED. Quarterly wages for the sectors of industry, construction, and services are available on Eurostat, a statistical database organized by the European Commission in the European Union. Unlike in the United States, less published data on wages are published in Spain. Thus, the only sectors available to compare were industry, construction, and services. While these sectors are more narrow than those chosen for the United States, they still vary in skills and education attainment required.

Statistical process

Using SPSS, linear regression models were created using interest rates as the independent variable and the average weekly earnings of the various sectors as the dependent variables. ANOVA regression analysis assumes that the mean of the errors terms is zero, errors are approximately normally distributed, the error terms have equal variances, and the error terms are independent. The slope of each regression lines measures the impact on the average hourly earnings for that sector of a one-unit change in the interest or discount rate. If applicable, the slope of each line was then tested against the industry average to see if it was statistically different. If the slopes for individual industries are significantly different from the industry average, this may

indicate that monetary policy has a greater impact on income for certain sectors of the economy over others.

RESULTS

United States

In order to assess the best type of regression possible, the wages by sector were graphed against interest rates to determine if a linear model was applicable. **Figure 1** shows that there may be linear trends between interest rates and wages of each sector. Despite all occurring at different wage levels, each line appears to follow a similar trend. However, regression analysis was needed to determine what this trend is.

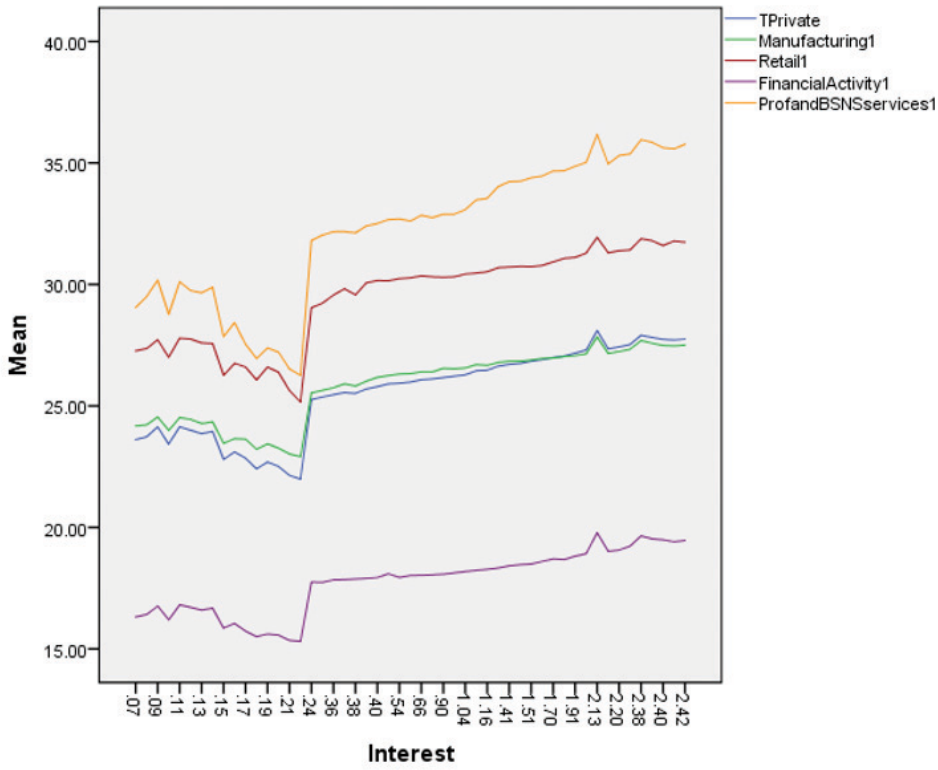

Figure 1:Mean Average Hourly Earnings by Sector and the Fed Funds Rate. Figure 1 shows the values of average hourly earnings for each sector graphed by interest rate. The vertical axis, labeled mean, uses the mean value of average hourly earnings for that sector at the specified interest rate. Because interest rates have repeated between 2000 and 2019, the function is not one-to-one. Using the mean enables SPSS to connect the data in a single line.

TABLE 1: UNITED STATES LEAST SQUARES REGRESSION SLOPES

Slope of each regression line as well as the correlation coefficient. The slope represents the change in average hourly earnings per a one unit increase in the interest rate. The correlation coefficient demonstrates how well the regression line represents the data. An R^2 value of one would indicate that the line fits the data perfectly.

United States Least Squares Regression Slopes		
Sector	**Slope**	**R^2**
Total Private	1.992	0.681
Retail	1.417	0.664
Manufacturing	1.66	0.672
Financial Activity	1.417	0.664
Professional Services	3.134	0.64

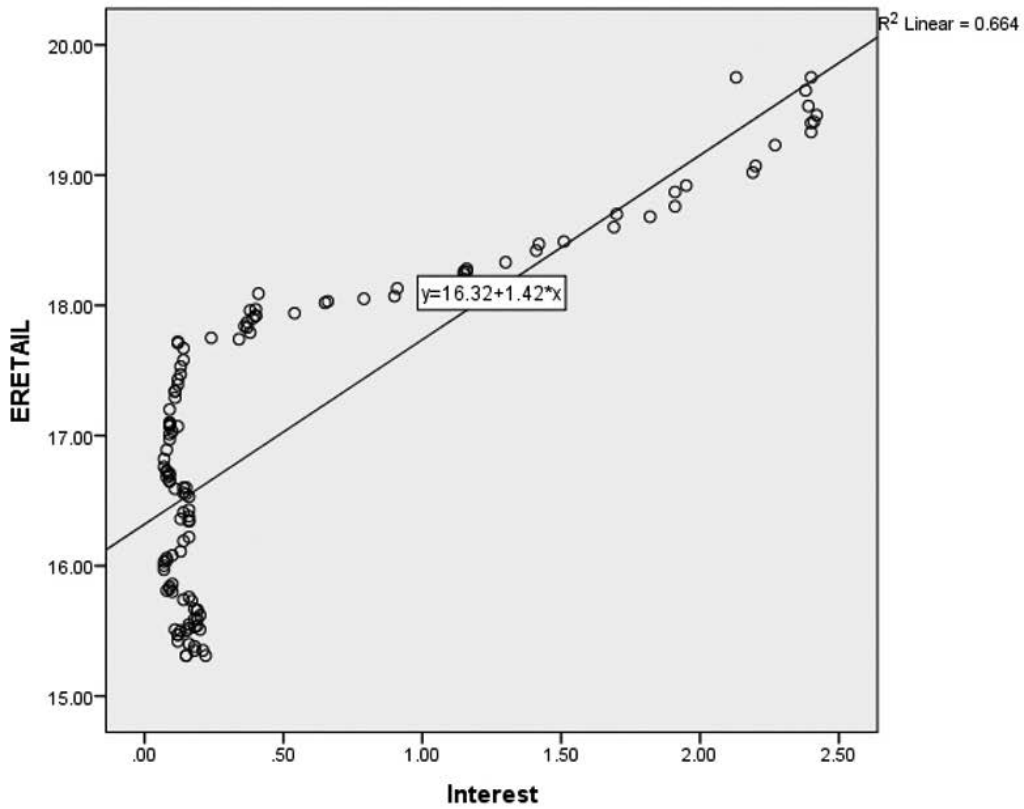

Figure 2: Average Hourly Earnings for Retail Scatter Plot. Figure 2 shows the scatter plot of the data for the average hourly earnings of retail employees by interest rate in the United States. The line on the graph is the least squared regression line calculated. As indicated by an R^2 value on 0.664, the line does not appear to fit the data very well. This trend is consistent for each of the sectors analyzed as evident by the R^2 values in table one.

As demonstrated by **Figure 2**, despite relatively low r^2 values, there appears to be a definite linear trend after an interest rate of 0.4. The graph below illustrates that all the sectors in the United States follow a similar linear trend. Using the same methodology, the experiment was re-conducted using only interest rate values above 0.4.

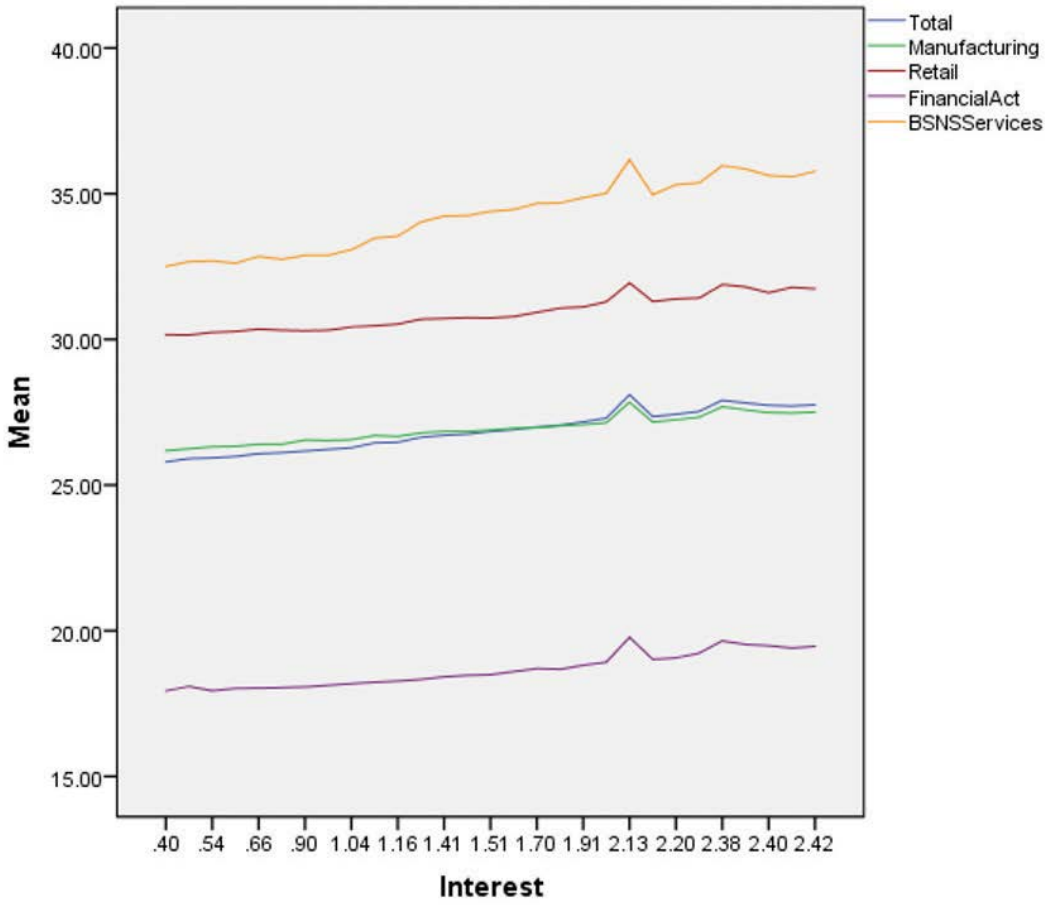

Figure 3: Mean Average Hourly Earnings by Interest Rates above 0.4. Figure 3 shows the linear trends evident between average hourly earnings by sector and the Federal Funds Rate when values at volatile interest rates are removed.

Just as in **Figure 1**, the vertical axis uses the mean value of the average hourly earnings from each sector at the given interest rate. In **Figure 2**, it is more obvious that there appears to be a definite linear trend. Using only this segment of the data, the regression analysis was reconducted to determine a new line of best fit.

TABLE 2: REGRESSION LINES ABOVE INTEREST RATES OF 0.4

The slope represents the change in average hourly earnings for each industry per one unit change in the Federal Funds Rate. The R^2 value gives the correlation coefficient indicating how well the regression line fits the data.

Regression Lines above Interest Rates of 0.4		
Sector:	**Slope**	**R^2**
Total	0.996	0.959
Manufacturing	0.655	0.926
Retail	0.808	0.922
Financial Activity	0.803	0.900
Professional Services	1.691	0.956

After emoving the volatile trend among lower interest rate values, the correlation coefficients are much higher. Thus, the regression lines are better models of the data. Additionally, with the exception of professional and business services, all the slopes are below one.

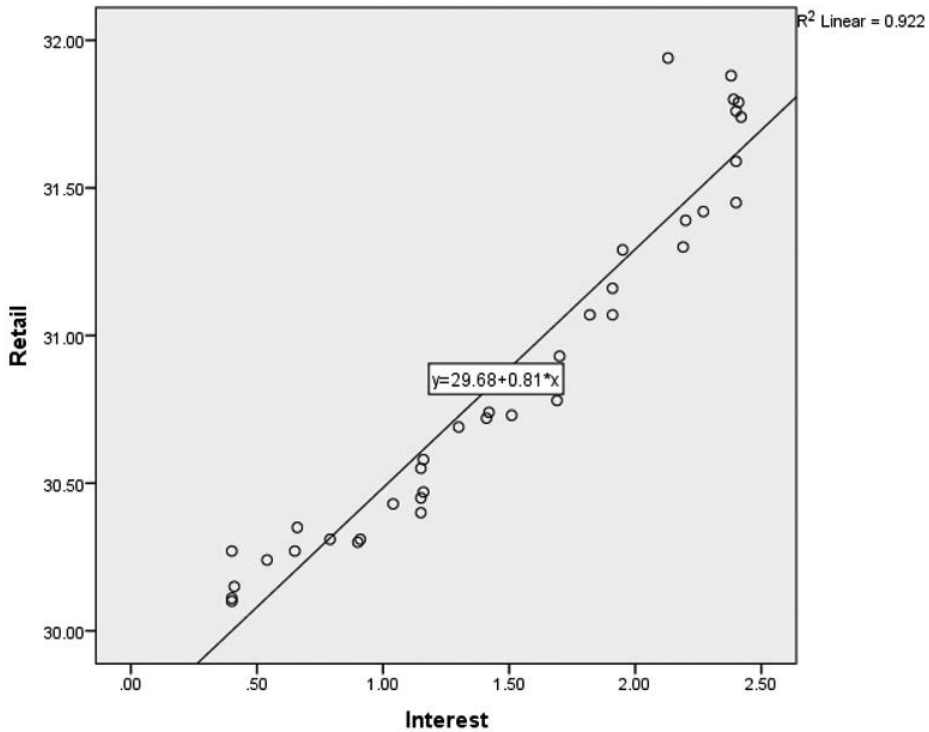

Figure 4: Federal Funds Rate and Average Hourly Earnings. Figure 4 represents the least squares regression line graphed against the scatter plot of average hourly earnings for retail and the Federal Funds Rate. The least squares regression line is represented by the equation y=29.68+0.81x, where y is the average hourly earnings and x is the Federal Funds Rate.

Figure 4 shows the relationship between average hourly earnings in retail graphed by interest rates above 0.4. Here, the least squares regression line represents the data more accurately. Thus, there appears to be a linear relationship between interest rate and average hourly earnings above a federal funds rate of 0.4.

Test of slope

After determining that a linear trend exists above an interest rate of 0.4, a test of slopes was performed to determine if the various sectors have slopes that are significantly different from one another. To determine this, the total average hourly earnings slope was compared to each sector's slope using a t-test. The corresponding p-value for each t-test is deemed significant if it is below 0.05.

TABLE 3: TEST OF SIGNIFICANCE OF THE SLOPE

Results from the test of significance when interest rates above 0.4 are included. The slopes of each sector are listed along with the standard error associated with the calculation of each slope. The t value in the fourth column shows the t statistic calculated by taking the difference between the slopes and dividing by the square root of the sum of the squared standard errors. The degrees of freedom are n1 + n2 -4. The p value is the significance value found from the respective t values. Using an alpha value of 0.05, all are significantly different from the total average hourly earnings slope.

Test of Significance of the Slope					
Factor	**Slope**	**s_b**	**t**	**df**	**p**
Total	0.996	0.035			
Manufacturing	0.655	0.031	-7.29339	68	0.00000***
Retail	0.808	0.040	-3.53711	68	0.00040***
Financial Activity	0.803	0.045	-3.38544	68	0.00060***
Professional Services	1.691	0.062	9.76166	68	0.00000***

***Significant at an alpha of 0.001

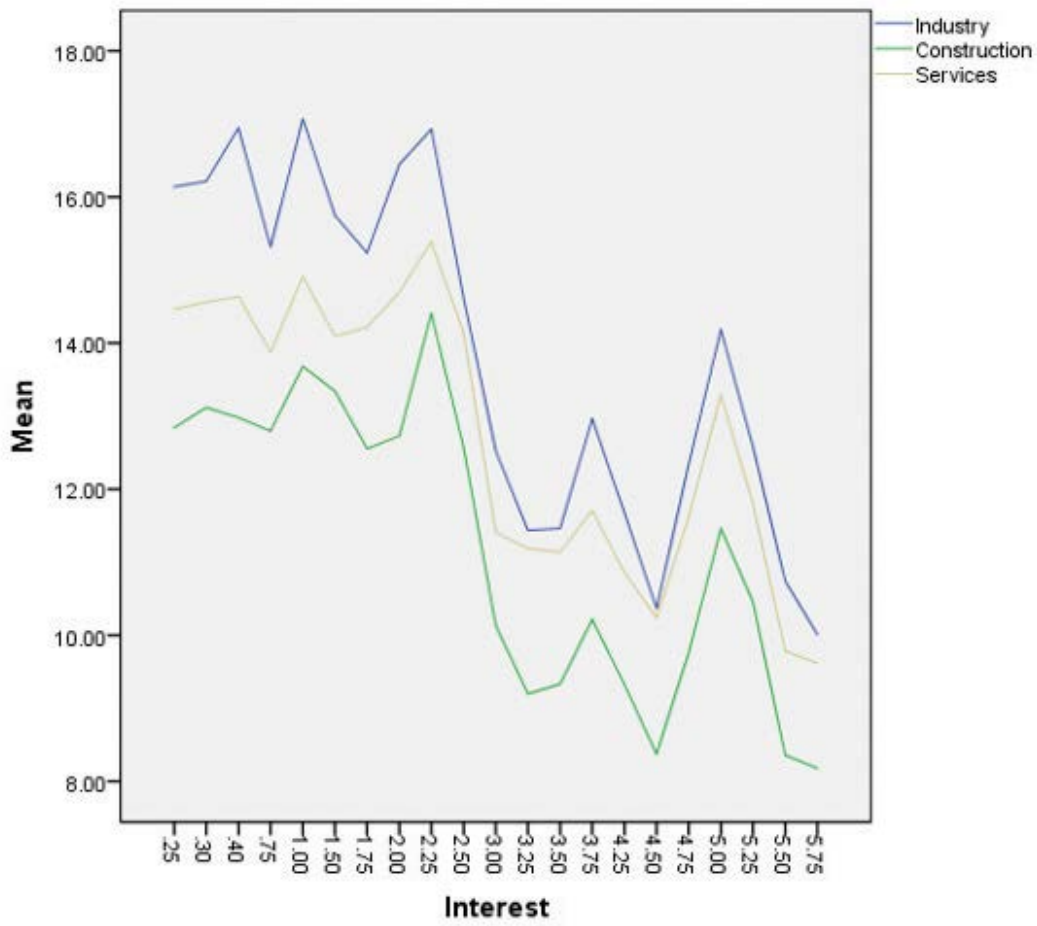

Figure 5: Mean Average Hourly Earnings by Discount Rate. Figure 5 models the trend between wages and interest Rates in Spain. The horizontal axis represents the quarterly discount rate. The vertical axis uses the average of the average hourly earnings for each sector at the given discount rate.

Figure 5 demonstrates that while each industry follows a similar trend, there does not appear to be strong linear relationship like the one seen in the United States data for any discount rate interval.

TABLE 4: SPAIN LEAST SQUARES REGRESSION LINES

Slopes of the lines for each sector as well as the respective correlation coefficients. Low R^2 values highlight that this relationship is not very linear.

Spain Least Square Regression Lines		
Sector:	**Slope**	**R^2**
Industry	-0.987	0.546
Construction	-0.817	0.517
Services	-0.78	0.506

In this case, the regression analysis does not appear to show a clear relationship between interest rates and wages in Spain. However, it is notable the all the slopes in this case are negative in comparison to positive slopes for the United States. Because low R2 values indicate the linear relationships do not fit the data well, further analysis of these slopes would not yield any significant results.

DISCUSSION

The primary finding from this investigation is that the Federal Funds rate appears to asymmetrically affect wages by sector. Analysis conducted for Spain does not yield any significant regression lines; however, it does demonstrate that there is a negative relationship between wages and the ECB's rate of discount. Though other studies on this topic have used regression techniques, this study is unique because it measures income inequality by wages of various sectors.

The goal of comparing the United States and Spain was to determine if a consistent underlying trend exists. These two countries make for an interesting case study because the monetary policy of the United States is based on the data for the United States, whereas monetary policy in Spain is dependent on the state of the entire Euro Zone. Although the Federal Reserve's monetary policy specifically targets aspects of the U.S. economy, ECB rates are less able to do this. Ultimately, the study showed that there was no similar underlying trend between the income inequality and monetary policy in the United States and Spain. This lack of trend in Spain was unexpected. A future study, investigating whether or not this trend is consistent for other Euro Zone countries, would be informative.

Analysis of the data from the United States seems to be in line with previous studies. Research conducted within the United States and Japan suggested that monetary policy has distributional effects when it is contractionary in nature (Feldkircher & Kakamu,

2018; Coibion et al., 2016). The current investigation yielded similar results. Though there appeared to be no trend at interest rates near the zero-lower bound, as the interest rate increase, or became more contractionary, a trend developed.

In an essay about economic dignity, Sperling (2019) defines *economic dignity* in terms of three pillars: ability to provide opportunity for one's family, chances to pursue one's potential, and the capacity to contribute economically with respect ("Economic Dignity," 2019). Income inequality has the greatest impact on the ability to provide for one's family. While the data showed that the wages of various industries are affected by monetary policy at significantly different rates, there was a positive correlation for each. Due to positive slopes for each category, there is no indication that monetary policy harms one group with benefiting another. However, despite these positive relationships, there is evidence that monetary policy adjustments provide greater benefits to certain sectors.

From the test of slopes, manufacturing and retail were the most negatively affected in comparison to total average hourly earnings. According to the Bureau of Labor Statistics (2018), incidence of falling into the working poor category varies by occupation. Individuals with high educational attainment such as business professions were calculated to have a 1.6% chance of being classified as the working poor as of 2016. In comparison, workers in service occupations, such as retail, characterized by low levels of education attainment and low earnings had a 10.7% of becoming working poor. Finally, manufacturing occupations have a 5.7% chance of being classified as working poor. Given these probabilities and the definition of economic justice, it is apparent that in addition to the wages of workers in the manufacturing and retail sectors in the United States being asymmetrically affected, workers in these sections already face a higher chance of being pushed below the poverty line. Given these two criteria, workers in these two sectors appear to have been treated unjustly.

One weakness of this study is that it does not take into account time lags of monetary policy. Finding a way to mathematically incorporate the time lags of monetary policy may indicate a more significant trend. However, because results seem to be in line with previous studies, policy lags may not have a significant impact on wages. Similar results without adjusting time lags may suggest that employers adjust wages with policy expectations in mind. However, due to the frequent changes in interest rates but relatively stagnant wages, this is unlikely.

Overall, significantly different slopes for different sectors indicate that United States monetary policy asymmetrically affects income in those sectors. However, while the sectors were growing at significantly different rates, the wages in each sector were still increasing as the interest rate increased. Further investigations could consider other indicators besides monetary policy that could impact rising rates of income inequality.

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