Bachelor's project

NTNU
Norwegian University of Science and Technology
Faculty of Economics and Management
Department of Economics

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Easing Income Inequality Through Quantitative Easing

A Case Study of Norway and the USA During the Period of 2000-2017

Bachelor's project in Economics
Supervisor: Colin Green
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Abstract

This paper focuses on analysing the potential effects Quantitative Easing (QE) may have on income inequality. An increase in money supply (m1) is used as a representation of QE and the Gini coefficient is used as the measurement for income inequality. This investigation is done through a Multiple Linear Regression (MLR) model using the Ordinary Least Squares method. The data for every variable included in this analysis is from the years 2000-2017, for both Norway and the USA.

When conducting the hypothesis test to see whether there is *any* statistically significant effect from an increase in money mass on the Gini coefficient in Norway, we fail to reject the null hypothesis. When conducting the same hypothesis test for the USA, using the data provided, we are able to reject the null hypothesis. The difference in results may potentially be due to large differences in taxation systems and initial differences in income inequality, however, this claim requires further study.

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1. Introduction

1.1 Chronology

The period from 2000 to 2007, the period before the economic crisis, can be described as a period of prosperity for most countries in the world economy. This period was characterized by economic growth and financial stability, with central banks applying conventional monetary policy to maintain inflation fluctuation at low, constant levels. Although this stabilization mechanism may have been effective, the financial crisis of 2008 exposed the weaknesses of the system. The maintenance of low and stable inflation failed to prevent asset market bubbles from occurring[1]. The sudden rise in general prices resulted in optimistic expectations that attracted more investors to actively participate in the market. This pushed prices in the housing market even higher, leading to a market crash and a deep recession, known as the Great Recession. With the interest rates approaching zero, central banks had to turn to unconventional monetary policies in order to help the economy recover. This unconventional monetary policy could be performed in many ways; the banks could set negative interest rates for a period, re-evaluate inflation targeting or expand their balance sheets.[2] The main aim of the banks, following this mechanism, was to increase the money supply, bringing new money in circulation. This was achieved by purchasing government bonds. This would increase market liquidity, borrowing and investments, which in turn would increase economic activity and strengthen the economy. This type of policy was called quantitative easing (QE). [3]

[1] Bodie,Kane, and Marcus, "*Investments"*, 358.
[2] Joyce, Miles, Scott, Vayanos, "Quantitative Easing and Unconventional,".
[3] Connor, "Does Quantitative Easing Contribute,".

1.2 Research question

The thesis is motivated by the historical use of quantitative easing, especially through times of economic crisis and how the use of this unconventional monetary policy affects the income distribution in countries, with initial high- or low-income inequality. This leads to the research question:

"Does an increase in money mass through quantitative easing reduce income inequality?" A Case Study looking into Norway and the USA during the period 2000 – 2017.

The importance of this research question lies in the potential mid-term/long-term effects of quantitative easing on socio economic development, one that may be neglected when focusing on stimulating the economy. The potential channels through which QE may affect income inequality is shown in section 2.6.

2. Conceptualization and Theory

It is important to describe the economic theories and concepts behind the variables used in the regression analysis throughout this paper. Both traditional and modern economic theories are used to rationalize the effects of quantitative easing on income inequality for this paper.

2.1 Traditional Monetary Policies

The aim of traditional or conventional monetary policy is to achieve the following macroeconomic goals: price stability (inflation targeting up to 2%) and high employment.[4] Conventional monetary policies are used by the central banks and find their application in the adjustments of the liability side of the balance sheet and of interest rates in order to maintain price stability.[5] This is done through either expansionary or contractionary monetary policy. Under expansionary policy the central bank is trying to stimulate overall consumption in the economy by increasing the money supply, lowering money market interest rates (or interbank interest rates), while the contractionary policy includes decreasing the money supply to reduce inflation and overinvestment.[6]

2.2 Unconventional Monetary Policies (Quantitative Easing)

Unconventional monetary policy comes into use when the conventional monetary policy cannot be used to help the economy gain traction again. A common case where unconventional monetary policy is necessary is when the interest rates are at a low bound, approaching zero. This type of policy, first applied in Japan in 2001[7] includes the following action by the central bank: changes in inflation targeting, expansion of banks' balance sheets or lowering of the interest rates (negative interest rates). Quantitative easing (QE) is a type of

[4] Ben S. Bernanke, "Monetary Policy and Inequality".
[5] Ivanova, "Quantitative Easing: A Postmortem,",4.
[6] Holden, *Makroøkonomi*",37-38.
[7] Iwata and Takenaka, "Central Bank Balance Sheet,".

unconventional monetary policy executed by the central bank. Central banks conduct monetary policy, by purchasing or selling government bonds and securities through open market operations in order to expand the balance sheet. This affects the money supply and decreases the capital market interest rates, stimulating the economy and adding more money in circulation, in addition to, increasing the inflation rate through overinvestment.[8] Taking housing prices as an example, low interest rates can stimulate the economy through house buyers being more willing to take up a loan at a low interest rate. The overall consumption and the demand for the assets increases as well as their prices, through the law of supply and demand. However, a potential problem that could arise by the long-term use of QE is hyperinflation. The transmission channel of how QE may affect income inequality can be viewed in section 2.6.[9]

2.3 Quantitative easing USA

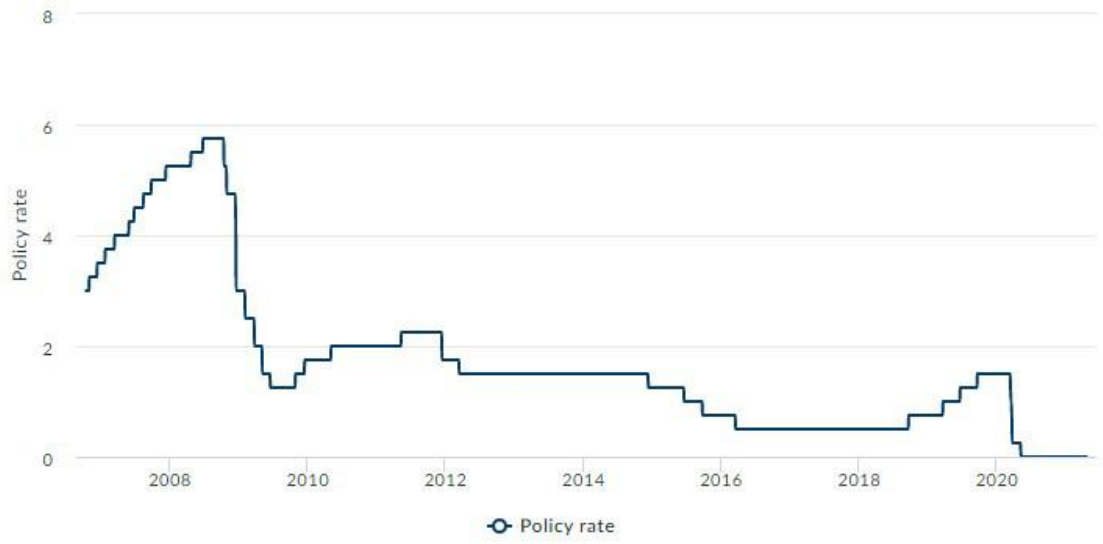
During 2000 and 2007 the Federal Reserve Bank (Fed) had to face two important historical events, “The Great Moderation” and “The Great Recession". When the financial crisis hit the world economy, the Fed started applying the balance sheet expansion strategy, through the purchase of long-term government bonds. In November 2008, the Fed proposed to buy $100 billion agent debt and $500 billion mortgage-backed securities. This act was called QE1. This act was followed by a purchasing program. In March 2009, the Fed used $850 billion to buy agent debt and mortgage-backed securities, and then used another $300 on securities. During 2010-2011 the Fed purchased long term treasuries worth $600 billion, called QE2. QE2 was introduced in November 2010, two months after the completion of QE1, and ended in 2011. After the QE2 termination, the Fed introduced the Operations Twist program, which was not included in the QE program. The aim of the program was not the expansion of the balance sheet, but increasing the bank's treasury portfolio by exchanging short-term to long-term treasuries. There were purchased Treasury securities worth $667 billion with 6 to 30 years maturities, offset by sales of $634 billion in Treasury securities maturing in up to 3 years and $33 billion of Treasury security redemptions. In December 2012, the QE3 was initialized. The QE3 included the monthly purchase of mortgage-backed securities worth $40 billion by the central bank that along with the long-term bond purchases, extended the balance sheet until it was completed in 2014. The QE programs were followed by a period (2015-2016) characterized by low federal funds rates and inflation rates while the Fed tried to moderate the financial vulnerabilities creating a normalized balance sheet by reducing Fed´s securities holdings. [10]

[8] Holden, *Makroøkonomi*”, 221-222.
[9] Joyce, Miles, Scott, Vayanos, “Quantitative Easing and Unconventional,”.
[10] Board of Governors of the Federal Reserve System, “FOMC statements (2008-2014)”. Every reference regarding FOMC statements from the Board of Governors of the Federal Reserve System has been used in this section.

2.4 Quantitative easing Norway

In Norway, monetary policy is a conventional monetary policy used for stabilization. Since 2001, Norges Bank has been targeting low and stable inflation rates, around 2-2,5% over time.[11] In addition, it sets the interest rate level considering external exchange rates, as Norway is a small open economy. The Norwegian economy suffered from the effects of the economic crisis in 2008 and the monetary policy was enough to tackle the market swings that hit the country with the external interest rates approaching 0%. Although the real interest rate was 2% lower than what was targeted, the QE-assistance was not required for Norges Bank, contrary to ECB and Fed, and negative interest rates were evaluated to be more costly than beneficial for the economy of the country.[12] The effects on the market and the illiquidity of the Norges Bank decreased the interest rate from 5.75% in 2008 to 1.25% in June 2009, however the economy did recover quickly, since it wasn't exposed to any loss linked to US backed securities. In 2014-2015, Norway experienced a fall in oil prices that decreased the value of its currency and lowered the interest rates level.[13] The lowering of the interest rates increased loan uptake resulting in the housing prices, as well as inflation, to rise.

Figure 1: Policy Rate -Norway 2007-2020[14]



[11] Olsen, "Navigating Normalisation".
[12] Olsen, "The Monetary Policy Toolkit,".
[13] NORGES BANK, "Experience with the Monetary,".
[14] NORGES BANK, "The Policy Rate,".

2.5 Fisher's Equation of Exchange

In this paper, the theoretical framework used to explain the effects of QE on income inequality can be understood through the use of the Fisher's Equation of Exchange.

In the book, “The Purchasing Power of Money”, published in 1911, Irving Fisher presents the equation commonly known as “Fisher's Equation of Exchange”, where he depicts the relation between the money in the economy (sometimes referred to as money mass), the velocity of money, prices level in the economy and aggregate transactions.[15] This is shown by the following equation:

$$M \cdot V = P \cdot T$$

Fisher's Equation of Exchange

M = Money in the economy (money mass)
V = Velocity of money
(How frequent transactions occur in the economy, in other words, how “fast” money flows in the economy)
P = Price level in the economy
T = Aggregate Transactions

These are the assumptions taken into account for this equation in this paper:

1. Price level (P) can only change due to changes in M, V, T.
2. V and T are exogenous, meaning that nothing within the equation influences them.
3. Assumed to be long-term, as there may be a delay between a money mass increase and a change in general price levels.[16]

From the equation we observe that the amount of money in the economy has a direct effect on the general price level of the economy if V and T is kept constant. One could in other words say that the money mass in an economy has a direct effect on its inflation level.

The assumption that V and T are kept constant is dependent on the state of the economy. If the economy is at a full/near to full capacity, one could say that there is no more capacity for “aggregate transactions" to expand, for which QE would only lead to more inflation (increase in price). On the other hand, if an economy is not at full/near full capacity (can be observed in employment rates), there is still capacity for “aggregate transactions" to increase, thus without necessarily a price increase (inflation).

[15] Fisher and Brown, “The Purchasing Power of ,”.
[16] E. Narayanan Nadar, “MONEY and BANKING”, 73–75.

This is shown as follows:

Note: No directional arrow indicates that the variable is kept constant.

$$M \uparrow \cdot V = P \cdot T \uparrow \rightarrow \text{Demand Bottleneck Economy}$$

$$M \uparrow \cdot V = P \uparrow \cdot T \rightarrow \text{Supply Bottleneck Economy}$$

Demand bottleneck economy indicates that there is still capacity for employment in a country, and thus as employment increases, the aggregate transactions in the economy also increase, without necessarily increasing inflation. However, in a supply bottleneck economy, there is close to full or full employment, which indicates that aggregate transactions in an economy cannot increase any further and thus an increase in money mass only manages to increase prices (inflation).

2.6 QE and Income Inequality (Theory of Change)

When applying this theory to QE, we must consider the different channels through which it can affect income inequality. This is shown by the following diagram:

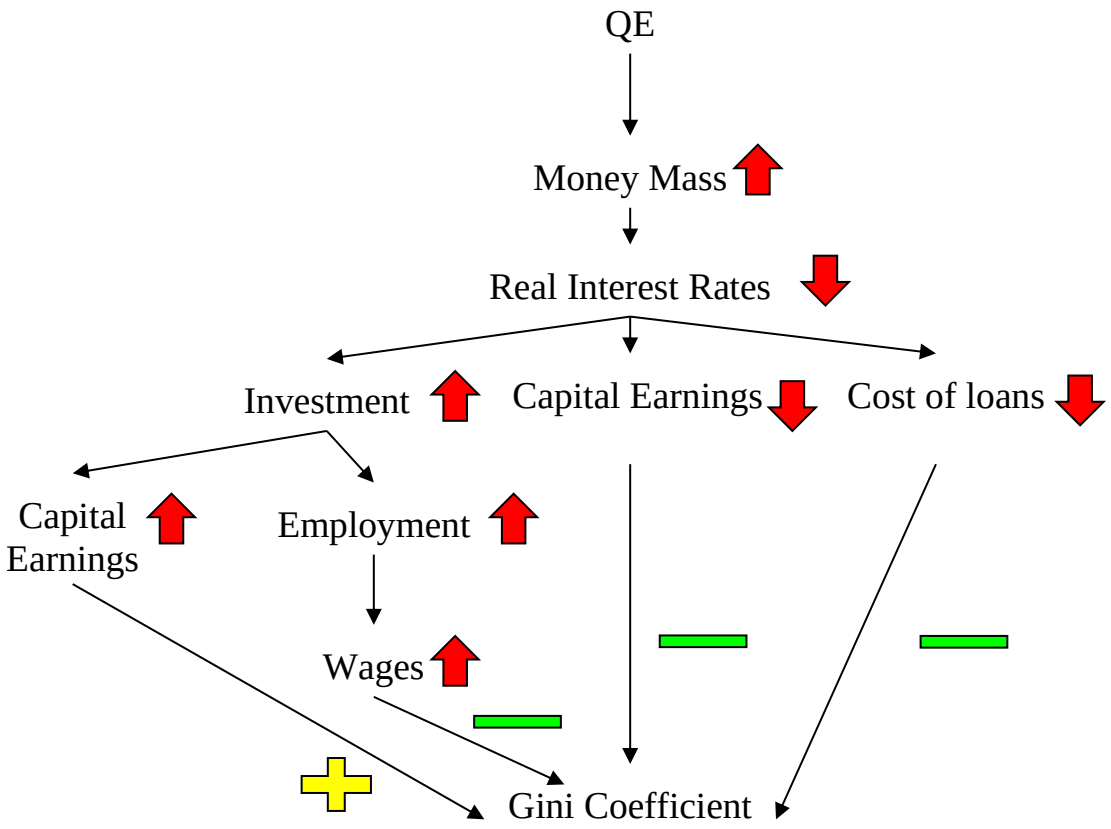


Figure 2: Transmission Channel in a Demand Bottleneck Economy.

QE has different channels through which it indirectly may affect income inequality. As money mass increases, real interest rates decrease, this allows for three different effects:

1. Cost of loan: The cost to take out a loan goes down, for which it is more accessible for people to invest into their entrepreneurial ideas or other investments. This has a *decreasing* effect on the Gini coefficient (*less inequality*).
2. Capital Earnings: The capital earnings of the wealthier portion of the population decreases, which leads to a reduction in the income inequality gap, decreasing the Gini coefficient (*less inequality*).
3. Investment: Investment has two effects that counteract each other:
    a. Capital Earnings: As interest rates go down, there is more consumption and investments. This leads to more capital earnings for the wealthy and thus increases the Gini coefficient (*more inequality*).
    b. Employment: investments increase the demand for labour, and thus may increase the wage workers are offered. These workers tend to be low-income earners. This leads to a reduction in the income inequality gap, decreasing the Gini coefficient (*less inequality*).

However, point 3 depends on whether the economy is a supply or demand bottleneck economy. If the economy is already close to or at full capacity, investments would only lead to more inflation as shown in Figure 3.

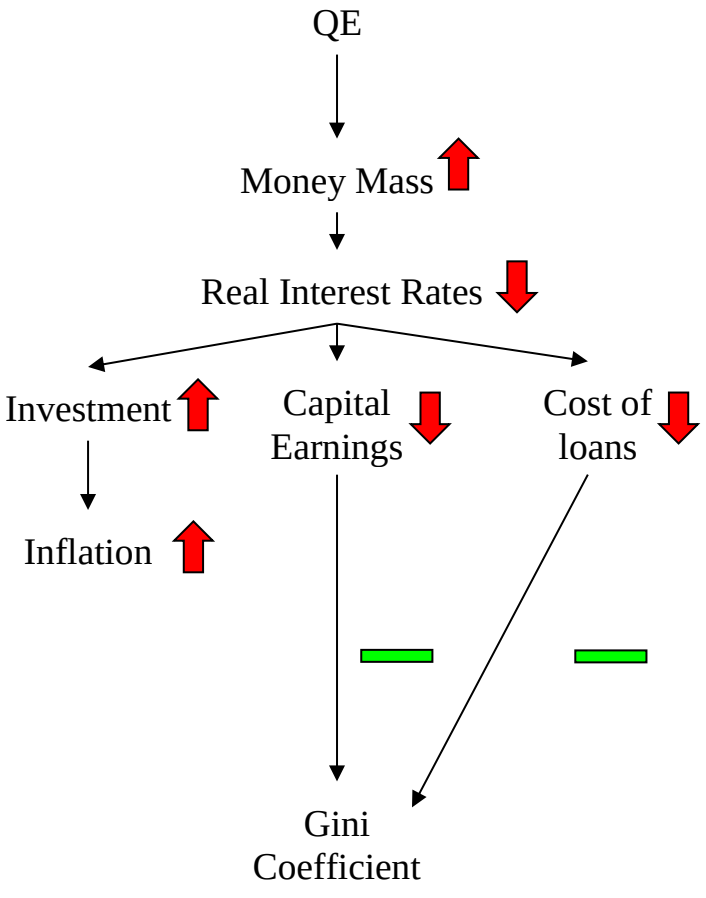


Figure 3: Transmission Channel in a Supply Bottleneck Economy.

Further in the paper, this framework is used as a foundation to explain the effects of quantitative easing on, not only inflation, which in turn may influence interest rates set by the central bank, but also to describe what possible effect it may have on income inequality.

2.7 Income Inequality

Apart from the social implications inequality may have for society, it also has economic implications. Income inequality has been shown to have a negative relationship on economic growth.[17] This suggests it is desirable to reduce it and thus promote economic growth. It has been shown that a reduction in income inequality does not only reduce the negative impact on economic growth, but can actually promote it.[18] However, inequality can affect different countries in different ways and for some countries even differently across different time horizons. There are studies that suggest that countries with low GDP are affected more by high income inequality than countries with high GDP, where it may even have a positive effect on economic growth.[19] Despite this, there is evidence to suggest that inequality can only be tolerated in the short run due to the "tunnel effect", where the portion of the population that does not benefit from a rising inequality in the beginning gain what one could say is "hope" for their economic situation to also become better.[20] This can also be supported by the idea that individuals tend to compare themselves to other individuals whom they consider to be similar, and thus the relative income of a person may feel more important to them rather than the absolute objective view of their income.[21] Income inequality thus seems to provide significance and relevance not only in a retrospective sense, but also in the present moment.

2.8 Income Inequality in Norway and USA

In the USA, there have been periods of reduced income inequality, however, in general, the income inequality has been increasing throughout 1980 to the late 2000s. In 2012, the average income of the richest 10% has been shown to have been 16% larger than the bottom 10% of the population according to an OECD report in 2014 comparing the USA to other OECD countries.[22]

In Norway, income inequality before taxation had risen by around 9 percentage points relative to a Gini index of 0.45 from 1986 to 2004, however income inequality after taxation during the same period had only increased by 5 percentage points.[23] This can be an indicator of the functioning redistribution system that Norway has in place. From 2008 to 2011,

[17] Alesina and Rodrik, "Distributive Politics and Economic", 465–490.
[18] Persson and Tabellini, "Is Inequality Harmful for Growth?", 600–621.
[19] Barro, "Inequality and Growth in,", 5–32.
[20] Hirschman and Rothschild, "The Changing Tolerance for,", 544–566.
[21] Duesenberry, "Income, Saving and the,".
[22] Forster, "United States, Tackling High,".
[23] Poinasamy, "The True Cost of,".

income inequality after taxation had actually reduced, making Norway one of the leading countries in income equality within Europe.[24]

There are different measures of inequality, in this paper we focus on the Gini coefficient as a way to measure income inequality in Norway as well as the USA. We assume that the income distribution can be used as a proxy for the distribution of wealth due to their equal tendencies and the difficulty in measuring wealth.

2.9 Gini Coefficient

The Gini Coefficient allows for easy comparison between countries based on the Lorenz curve. Due to its numerical property, comparisons between several countries are made easier to interpret. The Gini coefficient measures the area in between the line of equality and the Lorenz curve relative to the total area. The line of equality implies the situation in which there is full income equality in a country. The Lorenz curve shows how much a country differs from the line of equality. Thus, the Gini coefficient is a value between one and zero, with one being full income inequality and zero being full equality.

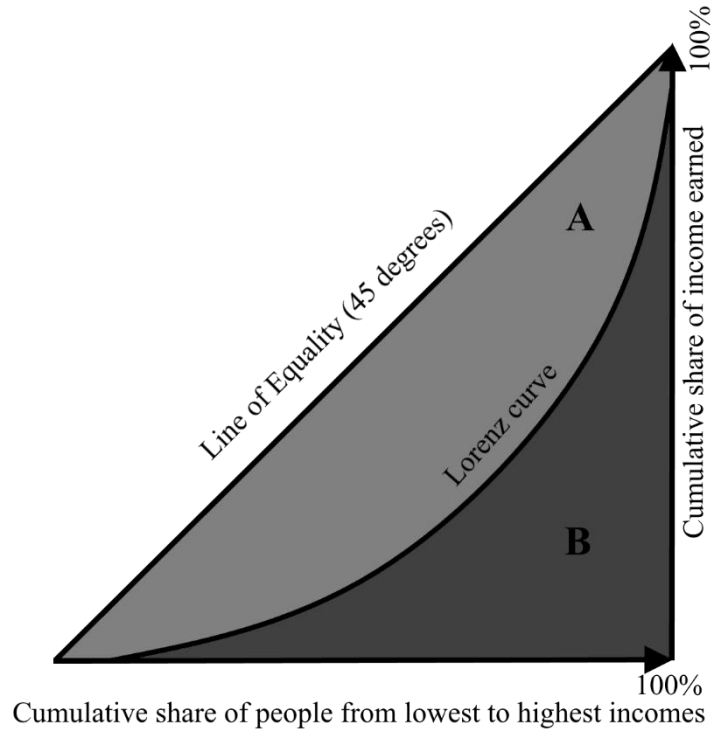


Figure 4. Lorenz Curve.[25]

From Figure 4, we can see the Lorenz curve and the corresponding shaded areas in the graph. The Gini coefficient would ultimately correspond to:

$$Gini\ coefficient = \frac{Shaded\ area\ A}{Shaded\ area\ A + Shaded\ area\ B}$$

[24] Ibid.
[25] Reidpath, "*Economics Gini Coefficient".*

3. Econometric Theory

3.1 Ordinary Least Squares Method (OLS)

The Ordinary Least Squares method in this paper is used to estimate parameters in a linear equation model, for either a simple linear regression or a multiple regression model. This would allow us to find the effect of explanatory variable "*x"* on the desired explained variable "*y*".[26]
This paper uses a Multiple Linear Regression (MLR) approach in order to estimate the relationship between the use of QE (money mass increase) and its effect on income inequality in a country, partialling out other variables that may have a strong influence on income inequality. Under the use of MLR model, a few assumptions are made in order to guarantee unbiasedness in the model. These assumptions are under the Gauss Markov Theorem. When these assumptions are met, the OLS estimators (beta parameters) are the best linear unbiased estimators (BLUEs).

The assumptions are the following:

MLR.1: Linearity in the parameters that affect the explained variable (ex. β instead of β^2)
MLR.2: Random sampling of both the explained and explanatory variables across all observations
MLR.3: Enough variation in the explanatory variables, no perfect collinearity (i.e., $V(x_i) \neq 0$)
MLR.4: Zero Conditional Mean assumption, implies that on average, the error term (u) is equal to zero cross different levels of x. So, there is no covariance between the error term and x. (i.e, $E(u_i|x_i) = 0$)
MLR.5: Assumption of Homoscedasticity. This implies that the variance remains constant for the data across x and y. (i.e., $V(u_i|x_1 \ldots x_k) = \sigma^2$)
MLR.6: Assumption that the error term (u) is normally distributed. [i.e., $u \sim N(0, \sigma^2)$][27]

We estimate the following MLR model using the OLS method:

$$\hat{y} = \hat{\beta_0} + \hat{\beta_1} x_1 + \hat{\beta_2} x_2 + \hat{\beta_3} x_3 \ldots + \hat{\beta_k} x_k$$

3.2 Goodness of Fit Theory

The fit of the regressed model can be assessed based on the R^2 that is obtained from the model. The R^2 explains how well the x values (the explanatory values) that are included in the model, explain the variation in y (the explained variable). This value is between one and zero, one being the highest level of fit and zero being the lowest.

[26] Zdaniuk, "Ordinary Least-Squares (OLS),".
[27] Wooldridge, "Introductory Econometrics: A Modern,".

R^2 is calculated as follows:

$$R^2 = \frac{SST - SSR}{SST}$$

$$SST\ (Also\ known\ as\ TSS) = Sum\ of\ Squares\ Total$$
$$Indicates: the\ total\ variability:$$

$$[(deviation\ from\ the\ mean)^2]$$

$$This\ can\ also\ be\ shown\ as\ follows:$$

$$SST = \sum_{i=1}^{n} (Y_i - \bar{Y})^2$$

$$SSR\ (Also\ known\ as\ RSS) = Sum\ of\ Squares\ Residual$$
$$Indicates: (how\ much\ y_i\ varies\ from\ the\ estimated\ regression\ line\ \hat{y})^2$$

$$This\ can\ be\ shown\ as\ follows:$$

$$SSR = \sum_{i=1}^{n} (y_i - \hat{y})^2$$

We can however simplify this equation by introducing SSE:

$$SSE\ (Also\ known\ as\ ESS) = Sum\ of\ Squares\ Explained$$
$$Indicates: [how\ much\ predicted\ y\ (\hat{y})\ varies\ from\ the\ the\ mean\ (\bar{y})]^2$$
$$This\ can\ be\ shown\ as\ follows:$$

$$SSE = \sum_{i=1}^{n} (\hat{y} - \bar{Y})^2$$

So,

$$SST = SSE + SSR$$

We can thus write R^2as follows:

$$R^2 = \frac{SSE}{SST}$$

This tells us how well the chosen model explains y.

There are however some issues to consider the validity of the R^2value. The more explanatory variables there are in the regression model, the higher $R^2$is, the "better of a fit" the model is. The issue is that these variables are always going to make R^2increase, however it does not necessarily mean that the model is significantly better able to predict the explained variable. For instance, adding an explanatory variable that represents the number of people wearing puffer jackets in a regression which aims to predict the number of hot coffees sold at an outside stand during winter. The puffer jacket variable makes the model more "accurate" as in, R^2increases. However, in reality, the puffer jacket has very little to do with the sales and is actually a consequence of the outside temperatures (the colder, the more people buy warm coffee from the coffee stand). $R^2 - adjusted$ aims to retract these kinds of variables from the accuracy of the model. The use of $R^2 - adjusted$ is however only significant if there are such misleading variables in the model.[28]

3.3 Testing Theory

Hypothesis tests are conducted in order to test whether our expected effect of the explanatory variable on the explained variable is statistically significant. We define a significance level which allows us to determine how sure we can be to either reject or accept the null hypothesis. This significance level is usually set to 5%, however 1% significance level is also not uncommon. The null hypothesis (H0) in this paper is going to be the "controlled" variable, in other words, that there is no effect from the explanatory variable on the explained. The alternative hypothesis (Ha or H1) is the hypothesis of the expected effect of the explanatory variable on the explained variable. During the testing, we may come to either the conclusion that the null hypothesis has been rejected given the data given, or that the null hypothesis is accepted given the data. This can be determined through testing.

The test conducted in this paper is going to be a T-test in a MLR model. The purpose of using a T-test is to individually look at how a specific variable affects the chosen explained variable. The use of MLR model allows us thus to more accurately partial out the other variables that may affect the explained variable. The T-statistic and the critical value dependent on the degrees of freedom are going to determine the outcome of the hypothesis testing.[29]

4. Presentation of Data

4.1 Data Information

The panel data involves measurements over time and in our case is covering the two countries studied: Norway and the US, between 2000-2017. We have collected data on Gini Coefficient, M1 (Narrow Money), unemployment rates, inflation rates, GDP growth per capita, tax revenue and central bank policy rate. This data gathered from the pre and post

[28] ibid.
[29] ibid.

crisis period will be used to measure the effect of QE on Gini coefficient (Where QE would be represented when there is an increase in Money Supply).

4.2 Dependent Variable (Gini Coefficient)

USA:

The Gini index data was collected from the World Bank. The World bank is a financial institution that provides loans to governments to finance their projects.
Gini coefficient value does not vary a lot in the US. We observed there are two significant periods of change, a value 0.8 since it fell from 40.8 in 2007 to 40 in 2010 and 1.1 (2010-2016). The Gini coefficient value never falls below 40 or raises more than 41.1points in the data collected.

NORWAY:

The data collected for the Gini Index for Norway have been also collected from the World Bank. The Gini Coefficient values have been fluctuating more than in the US during 2000-2016. The peak value in the chosen period was in 2004 with a value of 31.6 and fell the following years reaching a value of 27.1 in 2007 and 25.3 in 2011. After 2011, the Gini index started rising gradually approaching 28.5 in 2016.

4.3 Independent Variables USA

All data presented in the USA section has been collected from the World Bank except for the unemployment rates that were gathered from the OECD and the policy rates that were collected from the IMF. OECD or Organisation for Economic Co-operation and Development has 37 members and was founded in 1971. It is an intergovernmental economic organisation committed to democracy that promotes international trade for economic growth. The International Monetary Fund (IMF) is an organization consisting of 190 countries, working to foster global monetary cooperation and international trade, secure financial stability, promote high employment and support sustainable economic growth as well as reduce poverty.

Money Mass/Narrow Money (M1)

M1 includes money in circulation such as banknotes and coins, plus check accounts and overnight deposits. In this paper we use M1 as a representation for money mass. M1 is measured in percentage points of the total money supply. In 2000, the money mass was at 4.1% and it changed considerably the following years reaching 0.99% in 2001 and then it started increasing again. When the financial crisis in 2007 began the money mass rate was at 1.8% and experienced a strong reduction lowering to -0.13% in 2008. It was further reduced to -2.53% in 2009, and increased again in 2010, reaching 2.5%. The following years it kept fluctuating between 1.5% and 2.9% in 2016.

GDP Growth per Capita

The GDP Growth per Capita was observed at around 2.9% in 2000, but experienced a sharp decline the following year with the rate being at around 0.003%. The GDP growth seems to have been strongly affected by the financial crisis as it fell sharply from 0.9% in 2007 to -3.38 in 2009, raised back to its normal level, 2.15% in 2015 and then fell again to 0.9% in 2016.

Inflation (GDP deflator, annual %)

The inflation rate is measured in percentage points. In 2000, the inflation rate in the US was around 2.235% and during the Great Recession it decreased, in 2009, to 0.762%. It later started to gradually rise, reaching 1.035% in 2016, which is still lower than the inflation rate in 2000.

Unemployment

The unemployment rate in the US is measured in percentage points of the total labour force. At the beginning of 2000, the unemployment rate was at 3.99% and started increasing gradually. In 2009, during the financial crisis, an important increase in unemployment was observed. The unemployment rate went from 4.62% in 2007 to 9.62% in 2010 and began to gradually decrease after that. In 2016, the unemployment rate was around 4.87%.

Central Bank Policy Rate

The policy rates are expressed in percentage points. From the data gathered from the IMF, we observe that in 2000, the policy rate was at 6.5%, while the years following it fell, to 1% in 2003. During the financial crisis, the interest rate fell from 4.25% in 2007 to 0.125% in 2008 and remained at the same level until 2014, rising to 0.375% in 2015 and 0.625% in 2016.

Tax Revenue (% of GDP)

The tax revenue is measured in percentage points of the GDP. In 2000, it was observed to be at 13%, falling at 9.8% in 2003 and then increased again to 11.3% in 2006. An interesting change was made after the financial crisis with the tax revenue falling from 11.3% in 2007 to 7.9% in 2009, and then gradually increasing again to 8.5% in 2010, 9.7% in 2012. Observing tax revenue at around 11.2% of GDP in 2015.

4.4 Independent Variables Norway

Money Mass/Narrow Money (M1)

The data for M1 revealed that the financial crisis had a similar impact in Norway as in the US. In 2000, the M1 measured in percentage of the total money supply in the country was at 3.2%. When the Great Recession (2007-2009) affected most of the countries the rate was at 2.99%, this was not a big difference compared to 2000. During the years of the financial crisis that followed the rate fell to 0.4% in 2008 and even lower reaching -1.7% in 2007. It then started to gradually and slowly increase again reaching 1.9% in 2015.

Central Bank Policy Rate

Policy rates in Norway were taken for the IMF. In 2000, the policy rate was at 9% and started gradually falling to 6.5% in 2001-2002, followed by a decrease to 1.75% in 2004. In 2008, the interest rate fell to 3%, further decreasing in 2009 to 1.75%. During 2012-2013, the policy rates remained at 1.5% and decreased to 0.5% in 2016.

Tax Revenue (% of GDP)

In Norway, the tax revenue measured in percent of GDP, is observed to be higher than in the US. In 2000, the tax revenue was 26.7% and then increased to around 28.3% where it stabilized during 2005-2007. The financial crisis led to a reduction in tax revenue in 2009 of 25.9% from the GDP. The lowest level was reached in 2016, where tax revenue in percentage of GDP reached 22.08%.

GDP Growth per Capita

The GDP Growth per Capita variable was gathered from the World Bank and is measured in percentage points. The GDP growth in Norway was at around 2.53% in 2000 and 3.35% during 2004 and then started falling. From 2007 (1.93%), the GDP growth had tended to fall even lower, reaching the minimum of -2.9% during the financial crisis in 2009 and began to go up again slowly to -0.3% in 2011. After this period although the growth was rising higher, it never reached the 2000 and 2004 levels, having a value of 0.9% in 2015.

Inflation

Norway follows an inflation targeting strategy which is 2-2.5%. The data collected from the World Bank revealed that the inflation rate in Norway had been varying a lot during 2000-2016. In 2000, the inflation rate was at 3.086% and in 2004 fell to 0.454%, rising again to 2.329% in 2006 and falling rapidly in 2007 to 0.713% during the Great Recession. In 2008, the inflation rate rose to 3.754% exceeding the inflation rate in 2000, being the highest in this period and then falling again to 0,697% in 2012. In 2016, the inflation rate reached 3,55%.

Unemployment

The unemployment rates measured in percentage point of the total labour force of Norway have been collected from the OECD and reveal that Norway was impacted relatively little in this aspect by the Financial Crisis. An increase of the unemployment rates during the years of crisis are observable, but not as high as in the USA, where the unemployment rate increased by 5%. The highest period of unemployment in Norway during the examined period was in 2016, with the rate of unemployment reaching 4.76%.

5. Econometric Analysis

5.1 Regression Analysis

The results are presented after a regression analysis in Stata of the data from the years 2000 to 2017 for each variable, for both Norway and USA. Where Model 1 (m1) represents USA and Model 2 (m2) represents Norway.

	(1)	(2)
	m1	m2
VARIABLES	usgini	nogini
usgdpgrthpc	-0.103	
	(0.0645)	
usinf	0.431**	
	(0.177)	
usunemp	-0.0795	
	(0.0810)	
usplyrt	-0.0200	
	(0.0746)	
ustaxrev	-0.0626	
	(0.127)	
usm1	0.0144*	
	(0.00457)	
nogdpgrthpc		0.514
		(0.301)
noinf		0.177
		(0.414)
nounemp		1.627***
		(0.766)
noplyrt		-0.0608
		(0.234)
notaxrev		0.136
		(0.271)
nom1		-0.0128
		(0.0193)
Constant	40.34*	17.85***
	(1.646)	(9.780)
Observations	18	18
R-squared	0.629	0.612

Standard errors in parentheses

*p<0.01 ** p<0.05, *** p<0.1

Table 1: MLR Regression on the respective Gini coefficients.

The variable names are explained in table 2 with their respective label.

VAR. NAME	VAR. LABEL
YEAR	*YEAR*
usgini	*GINI COEFFICIENT US*
nogini	*GINI COEFFICIENT NORWAY*
usinf	*INFLATION US*
noinf	*INFLATION NORWAY*
uspltyrt	*POLICY RATES US*
nopltyrt	*POLICY RATES NORWAY*
usunemp	*UNEMPLOYMENT US*
nounemp	*UNEMPLOYMENT NORWAY*
ustaxrev	*TAX REVENUE US*
notacrev	*TAX REVENUE NORWAY*
usm1	*MONEY MASS US*
nom1	*MONEY MASS NORWAY*
usgdpgrthpc	*GDP GROWTH PER CAPITA US (annual%)*
nogdpgrthpc	*GDP GROWTH PER CAPITA NORWAY (annual%)*

Table 2: Variable Names with Their Respective Label.

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
year	18	2008.5	5.339	2000	2017
usgini	18	40.794	.417	40	41.5
nogini	18	27.322	1.599	25.3	31.6
usinf	18	1.935	.671	.762	3.115
noinf	18	2.056	.946	.454	3.754
usunemp	18	6.114	1.775	3.992	9.617
nounemp	18	3.7	.609	2.558	4.758
usplyrt	18	1.653	2.029	.125	6.5
noplyrt	18	2.861	2.394	.5	9
usm1	18	63.39	26.256	36.524	116.615
nom1	18	54.061	31.129	24.034	126.761
ustaxrev	18	10.469	1.234	7.919	12.969
notaxrev	18	26.099	2.162	22.087	28.909
usgdpgrthpc	18	1.181	1.51	-3.387	2.975
nogdpgrthpc	18	.788	1.442	-2.959	3.357

Table 3: Descriptive statistics for each variable.

From the data collected, we highlight and compare the most important variables and how they vary during the period 2000-2017.

The Gini coefficient in Norway was at around 27.3 points on average, while in the USA, the mean was at around 40.7 points. This indicates greater inequality during the observed period in the US compared to Norway, however, the standard deviation is higher in Norway for which income inequality levels in the country have been fluctuating more than in the US.

The general rise in price level in the USA during the observed period seems to have fluctuated less than in Norway, reaching its maximum 3.15%, which is lower than in Norway's maximum (3.7%). The average overall inflation rate between the two countries was almost at the same level: 1.9% change in prices in the US and 2% in Norway. We need to notice here that Norway applies an annual inflation-targeting strategy, trying to maintain the annual increase in prices at around 2%-2.5%.

Norway's unemployment has at the maximum in this period been 4% while in the USA 9%. The US seems to have a higher unemployment rate on average.

The money mass for Norway is observed to be at its maximum point 126.7 which is higher than in the US (116.6), but inversely, the minimum point in the US at around 36.5 is higher than in Norway (24) during 2000-2017. By observing the standard deviations for the two countries it is remarkable to notice that the standard deviation in the US is 26.5 which is, again, lower than in Norway (31.2). The numbers are indexed to 2015, where 2015=100.

During 2000-2017 the policy rates in both countries have been fluctuating a lot. The lowest policy rate in the US was observed during the attempt to tackle the Financial Crisis. The minimum policy rate for the US reached 0.125%, while the same policy rate in Norway did not fall lower than 0.5% (2017). Norway's policy rate during the financial crisis was also low at 1.5%. As we can observe from the values of the mean policy rates, the USA (1.6%) has a lower policy rate on average than in Norway (2.8%) during this period.

Tax revenue is observed to be much higher in Norway than in the USA. The maximum value for Norway is 28% and the minimum 22%, while for the USA, the maximum value is 12% and the minimum is 7%. The average tax revenue (during 2000-2017) observed for both countries indicates that Norway has had a much higher tax revenue than the USA.

The average GDP growth per capita for the observed period is slightly higher in the US (1.181%) than in Norway (0.788%).

5.2 Hypothesis testing (QE reducing the Gini Coefficient)

A t-test is used to test whether the money mass (usm1 / nom1) which serves to represent quantitative easing in a numerical way, affects the Gini coefficient. The hypothesis is that QE does in fact lower the Gini coefficient and thus income inequality. The null hypothesis states that an increase in money mass has no effect on the Gini coefficient, while the alternative hypothesis states that an increase in money mass has a negative effect on the Gini coefficient, lowering it, meaning more income equality. For this, we use a one-sided t-test.

5.2.1 Hypothesis Testing for the USA Model

Hypothesis:

The null hypothesis is represented by H0, while the alternative hypothesis is represented by Ha.

$$H0: b[usm1] = 0$$

$$Ha: b[usm1] < 0$$

T-stat:

$$TS = \frac{(0.0144 - 0)}{(0.00457)} = 3.15$$

Degrees of Freedom (DF):

Degrees of Freedom are given by taking the number of observations, minus all the independent variables taking into the regression analysis (including the constant).

DF=11

Stating the rejection region (stating critical value)

Find c using the 1% significance level:

1% significance level:

$$c = -2.718$$

Conclusion:

1% significance level:

TS>c, for which we fail to reject H0 and conclude that with the data provided (99 % confidence level), the money mass does not have a reducing effect on the Gini coefficient in the USA.

5.2.2 Hypothesis Testing for the Norwegian Model

Hypothesis:

The null hypothesis is represented by H0, while the alternative hypothesis is represented by Ha.

$$H0: b[nom1] = 0$$

$$Ha: b[nom1] < 0$$

T-stat:

$$TS = \frac{(-0.0128 - 0)}{(0.0193)} = -0.66$$

Degrees of Freedom (DF):

Degrees of Freedom are given by taking the number of observations, minus all the independent variables taking into the regression analysis (including the constant).

DF=11

Stating the rejection region (stating critical value)

Find c using the 1% significance level:

1% significance level:

$$c = -2.718$$

Conclusion:

1% significance level:

TS>c, for which we fail to reject H0 and conclude that with the data provided (99 % confidence level), the money mass does not have a reducing effect on the Gini coefficient in Norway.

Given the data gathered for both countries, the money mass does not seem to have a reducing impact on the Gini coefficient and thus income inequality. We fail to reject the null hypothesis even at a 10% significance level for both countries.

5.3 Hypothesis testing (Does QE have *any* effect on the Gini Coefficient?)

This extra section of hypothesis testing aims to find whether QE (an increase in money mass) has *any* effect on income inequality (Gini coefficient) in both countries. It differs from the last section, in the sense that this section includes the possibility that an increase in the money mass may actually increase income inequality. The null hypothesis states that an increase has no effect on the Gini coefficient, while the alternative hypothesis states that an increase in money mass does have, either, a negative or positive effect on income inequality.

5.3.1 Hypothesis Testing for *Any* Effect in USA

Hypothesis:

The null hypothesis is represented by H0, while the alternative hypothesis is represented by Ha.

$$H0: b[usm1] = 0$$

$$Ha: b[usm1] \neq 0$$

T-stat:

$$TS = \frac{(0.0144 - 0)}{(0.00457)} = |3.15|$$

Degrees of Freedom (DF):

Degrees of Freedom are given by taking the number of observations, minus all the independent variables taking into the regression analysis (including the constant).

DF=11

Stating the rejection region (stating critical value)

Find c using the 1% significance level:

1% significance level:

$$c = |3.106|$$

Conclusion:

1% significance level:

TS>c, for which we reject H0 and conclude that with the data provided (99 % confidence level), the money mass does have a significant effect on the Gini coefficient in the USA.

5.3.2 Hypothesis Testing for *Any* Effect in Norway

Hypothesis:

The null hypothesis is represented by H0, while the alternative hypothesis is represented by Ha.

$$H0: b[nom1] = 0$$

$$Ha: b[nom1] \neq 0$$

T-stat:

$$TS = \frac{(-0.0128 - 0)}{(0.0193)} = |-0.66|$$

Degrees of Freedom (DF):

Degrees of Freedom are given by taking the number of observations, minus all the independent variables taking into the regression analysis (including the constant).

DF=11

Stating the rejection region (stating critical value)

Find c using the 1% significance level:

1% significance level:

$$c = |-3.106|$$

Conclusion:

1% significance level:

TS>c, for which we fail to reject H0 and conclude that with the data provided, the money mass does not seem to have a significant effect on the Gini coefficient in Norway.

5.4 Testing Summary

When conducting the hypothesis test for Norway to see whether there is *any* significant effect from an increase in money mass on the Gini coefficient, we fail to reject the null hypothesis, even at a 10% significance level.

For the USA, using the data provided, we are able to reject the null hypothesis when testing if an increase in money mass has *any* effect on the Gini coefficient. As the first hypothesis test for the USA indicated that the money mass has no *reducing* effect on income inequality, it can be potentially deduced that the money mass may actually *increase* income inequality in the USA.

The reason for an increase in money mass potentially having a significant effect on the Gini coefficient in the USA but not in Norway is unclear. However, differences such as initial levels of income inequality in the country (where the USA frequently has approx. 50% higher income inequality than Norway), and big differences in taxing systems (where Norway has on average approx. 160% higher tax revenue than the USA) may play a role in this effect.

Using the previously presented theoretical framework, the initial inequality level may greatly affect the magnitude of investment and capital earnings of the wealthiest (See section 2.5). If the wealthiest have a great amount invested in capital, it may actually surpass the other effects that reduce income inequality to the extent that income inequality actually increases. This may give reason for why in countries with initially lower income inequality, such as Norway, do not see an increase in inequality. The distributive taxation system could potentially be responsible for maintaining a more or less stable equality.

6. Limitations

6.1 Data Limitations

The data used in the regression analysis come from reliable sources such as, The World Bank, OECD, and IMF, however despite this, there are some limitations to them. The period for which data was collected for this analysis ranges from the years 2000 to 2017. This poses a limitation on how accurate we can make an inference based on the data. The degrees of freedom are lower, which makes it more difficult to reject the null hypothesis. In addition, one must consider that M1 has been used to represent QE instead of using QE as a dummy variable (1=yes, 0=no). This allowed quantitative data which makes it easier to see changes in the money mass per year. However, rather than a limitation, it is an extra consideration.

Real interest data may have been more suitable to use as it aligns better with the theoretical framework presented earlier in the report (see section 2.5). Despite this being an improvement, the central bank's policy rate still aims to capture this effect but in a less direct way. The Gini Coefficient data is based on the World Bank estimation and must be

understood that way, it is not a robust figure, and may change depending on source. Its aim is to provide convenience when comparing countries.

6.2 Methodology

The methodology used to analyse the data was by using the Ordinary Least Squares and a multiple linear regression model. This however, only takes a look at the variables included in the regression and determines the effects. The limitation with this is that time is not taken into consideration. Taking time into account may be important for this analysis as different years may have had different effects. In addition, it is likely that QE has a lagging effect on income distribution. This means that the year where the money mass increased due to QE may not affect the Gini coefficient the same year, but rather a year later for example.

Considering these limitations, it may be interesting to further pursue studies regarding the effects of QE on income inequality, as we have indications that different economies react differently to an increase in money mass. Possible reasons may be that the initial level of income inequality in a country affects the way the Gini coefficient changes when QE is applied. Another reason may be that the tax system has a more significant impact at maintaining income equality relatively stable than previously thought, despite increase in money mass. These topics may be interesting to research further as QE becomes increasingly more common to use to stimulate the economy.

7. Conclusion

This paper focused on the impact of quantitative easing on income inequality in both Norway and the USA for the period 2000-2017. The theoretical framework presented served as a foundation for the hypothetical effects of QE on income inequality, showing different transmission channels through which, the Gini coefficient could be affected by.

We conclude, from our regression analysis, that for Norway, QE has *no* effect on income inequality. In addition, Norway has not officially used QE, however, it has had an increase in money mass and a reduction in interest rates which simulate the effects of an official QE application. For the USA, where QE was officially applied, QE does *not* have a *reducing* effect on income inequality, however, does have *a* significant effect. As the effect is not a reducing one, it can be deduced that QE in the USA has an *increasing* effect on income inequality. The difference in effects from QE may likely be due to possible differences in initial income inequality and taxation system between Norway and the USA. This suggests that the effect of QE on income inequality may in practice magnify the already existing income inequality in a country if income inequality surpasses a certain threshold, however this is an area that requires further investigation.

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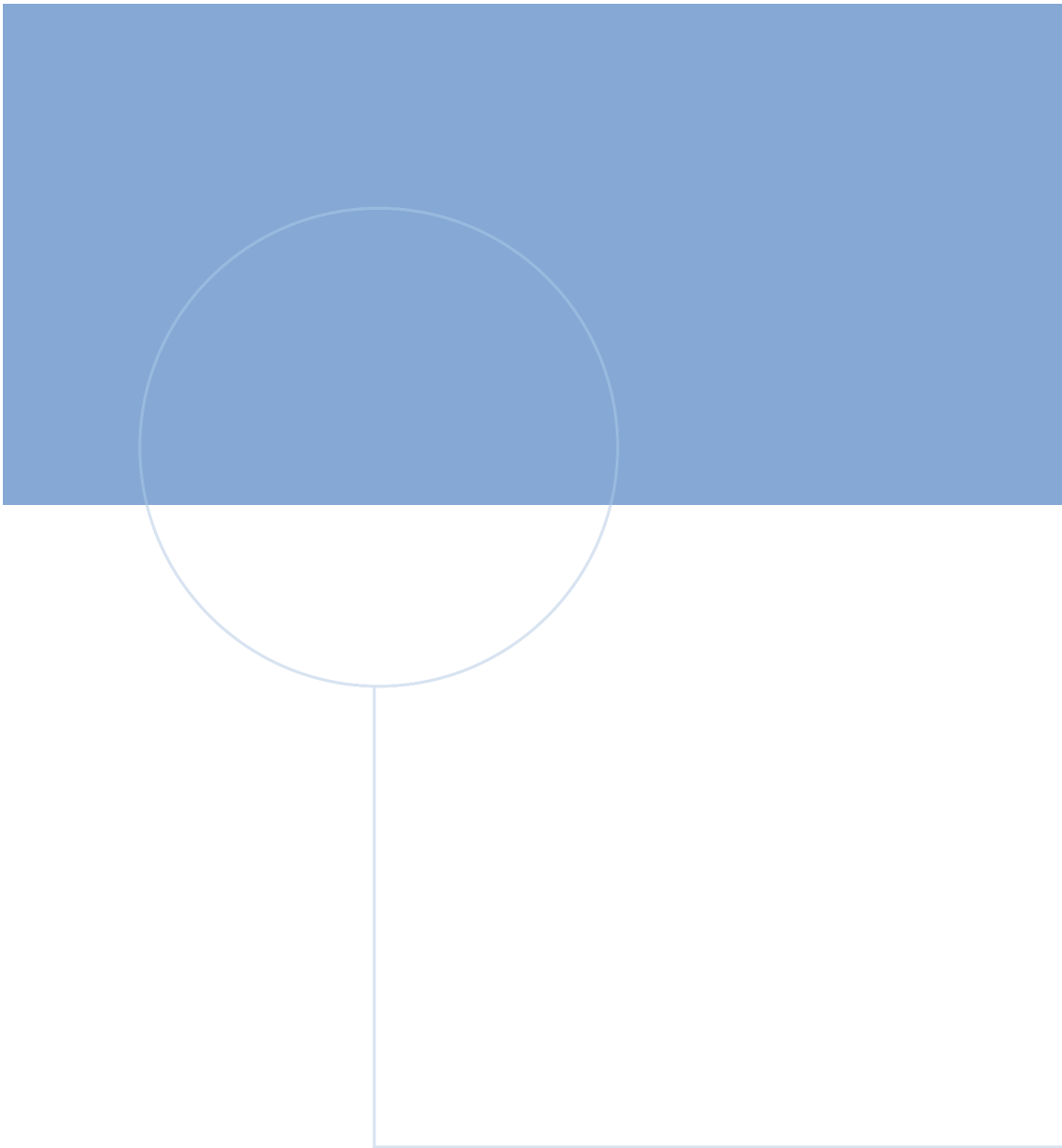

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