



UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Does Quantitative Easing Affect Income Inequality?

A Panel Data Study

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Authors:

Aleksandar Miljkovic 940509-4070

Oscar Thelander 940121-0530

Supervisor:

Inge van den Bijgaart

Abstract:

In this essay, we examine the effect that quantitative easing has on Gini coefficients. This was done via quantitative data analysis through two different statistical methods, Ordinary Least Squares and Panel Data regression analysis using Fixed Effects. The panel data set consists of 12 countries between the years 2000 and 2014, with annually collected data for seven variables.

Our results show that quantitative easing has a negative statistically significant relationship to Gini coefficients, which suggests that using this unconventional monetary policy reduces Gini coefficients and consequently income inequality. Beyond this, we attempt to shed some light on the distributional channels through which monetary policy affects income inequality and tie that together to our data set.

Key Words: Quantitative Easing, Monetary Policy, Gini Coefficient, Panel Data, Fixed Effects, Income Inequality.

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1. Introduction

Before the financial crisis in 2008 the world economy was stable and blooming. Conventional monetary policy was used to stabilize the economy and the central banks were successful in maintaining price stability, financial stability and economic growth. Many of the world's largest economies maintained a low and stable inflation rate during decades but the financial crisis in 2008 revealed that there are other important factors too. The conventional monetary policy achieved a low and stable inflation but did not prevent the asset market bubbles from occurring. During the financial crisis 2008 the housing market bubble burst and the world economy fell into a deep recession. Conventional monetary policy began to lose its function when the interest rate neared zero and the central banks no longer could use the conventional policies to boost the economy. At that point several central banks turned to unconventional monetary policies in order to affect the economy. Unconventional monetary policy has no clear definition, but it can be the act of using negative interest rates, changes to inflation targets or more commonly: expansion of central bank's balance sheets. This is primarily done through purchasing of securities in order to provide liquidity to a slow market. This procedure, called quantitative easing, has been a policy that has gained great notoriety since the crisis 2008 and there is not, compared to most conventional policies, a lot of research on its effectiveness or its spillover effects in other parts of society. With economic inequality being a hot topic in today's society, the distributional factors of these large asset-purchases have sparked discussion in regard to its effect on income and wealth inequality. Because most research regarding quantitative easing focuses on whether it raised interest rates or not, we aim to give some answers to whether quantitative easing has affected income inequality or not.

The purpose of our thesis is to look at the income inequality effect of quantitative easing. We do so by studying income inequality levels across countries that did and countries that did not conduct this form of unconventional monetary policy after the 2008-crisis. This we attempt to answer through quantitative analysis of data between the years 2000 and 2014. Income inequality has been shown to have a negative effect on sustainable economic growth so, apart from answering the research question, we hope that this study can incentivize others to look

further into the effects of quantitative easing's impact on inequality and research it on a broader level.

2. Core Concepts and Background

In this section, theories and concepts used in the paper necessary to understand the data set and regressions are described.

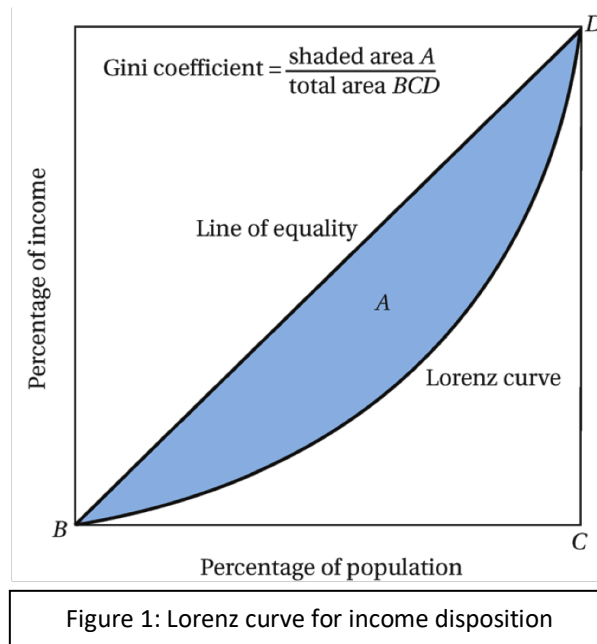
2.1 Core Concepts

2.1.1 Economic Inequality: Income Inequality

Economic inequality refers to the unequal distribution of economic variables between people in a society. There are numerous dimensions of economic inequality, typical dimensions studied are income, wealth and consumption inequality. The measurements are done on an individual or household level.

Income inequality captures how the income is distributed throughout a country. It is often measured through the Gini coefficient, the generalized entropy index or the Atkinson index. (De Maio 2007)

We exclusively use the Gini coefficient in our research. The Gini coefficient corresponds to the area between the Lorenz curve and the line of absolute equality. The Lorenz curve shows the percentage of a population which has what percentage of a given measure, in this case income. The line of absolute equality is a 45-degree line where x% of society has x% of the income. The Gini coefficient range between 0, "perfect equality" where everyone earns the same income (line of absolute equality), and 1, "perfect inequality", where all income is distributed to one person. (OECD 2011)



2.1.2 Conventional Monetary Policy

A central bank's purpose is to maintain stability in the economy with, in general, the primary goal being price stability. However, some central banks have more than one primary goal. In the case of the Fed, it is price stability and maximum sustainable employment simultaneously. (Federal Reserve 2018) The price stability goal is achieved by having a low and stable inflation target, which by many central banks is in the range of 2-4 percent per year. This is done through monetary policy; expansionary or contractionary. Monetary policy should, apart from achieving price stability, aim to achieve low unemployment levels, economic growth as well as functioning financial markets without sacrificing the original price stability goal. (European Central Bank 2018) (Gottfries 2013)

Central banks conventionally conduct monetary policy through open market operations by purchasing or selling short-term government bonds. Through open-market operations, the money supply is changed in the market which affects the interbank lending rates and thus the interest rate at which commercial banks lend money. The interest rate influences asset prices. As an example, when interest rates go down, it promotes borrowing which tends to raise housing prices and increase overall consumption. (Gottfries 2013)

2.1.3 Unconventional Monetary Policy - Quantitative Easing

Unconventional monetary policy takes several forms and is used when interest rates are at the lower bound, near 0%, when conventional monetary policy cannot be used to boost the economy. It can be implemented through negative interest rates, changes in the inflation target or expansion in the central bank's balance sheet. (Sheedy 2017)

Quantitative easing (QE), which is a form of unconventional monetary policy, was first implemented by Japan in the 1990's. The theory is that the central banks buy long term bonds instead of short term, to lower the long-term yield and raise the prices on long term investments. The fall of the long-term yields makes these bonds unprofitable for private banks to invest in (which usually is preferable during a recession when the private market is unstable and has a substantial risk). These purchases of long-term bonds by the central bank are done with hope that it will make commercial banks find investment opportunities elsewhere, preferably in the private market by lending to people and companies. This would eventually lead to a boost in the economy through higher consumption in the private market. The difference in how quantitative easing and conventional monetary policy affect the yield curve can be shown by Figure 2 where we see that the yield curve is shifted by monetary policy, while its flattened by QE, which results in a decrease in the yield spread. (European Parliament 2017)

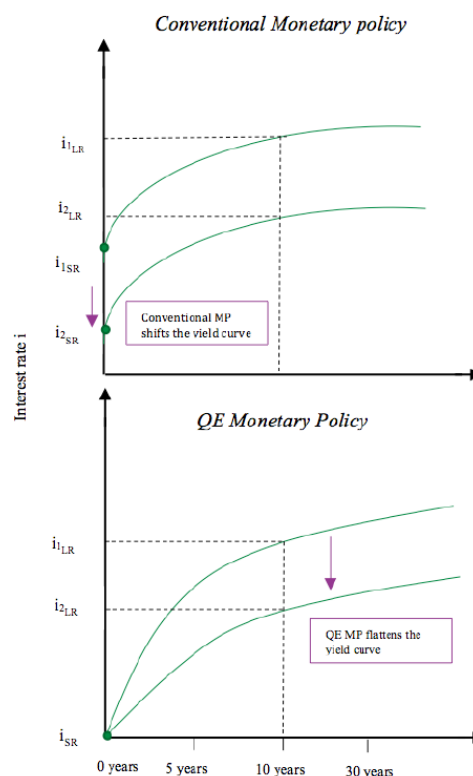


Figure 2: Yield spread for Conventional Monetary Policy versus QE (Sakri)

When central banks, besides the purchasing of bonds, purchases more risky assets from private banks (i.e. mortgage backed securities) they further expand their balance sheet, while private banks become more liquid. (Joyce et al. 2012)

2.2 Background: Quantitative Easing

2.2.1 United Kingdom

During the crisis the BoE (Bank of England) repeatedly cut the interest rates and in the beginning of 2009, the BoE cut it down to a half percent, in order to increase nominal spending. The Monetary Policy Committee thought that this would not be enough to meet the 2% inflation target, so they decided to go through with a large-scale purchasing program (QE) to boost the economy and in that way, try to achieve the inflation target. The first wave (QE1) started in March 2009 when the BoE bought medium and long-term gilts for 25£ billion and continued with this amount of purchases monthly until August the same year. QE2 was announced at the end of QE1 where the amount of purchases was changed to 16£ billion per month. This period was ended in November with a purchase of 8£ billion. (Joyce, Tong, Woods 2011)

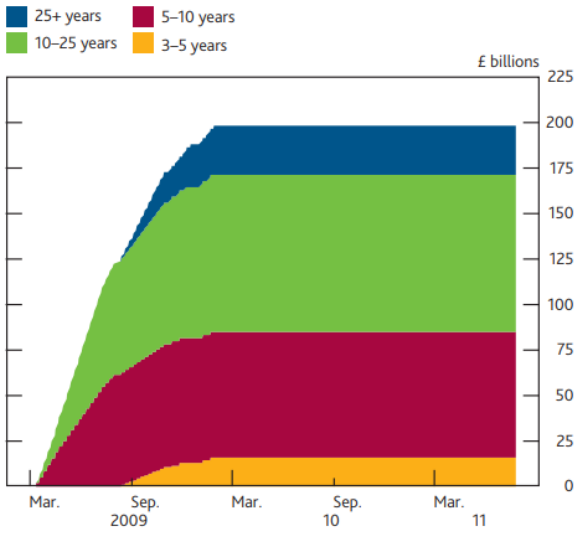
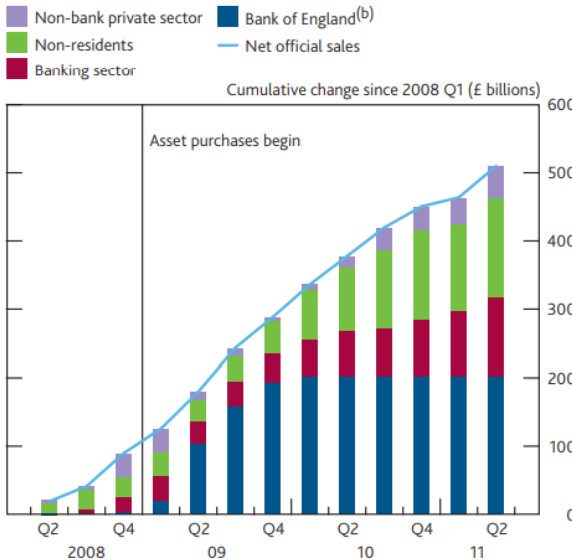


Figure 3: Cumulative change in purchases of gilts (BoE)

Figure 4: Cumulative gilt purchases by BoE by maturity (BoE)

The quantitative easing program resulted in a total of 200£ billion purchases of gilts, representing around 30% of the supplied gilts in the market at that time and 14% of the GDP. Compared to 2008, when the holdings of gilts were around 4% of the total supply (mostly shorter yields), the portfolio changed into containing more medium- and long-term gilts. The portfolio was also 7 times bigger than before the crisis. Not only did the purchases of government bonds take place, but corporate bonds were also bought. During the announcement of the quantitative easing program the overall gilt yields fell by 100 basis points (1%). Looking at the bigger picture throughout the entire year, the total QE program resulted in a short-term corporate yield fall by 400 basis points while long-term corporate yields fell by 2000 basis points. (Joyce et al. 2011)

2.2.2 United States of America

When QE1 was announced in the United States the initial amount of purchase was planned to be \$500 billion of mortgage back securities and \$100 billion of agency debt. However, the Fed ended up purchasing \$1.25 trillion of mortgage back securities, \$175 billion of agency debt and \$300 billion of government treasury bills during 2009. The purchases were distributed through \$100 billion a month during a 17-month period and ended in June 2010 because of the recuperation of the economy. QE1 resulted in total purchases of an amount which corresponded to 11% of GDP in 2009. Two months after the termination of QE1, the Fed reintroduced the purchases to keep its holdings at \$2 trillion by purchasing \$30 billion of long-term treasuries monthly until QE2 was introduced in the beginning of November 2010. QE2 stretched until June 2011, resulting in \$600 billion of total purchases of long-term Treasury securities. In the end of 2011 the Fed announced that they would go through with *Operation Twist*, which was not by definition a QE-program because of its structure. *Operation Twist* was not an extension of the balance sheet, but an exchange of short-term to long-term Treasuries. Between September 2011 and December 2012, the short-term bonds were sold while medium and long-term bonds were purchased instead, for the same amount (which affects the yield spread, as explained earlier). QE3 was initialized in September 2012 and was distributed equally between purchases of mortgage back securities and long-term treasuries, extending the balance sheet by \$80 billion monthly until October 2014 when the QE-programs came to an official end. (Wu 2014)

3. Literature Review and Theoretical Framework

This section is in two parts. First, we cover the relevant literature for this thesis and then move on to the theoretical framework.

Regarding the literature section, we first cover literature that explores the effects of conventional monetary policy on income inequality and then literature covering the effects of quantitative easing on income inequality.

Furceri, Loungani and Zdzienicka (2016) found, by estimating impulse response functions (IRFs), in their panel data study of 32 *advanced and emerging markets* that expansionary monetary policy increases income inequality. They found that an unexpected increase of the policy rate by 100 basis points increases inequality (as measured by the Gini index) by about 1.25 percent in the short-term (1 year after the shock) and by about 2.25 percent in the medium term (5 years after the shock). They also found that expansionary monetary policy increases wealth inequality in the short-term but reduces it in the medium term.

Another study, conducted by Coibion, Gorodnichenko & Silvia (2012), found that contractionary shocks have significant persistent effects on inequality, leading to higher levels of income- and consumption inequality across households. These findings are based on studying the effects of monetary policy shocks in the US since 1980. They argue that the increase in inequality is primarily driven by the *earnings heterogeneity channel*, the different responses of labor earnings for high- and low incomes following a monetary policy shock.

Similar results have been obtained by Gornemann, Kuester and Nakajima (2016). They constructed a New Keynesian business-cycle where they were able to take into account the heterogeneity in income across households, differences in productivity as well as employment status. They concluded that contractionary monetary shocks lead to increasing inequality in wealth, income and consumption inequality.

Romer, Romer (1998) states that expansionary policy can reduce poverty, but only temporarily. They argue that monetary policy cannot generate a permanent effect because output will return to the natural rate, as will the poverty rate. Looking at a cross-country level, they further suggest that monetary policy that aims at low inflation and aggregate demand is the most effective approach in order to reduce poverty rates in the long run.

Research looking at the redistributive effects of unconventional monetary policy, in particular quantitative easing, are few because of its recent implementation and are mainly focused on one country at a time.

Saiki and Frost (2014) concluded, through construction of a vector autoregression (VAR), that unconventional monetary policy increased income inequality in Japan after 2008 when the Bank of Japan resumed a zero-interest rate policy. They accredit a large part of this to the *portfolio channel*, the fact that on average, low-income households, in real terms, hold more currency than higher-income households and that they are affected differently.

Montecino and Epstein (2015) looked at net income in the US in two periods, 2008-2010 and 2011-2013. They primarily looked at the effects of QE through three channels: the *employment channel*, the *asset appreciation and return channel* as well as the *debtor redistribution and refinancing channel*. They found that there was an increase in overall inequality. This, they attribute mainly to the effects of equity price appreciations and further state that employment changes and refinancing were equalizing in their effect.

Nakajima (2015) argues that the distributional effects of monetary policy are negligible when the economic fluctuations are mild enough to not need monetary policies that causes large effects. As an example, Nakajima uses the period between mid-1980s and early 2000s wherein the Federal Reserve conducted conventional monetary policy which was not in the aggressive fashion as the unconventional monetary policy conducted post-2008. When conducting the more drastic versions, Nakajima argues, redistributive factors are more important to look at. Nakajima, however, balances that point by stating that if the true gain to society's well-being from stabilizing the economy outweighs the loss from associated distributional effects, one could argue that the overall societal effect is more important.

As seen in the above discussion, the effect of monetary policy on inequality is hard to define since there are different transmission channels whose effect taken together can lead to increases or decreases in inequality. In the following theoretical framework, we attempt to define these channels and their individual effect:

Coibion et al. (2012) summarized primarily five channels through which monetary policy affected income and consumption inequality. The first, *income composition channel*, is because different households have different primary sources of income. Most households heavily rely on labor earnings while some receive a larger portion of their income through

financial sources. Because monetary policies affect these different income sources differently, the outcome for the households will not be the same. Ohlsson (2017) mentions that, for example, rising asset prices due to expansionary policy greatly benefits households with a larger portion of their income coming through financial sources.

The second channel, *financial segmentation channel*, states that those who are active in the financial markets are affected earlier by a monetary policy. Since those active in the financial market on average have higher income, an expansionary policy will redistribute wealth toward them, which causes larger inequality.

The *portfolio channel* further supports the previous idea because on average, low-income households hold more currency than higher-income households. When inflationary actions occur, an increase in consumption inequality follows, because the low-income household's currency drops in real value and the high-income households are not affected in the same proportions.

The last two channels: *savings redistribution channel* and *earnings heterogeneity channel* will, in contrast to the first three channels, tend to decrease inequality in response to an expansionary monetary policy. A decrease in interest rates will, according to the *savings redistribution channel*, hurt savers and benefit borrower which decreases consumption inequality (assuming wealthier people are more often savers). The second, *earnings heterogeneity channel*, states that labor-income will respond differently to monetary policy shocks depending on if one is a high- or low-income household. For example, an expansionary monetary policy will likely decrease unemployment which disproportionately affects the low-income households, and thus reduces inequality. (Coibion et al. 2012).

Bernanke (2015) chooses to sum up the distributional effects of quantitative easing and low interest rates in three channels: The *asset appreciation channel*, which can be likened to the *income composition channel* above. The second, the *employment channel*, which could be attributed to be a part of the *earnings heterogeneity channel* by looking at the employment effect of policies. The third, the *debtor redistribution and refinancing channel*, which can be likened to the *savings redistribution channel* because of the different effect that inflationary actions as well as has on debtors versus creditors.

As this list of redistribution channels suggests, it is difficult to measure which channel accounts for how much of the overall change in inequality, but the overall effect is important to interpret.

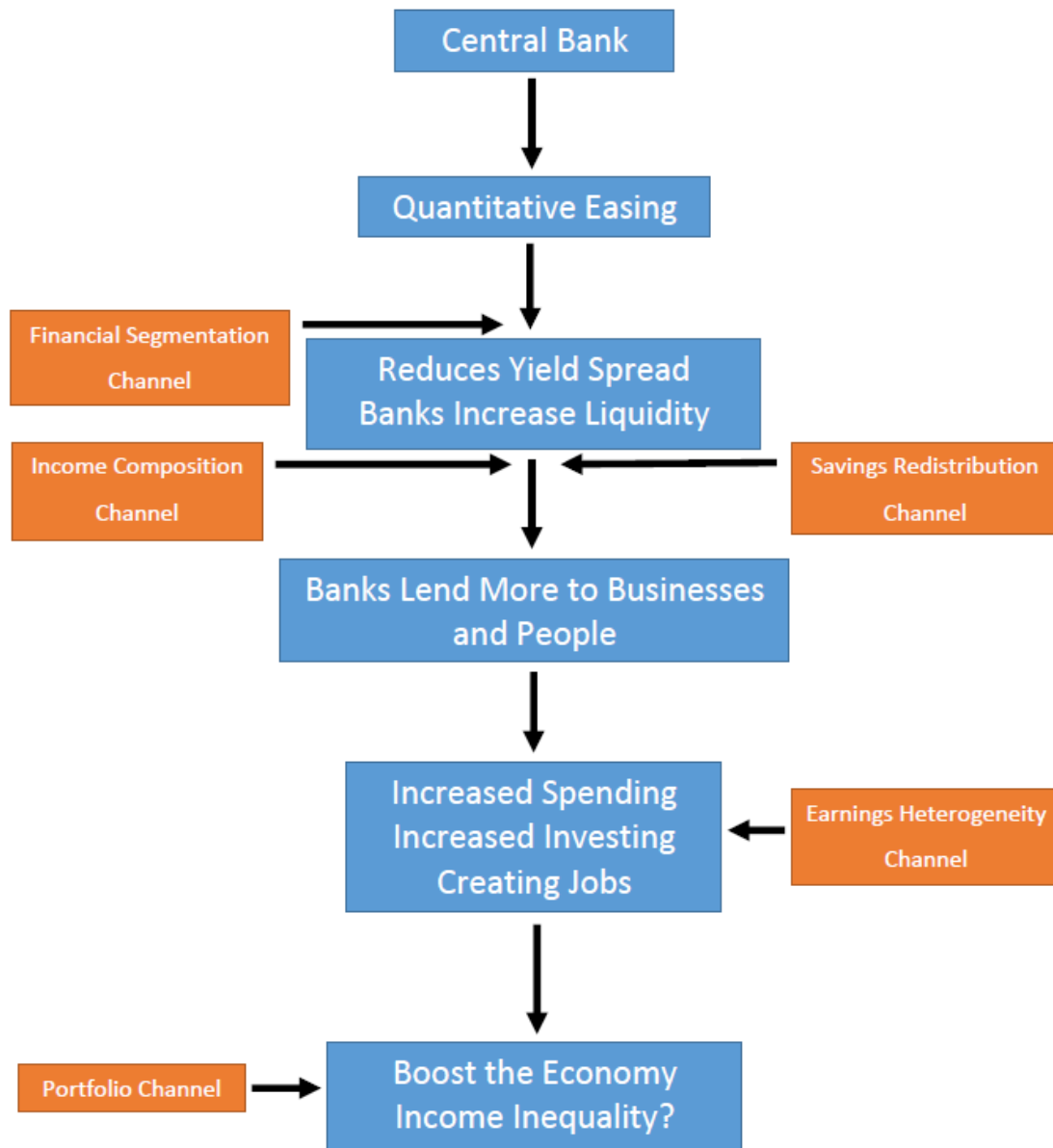


Figure 5: Flow Chart for QE Transmission Channels

4. Data and Empirical Approach

4.1 Data and Summary Statistics

The panel data set covers 12 countries¹ between the years 2000-2014. These countries were chosen based on size and data availability. More specifically, we focus on G20 members for which we could obtain full series for our dependent and independent variables. We collected data on Gini coefficients, quantitative easing, unemployment, GDP growth, inflation and total individual tax on income. By having data covering the years pre- and post-crisis, we hope to measure the effect of QE on Gini coefficients. Using a quantitative data set seemed natural considering the purpose of our thesis. The data was gathered using well credited data banks which is discussed separately below.

4.1.1 Dependent Variable: Gini Coefficient

We use Gini coefficients as the dependent variable for all regressions.

The data for the Gini coefficients was gathered using The Standardized World Income Inequality Database (SWIID). SWIID combines data from the OECD Income Distribution Database, Eurostat, the World Bank's PovcalNet, the Socio-Economic Database for Latin America and the Caribbean, the UN Economic Commission for Latin America and the Caribbean into one database in order to provide a large dataset for conducting cross-national research as we are. SWIID provides Gini coefficients for both disposable and market income inequality where we exclusively used the Gini coefficients for disposable income. (Solt 2016)

The average value for the Gini coefficient in the dataset is 0.39 where the highest recorded is 0.59 (South Africa, 2008) and lowest 0.27 (Germany, 2000). As shown in Figure 5 below, the data set for Gini coefficients is quite stable where Argentina and Brazil stand out with an increase in income equality by 0.08 and 0.07, respectively.

¹ Argentina, Australia, Brazil, Canada, France, Germany, Italy, Mexico, South Africa, Turkey, United Kingdom, United States.

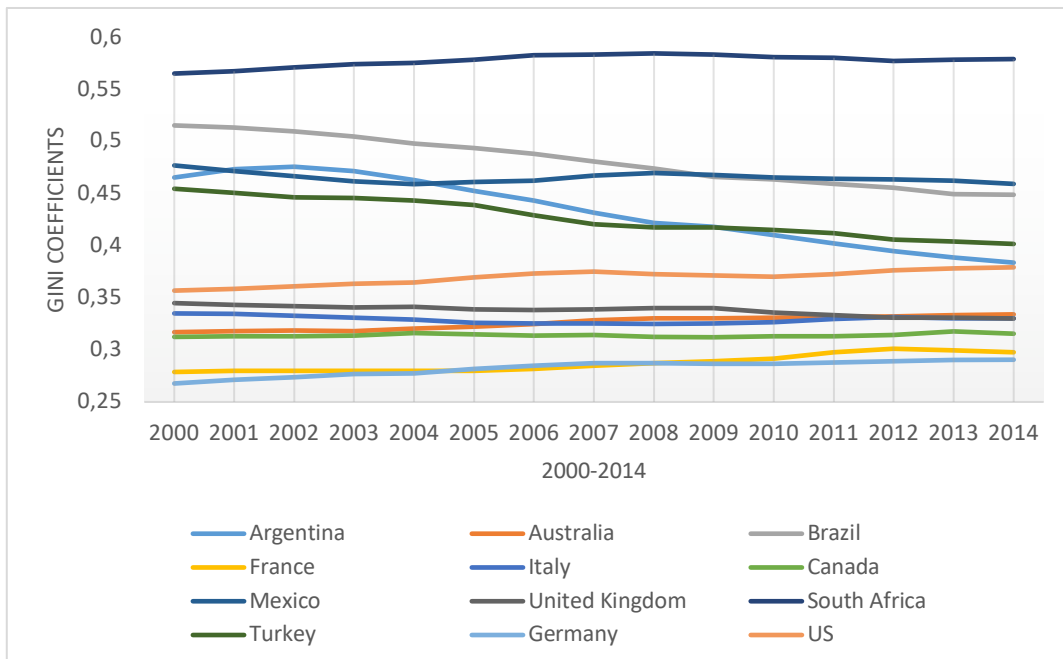


Figure 6: Graph showing Gini coefficients for the countries included in the data set

4.1.2 Independent Variables

The independent variables that we used were chosen based on what was discussed in the distributional factors-section as well as what earlier research has found significant. Apart from this, the general data is discussed as well as how the variables were used in the regression.

Quantitative Easing

Quantitative Easing is measured as a dummy variable throughout all regressions. The use of dummy variables allows one to incorporate binary information into a regression analysis. In our regression, this is done by having $QE = 1$ when quantitative easing was used that year and $QE = 0$ when it was not.

In our panel data set covering 12 countries, the UK and the US were the countries that between 2000 and 2014 conducted quantitative easing. The UK performed quantitative easing starting in 2009 and ended the policy in 2012. The US implemented quantitative easing in 2008 and ended in 2014. Consequently, $QE = 1$ for these years for the UK and the US. Concerning the rest of the countries, the QE variable is 0 for the whole data set.

The information for constructing the dummy variables was collected from reports written by Wu (2014) as well as Joyce et al. (2011).

GDP Growth

The data for GDP growth is measured as percentage change from previous year, where Argentina had the lowest GDP growth with -10.89 percent in 2002. Argentina also recorded the second largest growth in 2010 with an increase of 10.13 percent, only trumped by Turkey who recorded the largest GDP growth in the data set with an increase of 11.11 percent in 2011. Australia was the only country in the data set that did not record a negative GDP change (1.81) in 2009, the year following the crisis.

Persson and Tabellini (1991) states that there is a statistical significance and negative relationship between inequality and economic growth. Ostry, Berg and Tsangarides (2014) supports this idea in their paper where they concluded that income inequality negatively affects growth. Yi and Zou (1998) however found in their paper both theoretically and empirically that income inequality has a positive, and most of the time significant, relationship to economic growth. They further suggest that the relationship between income inequality and economic growth is very complicated. As an example, they discuss the fact that China had an increase in Gini coefficients and economic growth from 1984 to 1992 but the UK between 1977 and 1991 had an increase in Gini coefficients but a negative episode of economic growth. The data for GDP growth covering all 12 countries was collected from the OECD data bank. (OECD 2018)

Inflation

The data for inflation was included as an independent variable in the regression due to its effect on the *portfolio channel*. Looking at the data set, Canada had the lowest recorded inflation with -2.29 percent in 2009. -1.09 (Argentina in 2001), -0.45 (Germany in 2000) and -0.17 (Australia in 2013) were the only other recorded negative values. The average inflation was 5.83 percent with a median of 3.13 percent. The reason for the difference in average versus median is Turkey, Argentina and Russia who recorded inflationary values as high as 52.93, 40.28 and 37.69 percent, respectively.

The data for inflation was collected from the OECD data bank. (OECD 2018)

Direct Taxes

Bernanke (2015) suggests that the correct source to rely on regarding change in economic inequality is fiscal policy (tax and government spending programs). Dabla-Norris et al. (2015)

found that lower marginal tax rates are associated with higher net inequality in their studies of *causes and consequences of income inequality*. This together motivates our choice to include direct taxes as an independent variable. The average was 12.58 percent with a minimum value at 3.49 percent (Argentina, 2002) and maximum at 21.82 percent (Canada, 2000).

The data was collected from the United Nations University World Institute for Development Economics Research (UNU-WIDER) and is measured in percentages. (ICTD/UNU-WIDER 2017)

Unemployment

The unemployment data is measured as the number of unemployed as a percentage of the labor force. In the data set, the average unemployment rate is 8.99 percent with the lowest measurement at 2.54 percent (Mexico, 2001) and highest at 27.14 percent (South Africa, 2003). South Africa stands out as an outlier being the only country above 20 percent in unemployment rate, which it manages for the whole data set.

Including unemployment rate as an independent variable was due to what was discussed in both the *income composition channel* and the *earnings heterogeneity channel*. First off, the fact that most household’s primary income source is labor-income. Secondly, that unemployment rates are generally affected by monetary policy, where expansionary monetary policy is theoretically thought to decrease unemployment and consequently, inequality.

The data was collected from the OECD data bank. (OECD 2018)

	<i>Gini Disposable Income</i>	<i>Unemployment</i>	<i>GDP Growth</i>	<i>Inflation</i>	<i>Direct Taxes</i>
Mean	0,3858874	8,9969444	2,3932897	5,8343612	12,5769288
Standard Error	0,0065865	0,3978372	0,2332904	0,5895369	0,3766614
Median	0,3508653	7,7450000	2,4569390	3,1311450	14,0427954
Standard Deviation	0,0883671	5,3375458	3,1299186	7,9094672	5,0252900
Sample Variance	0,0078087	28,4893956	9,7963905	62,5596713	25,2535395
Minimum	0,2677058	2,54	-10,8945	-2,29425	3,4882585
Maximum	0,5845668	27,14	11,1135	52,92366	21,8155126
Count	180	180	180	180	178

Table 1: Summary Statistics

4.2 Empirical Approach

To test the effect of quantitative easing on income inequality as measured by the Gini coefficients, we regress the effect of quantitative easing on inequality. We use both Pooled OLS and Panel Data Fixed Effects methods. This section will briefly introduce these methods:

4.2.1 OLS Regression

Our initial regressions are done with an Pooled OLS approach.

Pooled refers to Pooled Cross Sections, which occurs when combining data from the years before and after a policy effect into a complete data set.

Ordinary Least Squares (OLS) is a statistical method that estimates unknown parameters into a linear model. This is done in the following way:

With k independent variables, we want to estimate $\hat{\beta}_0, \hat{\beta}_1, \dots, \hat{\beta}_k$ into an equation such as:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \dots + \hat{\beta}_k x_k$$

The OLS estimates are chosen to minimize the sum of squared residuals using the following method:

$$\sum_{i=1}^n (\hat{y} - \hat{\beta}_0 - \hat{\beta}_1 x_1 - \dots - \hat{\beta}_k x_k)^2$$

Omitted variable bias, a concern when using an OLS approach, occurs when there are unobservable factors in the error term that are correlated with the variables included in the regression. Certain assumptions thus need to be made, called Gauss-Markov Assumptions² which upon fulfillment suggests that the regression is unbiased and appropriate to use. (Wooldridge 2013)

² Linear in Parameters, Random Sampling, Sample Variation in the Explanatory Variable, Zero Conditional Mean, Homoskedasticity.

4.2.2 Fixed Effects Model

Using panel data estimation through a fixed effects model, we attempt to minimize omitted variable bias by removing time-invariant unobserved factors (i.e. variables that do not change over time). When using country as fixed effect, the model accounts for certain factors within each country that may affect the outcome but are unobserved. Thus, it allows us to assess the net effect of the predictors on the dependent variable.

Algebraically, consider a model with k independent variables:

$$y_{it} = \beta QE_{it} + \dots + \beta x_{itk} + \alpha_i + u_{it}, t = 1, 2, \dots, T$$

Where QE is the dummy variable described above and the other x 's are the control variables. For each i , the average for this equation over time is:

$$\bar{y}_{it} = \beta_1 \overline{QE_{it}} + \dots + \beta_k \bar{x}_{itk} + \bar{\alpha} + \bar{u}_i$$

Because α_i is country specific and not time dependent: $\alpha_i = \bar{\alpha}_i$. If we then subtract the original model with the average model:

$$y_{it} - \bar{y}_i = \beta_1(QE_{it} - \overline{QE_i}) + \dots + \beta_k(x_{it} - \bar{x}_i) + (\alpha_i - \bar{\alpha}) + (u_{it} - \bar{u}_i), t = 1, 2, \dots, T$$

We end up with the time-demeaned data on y , x and u with α_i removed:

$$\ddot{y}_{it} = y_{it} - \bar{y}_i = \beta \ddot{QE}_{it1} + \dots + \beta \ddot{x}_{itk} + \ddot{u}_{it}, t = 1, 2, \dots, T$$

Thus, we have estimated a model with fixed effect.

The fixed effects model is preferred when, in contrast to the random effects model, the unobserved effect is thought to be correlated with explanatory variables. This works well for our model because certain country-specific factors, for example cultural factors, have an effect on the independent variables. (Wooldridge 2013)

4.2.3 Estimating Equations:

All the variables are continuously representing the year where they were observed except for QE and Inflation, which are used both in present as well as lagged form.

QE is lagged for one and two years. We decided this because when QE is employed, financial papers are purchased on the credit market and from commercial banks. This leads to an increased liquidity for the commercial banks. When their long-term investment opportunity is made unprofitable they seek other investment opportunities, such as lending to private companies. This economic process takes time. Apart from this, the purchases were made during a lengthy period of time and not in one instance, which applies to both the UK and the US. Because of these reasons, we decided to lag QE in order to capture its true effect.

Regarding Inflation, according to Gottfries (2013) prices are fixed in the short run and sticky in the medium run. This means that prices of goods changes slowly. Nominal wages are even more rigid than prices, meaning that the real wage will fall during a year, perhaps several years, until one gets a raise. Due to this reasoning, we decided to look at inflation in both present as well as in a one-year lagged format.

Regarding estimating equations, the order through which we conduct the regression analysis is that we start with single variable OLS regression. We step by step add lagged variations for the QE-variable and Inflation-variable as well as adding the other independent variables; GDP growth, Unemployment and Tax. Then we change the method through which we estimate the variables and use a fixed effects model. In this way, we aim to find the best results in the fixed effects regression with QE and Inflation in lagged variations.

5. Results

Table 2 below shows results from five different OLS-regressions.

Regression 1 and 2 are simple OLS-regressions. The first one has the present QE as independent variable. The second one has QE being lagged one year as independent variable. Regression 3-5 are multiple variable regressions with 5 independent variables³ where QE and Inflation are modified in different variations in order to test for the effect of time lag.

Table 3 shows the results from eight panel data regressions with fixed effect, thus accounting for time-invariant factors in each country. As explained previously, this means that characteristics within each country (i.e. cultural, structural, societal) are removed. In this table we use the same structure for the regressions as in Table 2, with the addition of looking at QE lagged for two years, which can be seen in regression 6, 7 and 8.

All the independent variables (except QE) are presented in decimal form (i.e. 1% is in the data shown as 0.01). A list of all the regressions is provided in the appendix.

³ QE, GDP Growth, Inflation, Tax, Unemployment

	OLS				
	1	2	3	4	5
Gini					
QE	-0.0275 (0.0275)		0.0144 (0.0176)		
QE_lag1		-0.0294 (0.0286)		0.0043 (0.0184)	0.0035 (0.0184)
QE_lag2					
GDPgrowth			0.4468*** (0.1349)	0.4331*** (0.1377)	0.3830*** (0.1391)
Inflation			0.1661*** (0.0600)	0.1606** (0.0685)	
Inflation_lag1					0.1374** (0.0654)
Tax			-0.5855*** (0.0943)	-0.5907*** (0.1012)	-0.6146*** (0.0988)
Unemployment			1.0303*** (0.0792)	1.0224*** (0.0833)	1.0293*** (0.0833)
Constant	0.3876*** (0.0068)	0.3873*** (0.0070)	0.3439*** (0.0160)	0.3475*** (0.0169)	0.3523*** (0.0163)
Observations	180	168	178	167	167
R-squared	0.0056	0.0063	0.6186	0.6100	0.6074

Standard errors in parentheses

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

Table 2: Table showing results from 6 OLS regressions

	Fixed Effect							
	1	2	3	4	5	6	7	8
Gini								
QE	0.0033 (0.0054)		-0.0075 (0.0047)					
QE_lag1		0.0009 (0.0053)		-0.0111** (0.0048)	-0.0112** (0.0047)			-0.0083 (0.0067)
QE_lag2						-0.0095** (0.0046)	-0.0094** (0.0045)	-0.0033 (0.0066)
GDPgrowth			0.0532 (0.0322)	0.0637* (0.0326)	0.0526* (0.0307)	0.1020*** (0.0323)	0.0934*** (0.0311)	0.0916*** (0.0311)
Inflation			0.0466*** (0.0169)	0.0363* (0.0191)		0.0210 (0.0242)		
Inflation_lag1					0.0476*** (0.0164)		0.0365** (0.0179)	0.0368** (0.0178)
Tax			0.0483 (0.1155)	0.0758 (0.1206)	0.0533 (0.1192)	0.0801 (0.1176)	0.0660 (0.1164)	0.0609 (0.1162)
Unemployment			0.4667*** (0.0560)	0.4764*** (0.0591)	0.4773*** (0.0573)	0.4431*** (0.0566)	0.4457*** (0.0556)	0.4586*** (0.0565)
Constant	0.3857*** (0.0011)	0.3855*** (0.0011)	0.3330*** (0.0168)	0.3298*** (0.0174)	0.3321*** (0.0171)	0.3325*** (0.0169)	0.3333*** (0.0166)	0.3330*** (0.0165)
Observations	180	168	178	167	167	156	156	156
R-squared	0.0022	0.0002	0.3160	0.3115	0.3323	0.3180	0.3344	0.3418
Number of country	12	12	12	12	12	12	12	12

Standard errors in parentheses

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

Table 3: Table showing results from 8 Fixed Effects regressions

The results indicate that QE used as a contemporaneous variable has no significant influence on the Gini coefficients. Looking at our preferred regressions (Table 3, regression 4-5), we find that QE lagged one year has an approximate effect of -0.011 on Gini coefficients at a 5% significance level. Because QE is programmed as a dummy variable, this suggests that for every year QE is employed, Gini coefficients will decrease by 0.011 the following year. Looking at regressions 6 and 7 in the fixed effects table, we lag QE for two years and see a smaller but still negative effect of -0.009 at a 5% significance level. This implies that the QE programs does not have the same effect two years after it has been employed but is still influencing the Gini coefficients. If we look at the regressions where QE_lag1 and QE_lag2 are both employed, we see an insignificant effect from both variables. This can probably be attributed to the high correlation between the variables. The high correlation can also be explained by the small difference between the coefficients of QE_lag1 (regression 4-5) and QE_lag2 (regression 6-7).

Looking at GDPgrowth, we find vastly different significance levels and values between regressions. In the OLS regressions, the GDP growth coefficient takes values between 0.38-0.44 and is significantly influencing Gini coefficients at a 1% significance level throughout all regressions. In the fixed effect regressions however, GDP growth becomes significant only when QE is used as a lagged variable. This we interpret as the fact that QE is an expansionary monetary policy, the effect from which occurs slowly and not the day that the purchases were made. Thus, we think that, in the fixed model, the fact that GDPgrowth becomes significant only when QE is lagged, seems natural. The coefficient for GDP growth is approximately 0.06 when QE is lagged for one year at a 10% significance level (regression 4-5). When QE is lagged for 2 years, it is approximately 0.1 at a 1% significance level (regression 6-8). This means that if GDP increases by 10% from one year to the next, the effect on Gini would be 0.005-0.011.

Inflation shows a significant influence throughout all OLS regressions, both in its contemporaneous- and lagged form. Looking at the fixed effects regressions, inflation shows significance in all regressions except for regression 6. The results indicate for all regressions, a positive relationship to the Gini coefficients. This suggests that when inflation rises, income inequality increases. This can be attributed to the *portfolio channel* previously discussed, where some households gain, and some lose from inflation changes because of the changes in nominal assets and debt. Households with a larger portion of their income coming from

financial channels (who are, on average, high-income households) can thus acclimate smoother towards inflation changes which is why income inequality increases. When QE is used in its lagged variation, both for one and two years, the Inflation-variable increases its significance level when also being lagged. This can be explained by the fact that prices are sticky and that adjustment of income is a slow process.

Looking at the coefficients for Inflation, a one percent increase in inflation will increase the Gini coefficients by approximately 0.0016 in the OLS regressions and 0.00036-0.00047 in the fixed effects regressions.

Tax has a significant effect on income inequality at a 1% significance level throughout all OLS-regressions, affecting Gini coefficients negatively by approximately -0.6. This leads to decreased income inequality when direct taxes are raised which we interpret as the nature of tax distribution throughout a society. The tax variable is however insignificant throughout all the fixed effect regressions and can therefore not be interpreted.

Unemployment has a significant influence on income inequality at a 1% significance level in all regressions. It affects Gini positively for all regressions which suggests that when unemployment increases by one percent, the Gini coefficient will change by 0.01 for the OLS regressions and approximately 0.0045 for the fixed effects regressions. This suggests that inequality increases when unemployment rises, which can be explained through the *earnings heterogeneity channel*, the fact that unemployment rate changes are heavily weighted to affect the low-income part of society.

6. Discussion

The empirical study in Coibion et. al (2012) found that contractionary monetary policy leads to an increase in income and consumption inequality. Similar results were found in the study of Gornemann, Kuester and Nakajima (2016). Reversing these findings, expansionary monetary policy would lead to a decrease in income and consumption inequality. Applying this argument to our study, since quantitative easing is an expansionary monetary policy, it should reduce income inequality, making the income distribution more equal.

In contrast to our study, Furceri, Loungani and Zdzienicka (2016) found that income inequality was increased by an unexpected expansionary policy. In comparison to the quantitative easing programs in the United States and United Kingdom, where the purchases were announced before conducted, the QE was not an unexpected event.

Studies that were conducted on the effect of QE on income inequality, such as Montecino and Epstein (2015) and Saiki and Frost (2014), state that unconventional monetary policy increases income inequality, which differ from our study.

Montecino and Epstein (2015) attribute this primarily to the *asset appreciation and return channel* while the *employment channel* and the *debtor redistribution and refinancing-channel* equalize each other's effect.

The *asset appreciation and return channel* which is similar to the *income composition channel* described by Coibion et al. (2012) leads to a higher income inequality when expansionary monetary policy is used, because expansionary policy affects financial income greater than labor income, at least in the short-term. Similar effects are shown through the *portfolio channel* that Saiki and Frost (2014) base their results on. This channel states that when inflation occurs, money holders are affected more than financial asset holders, in terms of real value, leading to increasing income inequality.

There are, however, some differences between our study and the studies discussed above. We conducted our study through a panel data set, looking at the effect between countries that did and countries that did not conduct QE, while the others looked at a single country level.

The negative effect of QE on the Gini coefficient that we saw as result, could be argued not to

hold, based on the *income composition channel* and *portfolio channel*. Factoring in the *savings redistribution channel* however, one can interpret the results differently. If interest rates fall, as they did during the crisis, savers suffer economically while consumers benefit. When QE is employed, and income inequality decreases, as in our result, it can be explained by the *earnings heterogeneity channel*. Quantitative easing boosts the economy and unemployment is reduced. If assumed that low-income households rely more on their labor income and that unemployment changes affect the low-income households more heavily, this leads to lower income inequality.

It is also important to recognize the limitations of one's study. Firstly, measuring QE as a dummy variable could be done differently. We believe that a preferable method would be to measure it in some quantitative way in shorter time intervals, i.e. as a % of GDP biyearly or quarterly. This is because the size of the purchases is a vital part of the theoretical base for the policy. We attempted this in the early stages of the thesis but had troubles finding solid data.

Looking at the sample size, a larger data set would have been preferable. Since this is a regression study looking at the effect on income inequality, whereas previously discussed, wages are slowly changing, a data set covering a longer period of time (primarily post-crisis) would have been preferable.

Critique of the Gini coefficient is, because it is a relative metric, that it does not capture absolute differences in income. If a country's Gini coefficient rises due to increasing income inequality but the number of people living in poverty decreases, the Gini coefficient cannot account for it. Also, because it is a relative measure, two countries could have the same Gini coefficient but drastically different income distributions.

7. Conclusion

The purpose of our thesis was to look at the effect that quantitative easing had on income inequality. This we attempted through econometric modelling with two statistical methods, OLS and Fixed Effects. Beyond that we aimed to give some context to how that effect occurred, through discussion of the distributional channels of monetary policies.

We conclude, for our data set and looking at our preferred regressions (4-5 in the fixed effects table), that quantitative easing had a statistically significant and reducing effect on Gini coefficients, and consequently, income inequality. The independent variables we included, except tax, all showed statistical significance in the preferred regressions.

Looking past our thesis, we believe an interesting way to further this research would be to build onto the idea of measuring QE in a quantitative way. In this way, we feel that an interesting approach could be to attempt to more precisely measure the distributional factors of quantitative easing which is beyond the scope of our ability.

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9. Appendix

OLS Regressions:

$$Gini = 0,3876 - 0,0275QE + u \quad (1)$$

$$Gini = 0,3873 - 0,0294QE_{lag1} + u \quad (2)$$

$$Gini = 0,3439 + 0,0275QE + 0,4468GDPgrowth + 0,1661Inflation - 0,5855Tax + 1,0303Unemployment + u \quad (3)$$

$$Gini = 0,3475 + 0,0043QE_{lag1} + 0,4331GDPgrowth + 0,1606Inflation - 0,5907Tax + 1,0224Unemployment + u \quad (4)$$

$$Gini = 0,3523 + 0,0035QE_{lag1} + 0,3830GDPgrowth + 0,1606Inflation_{lag1} - 0,6146Tax + 1,0293Unemployment + u \quad (5)$$

Fixed Effects Regressions:

$$Gini = 0,3857 - 0,0033QE + u \quad (1)$$

$$Gini = 0,3855 + 0,0009QE_{lag1} + u \quad (2)$$

$$Gini = 0,3330 - 0,0075QE + 0,0532GDPgrowth + 0,0466Inflation + 0,0483Tax + 0,4667Unemployment + u \quad (3)$$

$$Gini = 0,3298 - 0,0111QE_{lag1} + 0,0637GDPgrowth + 0,0363Inflation + 0,0758Tax + 0,4764Unemployment + u \quad (4)$$

$$Gini = 0,3321 - 0,0112QE_{lag1} + 0,0526GDPgrowth + 0,0476Inflation_{lag1} + 0,0533Tax + 0,4773Unemployment + u \quad (5)$$

$$Gini = 0,3325 - 0,0095QE_{lag2} + 0,1020GDPgrowth + 0,0210Inflation + 0,0801Tax + 0,4431Unemployment + u \quad (6)$$

$$Gini = 0,3333 - 0,0094QE_{lag2} + 0,0934GDPgrowth + 0,0365Inflation_{lag1} + 0,0660Tax + 0,4457Unemployment + u \quad (7)$$

$$Gini = 0,3330 - 0,0083QE_{lag1} - 0,0033QE_{lag2} + 0,0916GDPgrowth + 0,0368Inflation_{lag1} + 0,0609Tax + 0,4586Unemployment + u \quad (8)$$