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The Impacts of Negative Interest Rates on the Eurozone Economy

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ABSTRACT

This thesis evaluates the effects of a monetary policy shock in the Eurozone. The investigation stems from the recent implementation of negative interest rates in select European countries and Japan. Impulse response functions are used to compare variable responses when not influenced by negative rates versus when significantly impacted by this monetary policy. The inconclusiveness in the comparison between these two models resulted in failing to reject the hypothesis that negative interest rates have yet to be successful in the Eurozone. However, any economy is a complicated environment that cannot be modelled precisely, as numerous other factors play a role in the movements of macroeconomic variables. Therefore, this research is simply one possible perspective regarding this monetary policy.

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Introduction

This thesis was written to explore an unusual aspect of the modern economic environment – negative interest rates. Formerly considered by economists as an impossible move, it is now critical to understand the thought process of each central bank and the effects of crossing the zero-lower bound. Thus far, the most common course of action has been to solely implement a negative repo rate, with no direct influence to consumers. With key targets in mind, such as 2% inflation, do we expect negative rates to remain a reality in the long-run? Furthermore, perhaps more surprising has been the implementation of negative mortgage rates. Consumers in countries such as Denmark have been receiving a positive interest amount on their loans. Despite the events of 2008, we are again observing the possibility of a housing bubble in multiple European countries due to declining borrowing costs. Negative side effects have plagued the region, which creates further doubt regarding this monetary policy.

This paper analyzes the effects of a monetary policy shock in the context of negative interest rates. From comparing the impulse response functions of two structural vector auto-regressions, it is evident that this monetary policy has yet to support the Eurozone economy to its desired economic health. Most importantly, this thesis strives to evaluate the success of this monetary policy and anticipate the European Central Bank (ECB)'s future policy decisions.

I. Literature Overview

Negative interest rates are still quite a novel concept to the global economy. Though there is plenty of literature regarding general monetary policies and interest rates, few authors have written about negative interest rates specifically, simply because we are still experiencing and observing its effects. The motivation of this thesis was drawn from both formal and informal text, but the primary paper used as a guide is "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy" by

Lawrence J. Christiano, Martin Eichenbaum, and Charles L. Evans (abbreviated from here on as CEE). This paper evaluates the effects of an expansionary monetary policy shock in the United States from 1965 to 1995 using significant indicators of interest rates and a vector auto-regression. The analysis in sections VI to IX will be building on the CEE model in terms of region and time frame in order to prove the hypothesis that n*egative interest rates have not yet been successful as a monetary policy in the Eurozone*. The hypothesis of this thesis has been largely inspired by the many detrimental consequences that have resulted from negative rates. Answering this statement will provide insight into how long we can expect negative rates to remain in the Eurozone, what other effects to expect in the short and long-run, and whether or not policymakers made the right decision. All of these ideas will be addressed in the sections below.

A lot of informal literature, such as news articles, have addressed the concerns and progress of negative rates thus far. Though solely theoretical, these sources, a few of which can be found in Appendix IV, provide great background regarding the issue at hand. For example, Levring (2016) speaks to side effects seen in the Danish housing market, where apartment prices rose 15.6% within a year. Negative interest rates reduce the cost of borrowing, and consumers are responding by investing a dangerous aggregate amount in real estate. Policymakers believed that increased spending would revive the European economy, but did not necessarily anticipate the undesirable effects that are now arising. Nevertheless, it is important to keep in mind that the ECB's monetary policy is multifaceted. For instance, from the content of Praet (2017), it is evident that the asset purchase programme (APP) also plays a critical role in the Eurozone's monetary policy. This text also reveals many of the side effects from negative rates and the APP. The ECB is constantly releasing new information regarding their monetary policies, and with such a current topic, there will undoubtedly be effects on this thesis' research. Potential ramifications are further discussed in section X.

Furthermore, a few existing papers address relevant material to this thesis. Bech and Malkhozov (2016) focus on the technical implementation of negative rates. For example, many banks had to configure their operational systems to accept a negative policy rate. Arteta et al. (2016) carry out a more in-depth investigation into the immediate and longer-term impacts of this monetary policy. The paper uses limited data, but concludes that there are no significant changes to inflation rate expectations. This result is interesting as policymakers expected negative rates to induce noticeable changes in key indicators such as the inflation rate. Feldstein (2012) speaks to the underlying reasons behind the collapse of the European economy and the primary reasons policymakers turned to negative rates. This publication's content is important to understand as we segue into the next section, which discusses indicators of interest rates and prefaces this paper's analysis by identifying the variables that will be used in the empirical model.

II. Indicators of Interest Rates

It is crucial to begin our analysis with the discussion of economic indicators that impact interest rates. Many of the factors mentioned in this section will later be converted into variables in our regression.

Inflation is defined by the ECB as the broad increase in the prices of goods and services (European Central Bank, 2016). It is measured by the annual percent change in consumer prices, measured with the Producer Price Index (PPI) or, more commonly in Europe, the Harmonized Index of Consumer Prices (HICP). The HICP is a weighted price index of a certain basket of representative goods and services, such as transportation, health services, and food, harmonized across all member states of the European Union. Inflation is the percentage change in this price index. Oftentimes, inflation is utilized to relate nominal and real interest rates through the Fisher Relation:

$$R \approx r + i$$

where R is the nominal interest rate, r is the real interest rate, and i is inflation.[1] This is a critical relationship that lenders use, stating that unless the lending rate is above the inflation rate, the lender will not profit from the loan. From this connection, we can see that inflation is a key indicator of interest rate.

Several factors have a strong correlation with a region's inflation rate. For example, unemployment is defined as the percentage of a population who have no job, but are in the labour force (available to work and actively seeking employment) (Bureau of Labour Statistics, 2015). With lower unemployment, consumer confidence improves, and workers strive for higher wages. If firms have to increase their wages, then the prices of their goods or services will increase. Alternatively, increased wages encourage a higher demand for commodities, and thus higher inflation. Ordinarily, this correlation would be maintained, but there have also been instances of stagflation in recent history, such as in the 1970s, when inflation and unemployment were both elevated.

Real gross domestic product (RGDP) is one of the most popular ways to evaluate an economy. A region's output directly reflects its health because it demonstrates its ability to produce. Its respective components allow for specific industry assessment and guide monetary policies to benefit struggling sectors of a country or region. Specifically, RGDP growth indicates the possibility of a few scenarios – increased productivity, higher prices, or a combination of the two. Regardless of the situation, it is almost certain that inflation will ensue in the short-run.

Another indicator of inflation rate trends is commodity prices. These respond rapidly to an increase in consumer demand. For example, oil prices were on the decline for a large portion of 2014 and 2015, and only recently displayed signs of recovery, as shown below in Figure 1. Inflation levels

[1] See Appendix I for the derivation of the Fisher Relation.

followed suit, immediately dipping with signs of faltering investor confidence in the oil sector. People are very dependent on oil for transportation and energy, which is why the industry is so important to global economic trends. However, commodity prices have been poor stand-alone indicators of inflation since the early 1980s, a period during which overall inflation has been relatively low and stable while commodity prices have been more volatile and generally declining relative to the overall price level.

Figure 1: U.S. Crude Oil Prices versus Inflation
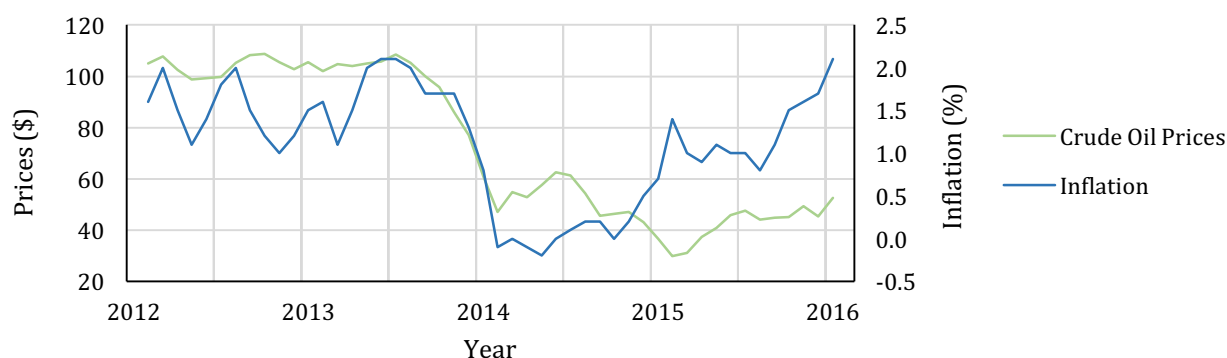
An economic environment such as that of the Eurozone is extremely complex, with many variables simultaneously responding to each other. By analyzing the critical indicators of interest rates, we are pinpointing the most important variables. Section VI will talk about the data used in further detail.

III. Global Economic Environment

In 2008, the world experienced its biggest financial crisis since the Great Depression. Also known as the subprime mortgage crisis, this recession was caused by the burst of the housing bubble, causing major firms such as Lehman Brothers Holding Inc. and Bear Stearns Companies Inc. to declare bankruptcy. For 18 months, the American economy contracted, consequently affecting economies around the world. Economic activity in the G7 countries dropped by more than 5%. Canada, for example, was not in the spotlight of this global recession, but suffered big setbacks in exports and investments. Europe spiraled into a debt crisis.

The European Sovereign Debt Crisis stemmed from an underlying problem – the fact that 19 member states of the Eurozone shared the same currency. This meant that any monetary policy initiated by the ECB applied to every country, despite differing economic health across the region. In early 2010, markets recognized the error of regarding all Eurozone countries as equally safe (Feldstein, 2012). Though a Eurozone member's debt was not to exceed 3% of GDP, certain countries such as Greece and Spain had mounting sovereign debts, upon which higher interest rates were instated. For example, the average Greek had public debt of $39,000. Insolvency fears regarding Greece resulted in a partial default. Many discussions ensued regarding the disbanding of the Eurozone, which would have allowed Greece to pursue a devaluation and default strategy.

With an extremely weak global economic environment and dipping interest rates, countries began to look at negative rates as a serious possibility. Recovery efforts with standard monetary policies were unsuccessful. The figure below illustrates interest rates of select G7 countries since 2001. The Group of 7 (G7) comprises of Canada, United States, Germany, France, Italy, Great Britain, and Japan. Formed in 1975, the group meets annually to discuss economic, global, and energy issues. It is apparent that rates never recovered after the recession.

Figure 2: Global Interest Rates from 2001 to 2016
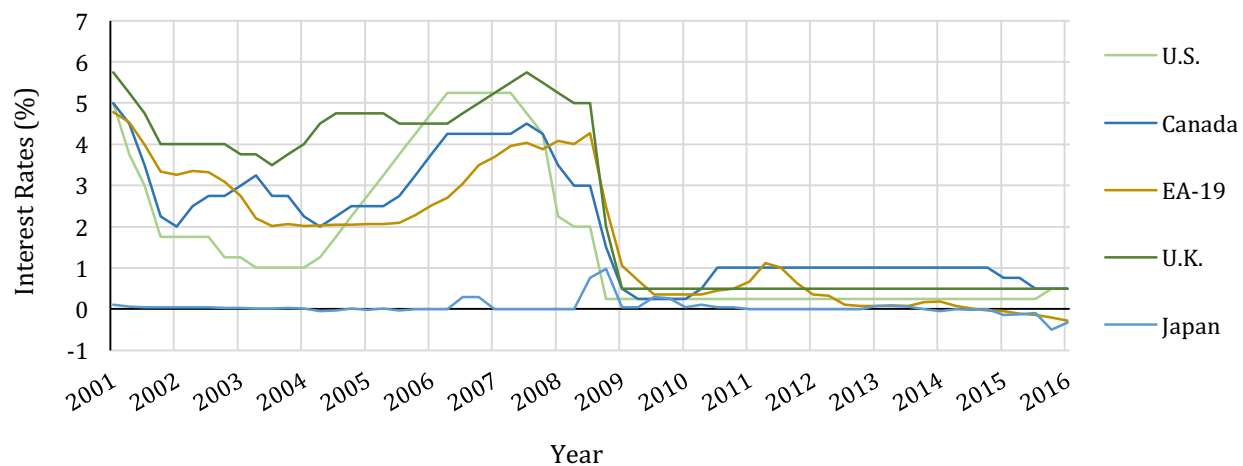
Further evidence of a weak global economy is shown below in Table 1. United States' inflation rate dropped from 2% to 0.25% in the last quarter of 2008, and the unemployment rate jumped from 5.8% to 9.3% from 2008 to 2009.

Table 1: Selected U.S. Statistics during the Subprime Mortgage Crisis

Year	U.S. Unemployment Rate		Quarter	U.S. Interest Rate
2010	9.61%		2008 Q4	0.25%
2009	9.28%		2008 Q3	2%
2008	5.80%		2008 Q2	2%
2007	4.62%		2008 Q1	2.25%

As standard monetary policies failed to spur economies across the world, a few countries opted for an unconventional route – implementing negative interest rates. In Eurozone countries, there is a small peak in CPI at the onset of 2015, which was one of the desired effects of negative rates. However, inflation rates only reached target rate of 2% last month, prompting many critics to remark that negative rates have been unsuccessful. One of these people is David Hoffman, IMF (International Monetary Fund) mission chief, who is concerned about Denmark's sky-rocketing housing prices. Growth in the housing market is a common effect of negative rates, as borrowing costs lower and consumers are putting more money into properties. Even as economic recovery has remained weak, apartment prices have grown 50% since their low point in 2009 (Levring, 2016).

IV. Negative Interest Rates

Conventionally, one would receive interest for deposited money. Negative interest rates reverse this notion, because one would pay a specified rate in order to keep money in the bank. This unconventional monetary policy is an act of desperation to assist economic recovery. For now, only the repurchase agreement (repo) rate has entered negative territory, rather than the deposit rate for consumers. The repo rate is the rate at which the central bank lends to commercial banks in any given country, a process used to replenish the reserves of banks. This section will discuss the theoretical

effects of negative interest rates. However, real-life economies with negative rates have not necessarily exhibited the same behaviour as predicted in theory.

Banks

Instead of keeping money with the central bank, negative interest rates encourage banks to hold their cash. However, an even better option for banks is to purchase alternative assets, or lend out money to smaller firms and consumers. Hence, borrowing costs fall in such a scenario. If banks choose to absorb the costs of maintaining deposits, their profits would be significantly impacted. Narrowing their net interest margins may be preferred over reducing deposit rates or increasing the charge to run current accounts, especially if it was believed that the negative rate was only going to exist in the short-run.

Consumers

Depending on expectations of the duration of a negative bank rate, commercial banks may or may not decide to lower the deposit rate. Consumers will only be directly affected if the banks decide not to absorb the costs of negative rates. Upon the implementation of a negative deposit rate, consumers would likely prefer to keep cash under their mattresses at home instead of paying the bank to keep their money, which poses an increased security risk. Nonetheless, consumers will likely experience lower interest rates, increasing their consumption and investment.

Economy

As alluded to above, depending on expectations of the duration of a negative bank rate, commercial banks may or may not decide to lower the deposit rate. The purpose of negative rates is to fight deflation, which, at unhealthy levels, causes economic slowdown. If demand for goods and services increases, inflation should theoretically rise as well.

V. The European Central Bank

The ECB is the central bank for the Euro Area, also known as EA-19. This zone consists of 19 member states, all of whom have adopted the Euro as their main currency. The ECB was the second bank in the world to implement negative interest rates after Danmarks Nationalbank. According to the ECB's website, their current monetary policy strategy is to maintain inflation rate at just under 2%. As of 2016 Q4, the rate was still below 1%[2], but reached 2% in February of 2017. Such developments are important to note as we consider the lifespan of negative interest rates. It is impossible to pinpoint the stimulus that caused inflation to increase, and thus we cannot give all the credit to negative rates.

VI. Data

The variables in the data set[3] have been adapted from CEE's paper, which explores the reactions of the American economy to a monetary policy shock. All the variables are values representing the Eurozone, or EA-19 region. In addition, all series have been transformed to growth rates, with the exception of *int*. The series that appear in the empirical model are shown below. It is important to note a few differences from the variables included in CEE's model. First of all, M1 has been replaced with M3. Both are money aggregates, though M1 represents the more liquid side of money supply. M3 is a much more common measure in the Eurozone. Furthermore, profits have not been included in this model as such data was unavailable on official Eurozone data resources. CEE also state that real profits had little response to a monetary policy shock.

Table 2: Variable and Series Names

Variable Name	Series Name
intrate	Interest Rate
hicp	HICP
rgdp	Real GDP
gdpdef	GDP Deflator

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[2] European Central Bank Statistical Data Warehouse, Series ICP.M.U2.N.000000.4.ANR "HICP – Overall Index"
[3] Available upon request.

cons	Consumption
inv	Investment
prod	Labour Productivity
M3	M3 Money Aggregate

The data is split into two series. Y_1 contains *rgdp*, *gdpdef*, *cons*, *inv*, *hicp*, and *prod*, while Y_2 consists of money supply. The distinction is made with the acknowledgment that the variables in Y_1 are not contemporaneously correlated with the central bank rate.

$$Y_t = \{Y_{1t}, int, Y_{2t}\} \quad (1)$$

When we think about correlation between two variables, it is important to consider whether or not contemporaneous responses would occur. In the case of the Y_1 variables, it is impossible that they would move at the same time as interest rate. Economic factors take time to respond to each other, and thus Y_1 has lagged responses to Y_t. On the other hand, money supply is immediately affected by movements in the interest rate. Y_2 is contemporaneously correlated with Y_t.

VII. Empirical Model

The methods used to test the impact of interest rates entering negative territory are a structural vector auto-regression (SVAR) and its subsequent set of impulse response functions (IRF). The SVAR measures the correlation of each variable and four lags with short-run constraints, which we have already explained above in the data. Though the CEE paper addresses its model as a vector auto-regression (VAR), its inclusion of contemporaneous values and short-run constraints points to the more appropriate SVAR model. The number of lags was also directly drawn from CEE, but a *varsoc* command was also run in Stata to confirm the optimal number. The IRF then shocks the interest rate to reveal the results for each variable, shown in section VIII. The SVAR equation is as follows:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + A_3 Y_{t-3} + A_4 Y_{t-4} + C\eta_t \quad (2)$$

The short-run constraints on this model are the 8×8 matrices below. These are Cholesky constraints, which allow us to assume that the percentage change in each variable is not contemporaneously affected by changes in any of the variables that appear after it. C is a lower-triangular matrix with the diagonal terms equal to 1, and η_t is a diagonal variance-covariance matrix. For example, a percentage change in real GDP does not have contemporaneous correlation with consumption. A percentage change in consumption would be affected by a change in real GDP but not investment.

$$C = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ . & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ . & . & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ . & . & . & 1 & 0 & 0 & 0 & 0 & 0 \\ . & . & . & . & 1 & 0 & 0 & 0 & 0 \\ . & . & . & . & . & 1 & 0 & 0 & 0 \\ . & . & . & . & . & . & 1 & 0 & 0 \\ . & . & . & . & . & . & . & 1 & 0 \\ . & . & . & . & . & . & . & . & 1 \end{bmatrix} \quad \eta_t = \begin{bmatrix} . & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & . & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & . & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & . & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & . & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & . & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & . & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & . & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & . \end{bmatrix}$$

Prior to proceeding with the model, Granger Causality tests were conducted to determine if the variables in Table 2 can be used to forecast each other. Specifically, we are testing if *rgdp, cons, inv, prod, hicp,* and *M3* Granger-cause *intrate*. A p-value of less than 0.05 allows us to reject the null hypothesis. Thus, all the variables below except for *rgdp* and *cons* Granger-cause *intrate*. However, causal relationships are not definitive in the sense that there are many other factors that determine the correlation between two variables. Failing to reject the null hypothesis in the cases of *intrate-rgdp* and *intrate-cons* could be due to a tertiary component not analyzed in the Wald tests.

Table 3: Wald Tests for Granger Causality

Equation	Excluded	chi2	df	Prob > chi2
intrate	rgdp	5.873	4	0.209
intrate	gdpdef	10.327	4	0.035
intrate	cons	8.8512	4	0.065
intrate	inv	13.761	4	0.008
intrate	prod	11.233	4	0.024
intrate	hicp	16.851	4	0.002
intrate	M3	10.65	4	0.031
intrate	ALL	96.675	28	0.000

VIII. IRF Results

Figures 3 and 4 exhibit the IRFs from four distinct models[4]. Since the data and regressions are adapted from CEE's paper, Model 1 is a replica of the regression described in part II, 'The Consequences of a Monetary Policy Shock', with the time range extended to 2016 Q3. Disparity in the IRF curve may also be due to slight discrepancies in data. By replicating CEE's analysis, it was then a much easier process to adapt the paper to Eurozone data, as shown in Model 2. Each variable was shocked across 20 periods, or quarters, as shown on the x-axes, and its percentage point responses are shown on the y-axes. The only difference between the two graphs below in Figure 3 is the region. We can see that real GDP responses did not exhibit drastic differences between the United States and the Eurozone. This observation was also true for the other six variables tested.
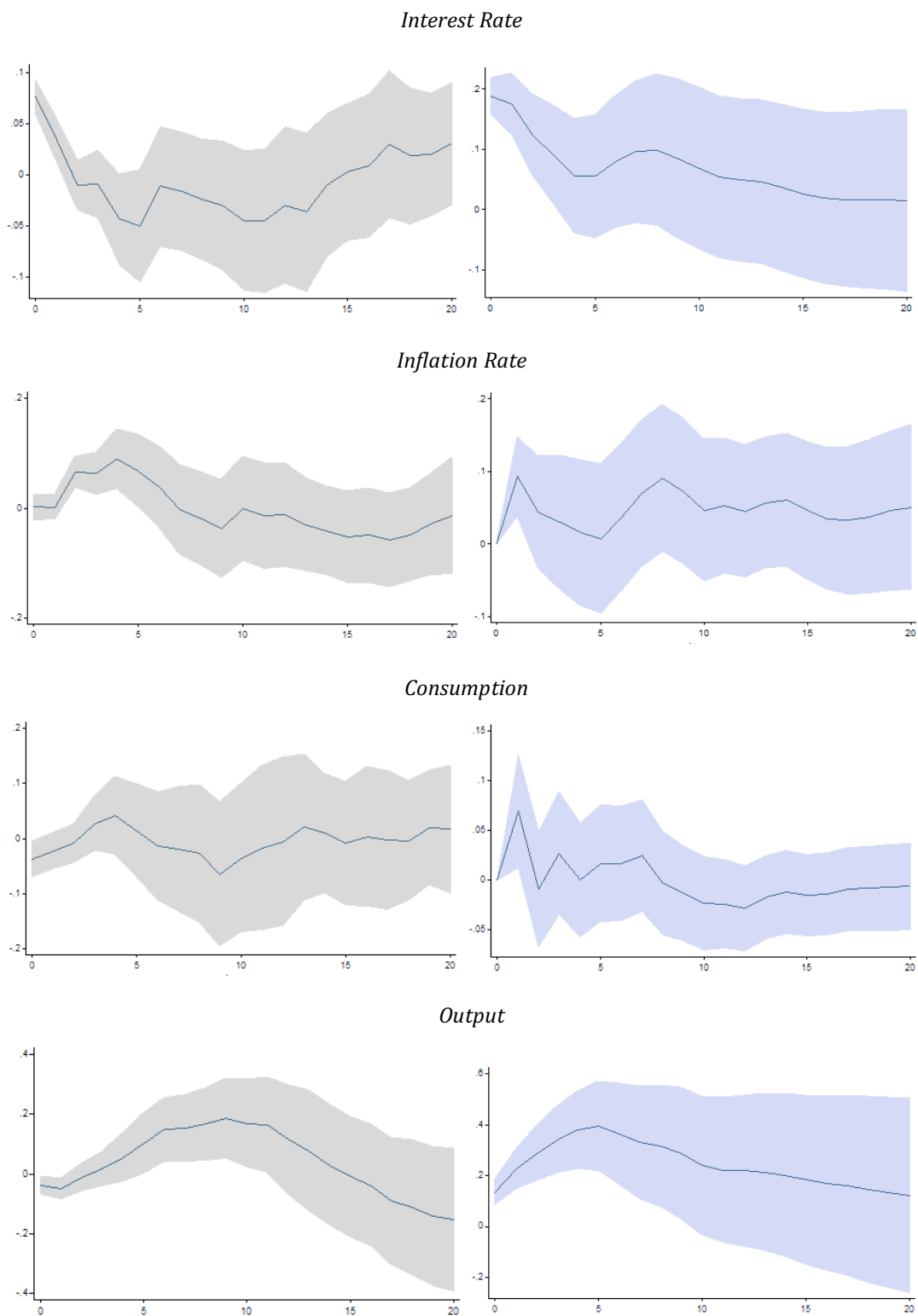
Figure 3: IRFs of Output Response to Interest Rate Movements, U.S. versus Eurozone

United States (Model 1)   *Eurozone (Model 2)*
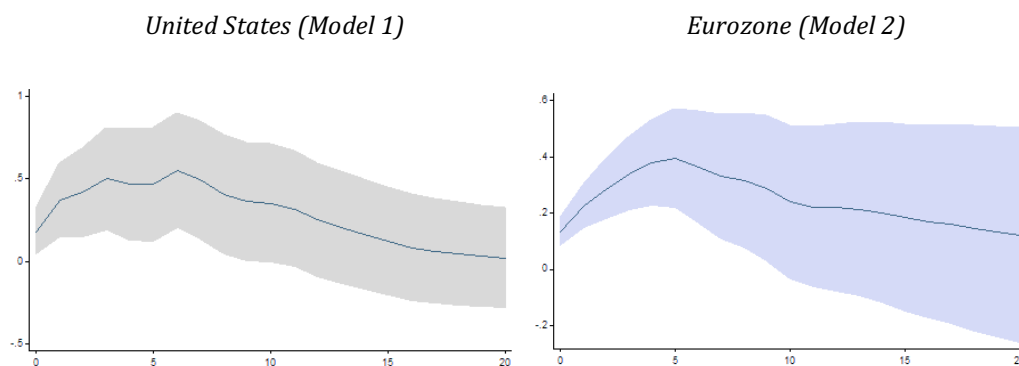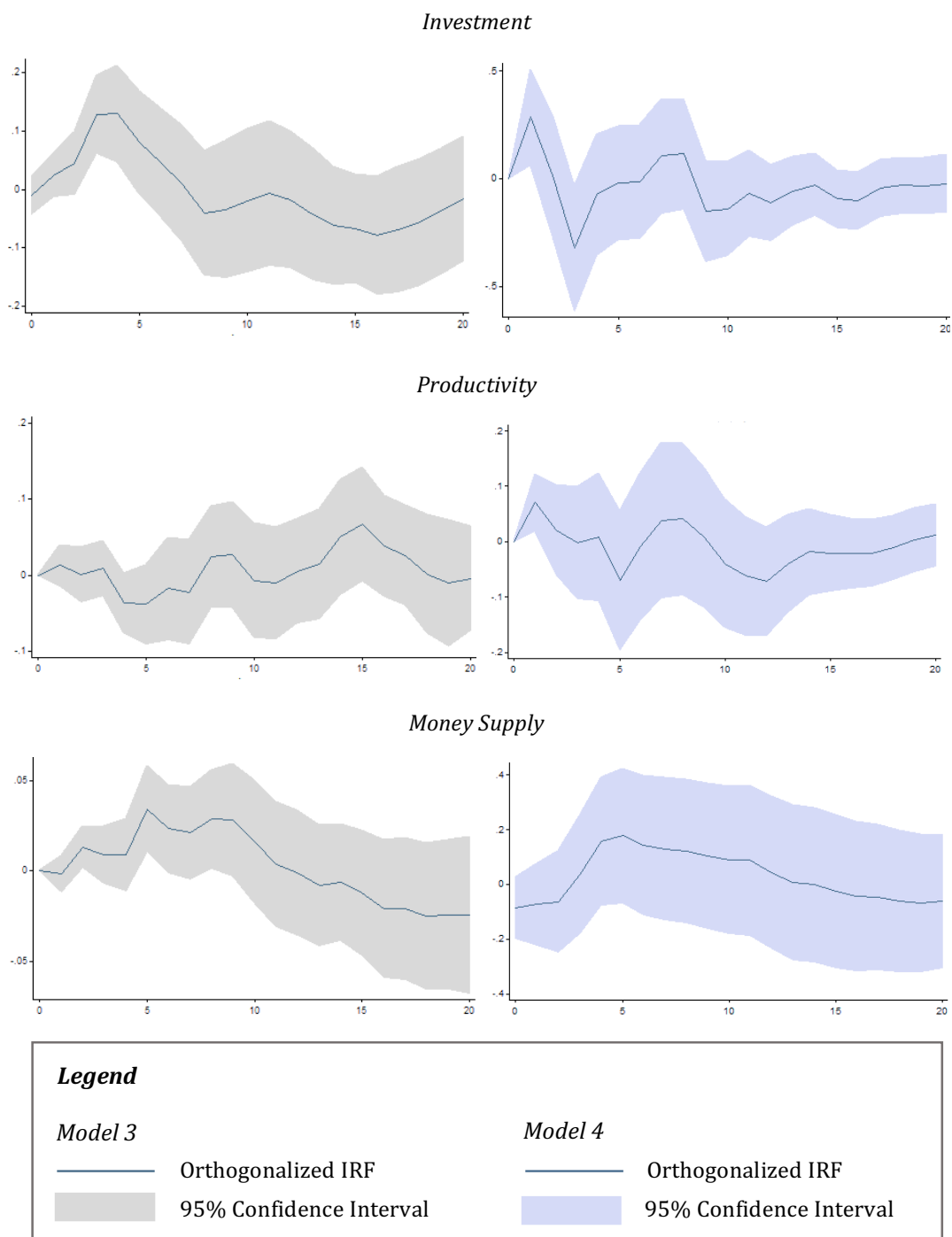

The regression process was then split into two additional models: Model 3, or the first set of graphs in grey, represents the results from an SVAR prior to the recession, or 2008 Q2. The regression was then simulated with the entire data set up to 2016 Q3. Model 4 is intended to have a large influence from negative interest rates, allowing us to best evaluate the impact of this monetary policy. Ideally, an additional regression would be run for the time period with solely negative interest rates. However, at a quarterly frequency, there are too few data points at this time to attain viable results.

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[4] See Appendix II for a visual summary of the four models.

Figure 4: Model 3 versus Model 4 SVAR-based IRFs

Interest Rate

Inflation Rate

Consumption

Output

Investment

Productivity

Money Supply

Legend

Model 3

——— Orthogonalized IRF

95% Confidence Interval

Model 4

——— Orthogonalized IRF

95% Confidence Interval

IX. Results Analysis

In analyzing the graphs in Figure 4, it is important to note the position and intervals of the y-axis. For example, in the first set of graphs for interest rates, 0, or where the x-axis would be, is positioned much lower in Model 4. With this in mind, there is no single generalization that can be made about

the relation between Model 3 and Model 4. It is immediately evident that interest rates react differently in the two models, following a consistently negative trend in Model 4. Another observation that can be made is that the addition of negative rates in the data creates a greater amount of uncertainty for the future. The impulse response functions exhibit wider confidence intervals in four of the seven variables of Model 4, which generally imply that the forecasted values are less precise. We also see varying levels in values across the two models. Output's behaviour is consistent with CEE's results, responding in a hump-shaped fashion. Money supply also increases before plateauing, with less fluctuations in Model 4. On the other hand, consumption, investment, and labour productivity exhibit more volatility, spiking up in the first year, wavering, and only becoming more stable after 15 quarters. This unpredictability indicates that in a negative interest rate environment, consumers' actions will not necessarily follow what is predicted in theory, as addressed in section IV. Finally, the most important indicator here, inflation, increases immediately, and does end up at higher levels than in Model 3.

Ideally, this monetary policy would have resulted in significant long-term effects to set off the side effects of negative interest rates. Many of Model 4's results are consistent with the expectations of negative interest rates and what has already happened in the Eurozone. For example, low interest rates should inspire higher levels of consumption and investment, which is consistent with the immediate peaks in their respective Model 4 IRF functions. Upon first glance, it does appear that these results contradict the original hypothesis. However, this analysis does not offer conclusive evidence. Long-term consequences and other monetary policy initiatives must be considered as well.

In its most recent monetary policy announcement, the ECB stated that its central bank rate would sustain or even decrease its central bank policy rate for an extended period of time, in addition to vamping up the APP (European Central Bank, 2017). As alluded to in section IV, if the repo rate

remains negative, commercial banks will be unable to sustain the profit losses and transfer the negative rates to consumers. If consumers begin to be charged for keeping money in savings accounts, they will disengage from the financial system and choose to store their cash elsewhere (El-Erain, 2016). The fact that the ECB is continuing aggressive monetary policies indicates that the central bank is not yet satisfied with its economy's status. Kane (2016) expresses concerns that negative interest rates will have a profound impact on consumers, bank profits, and foreign exchange markets. Negative rates were considered a 'last resort' policy, so if they fail, the ECB has no other stimulus to turn to.

X. Considerations

Given the results of the SVAR and IRFs, a few steps are advantageous to furthering this research. First, I was unable to test the time period that exclusively had negative interest rates, namely 2014 Q4 – 2016 Q3, simply because there were not enough periods to appropriately forecast 20 steps forward. Such analysis would be advantageous in a few years. Secondly, I would like to find an alternative variable for *profits* used in the CEE model to more accurately replicate their analysis. The ECB does not release a specific net profits statistic. Furthermore, there are many other factors that constitute a nation's economic performance. With recent announcements showing that Eurozone inflation has actually surpassed 2% with the help of bond-buying programs, I would ideally like to evaluate the impact of programs such as the APP. When coupled with negative interest rates, how do macroeconomic variables respond? Finally, this research would be more well-rounded if all regions with negative interest rates were analyzed. It would be worthwhile to assess the consequences that other places have experienced in comparison with those of the Eurozone. In terms of the rest of the world, it is quite unlikely that negative rates be brought to North America or the rest of Asia. Interest rates are already very low worldwide, and unless an extreme economic event occurs, such a drastic monetary policy is unlikely to be implemented.

XI. Conclusion

Recall that the hypothesis for this thesis was *negative interest rates yet to be successful as a monetary policy in the Eurozone*. From the analysis above, it is unclear whether negative interest rates will have a long-term effect on any of the variables. When first introduced, this controversial monetary policy was expected to generate an uplifting force on inflation, consumption, investment, and on a whole, the economy. Without evidence to support otherwise, a consideration of the entire Eurozone economy indicates that negative interest rates have yet to be successful. The IRF results do demonstrate that some key indicators would increase, but with no measurable long-term changes, which is the opposite of what is needed in the shaky European economy. Page 9 of CEE's paper states that policy shocks only account for a small fraction of inflation. With its current monetary policy goals, the ECB needs to re-evaluate its options. There have been no plans to revert interest rates to positive values, but the side effects of negative interest rates, such as soaring house prices, overpaying taxes, and increasingly cashless societies seem to outweigh the benefits. Thus, negative interest rates are not necessarily the best choice for the European economy.

Appendix I: Derivation of Fisher Relation

Assume that

R = nominal interest rate

r = real interest rate

i = inflation rate

P_1 = price level today

P_2 = price level tomorrow

In nominal terms,

$1 today would be $(1 + R)$ tomorrow

In real terms,

$\frac{\$1}{P_1}$ today would be $\frac{\$(1+R)}{P_2}$ tomorrow

$$1 + r = \frac{\frac{1+R}{P_2}}{\frac{1}{P_2}}$$

$$1 + r = \frac{1+R}{1+i}$$

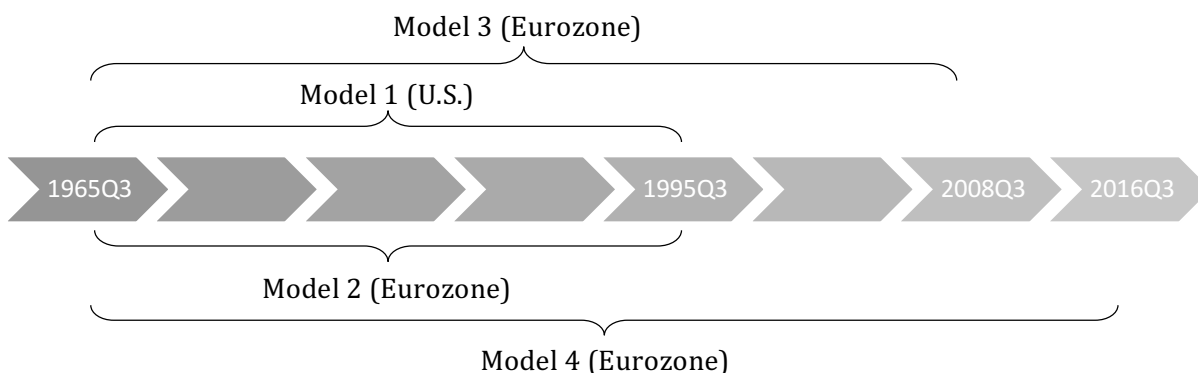$$1 + R = (1+r)(1+i)$$

$$1 + R = 1 + i + r + i \cdot r$$

With interest rate and inflation rate at small amounts such as 2%, $i \cdot r$ becomes very small. Thus,

$$\boxed{R \approx i + r}$$

Appendix II: Representation of Structural VAR Models

Model 3 (Eurozone)

Model 1 (U.S.)

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1965Q3          1995Q3          2008Q3   2016Q3
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Model 2 (Eurozone)

Model 4 (Eurozone)

Appendix III: Glossary

Eurozone: 19 of the 28 states of the European Union who have adopted the Euro as their currency (thus also known as Euro Area-19, or EA-19)

HICP (Harmonized Index of Consumer Products): indicator of inflation for the European Central Bank, or the equivalent of CPI (Consumer Price Index)

Inflation Rate: sustained increase in the general level of prices of goods and services in a region

Repo Rate (formally known as the repurchase agreement rate): the lending rate between central banks and commercial banks in a region or country

Unemployment Rate: the percentage of a population who have no job, but are in the labour force (available to work and actively seeking employment)

Zero Lower Bound: the economic environment that occurs when the central bank policy rate has reached zero or nearly zero

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