Economics
2022; 11(1): 49-68
http://www.sciencepublishinggroup.com/j/eco
doi: 10.11648/j.eco.20221101.17
ISSN: 2376-659X (Print); ISSN: 2376-6603 (Online)

An Econometric Approach to Assess the Impact of Negative Interest Rate Policy (NIRP) on Real Estate Price Inflation in the Eurozone

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To cite this article:

Bassam Hamdar, Yaman Skheita, Mohammad Bassam Hamdar. An Econometric Approach to Assess the Impact of Negative Interest Rate Policy (NIRP) on Real Estate Price Inflation in the Eurozone. *Economics*. Vol. 11, No. 1, 2022, pp. 49-68. doi: 10.11648/j.eco.20221101.17

Received: February 2, 2022; **Accepted**: February 25, 2022; **Published**: March 9, 2022

Abstract: Contemporary economists argue that negative interest rate as an unconventional monetary policy helps stimulate economic growth. The European Central Bank (ECB) entered Negative Interest Rate Policy (NIRP) territory in June 2014, when it lowered its deposit rates to below zero levels, making it the first major central bank to adopt such policy. In contrast, NIRP can have negative effects on certain economic sectors, such as the property and housing. This paper highlights the effects of negative policy rates on the real estate price inflation inside the Eurozone. The relationship between house price index, negative policy rates, government deficit, unemployment rate, and nominal unit labor cost is addressed and analyzed. Two main hypotheses were adopted i.e., to determine the direct relationship between the Deposit Interest Rate and the House Price Index, and the indirect relationship between the Deposit Interest Rate and the House Price. Furthermore, an econometric model is utilized to sort out the impact of NIRP on the real-estate price inflation in the Eurozone. The outcome of the model shows a strong relationship between negative policy rates and house price index, with government deficit, unemployment rate, and nominal unit labor cost acting as confounding variables.

Keywords: NIRP, Real Estate Sector, Price Inflation, Eurozone, Econometric Approach

1. Introduction

The International Monetary System (IMS) is the system of operations that governs the interaction between governments and financial institutions around the world. The mechanism that links the national economies with one another, for economic cooperation and the flow of trade. The IMS establishes a structure and sets processes and regulations for exchange rates, capital movements, and the flow of payments across countries [1]. It is responsible for providing foreign exchange markets with organization and consistency, to facilitate the removal of balance of payments problems between countries, and to enable access to international credit in times of economic instabilities. In the lack of an effectively performing IMS, it is difficult for countries to utilize the returns of international trade and foreign lending. Understanding the modus operandi of the international monetary system is essential to understand the international economy [2].

The design of the IMS and the financial system is a main factor of how effectively the global economy can fulfill its potential, how severe the risks of economic catastrophes and disturbances are. Governments and policy makers usually focus on the input-output, inflation, and the balance of payments, but they fail to target other aspects of the influences that result from the relationship between the international monetary system and the financial conditions in their countries. The monetary policy is one of the key elements of all the international monetary systems, and it is one of the main constraints. The monetary policy is governed by a “trilemma”; a nation could concurrently have two of the following three elements but not all three simultaneously: stability of exchange rate, cross-border trade flexibility, and monetary policy's primary focus towards domestic goals [3-5].

1.1. European Monetary System (EMS)

The European Community created the European monetary system in the year 1978. The new system had three main objectives. To stabilize exchange rates of European currencies, to enhance the planning and organization of economic and monetary policies among the member countries, and to pave the way towards Europe's monetary unification. A monetary union inside Europe was not envisioned during the early stages, which prepared for the creation of the European Community in the late 1950's. Nevertheless, there has been a considerable determination put into these issues by the EC. Several attempts were carried by the European Monetary System to stabilize exchange rates, but did not witness much success. Economists from around the world predicted that the new system would not live long enough to witness success and would eventually fail; the general perception of the EMS was mostly negative. The main objectives of the European Monetary System was to enhance the stability of the nominal--and if possible--real exchange rates within the European Economic Community, European economic integration, and eventually, the existing national monies would be replaced by a common European currency [6]. Many economists argued that an economic unification between high inflation nations like France with low inflation nations like Germany is a difficult endeavor, and could not endure for a long period under the constraint of fixed nominal exchange rates weighing in on the strength of conventional open-economy macroeconomics [7]. Arrangement among industrial countries since the breakdown of the Bretton Woods system" [7].

1.2. Interest Rate

Governments around the world have been employing interest rate policies to control market liquidity, which in turn controls inflation and stimulates economic growth. Numerous methods have shown that the association between production and interest rates is negative. "i.e., Tobin's monetary growth model posits that a higher real yield on money as an alternative asset to capital has a negative effect on demand for capital in the medium term, but it says nothing about the short-term period"[8]. During periods of low economic growth, governments tend to decrease interest rates in order to stimulate investment of capital held in bank deposits, and into the economy. On the contrary, during periods of high inflation, governments tend to increase interest rates to control the amount of liquidity in the economy, and to limit the inflation rate. For decades, interest rate policies proved to be a very effective tool in economies around the world; but the recent years have proved that this is no longer the case. The economies of the developed countries have been witnessing an economic slow-down in recent years. Unconventional monetary policies played a substantial role in the stabilization of their economies. The Zero-Lower Bound (ZLB) was successfully lowered below zero by applying Negative Interest Rate Policies (NIRP). However, such unconventional tools can only be used for short periods, since their long-term effect on the economy could be risky and more damaging than their constructive part. Governments aim by lowering interest rates to encourage depositors to invest the money they have saved in bank accounts, and to make the cost of acquiring money cheap so that potential borrowers would borrow money and would either spend or invest it into the economy, all in the aims of stimulating economic growth [9].

There are certain economic models that displays a mixed effect of interest rate on production and output [8]. The theory of irreversible investment shows that there is a diverse effect of interest rate increase in the economy. When governments increase interest rates, a negative effect is observed on economic growth [10].

Nevertheless, controversially, increases in interest rate also have a positive effect on the economy, since producers and investors will speculate that the interest rate will keep on rising in the future, so they will more likely engage in investment decisions in the current period rather than in future periods [11].

1.3. Negative Interest Rate Policy

Negative Interest Rate Policy (NIRP) is a nonconventional monetary policy enforced by central banks, which aims at stimulating growth and raising inflation expectation by encouraging lending to the real economy, and by suppressing borrowing costs. The main idea behind NIRP is the charging of commercial banks for reserves placed on deposit with the central bank. Many central banks throughout the world, including the Bank of Japan, the European Central Bank (ECB), the Swiss National Bank (SNB), the Swedish Riksbank, and the Danish Central Bank (DN) have employed NIRP [12].

The motivation behind adopting NIRP in mid-2014 and early 2015 differed between the ECB, SNB, DN, and Riksbank, with each one facing a challenging macroeconomic environment in its area. In some cases, the central banks' declared objective was to counter a subdued inflation outlook, while in others they focused on currency appreciation pressures in the context of bilateral pegs or floors on their exchange rates [13].

Since the beginning of the past decade, Negative Interest Rate as a monetary policy has been a very rare event. During the great depression, and during the sub-prime mortgage financial crisis of 2008, treasury yields in the United States fell below zero for a short period. During the 1970's, the Swiss National Bank lowered interest rates to below zero levels on foreign deposits in an effort to stop capital influxes and the extreme appreciation of the Swiss franc [14]. During the economic decline of the late 1990's, Japan lowered the returns on its government bonds to below zero for a short period of time [15]. In Sweden, and during the crisis of 2009, the central bank of Sweden (Riksbank) also lowered the interest rates to below zero [16]. Nevertheless, negative interest rates as a monetary policy persists as a tool used in very particular situations specific to financial crises [17].

Negative interest rate policy is becoming a mainstream macroeconomic approach and a part of central banks' policy tools. Ben Bernanke, the former chair of the Federal Reserve

(FED) announced in December 2015 that the FED was prone to adding NIRP as a policy tools to be used in the future. Bernanke followed that statement up in March 2016 with an extended Brookings Institution blog on the tools central banks have to fight slow growth, beginning with negative interest rates. Janet Yellen, the Federal Reserve Chairwoman, reconfirmed those statements in February 2016, asserting that they could still apply NIRP as a monetary policy in the future. In April of year 2016, the managing director of the IMF Christine Lagarde stated that negative interest rates are “a net positive to the global economy”, a statement that was supported by the IMF financial counsellor Jose Vinals in a briefing at the IMF 2016 spring meeting [12].

2. Scope of the Study, and Problem Statement

This study aims at investigating what macroeconomic variables affect house prices in the Eurozone. In specific, it is intended to examine controllable macroeconomic variables stemmed by governmental policies i.e., deposit interest rates; government deficit, unemployment rate, and labor cost.

The study will examine the countries inside the Eurozone area, a monetary union inside the Europe, which is comprised of 19 countries, Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. These countries share a unified currency, which is the Euro, controlled by the European central bank (ECB).

Recently, the enforcement of negative interest rates by the European central bank have sparked many studies, which investigated the effects of such policies on a multitude of social and economic levels. The reason behind these studies stems from the principle that negative interest rates defy economic logic. Neoclassical theory in Economics hypothesize the close relationship between savings and investments, whereby a portion of the disposable income, which is saved by consumers, is used in future periods by investors. This is the case of many countries, such as Germany, where a large proportion of its citizens are actively engaged in savings, and this transforms at later stages to investment initiatives. Zero Lower Bound (ZLB) and negative interest rates shake the foundations of these economic (and somehow sociological) norms, they place a fee on money tucked away into savings accounts, idle money, in an effort to force consumption to stimulate growth. Such growth can be temporary and medium range, and across multiple aspects of the economy, but sometimes this growth can unequally flow in certain sectors of the economy. One of those sectors are property markets or housing markets in specific. In an effort to escape the effects of negative rates, individual depositors, corporations, and large investors alike tend to look at a safe place to maintain their deposits, stable sectors with low volatility; and that is where properties start to look interesting.

3. Literature Review

3.1. The Theory Behind NIRP and ZLB

The western world has witnessed a large reduction in interest rates since the recent financial crisis of 2008. This crisis and the recession that followed have been labeled as the most serious economic crisis since the great depression [18]. More than twelve years after the beginning of the crisis, a large number of central banks have set their interest rates to zero, close to zero, or entered in the negative territory. In the United States of America, the Federal Reserve Bank (FED) has lowered the nominal interest rate to below 2% as of August 2019. Four of Europe’s central banks have also lowered interest rates to below zero viz; the European Central Bank (ECB), the Swiss National Bank (SNB), Denmark’s National Bank (DNB), and Sweden’s Riskbank (BOS) [19]. In Eastern Asia, the Bank of Japan (BOJ) has also entered the negative interest rate territory [20]. The levels of investment and capacity utilization nonetheless have persisted lower than the normal levels in many industrialized nations. Such unconventional monetary policies of reducing market interest rates have been undertaken in an effort to stimulate aggregate demand and to drive economic growth in post-crisis inflicted economies. Coupled with quantitative easing, the NIRP enforced by central banks have had limited success in economic revival in major countries i.e., the United States of America [21]

The theory of NIRP dates back to the late 19th century, to the German economist Silvio Gesell who came forth with this idea, in its most complete form. Gesell is considered the first economist advocate for an intermittent tax on money in order to stimulate collective demand, drive growth and fight economic crises [22]. Many economists have adopted Gesell’s theories and expanded on them, and the current free-economy movement is a proof of that [23]. In addition, while his ideas for a money tax has never been implemented on a wide scale, there have been some provincial measures since the Great Depression [24]. Although Gesell’s ideas were established as a criticism to capitalism by an economist collaborating with liberal socialists, it is interesting how he managed to end up as a reference for a large number of leading economists, and policies of major central banks around the world.

During the twentieth century, the leading American economist Irving Fisher endorsed Gesell’s theories. Fisher put forth an economic theory (called Fisher Effect) that explains the relationship between inflation and both nominal and real interest rates. The model maintains that the real interest rate equals the nominal interest rate minus the expected inflation rate. Thus, as inflation increases the real interest rate decreases, unless nominal rates increase at the same rate as inflation. Fisher’s monetary theory of economic fluctuations revolved around the incomplete short-run adjustment of money interest rates. Fisher held that 'periods of speculation are the result of inequality of foresight; It happens that when prices are rising, borrowers are more apt to see it than lenders [25].

Gesell’s works were also inspiring for the prominent British economist John Keynes, who mentioned Gesell’s theories in his renowned book (The General Theory of Employment, Interest and Money). Keynes advocated parts of Gesell’s theories and described him as a ‘strange, unduly neglected prophet’ [26].

After World War 2 (WW2), conventional economists gave little importance to the prospects of negative interest rates, and economic thought history scholars doubted Gesell’s theories and considered them to be irrational and impractical [27]. However, many economists were prompted to re-examine the theory of taxing money in light of Japan’s recent experience of persistent deflationary pressure and economic stagnation, in an effort to defeat the zero bound on interest rates [28]. Even though these economists have repeatedly referred to Gesell, as the initial advocate for an intermittent tax on money, they did not focus much on his economic theory. In arguments supporting their policies, they “examined the benefits of NIRP in Walrasian Dynamic Stochastic General Equilibrium (DSGE) models”, where money has an insignificant part since it is unnecessary for the efficient distribution of resources. The majority of their supporters had ignored the existence of other models, which view money tax as a tool to enhance efficiency [21].

3.2. Economic Effect of NIRP

Negative interest rates have been the focus of media and research since their introduction in Europe in the year 2014. Studies show that negative NIRP can stimulate the economy and drive growth by encouraging banks to engage in more lending activities and inciting depositors to invest their money instead of maintaining them in bank accounts. These initiatives have the eventual effect in stimulating economic growth and subsequently increasing inflation. Other researchers argue that the adverse effects of negative interest rates outweigh the benefits, especially when applied over prolonged periods. Undesirable effects of NIRP span across many aspects of the economy and pose a great risk for many social classes such as the pensioners, poor and lower middle-class households. Like other unconventional monetary policies, NIRP could also encourage excessive risk-taking, which could contribute over time to the formation of asset price bubbles. Recent research also documents an inverse relation between short-term interest rates and bank risk-taking. Greater risk-taking may contribute to the formation of asset bubbles, which could be damaging for the real economy, particularly in the housing market [29]. However, increases in equity and house prices have thus far, remained moderate in most economies where NIRP has been implemented (with the exception of Sweden). There is no conclusive evidence yet of a significant and broad-based increase in leverage, or of excessive asset price valuations that could signal looming financial stability risks [17]. Negative interest rates have direct and indirect short and long-term implications on the economy of states. Such policies increase the price of financial assets particularly, risky assets like equities, which become more attractive as interest rates fall. Since richer families mainly own these risky assets, this further raises their relative wealth at a time of increased income and wealth inequality [12].

NIRP's lower economic bound is mainly defined by the effect of negative rates on financial intermediation. Paying interest on excess reserves kept by banks at the central bank has some direct cost pressure (indicating limits to negative interest rates based on banks ' propensity to increase cash balances), a few central banks have adopted mitigating strategies to restrict the incentive to switch into cash, such as penalties for banks making major reserve transactions and tiered reserve systems. As interest rates move further negative, the lower nominal bound is progressively determined by the wider indirect stress coming from shrinking profitability of banks, since most lending rates decrease more than deposit rates. A recent study by [30] assessed the effects of negative interest rates on banks’ risk-taking. The researcher used a panel dataset of 9421 banks from 59 countries over the period 2009–2018 and a Difference-in-Differences estimator. It was found that “banks’ risk-taking has been lower in countries where negative rates have been implemented. This effect depends on the characteristics of a country’s banking system, namely the level of capitalization and size”.

In a study conducted by Feldkircher et al. [31]. The transmission of Euro area interest rate shocks to Asia, and its impact on Asian governments’ bond yields was examined. The research proposed a non-linear factor-augmented vector autoregressive model, to evaluate spillovers to Asia from an unexpected rate cut in the Euro area. The potential asymmetries in the transmission of the shock that could arise due to prevailing negative interest rates in the Euro area, was highlighted. The findings indicated significant and negative effects on short-and long-term interest rates throughout selected Asian economies. While the cross-country impact on yields is quite homogeneous when the policy rate in the euro area is positive, large heterogeneity emerges when the shock occurs under a negative interest rate environment in the euro area. For several countries, the effects on Asian long-term yields are stronger; this implies that not only relative yield differentials play a role for international investors but also the absolute yield level. In this sense, negative interest rate policies can act as an amplifier of international portfolio rebalancing.

The effect of interest rates on households has been a matter of economic debate between numerous researchers. Classical economists argue that consumer savings play a crucial role in economic development and future growth. Household savings accumulated over time tend to be invested in startups, businesses, stock market, and other financial institutions. A study by Bairamli, and Kostoglou [32], investigated the role of savings in the economic development of the republic of Azerbaijan. The paper analyzed the possibilities of the accumulation and mobilization of savings and their role in the economic development of the Republic of Azerbaijan. Results indicated that the mobilization of domestic savings is crucial for raising the economic growth and promoting development, as it is the private savings that affect the domestic investments significantly. “Channeling savings into productive investments would lead to lowering unemployment and increasing economic growth”.

3.3. Negative Yields - The Case of the USA

During the 1930’s economic depression and deflation in the

United States of America, the US treasury bills had negative yields at times (even though the returns were positive).

The US treasury liberty bond yield was officially listed to have a return of 3.5 percent at the end of December of the year 1932. When adjusted for inflation, the real yield was negative 1.74 percent. This was an unprecedented phenomenon at that time, since investors can choose to hold on to their money instead of investing it in government bonds which have a real negative return, so since basically investments should return positive future returns. It is documented that the sale price of treasury bills during the great depression of 1929 surpassed par level, but the negative returns percentage was too minimal, only at around negative 0.05 percent. One of the reasons behind this phenomenon was that personal property taxes did not apply to treasury bills, so investors acquired them as a means of evading being taxed; and in order for a bank to hold united states government deposits it was obliged to have T-bills securities as an insurance [33]. In contrast, negative nominal treasury bills returns on the level of up to negative two percent are a very different case. In reality, from the second half of 1930's until the first half of the year 1942, the bulk of coupon carrying United States government bonds had negative nominal returns during the time they reached maturity [34].

Theories of investments and returns do not cater for negative yielding bills. Therefore, the demand for these securities had to result from other than their value especially, when investors can always keep their cash as deposits instead of investing them [35].

The standard operating procedure of United States treasury department during the 1930's was to issue new bills at par level but with coupon premiums that reflected an above par value market price. Throughout the auction of these new issues, owners of maturing T-bills and notes were given a privileged treatment, whereby the coupon carrying T-bills had an exchange process called the "exchange privilege"; these bills could be traded at par value for new government issued securities at their maturity date (US Treasury Department, 1926). Aside from being coupon securities, the government bonds were also considered options, and the quoted price included the option value [36]. The premiums on bonds, when these bonds reached maturity, triggered the price to increase large enough that the return became negative [34].

For much of the 1930's, the liquidity trap the United States was in, had caused the short term "overnight" rates of treasury bills to approach zero, at one quarter of a percent; and this spanned for a period of five years from 1934 till 1939, till the beginning of the WW2 [37].

According to Trevino and Yates [38], the performance of treasury bills was surpassed that of bonds and stocks in the years that witnessed very high and high increases in inflation, signifying a high correlation between economic inflation and T-bills returns. There was an adverse effect in increases in inflation on stocks and bonds, whereas the T-bills returns were not affected. Historical facts show that T-bills are not recommended as a good hedge against economic inflation, but given the more adverse effect of inflation on the stock and bond markets, T-bills could act as a temporary safe haven.

3.4. Quantitative Easing (QE) to NIRP - The Case of the Japan

Japan has the highest deb to Gross Domestic Product (GDP) ratios among all industrialized first world countries. Japan's public gross debt and net debt, as a share of Nominal GDP (NGDP), have risen from 19% and 64%, respectively, as of 1991, to 156% and 238%, respectively, as of 2018 [39]. The Bank of Japan, Japan's central bank, has enforced a number of unconventional monetary policies. The first policy adopted by the bank of Japan during the early 1990's was to lower the nominal interest rates, where they reached around 0.5% in the late 1990's. Meltzer notes in an analysis of the Japanese economy from 1985 till 1999 that the recession early in the1990s was induced by a decline in money growth; whereas the recession in the late 1990's was induced mainly by a fall in real exports [40].

The second policy adopted by the central bank of Japan since March of the year 2001 is Quantitative Easing (QE), enforced as part of efforts to stimulate growth in the Japanese economy. A study by Honda & Tachibana [41] noted that QE policies enforced by the Bank Of Japan (BOJ) had led to an increase in bank reserve balances which resulted in a boost to stock prices first, and then industrial production. It also led to an increase in bank reserve balances by 1 trillion yen, which resulted in the rise of stock prices by a range of 0.2% to 0.9%, and to the increase in industrial production by a range of 0.03% to 0.18%. Given these efforts, there are clear indications that the growth witnessed by the Japanese economy, resulting from Japan's cheap money policies, was in fact illusory, where it did not succeed in improving the country's economic stagnation. The more Japan used monetary policy to stimulate the economy, the less they witnessed economic growth. A study by Ueda [42] indicated that the QE strategies, however, have failed to bring the Japanese economy out of the deflation trap so far.

The Bank of Japan consequently performed heavy cuts to the interest rates between the year 1991 and 1995, leaving the discount rate on loans a mere 0.5% above the zero-bound level. In the 1990s, fiscal economic policies were vigorously used as Japan initiated nine stimulus programs totaling 140.7 trillion yen, or the equivalent of $1.3 trillion, over the decade. Even though Japan was the first industrialized nation to use these initiatives, they were unsuccessful in causing economic recovery. A study by Fujiwara [43] evaluated the Japanese economy's monetary policy when nominal interest rates are almost zero. The findings showed a structural break in the macroeconomic dynamics describing the monetary transmission mechanism, around the time when the Bank of Japan resumed the de facto zero nominal interest rate policy in the mid-1990s. Increases in monetary supply, seems to have slightly positive but statistically insignificant effect; and "the impact of monetary policy on the macroeconomy using monetary expansion becomes significantly weaker after the structural break, suggesting that within the regime currently prevailing, monetary policy is not fulfilling its desired role. Throughout the 1990's and until the year 1997, the Japanese economy was suffering from low growth rates, inflation rates, and interest rates, and huge amounts of bad debts [44]. The Japanese banks wrote off more than fifty trillion yens of bad loans between the years 1995 and 1998 [45]. The Bank of Japan decided to adopt policies to supply Japanese banks with trillions of yens in money notes between late 1997 and late 1998. The process was not called quantitative easing at that time [46].

The economic growth continued to be moderate, so the Bank of Japan increased the level of asset purchases based on an advice given by the American economist Paul Krugman [42]. More than 35 trillion yen were given to Japanese banks as monetary injections between the year 2001 and 2004 [47]. The Japanese banks also engaged in the purchase of long-term government securities, which caused the yields on assets to decrease [48]. Consequently, the period between 2002 and 2007-witnessed positive economic growth. Nevertheless, this period of growth was interrupted by the sub-prime mortgage crisis of 2008 and the recession that followed it [49]. The Bank of Japan started another round of quantitative and qualitative easing (QQE) in the year 2013 (qualitative easing consists in central bank policies that deteriorate the average quality of the assets that it holds), following the lead of the United States and Europe. QQE did little to stimulate the Japanese economy, and it was deemed ineffective [50].

The Bank of Japan's asset purchases of 80 trillion yen was ineffective in stimulating the economy and driving it out of recession, which forced the BOJ to announce in October of year 2014 another round of quantitative and qualitative easing (QQE2) [51]. In the eight months that followed, there was an increase of 33% in Japanese stocks because of QQE2, but real economic growth was still stagnating [52].

Moreover, this led the Bank of Japan to announce the adoption of a negative Interest Rate Policy (NIRP) in January of year 2016, in a desperate attempt to stimulate growth [53]. Investors have long looked at the Japanese public debt as a weak point. Economists and financial analysts argue that the massive debt of Japan (including private debt) which totals around 450% of GDP has huge servicing costs [54], that decreases the possibility for savings or investment, the main driver of future economic growth and higher returns. Monetary policies be the pure Keynesian, quantitative easing, quantitative and qualitative easing, or negative interest rates, have done little to help Japan's economy escape the gigantic fiscal deficit for over 30 years [55].

3.5. QE to NIRP – The Case of Europe

In June of the year 2014, the Governing Council of the European Central Bank took the decision to cut the interest rate on the deposit facility to negative 0.1%, having been set at zero levels since July 2012 [56]. It was a bold and unorthodox decision by the central bank governing council, for no similar large enough union or country had ever ventured into such an economic policy, not even the United States of America.

After the great financial crisis of 2008, many countries introduced unorthodox economic policies in an effort to stimulate their lagging economies, many of whom have been having a zero or close to zero policy rates in the preceding years [57].

Five European Central Banks declared that they would shift their monetary policy rates to the negative territory, something that is usually observed as the lower bound for nominal interest rates. These central banks are the Danish Central Bank (Danmarks Nationalbank – DN), Swedish Central Bank (Sveriges Riksbank -SR), Swiss Central Bank (Swiss National Bank – SNB), and the European Central Bank (ECB) [58]. Each one of those central banks had different reasons behind its decision to adopt NIRP, and therefore each of them differed in its implementation of these policies.

The European Central Bank decided to decrease its deposit interest rates to below zero in June 2014 in an effort to reinforce the solid anchoring of the inflation prospects on the medium and long-term, as announced by the ECB's president at that time Mario Draghi [59]. The Swedish central bank followed suit in Q1 of year 2015 and lowered the interest rates to sub-zero for similar reasons as the ECB [60]. The purpose behind the SR's decision was the preservation of the function of inflation target as a nominal safeguard for price and income setting [61]. Along NIRP, other unorthodox processes were adopted by those central banks. The covered bonds acquisition was continued by the ECB, and they broadened their asset acquisition plans to cover asset-backed securities and government bonds; long term financing for banks was also offered by the ECB [62]. The SR also stared the acquisition of securities [63], which were projected that by the end of the second quarter of 2016 would exceed that of the ECB on a proportion comparison, encompassing a little over 30% of outstanding nominal government bonds.

All of the European countries, which executed the NIRP, did it through their current operational frameworks, except for the Swiss National Bank, which was forced to change its terms of business before implementing it. The compensations on reserves, whether positive or negative, was not an element of the contractual structure for deposit accounts before the end of 2014. In addition, site deposit accounts were treated with additional individual exemption limits by the Swiss national banks, where that NIRP only applies to deposit above the limit [64].

Central banks have different structures of liabilities and their compensation methods. The banking system in each territory holds assets and other central bank securities in excess of the mandatory quantities. The excess liquidity in the Euro area and Switzerland is kept as overnight deposits, while it is stored as a mix of overnight liabilities and single-week liabilities in Denmark and Sweden; and a part of the reserve capital is excluded from the NIRP policy by the aforementioned central banks except the Sveriges Riksbank [60].

3.6. Property Markets in the Eurozone

Most studies have mainly concentrated on the stock and bond markets, while little attention has been given to the real estate markets inside the European Union, and the effects of a unified currency on the property markets in Eurozone countries. Many macroeconomic factors such as prices, nominal rates, output and investment all directly influence the real estate markets. The nominal interest rates, moreover, have a direct and heavily influential effect on real estate markets [61].

The real estate markets appear to be influenced by the same macroeconomic factors, which influence financial assets, and bonds. There seems to be substantial interrelationships between the real estate markets inside the Eurozone since the creation of the European monetary union, and the introduction of the unified currency in the year 1999 [62].

The housing markets in the central and eastern European countries, whose borders lie close to the Eurozone, had been weak and almost nonexistent before the early 2000's. However, with the formation and the expansion of the Eurozone, enhancements were applied to the regulatory and institutional framework in those countries due to the establishment of the Eurozone. Easier access to credit had caused expansions in those markets and increases in the real estate trade. The economic reforms, along with the restructuring of the financial sector and the purchase of local banks by foreign banks, have prompted the expansion of real estate markets and property financing [63]. Multiple central and eastern European banks started providing long-term real estate mortgages, and interest rates began to decrease. Even though real estate credit is harder to acquire for lower-income households in central and eastern European countries, and the penetration level of mortgages in these countries lags those of the Eurozone [64]. Global real estate market movements are affected by the European real estate markets as well. A study by McAllister & Lizieri [65] suggested that when considering the real estate markets, The European factor affects non-Eurozone members and non-EU members in the same way as Eurozone members. where the largest increase in correlation for real estate equities is for non-Eurozone and non-European Union markets, which might be explained in a sense that that broader regional economic integration rather than more narrow monetary integration is driving the European factor. On the other hand, Merikas, Merika, Laopodis, & Triantafyllou [66] investigated the impact of the adoption of the common currency on real house prices between the years 1990 and 2009. Their findings suggested that the movement of the housing prices of the Eurozone countries apart from the well-known fundamentals of GDP i.e., interest rates and stock returns, is also based on a number of idiosyncratic and structural factors like demographics, the tax system, and government intervention which determine the duration and the strength of the housing cycles in each country.

Real estate movements and property price disturbances can cause substantial effects on national as well as international economies, thus it is vital for an economic and monetary union like the European Union to comprehend how property price disturbances spread through the union states. The global financial crisis of 2008, which spread from the United States, caused great difficulties for Eurozone countries such as Spain and Ireland [67].

3.7. Effects of Interest Rates on Real Estate Markets

The relationship between demand for real estate and nominal interest rates is thought to be linear. When interest rates start to increase, after a prolonged period of being stable, consumers will expect it to further increase in the future. When interest rates increase, this would spark the interest of consumers to engage in home ownerships, and would theoretically lead to an increase in demand for homes [68]. When the risk factor is taken as a variable, tenures who are risk avoiders will tend to invest in property ownership since they prefer to purchase housing at fixed terms [69].

Moreover, tenures might view increasing interest rates as a sign of economic inflation (bull market), and thus consider that the real estate investment would provide higher returns in the future, therefore higher financial returns [70].

According to a study by Harris [68] conducted in the United States, expectation of future appreciation of home values was found to be an important determinant of home prices, and home buyers view real rate of interest as the primary mechanism affecting change in housing price levels. Furthermore,

Pukthuanthong-Le & Roll [71] investigated the relationship between real interest rates, inflation, and real estate returns in US and Canada. Their findings suggested that there is a positive relationship between nominal interest rate and house prices in the United States, where house prices have boomed in periods of inflation, whereas there is a negative relationship between nominal interest rates driven by inflation and house prices.

4. Research Methodology

The economic and financial repercussions of the monetary policy enforced by the ECB since the year 2014 have been felt in countries all over the Eurozone. There seems to be mixed feedback from researchers and market observers regarding the economic and financial implications of negative policy rates, but the larger part of the published studies seems to fall in the positive territory. A recent study by Czudaj [72] assessed a survey-based expectations data for up to 44 economies from 2002 to 2017, and analyzed the impact of the adoption of a negative interest rate policy on expectations made by professionals based on a difference-in-differences approach. The findings show that the introduction of negative policy rates significantly reduces expectations regarding 3-month money market interest rates and 10-year government bond yields. Furthermore, the study provided a strong evidence for a significantly positive effect of this unconventional monetary policy tool on GDP growth and inflation expectations. However, other studies focused on the financial institutions and bank profitability. Altavilla, Boucinha, & Burlon [73] concluded that firms' own exposure to negative deposit rates creates incentives to increase investment. Moreover, lower interest rates mechanically translate into an increase in financial asset valuations leading to capital gains for banks. A study by Lopez, Rose, & Spiege [74] explored the impact of negative policy rates on banks, using data on 5200 banks from 27-advanced European and Asian countries between the years 2010–2017, the results indicated that negative interest rates have benign implications for bank profitability.

This paper explores the effects of NIRP on the property markets. The housing market is a component of the property markets. Citizens of each country share the same needs for housing and shelter, and the United Nations considers this a basic human right. Economic policies, which are adopted by governments and central banks to control and stimulate economic growth and drive inflation, must take into consideration the possible direct and indirect effects on vital markets such as the property market. Economic policies that could have a negative effect on the financial and social wellbeing of citizens must be studied and revised. Moreover, the effect of negative interest rates on house price index in the Eurozone is highlighted through two hypotheses:

H1: Determine the direct relationship between the Deposit Interest Rate in the Eurozone and the House Price Index in the Eurozone.

Deposit Interest Rate will have a negative relation with House Price Index.

H2: Determine the indirect relationship between the Deposit Interest Rate in the Eurozone and the House Price Index in the Eurozone, catering for Unemployment Rate, Nominal Labor Cost, and Government Deficit.

Deposit Interest Rate will have a negative relation with House Price Index, catering for Unemployment Rate, Nominal Labor Cost, and Government Deficit.

4.1. The Research Type

This research adopts the time-series design, consistent with studying changes of quantitative variables over prolonged periods. When arranged in a chronological manner, a set of observations is called a time series [75]. Time series assist economists and statisticians of all types in leveraging historical data points to predict future development of a variable. A set of "time series, is called a multiple time series [76].

Time series models can be categorized into two main categories, linear time series and nonlinear time series. Linear time series models (Gaussian) exhibit characteristics where each data point Yt, can be viewed as a linear combination of past or future values or differences (Linear time series trend component). Nonlinear time series exhibit nonstandard features as in nonnormality, asymmetric cycles, bimodality, and nonlinear relationship between lagged variables [77].

Linear time series trend component can be modeled in two ways, through a deterministic trend or through a stochastic trend. The trend component of the time series can be tricky, and different analysts might interpret it differently. According to Casdagli, deterministic time series models exhibit broadband spectra and masquerade as random time series when analyzed with linear technique [78]. Nevertheless, it may be possible to develop a model that is able to calculate the probability of a future value lying between two specified limits. This is called the stochastic model or probability model [79].

The statistical model used by this paper to analyze how the variables influence each other is the Multiple Linear Regression (MLR) model. MLR extends the simple linear regression function to include two or more exploratory variables. The same linear assumptions as of the simple linear regression model whereby the dependent variable is believed to be directly related to a linear combination of the explanatory independent variables [80].

The Data

Secondary data on deposit interest rates and on unemployment rate in the Eurozone was acquired from the European Central Bank (ECB) website, while the data on house price index was acquired from Eurostat website (the statistical office of the European Union situated in Luxembourg). The data covers the Eurozone (or officially called the Euro area) which is a monetary union of 19 of the 28 European Union member states which have adopted the Euro as their common currency and sole legal tender. The Eurozone consists of Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

Each variable's data is measured on a different scale, and data periods available differ between each variable. The labor cost index data, for example, is available on a quarterly basis and since the first quarter of year 1999, whereas house price index is available on a quarterly basis and since the first quarter of year 2005. The following is a detailed description of the used variables in this paper.

4.2. House Price Index

The house price index is a quarterly index retrieved from the Eurostat public access API. The Eurostat website metadata states that:

The deflated house price index (or real house price index) is the ratio between the House Price Index (HPI) and the national accounts deflator for private final consumption expenditure (Households and Non-Profit Institutions serving households (NPISHs)). This indicator therefore measures inflation in the house market relative to inflation in the final consumption expenditure of households and Non-Profit Institutions (NPIs). Eurostat HPI captures price changes of all residential properties purchased by households (flats, detached houses, terraced houses, etc.), both new and existing, independently of their final use and their previous owners. Only market prices are considered, self-build dwellings are therefore excluded [81].

The name of the table selected is "tipsho40". The 2010-year index equal to 100 is the base period. For any other period, the HPI can be reckoned of as the amount that the buyer would have to spend on average in that given period to buy a residential property having a value of 100 in the base period.

Quarterly data for the period between quarter 1, 2005 and quarter 4, 2019 was retrieved. The data points for the 19 Eurozone states mentioned earlier were selected and the rest were dropped accordingly. The quarterly index "unit = INX_Q" was selected from the API table. The data retrieved from the API is grouped by country, thus 997 data points were observed in the data set. From the dataset's date column the year and quarter, were extracted and stored in an independent column. The house price index data for the independent countries was then grouped by year-quarter, and the mean (average) index for all countries per quarter was computed. This reduced the total observations from 997 to 60, in consistence with the research methodology.

4.3. ECB Deposit Facility

The deposit facility rate is a percentage metric retrieved from the European Central Bank's public access API. The ECB website metadata states that:

Deposit facility rates are the overnight interest rates charged by the European Central Bank on bank reserves kept in their accounts at the ECB. The data is represented in percentages, and each observation represents the interest rate or the change in that rate at the specified date and time [81].

The name of the table selected from the API is "FM.D.U2.EUR.4F.KR.DFR.LEV". Daily data for the period between January 1999 and May 2020 was retrieved. The ECB data represents the interest rates applied throughout the entire Eurozone monetary union, thus there is only one observational data point for each date period. At the time of writing this paper, there was 7799 data points in the publicly available dataset. Some adjustments to the data were applied before proceeding with the analysis.

From the dataset's date column, the year and quarter were extracted and stored in an independent column. The daily deposit rate data was then grouped by year-quarter, and the mean (average) rate per quarter was computed. This reduced the total observations from 7799 to 60, in consistence with the research methodology.

4.4. Unemployment Rate

The Unemployment rate (as a percentage of labor force) is a percentage value metric retrieved from the Eurostat public access API. The Eurostat website metadata states that:

Unemployment by sex and age - monthly data is a dataset with series on a monthly basis, which is, where necessary, adjusted and enriched in various ways, in accordance with the specificities of the indicator. The monthly unemployment indicator is calculated with special methods and periodicity, which justify the present page. Quarterly and annual unemployment is published in the section 'LFS main indicators', which is a collection of the main statistics on the labor market. Unemployed persons are all persons 15 to 74 years of age (16 to 74 years in Spain –ES, Italy- IT, and the United Kingdom-UK) who were not employed during the reference week, had actively sought work during the past four weeks and were ready to begin working immediately or within two weeks. [82].

The name of the table selected is "une_rt_q". Quarterly data for the period between quarter 1, 1992 and quarter 4, 2019 was retrieved. The dataset contains both unadjusted and seasonally adjusted data, the latter was chosen for the variable and the rest was discarded.

The data points for the 19 Eurozone states mentioned earlier was selected and the rest were dropped accordingly. The unit of measure percent of active population "unit = PC_ACT" was selected from the API table. The population age class from 15 until 74 years was selected, representing all age groups of the active population. The total of both males and females was also selected. The data retrieved from the API is grouped by country, thus 1800 data points is observed in our data set. Since the objective of this study is the Eurozone as a whole, some adjustments to the data is needed before proceeding with the analysis.

From the dataset's date column, the year and quarter were extracted, and stored in an independent column. The unemployment rate data (as a percentage of labor force) for the independent countries was then grouped by year-quarter, and the mean (average) index for all countries per quarter was computed. This reduced the total observations from 1800 to 60, in consistence with the research methodology.

4.5. Government Deficit

The government deficit (-) or surplus (+) (as percentage of GDP) is a percentage value metric retrieved from the ECB public access API. The ECB website metadata states that:

The government finance statistics (GFS) provide a comprehensive overview of fiscal developments in the Euro area, the European Union, and individual EU Member States. The recorded data contains Net lending (+) / net borrowing (-), the balance of credits minus debits. The sectors include Total economy, Current prices, Standard valuation based on SNA/ESA [81].

The name of the table selected is "GFS.Q.N.I8.W0.S13.S1._Z.B.B9._Z._Z._Z.XDC_R_B1GQ_CY._Z.S.V.CY._T". Quarterly data for the period between quarter 1, 1999 and quarter 4, 2019 was retrieved. The dataset contains neither seasonally adjusted nor calendar adjusted.

The ECB data represents the government deficit or surplus recorded throughout the entire Eurozone monetary union, thus there is only one observational data point for each date period. 84 data points were available in the dataset. Some adjustments to the data were applied before proceeding with the analysis.

From the dataset's date column, the year and quarter were extracted and stored in an independent column. The government deficit or surplus data was then grouped by year-quarter, and the mean (average) rate per quarter was computed. This reduced the total observations from 84 to 60, in consistence with the research methodology.

4.6. Nominal Unit Labor Cost

The nominal unit labor cost (NULC) is a quarterly ratio retrieved from the Eurostat public access API. The Eurostat website metadata states that:

The unit labor cost (ULC) measures the average cost of labor per unit of output. It is calculated as the ratio of labor costs to labor productivity. ULC represents a link between productivity and the cost of labor in producing output. Nominal ULC (NULC) is calculated as: [D1 / EEM] / [B1GQ / ETO], where the D1 is the Compensation of employees, all industries, in current prices; the EEM is the Employees, all industries, in persons; the B1GQ is the gross domestic product at market prices in millions, chain-linked volumes reference year 2010; and the ETO is the Total employment, all industries, in persons [83].

The name of the table selected is "tipslm40". The 2010-year index equal to 100 is the base period. Quarterly data for the period between quarter 1 1995 and quarter 1 2020 was retrieved. The data points for the 19 Eurozone states mentioned earlier was selected and the rest were dropped accordingly. The quarterly index of year 2010 "unit = I10" was selected from the API table. The data retrieved from the API is grouped by country, thus 1777 data points are observed in the data set. Since the objective of this study is the Eurozone as a whole, some adjustments to the data is needed before proceeding with the analysis.

From the dataset's date column, the year and quarter were extracted and stored in an independent column. The NULC data for the independent countries was then grouped by year-quarter, and the mean (average) index for all countries per quarter was computed. This reduced the observations from 1777 to 60, in consistence with the research methodology.

5. Data Validation

5.1. Seasonal Decomposition

As part of the exploratory data, the analysis that will be undertaken in this paper is the seasonal decomposition of the variables. Data from time series can display a multitude of behaviors, and it is sometimes important to divide a time series into different components, every one of the components expressing a fundamental classification. Time series decomposition offers an important conceptual model for looking at a series from other perspectives, and for better comprehension of issues during time series analysis and forecasting.

The decomposition method used is the X-11 method. This method was developed by Shiskin et al. [84], and originated in the US Census Bureau and Statistics Canada; it is a popular method for decomposing quarterly and monthly data. In principle, the Census X-ll is a heuristic method, which separates the trend-cycle component from the seasonal and irregular components by repeated application of weighted moving averages. It enjoys its worldwide popularity as a seasonal adjustment method mainly because of its wide applicability and the flexibility with which shifts in the seasonal pat- tern can be described" [85].

According to Hyndman and Athanasopoulos [86], the X-11 method splits the time series into three main components: a trend-cycle component, a seasonal component, and a remainder component (containing anything else in the time series),

The trend-cycle estimates are available for all observations including the end points, and the seasonal component is allowed to vary slowly over time. X11 also has some sophisticated methods for handling trading day variation, holiday effects and the effects of known predictors.

Seasonal cycles are rhythmic cycles in the time series, which demonstrates that the series displays similar patterns or behavior in specific months or quarters, due to either natural occurring phenomena or fabricated interventions. Studying seasonal patterns can help researchers better analyze the time series and aid in much more accurate forecasts.

The remainder component is what is left over when the seasonal and trend-cycle components have been subtracted from the data. It shows the value of the data/observations which are not explained by the trend and seasonality. The remainder component gives researchers important insights of how well the seasonal decomposition can define the time series, and the presence of large values in the remainder shows that the time series is not well defined by the trend and seasonal component, or other indications are present and need to be further researched. The X-11 seasonal decomposition is applied for each variable.

5.2. Test of Stationarity

As part of the exploratory data analysis that will be undertaken in this paper, is the stationarity test for the adopted variables. A stationary time series is one whose properties do not depend on the time at which the series is observed [87]. Consequently, the trend and seasonality will influence the value of the time series at different times when that time series components such as trend and seasonality are non-stationary [86]. As indicated by Mushtaq (2011), testing for stationarity of time series data in macroeconomics is very important. Many economic and financial time series exhibit trending behavior or non-stationarity in the mean. Granger, Newbold, & Econom [88] argued that Spurious Regression necessitates the importance of conducting a unit root test on macroeconomic timeseries data since such data in most cases contains a trend component, and as such using these variables in econometric models may cause spurious regression and model misinterpretation and/or wrong results.

One of the most widely used unit root tests for timeseries stationarity is the Augmented Dicky-Fuller (DF) test. The DF unit root test determines how strongly a time series is characterized by a trend, and uses an autoregressive model and optimizes an information criterion across multiple different lag values [89].

Many studies in the macoreconomics have utilized the unit root tests on timeseries variables which proved to be a very effective in determining trend characteritstics of such series over prolongued time intervals. One stuch study was conducted by Wang & Tomek [90], where the researchers utilized unit root tests in studying commodity prices, and the results indicated that nominal prices do not have unit roots, but the results are sensitive to the specification of the test equation. Another study conducted by MacDonald [91], he investigated the panel unit root tests and real exchange rates, where a panel unit root test was used to jointly test for a unit root in a group of OECD real exchange rates for the recent floating experience. Jewell, Lee, Tieslau, & Strazicich [92] studied the stationarity of health expenditures and GDP using panel unit root tests with heterogeneous structural breaks. Their paper re-examined the stationarity of national health care expenditures and GDP in a panel setting utilizing data from 20 OECD countries over the period from 1960 to 1997. The findinges noted an advancement of the existing literature by utilizing a recently developed panel LM unit root test that allows for heterogeneous level shifts.

The ADF plays a significant role in aiding researchers and analysts to test if a trend exists in a time series. Moreover, seasonal decomposition of the time series extracts the trend and it is easier to plot it agains the real data, but visual inspections do not confirm nor refute the existance of the trend or the extent to which it exists in the data. The ADF shows the level of significance of this trend component. Failure to detect unit root presence in time series data can cause problems in statistical inference involving time series models. This paper utilizes the Augmented Dickey-Fuller test on each variable.

5.3. Correlation Analysis

Sampled varibales often carry charateristcs which, once examined, reveal some sort of linkage or association between each other. Such is the case with Correlation where one variable appear to display trends associated with another variable over time or observations. In data classification approaches, it is important to discover correlations between variables since such associations might affect the model performance and results, and removing one of the correlated variables is important for the model health and performance, minimizing redundancy [93].

One of the most widely used correlation tests is the Bravais-Pearson correlation coefficient "product–moment correlation coefficient". The coefficient was the result of work by the French physicist Auguste Bravais (1811–1863) and the British mathematician Karl Pearson (1857–1936). Cleff [94] dfined pearson Correlation as follows:

An absolute measure that can assume values between r = (-1) and r = (+1). The coefficient takes the value of (+1) when two metric variables have a perfect linear and positive relationship (i.e. all observed values lie along a rising linear slope). It takes the value of (-1) when two metric variables have a perfect linear and negative relationship (i.e. all observed values lie along a falling linear slope). The closer it is to 0, the more the value pairs diverge from a perfect linear relationship.

To compute the person correlation, the covariance between the two variables must be computed first. The equation to calculate the pearson correlation is as such:

Correlation is negative when larger values for one variable are paired with smaller numbers of the other variable. Positive correlation is the opposite, the values of both variables increase with one another [94].

The pearson Correlation is used to test for the correlation between all pairs of the study variables. The correlation output is as follows (Figure 1):

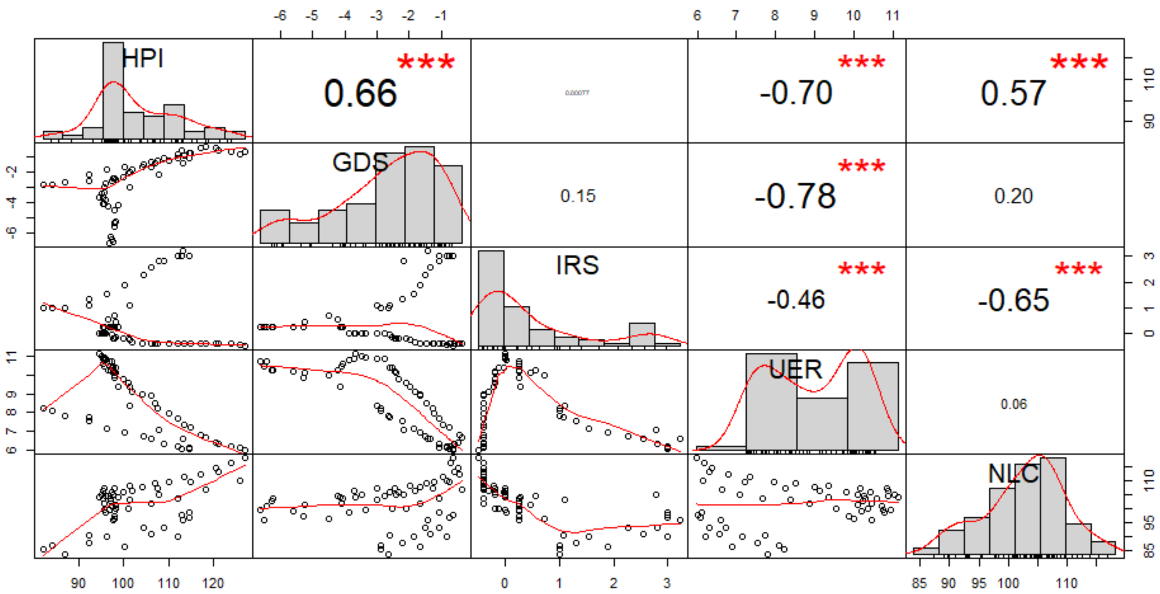

Figure 1. *Correlation Results.*

5.4. Heatmap Visualizations

A better and clearer way to visualize the correlation between variables is through a heatmap. A correlation heatmap uses colored cells, typically in a monochromatic scale, to show a 2D correlation matrix (table) between two discrete dimensions or event types [95]. Heatmaps are used across diciplines, and are a fundamental visualization method that is broadly used to unravel patterns hidden in genomic data [96]. Heatmaps are popluar in biostatistics and especially popular for gene expression analysis [97], and methylation profiling [98].

In this paper, a heatmap was used to visualize the person Correlation results.

5.5. Cross Correlation Function (CCF)

Although pearson Correlation is a rubust test for determilining the level of association between two variables, it falls short when it comes to analyzing time series variables. Time series variables are differentiated from other varialbes in the sense that the are temporal, failing to take into consideration the temporal properties of the variables could result in temporal leakage.

The cross correlation function (CCF) presents a technique for comparing two time series and finding objectively how they match up with each other, and in particular where the best match occurs. It can also reveal any periodicities in the data [99]. The CCF between the two time-series helps to identify the nature of the relationship and how they are correlated in time [100]. In the relationship between two time series, the series may be related to past lags of the x-series. The sample cross correlation function (CCF) is helpful for identifying lags of the x-variable that might be useful predictors of [101]. At each lag the correlation coefficient is computed to see how well one series predicts the values in the other. Then the series are shifted and the process repeated.

In other words, CCF provides a way to look at two time series variables at different points in time, and how correleated they are at different lags or folds could be found out. Knowing at which folds in time the two series correlated can aid in better understanding of the two series, each explains a phenomenon. By better understanding how the two series interact, researchers can use better statistical models and are able to forecast future data more effectively.

The cross Correlation function is computed to each of the study variables, and the figures obtained are found in table 1 as follows:

Table 1. *Cross Correlation Values.*

lag	Cross Correlation Values for each Variable					Lag	Cross Correlation Values for each Variable				
	CCF IRS & HPI	CCF IRS &GDS	CCF IRS & UER	CCF HPI &GDS	CCF HPI & UER		CCF IRS & HPI	CCF IRS &GDS	CCF IRS & UER	CCF HPI &GDS	CCF HPI & UER
-14	0.025413529	0.16906207	-0.30842453	0.18595464	0.233346786	0	0.000766588	0.14683062	-0.45943628	0.65863347	-0.69931128
-13	-0.043876082	0.14951334	-0.32227077	0.2243898	0.173549451	1	0.00476232	0.11529497	-0.41887233	0.57732712	-0.637904927
-12	-0.103916607	0.12985026	-0.33259453	0.26333334	0.106283521	2	-0.01354172	0.05039174	-0.35071247	0.47314942	-0.554405241
-11	-0.161390525	0.11333286	-0.34190846	0.3042473	0.037288853	3	-0.04356171	-0.04476346	-0.26682941	0.35219737	-0.459724678
-10	-0.210361431	0.10149138	-0.35306935	0.34347623	-0.03586086	4	-0.08516843	-0.15923449	-0.1721587	0.21906108	0.357748117
-9	-0.234414605	0.09144729	-0.36751977	0.38383928	-0.11273789	5	-0.13123134	-0.28102239	-0.07008072	0.08477027	-0.25032152
-8	-0.236116728	0.08581729	-0.38468711	0.42394358	-0.19443559	6	-0.17901144	-0.39918128	0.02974551	-0.03805961	-0.152214312
-7	-0.222299524	0.08608376	-0.40530987	0.46610955	-0.27399191	7	-0.22501251	-0.51078522	0.11825749	-0.1479016	-0.065672968
-6	-0.191554173	0.09520578	-0.42667664	0.51439572	-0.35731207	8	-0.26743226	-0.60654709	0.1940316	-0.2376914	0.003129209
-5	-0.144978938	0.11306227	-0.45034586	0.56421069	-0.43813726	9	-0.30116874	-0.67741446	0.25899198	-0.30241309	0.056929951
-4	-0.095027681	0.13495307	-0.47261007	0.60812923	-0.51694322	10	-0.32610702	-0.72307074	0.31006063	-0.33689923	0.090724858
-3	-0.042464095	0.15591232	-0.49026438	0.64180022	-0.58605317	11	-0.34633429	-0.74300383	0.34797832	-0.3374469	0.105636017
-2	-0.001529227	0.16925755	-0.49791408	0.66280398	-0.64204028	12	-0.36432028	-0.74370035	0.38012843	-0.30610841	0.099237647
-1	0.016896459	0.16938983	-0.49067269	0.66824312	-0.68059004	13	-0.38141219	-0.73030463	0.40794749	-0.2559108	0.086633507
0	0.000766588	0.14683062	-0.45943628	0.65863347	-0.69931128	14	-0.39408906	-0.70451869	0.43226036	-0.19412171	0.064312274

5.6. Principal Component Analysis

The Principal Component Analysis (PCA) is a popular approach for deriving a low-dimensional set of features from a large set of variables. PCA is a technique for reducing the dimension (number of variables) of a data matrix. The first principal component direction of the data is that along which the observations vary the most [102]. PCA finds a low-dimentional representation of a data set that contains as much possible of the variation.

As defined by Abdi & Williams [103], PCA is a multivariate technique that analyzes a data table in which observations are described by several inter-correlated quantitative dependent variables. It aims at extracting the important information from the table, to represent it as a set of new orthogonal variables called principal components, and to display the pattern of similarity of the observations and of the variables as points in maps. Ringnér [104] states that:

By using a few components, each sample can be represented by relatively few numbers instead of by values for thousands of variables. Samples can then be plotted, making it possible to visually assess similarities and differences between samples and determine whether samples can be grouped.

The factor loading matrix allows the researcher to check the quality of the item representaiton by the factors. It indicates to which extent are the variables determined by the principle factors. The sum of all squared factor loadings for a factor is called the eigenvalue. Eigenvalues allow to weigh factors based on the empirical data. "When the eigenvalue of an individual factor is divided by the sum of eigenvalues of all extracted factors, the outcome is a percentage value reflecting the perceived importance for all surveyed persons" [94]. Applying a principal component analysis to a data set can help determine which set of variables describe the same set of features in the data set. The results of such an analysis could lead to a drop of certain variables since others might represent the same features more strongly. Thus a PCA is performed on the study variables and the results are as follows

Table 2. *Principal Component Analysis Eigenvalues for the study Variable.*

Displaying the Eigenvalues/Variances of the Principle Component			
Dimension	**Eigenvalue**	**Variance percent**	**Cumulative variance percent**
Dim.1	2.55634813	51.126963	51.12696
Dim.2	1.83972758	36.794552	87.92151
Dim.3	0.37686849	7.53737	95.45888
Dim.4	0.172157	3.44314	98.90202
Dim.5	0.05489881	1.097976	100

5.7. Training and Test Split for Regression Analysis

A linear and a multi-linear regression analysis are applied to test the hypetheses presented in this paper. In order to assess the robustness of the model, the original data set was split into two sets, a training set and a test set. As indicated by Zhang [105], in order to assess the forecasting performace of statistical models, the data set is split into two different sets, whereby the training data set is used exclusively for model development and then the test sample is used to evaluate the established model. The logic behind this approach stems from the nature of statistical models to overfit data. Overfitting happens when the error (RMSE for example) on new observations is very large compared to the error on the data in the trained model, because the supposed patterns that the method found in the model data simply don't exist in the new data [102]. Thus in the research methodology a training and test split were opted for, in order to evaluate the model performance and simulate real world scenarios.

In this paper, the original data set contians 60 time series observations. The training set was assigned 52 observational data points from Quarter 1, 2005 till Q4, 2017, and the test set was assigned 8 observational data points from Quarter 1, 2018 till Quarter 4, 2019.

It is important to mention that the data preprocessing transformational steps, where the average per quarter was computed, was limited to the quarter where the data was acquired in. As such, data leakage risks are mitigated. The applied models are thus trained on the training set, then the model performance is tested on the test set.

6. Results and Findings

The exploratory data analysis performed on the variables revealed a number of characterisitcs that play an important role in determinng relationships between variables that could affect the house price index.

6.1. Seasonal Decomposition Results

The first part of the EDA involved a seasonal decomposition for the variables usings the X-11 method. The first variable analyzed is the House Price Index. The X-11 decomposition shows a clear positive trend which started to appear in the year 2014, around the same time the negative interest rates were implemented. The House Price Index started from the value 95 then increased till it reached 126 by the end of 2019. The data shows signs of seasonality. Notice that the seasonal component changes slowly over time, so that any two consecutive quarters have similar patterns, but quarters far from each other may have different seasonal patterns. The remainder component shown in the bottom panel is what is left over when the seasonal and trend-cycle components have been subtracted from the data, and it displays intermediate changes over the quarters of the time series.

The second variable analyzed is the Deposit Interest Rates. The X-11 decomposition shows a clear negative trend which started to appear in the late 2008. The Deposit Interest Rates dropped from value of around 3.2% then decreased till it reached -0.5% by the end of 2019. The data shows signs of seasonality. Notice that the seasonal component changes slowly over time, so that any two consecutive quarters have similar patterns, but quarters far from each other may have different seasonal patterns. The remainder component shown in the bottom panel displays little change over the quarters of the time series.

The third variable analyzed is the Unemployment Rate. The X-11 decomposition shows a clear negative trend which started to appear in the year 2015. The Unemployment Rate dropped from value of around 10% then decreased till it reached 6% by the end of 2019. The data shows signs of seasonality. Notice that the seasonal component changes slowly over time, so that any two consecutive quarters have similar patterns, but quarters far from each other may have different seasonal patterns. The remainder component shown in the bottom panel displays little change over the quarters of the time series.

The fourth variable analyzed is the Government Deficit. The X-11 decomposition shows a clear positive trend which started to appear by the second half of year 2010. The Government Deficit decreased (decreased deficit means surplus) from value of around -6.5% then increased till it reached -0.6% by the end of 2019. The data shows signs of seasonality. Notice that the seasonal component changes slowly over time, so that any two consecutive quarters have similar patterns, but quarters far from each other may have different seasonal patterns. The remainder component shown in the bottom panel displays intermediate changes over the quarters of the time series.

The fourth variable analyzed is the Nominal Labor Cost. The X-11 decomposition shows a clear positive trend which started to appear by the since the first quarter of 2005, plateaued in the wake of the financial crisis of 2008, then resumed its upward trend till the end of 2019. The fifth variable is the Nominal Labor Cost which decreased (decreased deficit means surplus) from around 85 then increased till it reached 118 by the end of 2019. The data shows signs of seasonality. Notice that the seasonal component changes slowly over time, so that any two consecutive quarters have similar patterns, but quarters far from each other may have different seasonal patterns. The remainder component shown in the bottom panel displays considerable changes over the quarters of the time series.

6.2. Augmented Dickey-Fuller Results

The Augmented Dickey-Fuller (DF) test results show that all tested variables are non-stationary. As indicated in the methodology, the DF test's Null Hypothsis H0 assumes that the time series has a unit root and is non-stationary, and a P-Value greater than 0.05 leads to failure of rejection of the Null hypothesis.

The reults of the test for House Price Index returned a DF statistic of -1.71 and a P-Value of 0.69, which indicated that the Null hypothesis cannot be rejected, the data has a unit root and is non-stationary.

The reults of the test for Deposit Interest Rate returned a DF statistic of -3.41 and a P-Value of 0.061, which indicated the Null hypothesis cannot be rejected, the data has a unit root and is non-stationary.

The reults of the test for Unemployment Rate returned a DF statistic of -2.28 and a P-Value of 0.45, which indicated that the Null hypothesis cannot be rejected, the data has a unit root and is non-stationary.

The reults of the test for Government Deficit returned a DF statistic of -1.5 and a P-Value of 0.77, which indicated that the Null hypothesis cannot be rejected, the data has a unit root and is non-stationary.

The reults of the test for Nominal Labor Cost show returned a DF statistic of -1.71 and a P-Value of 0.69, which indicated that the Null hypothesis cannot be rejected, the data has a unit root and is non-stationary.

Thus, with a P-Value greater than 0.05, all of the tested variables are adjudged as non-stationary.

6.3. Correlation Analysis Results

The Bravais-Pearson correlation coefficient test results states which variables are highly correlated with each other as follows:

The House Price index displays a positive correlation coefficient of 0.66 with Government Deficit, and scores a negative 0.7 correleation coefficient with Uemployment rate. This indicates that there is a positive relationship between House Price Index and Government Deficit, while there is a negative relationship between House Price Index and Unemployment Rate. Moreover, the Government Deficit displays a negative correlation coefficient of negative 0.78 with Unemployment Rate. This indicates that there is a negative relationship between Government Deficit and Unemployment Rate. Finally, the Deposit Interest Rate displays a negative correlation coefficient of negative 0.65 with Nominal Labor Cost. This shows that there is a negative relationship between Deposit Interest Rate and Nominal Labor Cost. However, the correlations between the remaining variables are weaker than the reported ones. Some of the reported correlations are high but not strong enough, where none of the results are greater than 0.8 in absolute terms. As such, none of the variables were eliminated from the analysis (table 3).

Table 3. *Correlation Index.*

	house price index	**Government Deficit**	**deposit interest rate**	**unemployment rate**	**Nominal labor cost**
House price index	1				
Government Deficit	0.66	1			
deposit interest rate	0	0.15	1		
unemployment rate	-0.7	-0.78	-0.46	1	
Nominal labor cost	0.57	0.2	-0.65	0.06	1

6.4. Cross Correlation Function (CCF) Results

As explained earlier, the cross correleation function (CCF) tests if two time series are correlated at different lags. The results and interpretation of the CCF plots for the variable paris are as follows:

For the first plot which displays the CCF between Deposit Interest Rate and House Price Index, theres is a significant negative cross correlation between the two time series at lag +8 and increases all the way till lag +14. This shows that for the two time series, the correlation between the two occurs at Y_0 and $X_{\geq +8}$.

For the second plot which displays the CCF between Deposit Interest Rate and Government Deficit, theres is a significant negative cross correlation between the two time series at lag +5 and increases all the way till lag +14. This shows that for the two time series, the correlation between the two occurs atY_0 and $X_{\geq +5}$.

For the third plot which displays the CCF between Deposit Interest Rate and Unemployment Rate, theres is a significant positive and a significant negative cross correlation between the two time series at lag +10 and increases all the way till lag +14, and at lag -7 and increases all the way till lag -14. This shows that for the two time series, the correlation between the two occurs at Y_0 and $X_{\geq +5}$, and at Y_0 and $X_{\leq -7}$.

For the fourth plot which displays the CCF between House Price Index and Government Deficit, theres is a significant positive and a significant negative cross correlation between the two time series at lag +9 and increases all the way till lag +12, and at lag +3 and fluctuates all the way till lag -11. This shows that for the two time series, the correlation between the two occurs at Y_0 and $(X_{\geq +9}$ and $X_{\leq +12})$, and Y_0 and $(X_{\leq +3}$ and $X_{\geq -11})$.

For the fifth plot which displays the CCF between House Price Index and Unemployment Rate, theres is a significant negative cross correlation between the two time series between lag -7 and lag +4. This shows that for the two time series, the correlation between the two occurs Y_0 and $(X_{\geq -7}$ and $X_{\leq +4})$.

6.5. Principal Component Analysis Results

The principal component analysis carried out earlier indicated that each variable falls on different axis and the visualization of clearly indicates this result. The first three dimentions or principal components explain up to 95% of the variability in the model, while the remaining two components explain only 5% of the variablity in the PCA model.

The results assert the fact that each of the variables in this study plays a distinct role, and none of which can replace the other.

6.6. Simple Linear Regression Analysis

A linear regression analysis is utilized to examine the impact of the independent explanatory variable, viz Deposit

Interest Rate on the dependent variable House Price Index. The regression model was trained on the training set (52 observations for quarters between Q1, 2005 and Q4, 2017), and the model was then evaluated on the test set (eight observations for the quarters between Q1, 2008 and Q4, 2019). The model results after training on the training set indicates that there no direct relation between Deposit Interest Rate and House Price Index (table 4).

Table 4. *Simple Linear Regression Summary Statistics.*

R.Squared	Adj.R.Squared	Sigma	Statistic	p-value	DF
0.14	0.12	6.99	7.85	0.007216794	2
summery statistics for impact of Deposit Interest Rate on House Price Index					

Table 5. *Simple Linear Regression Analysis Results.*

term	estimate	standard error	statistic	p-value	significant
(intercept)	98.69	1.14	86.92	0	yes
IRS	2.42	0.86	2.8	0.0072	yes

The R Square value of the regression model is not significant at 0.014, indicating that there is no relationship between the two variables; the adjusted r square is 0.12 also indicating no relationship between the two variables. The P Value of the Deposit Interest Rate is 0.007, which indicates that the variable is significant. The F Statistic is 7.85 at two degrees of freedom (table 4). The regression Line formula is shown by table 5, as follows:

$$House\ price\ index = 98.69 + 2.42xDposit\ interest\ rate$$

6.7. Testing for Moderator Effect Results

A linear regression analysis is carried out to examine if there is an indirect relationship between the independent explanatory variable, viz, Deposit Interest Rate on the dependent variable House Price Index. Unemployment rate was added to the model to test the hypothesis. The regression model was trained on the training set (52 observations for quarters between Q1, 2005 and Q4, 2017), and the model was then evaluated on the test set (8 observations for the quarters between Q1, 2008 and Q4, 2019). The model results indicate that there is an indirect relationship between Deposit Interest Rate and House Price Index, taking into consideration the effect of Unemployment rate as a moderator variable (Table 6).

Table 6. *Moderator Analysis Summary Statistics.*

R.Squared	Adj.R.Squared	Sigma	Statistics	p-value	Df
0.9704132	0.958o653	1.524625	78.7122	6.45E-25	16

Summery statistics for impact of Deposit interest rate on house price index with unemployment rate as a moderator.

Table 7. *Moderator Analysis Regression Results.*

term	estimate	standard error	statistic	p-value	significant
(intercept)	128.61	113.22	1.14	0.2635	
IRS	566.48	153.98	3.68	0.0008	YES
UER	-2.31	12.71	-0.18	0.8569	
GDS	198.01	53.26	3.72	0.0007	yes
NLC	0.17	1.07	0.15	0.8782	
IRS*UER	-99.6	26.35	-3.78	0.0006	yes
IRS*GDS	-66.87	39.4	-1.7	0.0983	
UER*GDS	-18.53	4.94	-3.75	0.0006	yes
IRS*NLC	-5.37	1.52	-3.53	0.00012	yes
UER*NLC	-0.02	0.12	-0.18	0.8616	
GDS*NLC	-1.85	0.52	-3.57	0.001	YES
IRS*UER*GDS	-3.16	5092	-0.53	0.5975	
IRS*UER*NLC	0.94	0.26	3.62	0.0009	YES
IRS*GDS*NLC	0.64	0.4	1.62	0.115	
UER*GDS*NLC	0.17	0.05	3.62	0.0009	YES
IRS*UER*GDS*NLC	0.03	0.06	0.47	0.6412	

The R Square value of the regression model is significant at 0.97, indicating that there is a relationship between the two variables given moderator effect of unemployment rate; the adjusted r square is 0.958, also indicating a relationship between the two variables (table 6). The P Value of the Deposit Interest Rate is zero implying significance, the P Value of the Unemployment Rate is 0.85 implying insignificance, the P Value of the Government Deficit is zero implying significance, and the P Value for the Nominal Labor Cost is 0.87 implying insignificance (table 7).

For the moderator effect, the significant P Values are for

Deposit Interest Rate (times) Unemployment Rate (PV at zero), Unemployment Rate (times) Government Deficit (PV at zero), Deposit Interest Rate (times) Nominal Labor Cost (PV at zero), Government Deficit (times) Nominal Labor Cost (PV at zero), Deposit Interest Rate (times) Unemployment Rat (times) Nominal Labor Cost at (PV at zero), and Unemployment Rate (times) Government Deficit (times) Nominal Labor Cost (PV at zero) The F Statistic is 78.71 at sixteen degrees of freedom (table 6).

The Moderator Regression Line Formula is as follows:

$$HPI = 128.6125 + 566.4800xIRS - 2.3076xUER + 198.0056xGDS + 0.1652xNLC - 99.6008xIRS.UER - 66.8713xIRS.GDS - 18.5307xUER.GDS - 5.3713xIRS.NLC - 0.0213xUER.NLC - 1.8496xGDS.NLC - 3.1560xIRS.UER.GDS + 0.9412xIRS.UER.NLC + 0.6416xIRS.GDS.NLC + 0.1735xUER.GDS.NLC + 0.0281xIRS.UER.GDS.NLC$$

The testing of hypotheses by using the linear regression was delineated as follows:

a) H1.1 Deposit Interest Rate and House Price Index;

It has been shown that deposit interest rate has no direct relation with house price index and thus the hypothesis is not supported.

b) H2.1 Deposit Interest Rate and House Price Index with Unemployment Rate, Nominal Labor Cost, and Government Deficit as a factor;

It has been shown that deposit interest rate has an indirect relation with house price index with unemployment rate, nominal labor cost, and government deficit as a moderator, and thus the hypothesis is supported.

6.8. Evaluation Metric Results for the Training and Test Sets

The evaluation of the moderator regression model on the test set used the Root Mean

Square Error (RMSE) metric. The metric is derived by applying the square root to the Mean Square Error (MSE). The MSE is computed by calculating the mean of the squared error of the predicted values versus the actual values [106]. According to Chai and Draxler, the RMSE is more appropriate to represent model performance than the Mean Absolute Error (MAE) when the error distribution is expected to be Gaussian. In addition, we show that the RMSE satisfies the triangle inequality requirement for a distance metric [107]. Hyndman and Koehler also propose that scaled errors become the standard measure for forecast accuracy, where the forecast error is scaled by the in-sample mean absolute error obtained using the naïve forecasting method [106].

In the moderator regression analysis, the RMSE score for the training set is reported as 1.27, and the RMSE score for the test set is reported as 1.94. the small difference in the error values between the training and the test set indicates that the moderator regression model trained on the training data generalizes well on new unknown test data, with a minimal increase in root mean square error.

The predction House Price Index values on the test set are shown in table 8:

Table 8. *Actuals values versus predicted values for year 2018 and 2019.*

Time	Measurement					Predicted Values		
year	Deposit interest rate	unemployment rate	Government deposit	labor cost index	observed house price index	predicted house price index	error	squared error
2019.4	-0.50%	5.97%	-0.65%	118.31	126.81	121.71	-0.9	0.81
2019.3	-0.41%	6.13%	-0.81%	110.06	125.81	121.21	4.6	21.18
2019.2	-0.40%	6.18%	-0.71%	116.54	123.96	124.55	-0.59	0.35
2019.1	-0.40%	6.29%	-0.58%	1.134	121.14	120.72	0.42	0.18
2018.4	-0.40%	6.37%	-0.46%	114.93	120.33	119.72	0.61	0.37
2018.3	-0.40%	6.64%	-0.35%	106.78	118.33	116.17	2.16	4.67
2018.2	-0.40%	6.78%	-0.45%	112.33	116.97	115.78	1.19	1.42
2018.1	-0.40%	7.21%	-0.76%	109.81	114.82	113.69	1.13	1.28

7. Conclusion

Since the early days of the modern internationally monetary system, governments and central banks have looked to interest rate policies as an effective tool that aids on multiple fronts, whether the objective is to stabilize the economy, to drive economic growth, to reach inflation targets, or to fight recessions, which is currently the most debated objective. History has taught economists that fiscal policy alone, although effective in certain conditions, does not suffice in today's world. The global economies have grown tremendously in the past 100 years, and the global trade linkages between countries are so complex that single-sided approaches to economic policies have little effect in the long term.

Even though government interventions through increased government spending, decreasing taxation, creating jobs and increasing wages, to name a few, has a positive and direct effect on the economy, such traditional approaches alone tend to have limited effect towards reaching the economic goals and desired growth targets. Likewise, the case of Japan has taught contemporary economists that monetary policy alone, either through quantitative easing or through the zero-lower bound, cannot lift an economy up, which caused Japan to enter a liquidity trap in the 1990's and is still suffering from enormous amounts of debt.

This paper sheds the light on the possible effects of unconventional monetary policies, specifically the negative interest rates, when enforced by one of the largest economies in the world and that is the European Union. The negative policy rate is perhaps one of the largest in the history of modern economics, deployed on a scale that spanned 19 countries and for over six years. This venture proved to stimulate economic growth, and has led the Eurozone out of the economic stagnation that it was in the early years of the second decade of the twenty first century. The continuation of this policy by the ECB post the year 2020, amidst the COVID-19 crisis, clearly shows that the European Union has not reached the goals it had initially intended to reach with NIRP. Media outlets across the globe started talking about the possibility of the United States Federal Reserve Bank to implement a negative interest rates policy, especially after the Fed's decision in March 2020 to slash the interest rates to zero and engage in another round of quantitative easing, in an effort to stimulate the heavily damaged economy amidst the ongoing crisis. Thus, it is improbable to assume that the European Union, led by the ECB, will venture out of the negative policy rates anytime soon; moreover, it is more probable that the ECB will further shift the interest rates away from zero.

Although the policy makers' intentions behind implementing negative interest rates are noble and aims at serving the greater economic good, the negative effects of such a monetary policy may have a widespread effect on certain economic sectors. As discussed in this paper, the effects of negative policy rates on the property markets are examined both directly and indirectly. The effects of such policies on the property markets may take years to show any results, and may last for years and sometimes decades. The consequences of house price inflation in the Eurozone, along with the imbalance between the union countries can manifest into economic, financial, and social mishaps, ranging from lightweight to serious ones. Excessive and unjustified increases in property prices, exceeding the economic inflation rates, can lead to a bubble formation in the market. Capital fleeing from negative rates territory looks for a safe haven to preserve itself, one that exhibits less volatility in relation to the general economy. With stable prices and secure growth rates, the real estate market seems like the ultimate safe haven at first, but such an outlook can be deceiving. In basic terms, real estate are finite assets, a limited number of properties are available for purchase in any given market. Under the demand and supply principles in economics, when the demand for real estate increases, the price will ultimately increase, and when financialization of real estates in the forms of direct investments and portfolio risk diversification enters the equation, the asset price increase will no longer remain linear. Such demand inflows could ultimately lead to the formation of property bubbles. These bubbles tend to grow in size until they reach a tipping point, and their burst would mimic the burst process of the property bubble of the US in 2007/8. During the formation years of these bubbles, the increase in real estate asset prices has a directly felt negative social effect. The citizens of countries affected by the bubble tend to find it harder and harder to own or rent real estate as time passes.

The model investigated in this paper highlights both the direct and the indirect relationships between the deposit interest rate and the house price index. The deflated house price index introduced here is the ratio between the house price index (HPI) and the national accounts deflator for private final consumption expenditure in the European Union, serves as an index for the increase or decrease in property prices inside the European Union. This indicator provides a general guide for house price observations and is a starting point towards more future research in this area. As reported, there was no direct linear relationship between the deposit interest rates and the house price index; this could be due to the non-linear characteristics of both variables, or it could be due to unobserved phenomena between the two dimensions.

When additional macro-economic variables are introduced, a new set of results was observed. Relevant economic variables, which are the Unemployment Rate, the Government Deficit, and the Nominal Labor Cost, were all tested alongside Deposit Interest Rates in order to study the effect on the House Price Index. Using a Multi-linear regression model with an interaction term (moderator effect), an indirect relationship quickly appeared between the mentioned variables, House Price Index being the dependent variable. The additional variables tended to explain the hidden relationship between the two main variables, producing a statistically significant linear model with a high regression coefficient.

8. Recommendations

The introduction of additional macroeconomic variables to further study how deposit interest rates and house price index are related is recommended. Further analysis on the country level is advisable to inspect if this relation equally affects different economies inside the Union. In addition, if this phenomenon is widespread amongst different Eurozone countries, then it is possible to generalize the utilized model in this paper on a global scale.

9. Limitations

This paper is limited to the Eurozone as a single monetary union. The data acquired for this study is a secondary one obtained from the European Central Bank (ECB), and from the European Statistics Office (ESO). The data is limited to the Eurozone on an aggregate level and does not take into consideration individual European countries. The results obtained are constrained by the available periods of data, which spans from 2005 until 2019. The model takes into consideration quarterly changes in the data. Generalization of this model to include individual countries or other monetary zones should be considered carefully based on the limitations and the scope of this paper.

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