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Abstract

When people buy or sell houses, either to live in or as an investment, we refer to this as the housing market. A house is the most valuable thing many people will ever own. The house market is one of the biggest in any developed country and therefore one of the most impactful.

Previous studies had been conducted using the different models and variables, however, to our knowledge at the moment, none has considered the best theoretical approach to the inherent structure of the data. In fact, past researches used mostly VAR models. The purpose of this study is to investigate key aspects of the UK house market. Our main objective is to understand the relationship between the house prices and the monetary policy. This is done using quarterly data from 1975 to 2020 and developing a time series Vector Error Correction Model. This approach allows us to distinguish between statistical correlation and economic causation.

From our final model, we find that the effect of a GDP on house prices is large, and the monetary policy shock is existent but not so relevant in the short-medium period while it increases in the long run but not as much as we would have expected. Shocks to the CPI and the interest rate are in turn found to have significant effects on house prices.

Due to the large confidence bands of the impulse responses this result is, however, in general not statistically significant. Further research should be conducted in order to better understand the effect of a market targeting monetary policy used to mitigate the economic uncertainty and unbalances.

Chapter 1 – Introduction

In this section, we will describe briefly the UK housing market.

1.1 General Landscape

The total value of homes sold in the UK in 2021 is expected to reach £461 billion.

In Britain, two thirds of households own the house they live in; half of these are still paying off their mortgage. The remaining third of households are renters, split fairly equally between private and social renting.

The housing market is closely linked to consumer spending. When house prices go up, homeowners become better off and feel more confident. Some people will borrow more against the value of their home, either to spend on goods and services, renovate their house, supplement their pension, or pay off other debt. When house prices go down, homeowners risk that their house will be worth less than their outstanding mortgage. People are therefore more likely to cut down on spending and hold off from making personal investments. Mortgages are the greatest source of debt for households in the UK. If many people take out large loans compared to their income or the value of their house, this can put the banking system at risk in an economic downturn. A rise in house prices is associated to a higher economic growth, while a drop is linked to lower economic growth.

In particular, in recent years many industrialised countries have experienced extraordinarily strong rates of money and credit growth accompanied by strong increases in house prices. This observation raises a number of questions which are potentially of importance for monetary and regulatory policies: Does the observed coincidence between house prices and monetary variables reflect merely the effects of a common driving force, such as monetary policy or the economic cycle, or does it reflect a direct link between the two variables? If there is a direct link, does it run from house prices to monetary variables or from monetary variables to house prices, or in both directions? Do fluctuations in house prices and monetary variables have repercussions on the macroeconomy, i.e. for the development of real GDP and consumer prices? And finally, what is the relevant monetary variable in this context, money or credit, or both?

There is also a collateral effect of house prices emanating from the fact that houses are commonly used as collateral for loans because they are immobile and can, therefore, not easily be put out of a creditor’s reach. As a consequence, higher house prices not only induce homeowners to spend and borrow more, but also enable them to do so by enhancing their borrowing capacity.

In reality, the house market size and effect is difficult to capture in its entirety because not all the parts that form it contribute to the GDP directly.

There are also more fundamental reasons why house prices may change. For instance, demand for housing may rise if the population is increasing or there are more single-person households. Growing demand usually means higher house prices. Prices will also tend to be higher if fewer houses are built, reducing the supply of housing. The fewer houses that are built, the more people will need to compete by increasing the amount of money they are willing to spend to buy a house

There have also been times when house prices have increased a lot just because people think prices will continue to rise. This is called a housing market bubble. Bubbles are always followed by housing market crashes when house prices fall sharply.

These theoretical considerations suggest that there are probably good reasons to believe that there exists a multidirectional link between money, credit, house prices and the wider economy. However, while these theoretical considerations give us some tentative indications, they do obviously not allow any definite conclusions. In the absence of a theoretical model integrating all the potential interlinkages between house prices and the macroeconomy, the issue ultimately has to be addressed empirically.

The paper is organized as follows: In section 2, we will investigate each variable searching for preliminary information and understanding the relationship between the variables. In section 3, we will present the first attempt to build a model based on past literature but considering new factors and using recent data. In section 4, we will explain considerations and implications of our study as well as its limitations. In section 5, we will state our conclusions along with policy concerns emerging from our study.

Chapter 2 – Data Description & Analysis

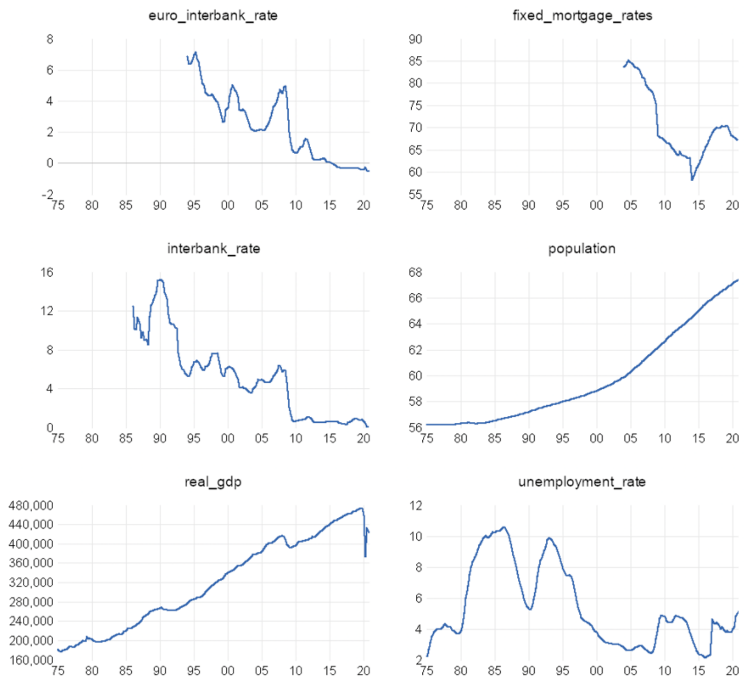
In this section, we will present what data has been gathered as well as their main description. We have collected data in the form of Time Series at UK level from Federal Reserve Bank of St. Louis, Bank of England and Nationwide quarterly from year 1975 to 2020.

2.1 Sales

The variables collected are the following:

- Real GDP
- Unemployment Rate
- Fixed Mortgage Rate
- Euro Interbank Rate
- Interbank Rate (3 months)
- Population

We considered different interest rates. The Fixed Mortgage Rate describes the interest rate of a fully amortizing mortgage loan from banks which remains the same throughout the term of the loan. The Euro Interbank Rate which describes the interest rate at which the banks lend and borrow money from other banks in the euro zone. Finally, the interbank rate describes the interest rate at which the banks lend and borrow money from other banks in UK (dealing with quarterly data, we opted for 3-months period rate).
From the graphs we can see that GDP drops down steeply in 2020 which is clearly due to uncertainty caused by the economic shocks, namely Covid-19 & Brexit. Interbank Rate & Euro Interbank Rate have decreased during the time 2015 – 2020. The unemployment rate has also increased during the year 2020.



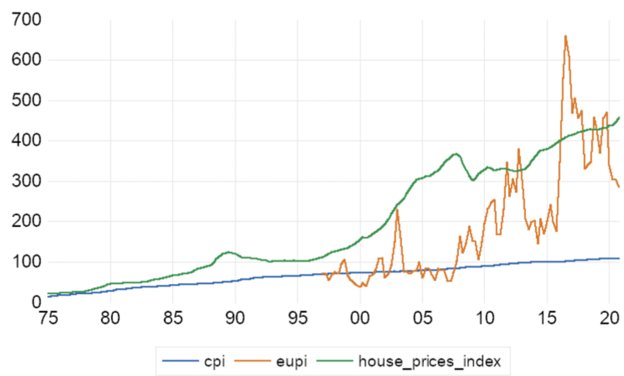
G1. Line plots of variables

2.2 Indexes

We collected data as:

- House Price Index
- CPI (Consumer Price Index)
- Economic Uncertainty Policy Index (EPUI)

Nationwide is one of UK's largest mortgage providers and has the longest unbroken run of house price data from 1952 on quarterly basis. Even though actual data would be better, the indexes serve as a good proxy. As you can see from the graph, it is the case of the House Price Index, which captures very well the instability of the economy.



G2. Indexes Graph

The Consumer Price Index (CPI) measures the average change in prices over time that consumers pay for a basket of goods and services. It is the most widely used measure of inflation and, by proxy, of the effectiveness of the government's economic policy. We can see that Consumer Price Index is increasing continuously from 1975 to 2020.

The Economic Policy Uncertainty Index (EPUI) measures the policy-related economic uncertainty. It is based on three components. The first component quantifies newspaper coverage of policy-related economic uncertainty. A second component reflects the number of federal tax code provisions set to expire in future years. The third component uses disagreement among economic forecasters as a proxy for uncertainty. The EPUI reached its peak in June 2016, which was the time of Brexit referendum.

Chapter 3 – Model Estimation

In this section, we will expose our methodology, the models we considered and their results.

3.1 OLS (Ordinary Least Square) Model

In this first step, we are interested in estimating the causality of a set of variables on the house price index. We also want to forecast it accurately. In order to do so we need to build a model based on past data following the below formula:

$$y_t = \gamma x_{t-1} + \varepsilon$$

where $y_t$is the raw data of house price index on time t, $x_{t-1}$is the combination of raw data of predictors on time t-1 and γ is the coefficient for each random variable.

The model equation is as follows:

$$\begin{aligned} house\_price\_index = \beta_o + \beta_1(real\_gdp) + \ \beta_2(interbank\_rate) + \beta_3(euro\_interbank\_rate) + \beta_4(fixed\_mortgage\_rate) \\ + \beta_5(unemployment\_rate) + \beta_6(cpi) + \beta_7(population) + \beta_8(epui) \end{aligned}$$

Despite fitting Ordinary Least Squares model, it is necessary to fit the time series model, given the fact that one of the assumptions underlying ordinary least squares (OLS) model is that the error terms are independent. This assumption is easily violated for time series data such as this one since it has a clear pattern in residuals over time. Therefore, we found that the error terms have autocorrelation.

3.2 Time Series Model

Firstly, we performed series of test for unit roots (stationarity) through Augmented Dickey Fuller Test. We found out that all the variables had unit roots. Fortunately, each one of them was resolved using first difference technique, except for population ,for which we had to use two differences. Then, we adopted the so called log-log transformation for both dependent and independent variables. Log-log model allows us to normalise the data and stabilize the variance (not all of them resulted in normalized variables, for example house_price_index). Dealing with macroeconomics policies such as monetary, it would be more realistic to assume an effect on prices extended over time. To capture this assumption, we applied a multiple test to choose the correct number of lags for the model. Following the results, the optimal number of lags was 4 or 5 considering the AIC (Akaike Information Criteria) as it is often used to build this type of models. We found out through Breusch Godfrey test that autocorrelation is persistent in our data. The last thing is to check the cointegration. We have performed Johansen Cointegration Test and found that the rank is at most 8. The cointegration test is performed to understand the long run relationship between the variables. Based on the results we decided best theoretical model for our analysis is Vector Error Correction Model with restricted trend and 4 lags. We checked the model by performing residual, normality and stability test, which led to not statistically significant results but nonetheless usable.

Vector Error Correction Estimates
Date: 06/24/21 Time: 16:15
Sample (adjusted): 2005Q2 2020Q4
Included observations: 63 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LPRICES(-1)	1.000000
LCPI(-1)	-13.41354 (0.70420) [-19.0480]
LEUPI(-1)	0.103497 (0.01593) [6.49572]
LEURO_INTERBANK(-1)	-0.099275 (0.02546) [-3.89874]
LFIXED(-1)	-3.493350 (0.19130) [-18.2612]
LGDP(-1)	-2.800013 (0.30559) [-9.16255]
LINTERBANK(-1)	0.188984 (0.01800) [10.4991]
LPOP(-1)	35.39956 (2.18945) [16.1682]
LUNEMP(-1)	-0.329858 (0.02365) [-13.9454]
C	-41.00175

Tab.1 – Long Run Results

3.3 Model Results

As per the results obtained from Cointegration Test, we chose to use Vector Correction Model. From Johansen Test we found that the rank is 8 which implies that 8 cointegrating equations are present in the model. The equation for Vector Error Correction Model is as follows:

$$x_t = \varphi_1 x_{t-1} + \cdots\cdots\cdots\cdots\cdots\cdots + \varphi_p x_{t-p} + \varepsilon_t$$

$$\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{p-1} \varphi_i^* \, \Delta x_{t-1} + \varepsilon_t$$

where π and $\varphi_i^*$the are functions of the φ. Specifically,

$$\varphi_j^* = -\sum_{i=j+1}^{p} \varphi_i, \text{ j= 1……,p-1}$$
$$\pi = -\left(I - \varphi_1 - \cdots\cdots - \varphi_p\right) = -\varphi(1)$$

where π is the rank of cointegration. If it is 0 then there is no cointegration.

For the sake of interpretability, we performed the VECM with 1 cointegrated equation. Through Johansen Normalization Restriction, we can infer the long run relationship between the independent variables and the home price index. The most unexpected results from our model were that GDP was not significant as well as the CPI, the Fixed Mortgage Rate and the Population. All the other variables were significant. In particular, the interbank rate and the euro interbank rate affect positively the home prices in the long run.

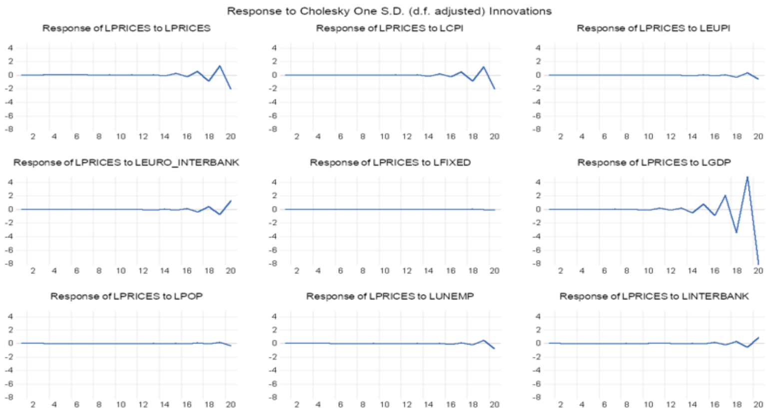
3.4 Impulse Response Function

Impulse Response Function shed further light on the information revealed by Granger Causality results. It is useful for being able to explain the sign of the relationship as well as how long these effects require to take place. It can show how responsive a dependent variable is to a shock in an independent variable.

Whereas IRFs from a stationary VAR die out over time, IRFs from a cointegrating VECM do not always die out. Since each variable in a stationary VAR has a time invariant mean and a finite time-invariant variance, the effect of a shock to any one of these variables must die out so that the variable can revert to its mean. We need to be extremely careful when interpreting and analysing IRFs when used with a VECM.

We need to ensure that we demonstrate that IRFs are most appropriate for VAR models, but that IRFs are useful for gaining an insight into the sign of the relationship (positive or negative). We understand that effect of shock in a VECM is permanent rather than transitory.

From the below graph we find out that House Prices has positive relationship with Euro Interbank Rate, Interbank Rate and initially there was a permanent effect of the shock to the House Prices due to EUPI, CPI, GDP and later it became transitory. There is positive relationship between the House Prices with Fixed Mortgage Rate, Population, Unemployment however the effect of Population and Unemployment rate shows a negative impact on House Prices in the later stage.



G3. IRF of House Prices to Monetary Shocks

Chapter 4 – Considerations and Implications

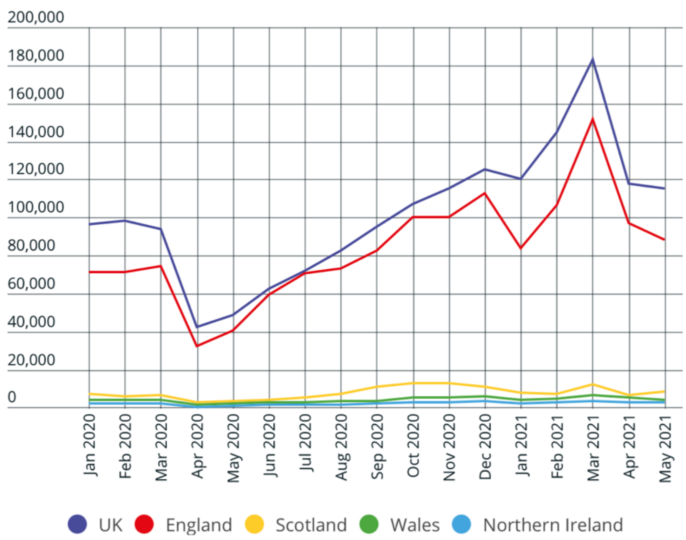
In this section, we will tackle the two main reasons behind this research: How does Monetary Policy impact Housing Market and How does Monetary Policy respond to economic shocks? While we investigated only the first aspect, here we explain why interest rate should be a fundamental aspect in future studies.

4.1 Brexit

On June 23, 2016, the UK decided via referendum to leave the EU. The economic and institutional consequences of this decision for both the UK and the EU are still to come and they are surrounded by great uncertainty. These are for sure challenging times to policy makers, who must negotiate the terms and conditions. The outcome of bilateral negotiations and how they will in practice be implemented will be key to assess the impact of Brexit. In the UK, the Parliament has given the Financial Policy Committee at the Bank of England responsibility for "the identification, monitoring, and taking of action to remove or reduce systemic risks with a view to protecting and enhancing the resilience of the UK financial system."

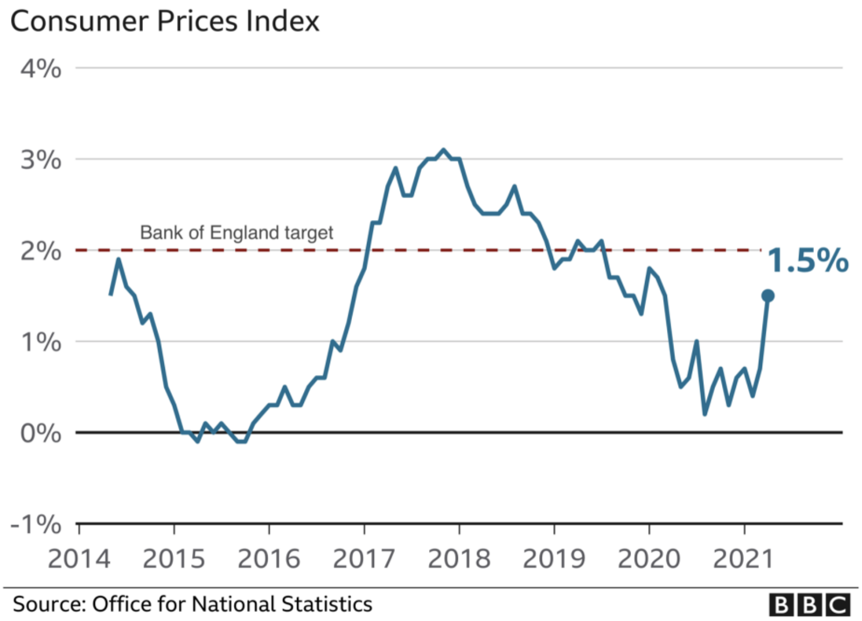
4.2 Covid

The UK housing market has boomed lately, with house prices rising by nearly 9% year on year. This increase has been fuelled by a temporary cut to stamp duty during the pandemic right below the £500,000.



During the emergency, more and more families revalued their priorities; among several, the need of a different type of housing rose. In fact, family homes are now more popular. This and the fear of contagion have made some city-centre flats less attractive to buyers. Because of the reduced taxes, people wanted to find a suited house in a short time and buy it almost immediately. This is reflected in the spike in March was caused by buyers rushing to complete deals before 31 March (the date the stamp duty holiday was originally meant to end). The short selling time and the recent rise of the demand hasn't been met by new properties coming on to the market, and this imbalance could keep prices high in the coming months, even with smaller tax savings on offer.

On the other hand, since the pandemic began, the number of mortgage deals on the market has fallen dramatically, despite the relatively low interest rates. The average rates have been on the rise in the last few months, but they still remain lower than pre-pandemic levels.



The above chart shows that there are signs that the rising cost of living is picking up speed. The Bank of England might choose to control that by raising interest rates. That would make mortgage borrowing more expensive, putting some new property buyers who borrowed to their limit in financial danger. Furthermore, an income shock, such as the loss of their job, would mean a certain risk for the economic stability

4.3 Monetary Policies

The Bank of England's Monetary Policy Committee (MPC) sets monetary policy to keep inflation low and stable, which supports growth and jobs. The Monetary Policy Committee currently uses two main monetary policy tools:

i) Bank Rate - Set the interest rate that bank and building societies earn on deposits or reserves, placed with the Bank of England.

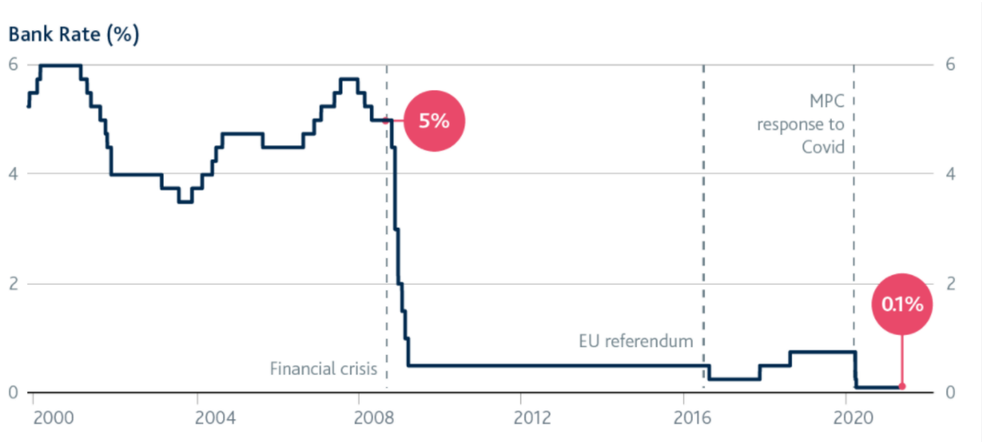
ii) Quantitative Easing or Asset Purchase- Buying government & Cooperate Bonds, financed by issuance of central bank reserves.

How does UK Monetary Policy respond to Brexit & Covid shock?

From the literature review we found that in response to Covid pandemic, MPC have taken prompt and substantial action to help household & businesses. MPC have taken following steps:

1. They have cut interest rate to 0.1% in March 2020 and kept them at the same level.
2. They had allowed UK banks and building societies to borrow cheaply from them so they can reduce the rates which they charge their customers.
3. Quantitative Easing, which helps to keep the interest rates on mortgages and business loans as low.

From the website of Bank of England, we found an interesting graph which depicts how MPC have cut interest rate due to Covid.



Bank Rate (Source: Bank of England)

A lower interest rate implies cheaper loans for businesses and households. It will help reducing the cost they face and encourage companies to employ people and invest.

Our analysis and the standard economic theory tell us that the monetary policy should affect house prices and housing finance more generally. Ceteris paribus (all else equal), higher interest rates increase the cost of owning a house, which implies a lower asset value.

When anticipating the future price movements in the housing market, it is essential to have the best possible forecast of demand and the demand for housing market is most importantly determined by incomes and unemployment rate.

There were some specific measures taken by the UK Government supporting activity in the housing market and the position of renters. One of the schemes getting most attention is the SDLT (stamp duty land tax) holiday. This started in July 2020 and was originally due to end on 31 March 2021, but in the March Budget it was extended to June 30, 2021. It is worth up to £15,000 on £500,000 houses, with bigger discounts for more expensive houses up to the ceiling of £500,00. Other measures were implemented aside from the extraordinarily low interest rates such as potential mortgage payment holidays for 6 months to those who had lost income due to Covid-19. Another scheme was launched in the March 2021 budget for first time buyers, wich allows a deposit of only 5% instead of the 20% which was applied since the financial crisis. There was also some help for tenants with a stop on evictions except in the most extreme circumstances.

An additional consideration is that the effects of the Covid-19 crisis are in context of absorbing the impacts of Brexit. The conclusion from the earlier research shows that Brexit will lead to slower economic growth and lower incomes. Hence there is a reason to think that Brexit may affect UK Housing Market.

Chapter 5 – Limitations & Conclusions

In this section, we will state our model limitations, our suggestions for future studies and reflections on possible presumptions from a policy maker perspective.

5.1 Limitations of our study & Recommendations for future Research

The main limitations of our study are the following:

1) The consideration of other correlated variables such as Nominal House Prices instead of House Price Index (which is a proxy variable) and Nominal Bank Credit to Private sector could have improved the accuracy of our analysis. We would expect that the results would be easier to interpret if these variables were considered in the analysis.
2) The use of dummy variables in the model could have been used to better capture the effects of economic shocks.
3) The use of some independent variables, such as disposable income, could have been used to better capture the wealth effect.
4) The research could have been made broader by using a dummy variable to distinguish metropolitan regions from rural areas. This could have given further insights on the effects of Covid 19 on house demand.
5) The same analysis could have been performed for renting market because results might be different. The house renters in the UK tend to be lower income, younger and working in sectors like tourism, retail or hospitality, which are adversely affected by the pandemic. We would have expected an immediate more adverse effect of Covid on rents respect to purchases.

An ideal model to understand the impact of exogeneous variable on Housing market would include a series of variables that we omitted. For example, a dummy variable could help to capture the crises effect. We performed our analysis considering the general landscape of the UK Housing Market. An improved version should divide the Housing Market into the owner-occupied market and rental market in addition to considering the regional analysis. Another limitation of our model was the use of Housing Price Index instead of actual values. Lastly, to be more accurate, discretionary income, which is the money that an individual or a family has to invest, save, or spend after taxes and necessities are paid, would be a better variable to predict the sales trend.

5.2 Conclusions

We started this paper with the intent to explore the impact of monetary policies on one of the biggest markets of every developed country, the house market. We limited our research to the United Kingdom from 1975 to 2020.

Opposed to past investigations, our analysis tried to reach the same inferences using the most correct model from a theoretical point of view. In fact, the VAR model is mostly applied, disregarding the intrinsic nature of the time series data we are dealing with.

The analysis conducted took in consideration the possible relation between house prices, real GDP, Consumer Price Index and several interest rates. In summary, the Vector Error Correction model we adopted was somewhat successful in matching our expectations. As the Impulse Response Function graph highlights, the effects of the independent variables are captured after a long period of time has passed. The biggest impact is the one of GDP, while the impact of CPI, Euro Interbank rate, Interbank rate, Economic Policy Uncertainty Index and unemployment rate are limited, nevertheless relevant. We found out that the Fixed Mortgage rate and the population don't have any kind of influence whatsoever on the house prices.

In conclusion, our model reflected the theoretical and empirical concepts we exposed in Chapter 4 within the limits of the case. As mentioned previously, this topic would be worth to be investigated more in detail with the use also of more complicated models, to understand fully the shocks that the house market is subjected to as well as the importance of monetary policy applications. In this matter, the government or the empowered institution could regulate its imbalances directly targeting the house market interest rates.

Appendix

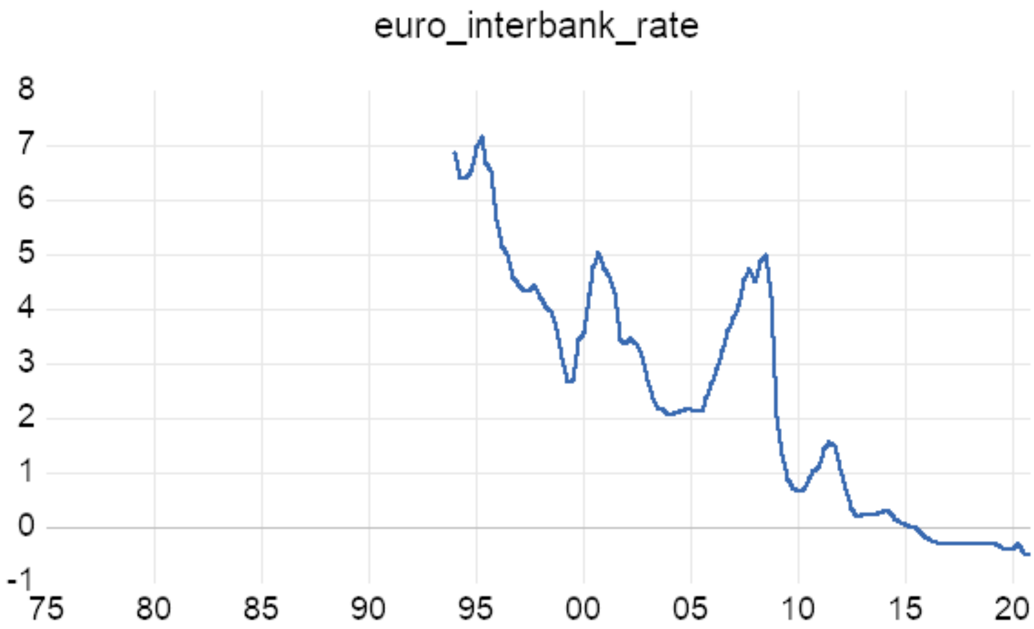


Figure 1. Euro Interbank Rate Trend

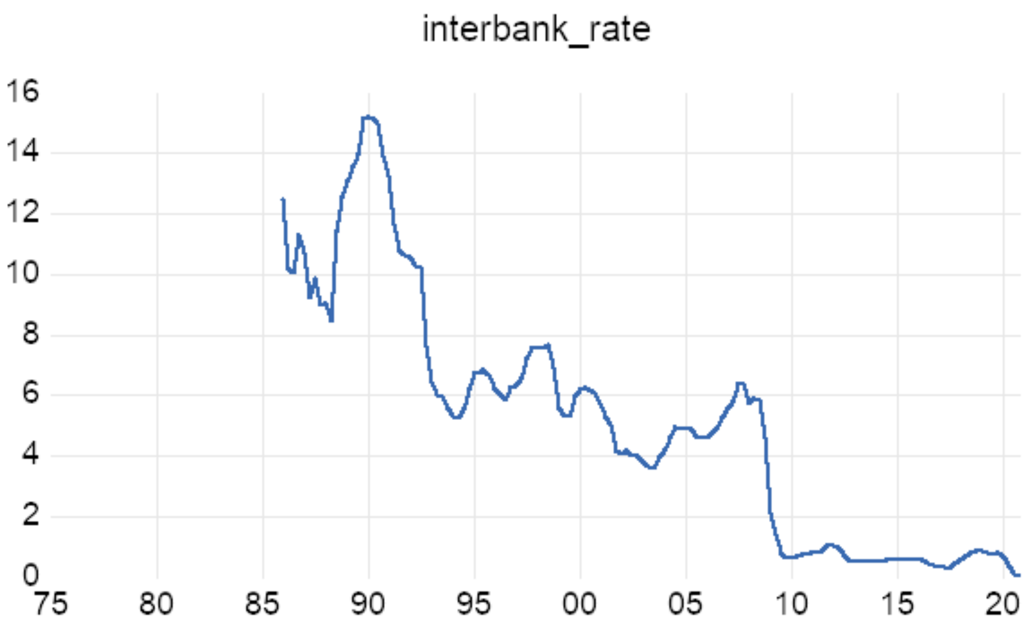


Figure 2 Interbank Rate Trend

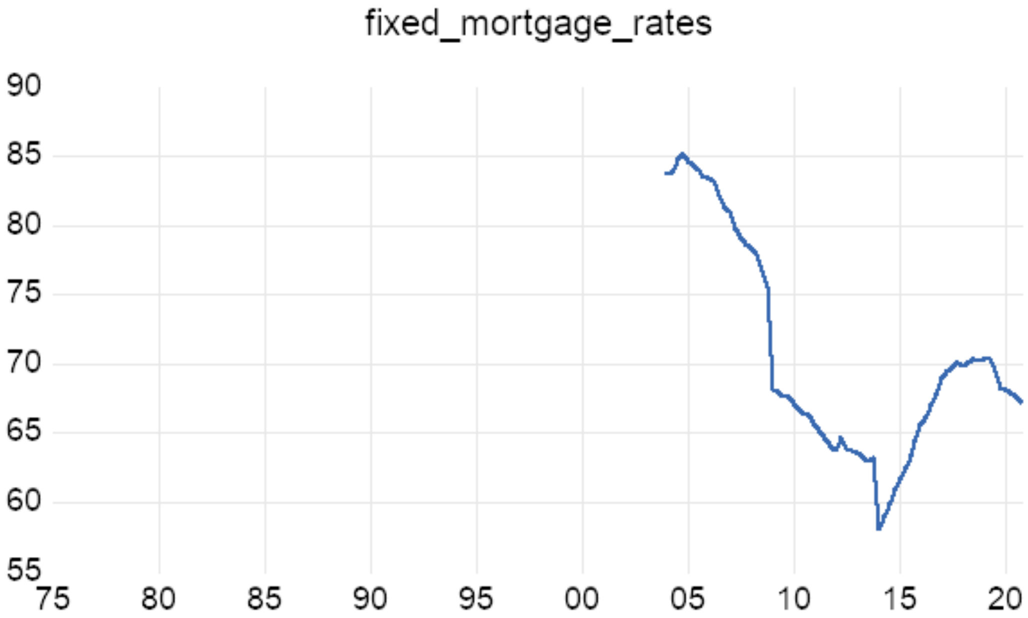


Figure 3 Fixed Mortgage Rate Trend

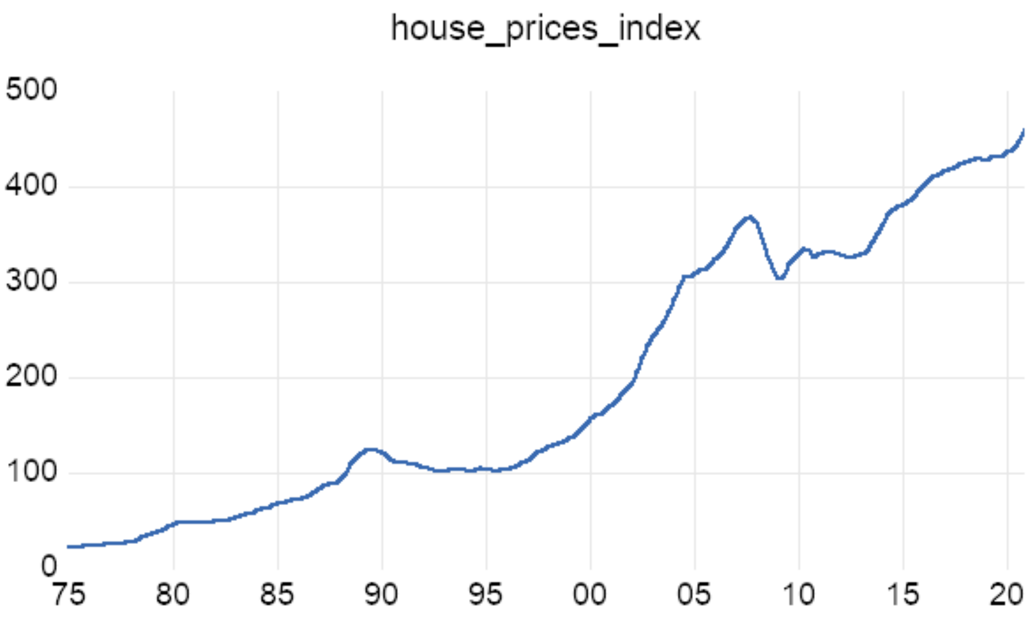


Figure 4 House Price Index Trend

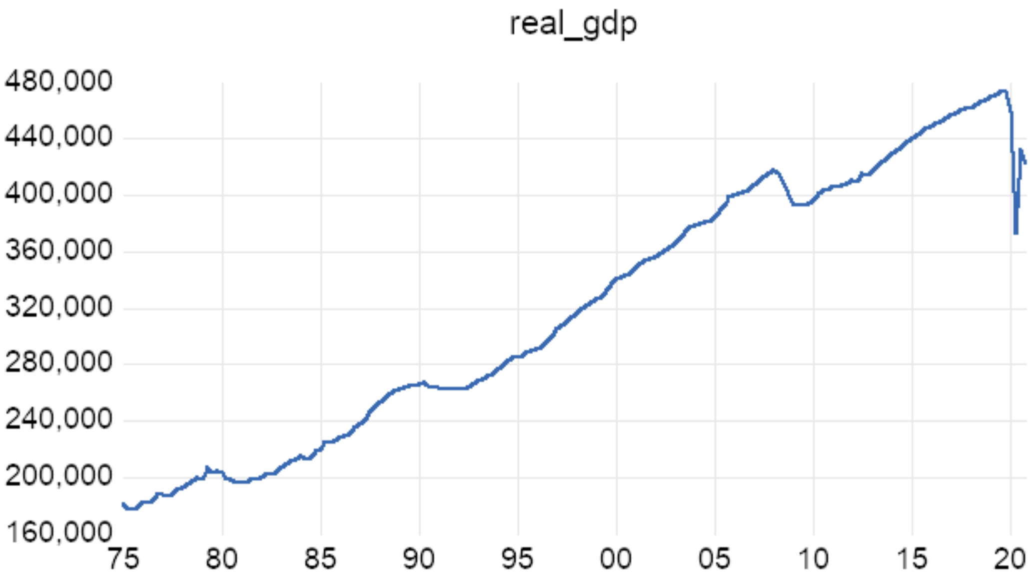


Figure 5 Real GDP Trend

Figure 6 Unemployment Rate Trend

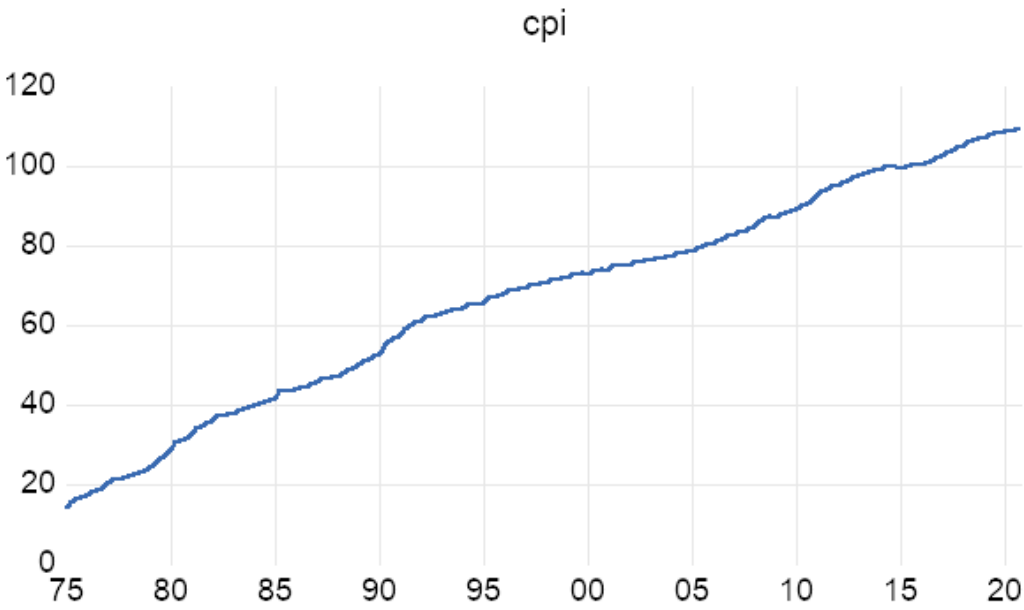


Figure 7 Consumer Price Index Trend

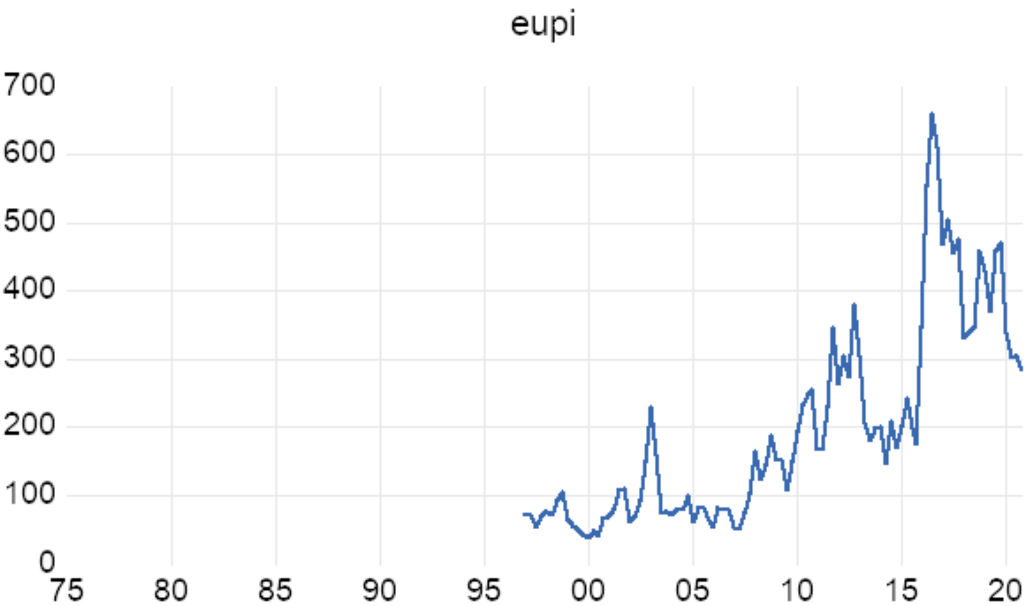


Figure 8 Economic Policy Uncertainty Trend

Null Hypothesis: CPI has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.012012	0.2816
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI)
Method: Least Squares
Date: 06/23/21 Time: 11:32
Sample (adjusted): 1976Q3 2020Q4
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI(-1)	-0.001920	0.000954	-2.012012	0.0458
D(CPI(-1))	0.263364	0.072384	3.638416	0.0004
D(CPI(-2))	0.092496	0.059655	1.550530	0.1229
D(CPI(-3))	-0.093730	0.059606	-1.572496	0.1177
D(CPI(-4))	0.605188	0.059724	10.13311	0.0000
D(CPI(-5))	-0.300433	0.071756	-4.186897	0.0000
C	0.351787	0.100539	3.499024	0.0006

R-squared	0.495338	Mean dependent var	0.513898
Adjusted R-squared	0.477631	S.D. dependent var	0.418191
S.E. of regression	0.302248	Akaike info criterion	0.483393
Sum squared resid	15.62150	Schwarz criterion	0.608519
Log likelihood	-36.02198	Hannan-Quinn criter.	0.534135
F-statistic	27.97350	Durbin-Watson stat	2.009116
Prob(F-statistic)	0.000000		

Figure 9 CPI Unit Root

Null Hypothesis: EUPI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.947837	0.3094
Test critical values:	1% level	-3.500669	
	5% level	-2.892200	
	10% level	-2.583192	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EUPI)
Method: Least Squares
Date: 06/23/21 Time: 11:40
Sample (adjusted): 1997Q2 2020Q4
Included observations: 95 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EUPI(-1)	-0.076490	0.039269	-1.947837	0.0545
C	17.02627	9.521428	1.788205	0.0770

R-squared	0.039197	Mean dependent var	2.225733
Adjusted R-squared	0.028866	S.D. dependent var	56.74927
S.E. of regression	55.92421	Akaike info criterion	10.90670
Sum squared resid	290859.1	Schwarz criterion	10.96047
Log likelihood	-516.0682	Hannan-Quinn criter.	10.92843
F-statistic	3.794070	Durbin-Watson stat	1.745142
Prob(F-statistic)	0.054450		

Figure 10 EUPI Unite Root

Null Hypothesis: EURO_INTERBANK_RATE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.681805	0.4375
Test critical values:	1% level	-3.493129	
	5% level	-2.888932	
	10% level	-2.581453	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EURO_INTERBANK_RATE)
Method: Least Squares
Date: 06/23/21 Time: 11:41
Sample (adjusted): 1994Q3 2020Q4
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EURO_INTERBANK_RATE(-1)	-0.021919	0.013033	-1.681805	0.0956
D(EURO_INTERBANK_RATE(-1))	0.538524	0.081203	6.631870	0.0000
C	0.022956	0.041695	0.550576	0.5831

R-squared	0.312084	Mean dependent var	-0.065025
Adjusted R-squared	0.298727	S.D. dependent var	0.346041
S.E. of regression	0.289782	Akaike info criterion	0.388515
Sum squared resid	8.649252	Schwarz criterion	0.463895
Log likelihood	-17.59127	Hannan-Quinn criter.	0.419067
F-statistic	23.36384	Durbin-Watson stat	1.868890
Prob(F-statistic)	0.000000		

Figure 11 EURO Interbank Rate Unit Root

Null Hypothesis: FIXED_MORTGAGE_RATES has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.690099	0.4316
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FIXED_MORTGAGE_RATES)
Method: Least Squares
Date: 06/23/21 Time: 11:44
Sample (adjusted): 2004Q2 2020Q4
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FIXED_MORTGAGE_RATES(-1)	-0.032622	0.019302	-1.690099	0.0958
C	2.058017	1.372459	1.499511	0.1386

R-squared	0.042095	Mean dependent var	-0.247761
Adjusted R-squared	0.027358	S.D. dependent var	1.241255
S.E. of regression	1.224158	Akaike info criterion	3.271780
Sum squared resid	97.40662	Schwarz criterion	3.337592
Log likelihood	-107.6046	Hannan-Quinn criter.	3.297822
F-statistic	2.856434	Durbin-Watson stat	1.665156
Prob(F-statistic)	0.095800		

Figure 12 Fixed Mortgage Rate Unit Root

Null Hypothesis: HOUSE_PRICES_INDEX has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.486337	0.9859
Test critical values:	1% level	-3.467418	
	5% level	-2.877729	
	10% level	-2.575480	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(HOUSE_PRICES_INDEX)
Method: Least Squares
Date: 06/23/21 Time: 11:45
Sample (adjusted): 1976Q4 2020Q4
Included observations: 177 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HOUSE_PRICES_INDEX(-1)	0.000681	0.001399	0.486337	0.6274
D(HOUSE_PRICES_INDEX(-1))	1.058265	0.076012	13.92228	0.0000
D(HOUSE_PRICES_INDEX(-2))	-0.326716	0.111603	-2.927485	0.0039
D(HOUSE_PRICES_INDEX(-3))	0.295583	0.112389	2.630000	0.0093
D(HOUSE_PRICES_INDEX(-4))	-0.451808	0.115239	-3.920624	0.0001
D(HOUSE_PRICES_INDEX(-5))	0.032915	0.117922	0.279124	0.7805
D(HOUSE_PRICES_INDEX(-6))	0.195853	0.079633	2.459463	0.0149
C	0.388759	0.330713	1.175517	0.2414

R-squared	0.728040	Mean dependent var	2.457735
Adjusted R-squared	0.716775	S.D. dependent var	4.576631
S.E. of regression	2.435632	Akaike info criterion	4.662434
Sum squared resid	1002.560	Schwarz criterion	4.805989
Log likelihood	-404.6254	Hannan-Quinn criter.	4.720655
F-statistic	64.63057	Durbin-Watson stat	1.932240
Prob(F-statistic)	0.000000		

Figure 13 House Prince Index Unit Root

Null Hypothesis: INTERBANK_RATE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.101902	0.7141
Test critical values:	1% level	-3.478189	
	5% level	-2.882433	
	10% level	-2.577990	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTERBANK_RATE)
Method: Least Squares
Date: 06/23/21 Time: 11:46
Sample (adjusted): 1986Q3 2020Q4
Included observations: 138 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INTERBANK_RATE(-1)	-0.012672	0.011500	-1.101902	0.2725
D(INTERBANK_RATE(-1))	0.354551	0.076051	4.662039	0.0000
C	0.022265	0.075068	0.296597	0.7672

R-squared	0.143543	Mean dependent var	-0.073784
Adjusted R-squared	0.130855	S.D. dependent var	0.585847
S.E. of regression	0.546173	Akaike info criterion	1.649738
Sum squared resid	40.27121	Schwarz criterion	1.713374
Log likelihood	-110.8320	Hannan-Quinn criter.	1.675599
F-statistic	11.31307	Durbin-Watson stat	1.928803
Prob(F-statistic)	0.000029		

Figure 14 Interbank Rate Unit Root

Null Hypothesis: REAL_GDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.050970	0.7345
Test critical values:	1% level	-3.466377	
	5% level	-2.877274	
	10% level	-2.575236	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(REAL_GDP)
Method: Least Squares
Date: 06/23/21 Time: 11:47
Sample (adjusted): 1975Q3 2020Q4
Included observations: 182 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REAL_GDP(-1)	-0.006574	0.006255	-1.050970	0.2947
D(REAL_GDP(-1))	-0.335272	0.070619	-4.747631	0.0000
C	3903.486	2079.088	1.877499	0.0621

R-squared	0.117675	Mean dependent var	1340.048
Adjusted R-squared	0.107817	S.D. dependent var	8229.980
S.E. of regression	7773.664	Akaike info criterion	20.77122
Sum squared resid	1.08E+10	Schwarz criterion	20.82403
Log likelihood	-1887.181	Hannan-Quinn criter.	20.79263
F-statistic	11.93657	Durbin-Watson stat	2.032911
Prob(F-statistic)	0.000014		

Figure 15 Real GDP Unit Root

Null Hypothesis: UNEMPLOYMENT_RATE has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.226907	0.1976
Test critical values:	1% level	-3.466580	
	5% level	-2.877363	
	10% level	-2.575284	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEMPLOYMENT_RATE)
Method: Least Squares
Date: 06/23/21 Time: 11:47
Sample (adjusted): 1975Q4 2020Q4
Included observations: 181 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMPLOYMENT_RATE(-1)	-0.016354	0.007344	-2.226907	0.027
D(UNEMPLOYMENT_RATE(-1))	0.461090	0.072168	6.389099	0.000
D(UNEMPLOYMENT_RATE(-2))	0.250960	0.073084	3.433835	0.000
C	0.091245	0.043763	2.084990	0.038

R-squared	0.421851	Mean dependent var	0.01105
Adjusted R-squared	0.412052	S.D. dependent var	0.32733
S.E. of regression	0.250994	Akaike info criterion	0.09507
Sum squared resid	11.15064	Schwarz criterion	0.16576
Log likelihood	-4.604380	Hannan-Quinn criter.	0.12373
F-statistic	43.04978	Durbin-Watson stat	2.04853
Prob(F-statistic)	0.000000		

Figure 16 Unemployment Rate Unit Root

Null Hypothesis: D(HOUSE_PRICES_INDEX) has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.238710	0.0194
Test critical values:	1% level	-3.467418	
	5% level	-2.877729	
	10% level	-2.575480	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(HOUSE_PRICES_INDEX,2)
Method: Least Squares
Date: 06/23/21 Time: 11:48
Sample (adjusted): 1976Q4 2020Q4
Included observations: 177 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(HOUSE_PRICES_INDEX(-1))	-0.187794	0.057984	-3.238710	0.0014
D(HOUSE_PRICES_INDEX(-1),2)	0.248394	0.079719	3.115846	0.0022
D(HOUSE_PRICES_INDEX(-2),2)	-0.077825	0.076018	-1.023777	0.3074
D(HOUSE_PRICES_INDEX(-3),2)	0.218720	0.077631	2.817424	0.0054
D(HOUSE_PRICES_INDEX(-4),2)	-0.233084	0.077128	-3.022034	0.0029
D(HOUSE_PRICES_INDEX(-5),2)	-0.199892	0.079020	-2.529631	0.0123
C	0.505158	0.227716	2.218372	0.0279

R-squared	0.293597	Mean dependent var	0.071821
Adjusted R-squared	0.268665	S.D. dependent var	2.841687
S.E. of regression	2.430157	Akaike info criterion	4.652534
Sum squared resid	1003.963	Schwarz criterion	4.778144
Log likelihood	-404.7492	Hannan-Quinn criter.	4.703476
F-statistic	11.77597	Durbin-Watson stat	1.931713
Prob(F-statistic)	0.000000		

Figure 17 1st Difference HPI Unit Root

Null Hypothesis: D(REAL_GDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-18.93006	0.0000
Test critical values:	1% level	-3.466377	
	5% level	-2.877274	
	10% level	-2.575236	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(REAL_GDP,2)
Method: Least Squares
Date: 06/23/21 Time: 11:48
Sample (adjusted): 1975Q3 2020Q4
Included observations: 182 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REAL_GDP(-1))	-1.336888	0.070622	-18.93006	0.0000
C	1806.540	584.6266	3.090075	0.0023

R-squared	0.665643	Mean dependent var	-44.66099
Adjusted R-squared	0.663786	S.D. dependent var	13410.46
S.E. of regression	7775.921	Akaike info criterion	20.76638
Sum squared resid	1.09E+10	Schwarz criterion	20.80159
Log likelihood	-1887.741	Hannan-Quinn criter.	20.78065
F-statistic	358.3471	Durbin-Watson stat	2.030447
Prob(F-statistic)	0.000000		

Figure 18 1st Difference GDP Unit Root

Null Hypothesis: D(INTERBANK_RATE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.522704	0.0000
Test critical values:	1% level	-3.478189	
	5% level	-2.882433	
	10% level	-2.577990	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTERBANK_RATE,2)
Method: Least Squares
Date: 06/23/21 Time: 11:49
Sample (adjusted): 1986Q3 2020Q4
Included observations: 138 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INTERBANK_RATE(-1))	-0.648293	0.076067	-8.522704	0.0000
C	-0.042242	0.047027	-0.898249	0.3706

R-squared	0.348149	Mean dependent var	0.015898
Adjusted R-squared	0.343355	S.D. dependent var	0.674539
S.E. of regression	0.546603	Akaike info criterion	1.644199
Sum squared resid	40.63341	Schwarz criterion	1.686623
Log likelihood	-111.4498	Hannan-Quinn criter.	1.661440
F-statistic	72.63648	Durbin-Watson stat	1.930343
Prob(F-statistic)	0.000000		

Figure 19 1st Difference Interbank Rate Unit Root

Null Hypothesis: D(FIXED_MORTGAGE_RATES) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.707173	0.0000
Test critical values:	1% level	-3.533204	
	5% level	-2.906210	
	10% level	-2.590628	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FIXED_MORTGAGE_RATES,2)
Method: Least Squares
Date: 06/23/21 Time: 11:49
Sample (adjusted): 2004Q3 2020Q4
Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FIXED_MORTGAGE_RATES(-1))	-0.825157	0.123026	-6.707173	0.0000
C	-0.212159	0.155499	-1.364376	0.1772

R-squared	0.412770	Mean dependent var	-0.012121
Adjusted R-squared	0.403594	S.D. dependent var	1.605425
S.E. of regression	1.239827	Akaike info criterion	3.297655
Sum squared resid	98.37890	Schwarz criterion	3.364008
Log likelihood	-106.8226	Hannan-Quinn criter.	3.323874
F-statistic	44.98617	Durbin-Watson stat	2.054166
Prob(F-statistic)	0.000000		

Figure 20 1st Difference Fixed Mortgage Unit Root

Null Hypothesis: D(EURO_INTERBANK_RATE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.639965	0.0000
Test critical values:	1% level	-3.493129	
	5% level	-2.888932	
	10% level	-2.581453	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EURO_INTERBANK_RATE,2)
Method: Least Squares
Date: 06/23/21 Time: 11:50
Sample (adjusted): 1994Q3 2020Q4
Included observations: 106 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EURO_INTERBANK_RATE(-1))	-0.461985	0.081913	-5.639965	0.0000
C	-0.027914	0.028949	-0.964239	0.3372

R-squared	0.234220	Mean dependent var	0.003953
Adjusted R-squared	0.226857	S.D. dependent var	0.332449
S.E. of regression	0.292318	Akaike info criterion	0.396737
Sum squared resid	8.886768	Schwarz criterion	0.446991
Log likelihood	-19.02708	Hannan-Quinn criter.	0.417105
F-statistic	31.80921	Durbin-Watson stat	1.860517
Prob(F-statistic)	0.000000		

Figure 21 1st Difference Euro Interbank Unit Root

Null Hypothesis: D(EUPI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.714514	0.0000
Test critical values:	1% level	-3.501445	
	5% level	-2.892536	
	10% level	-2.583371	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EUPI,2)
Method: Least Squares
Date: 06/23/21 Time: 11:50
Sample (adjusted): 1997Q3 2020Q4
Included observations: 94 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EUPI(-1))	-0.905367	0.103892	-8.714514	0.0000
C	2.010751	5.895636	0.341057	0.7338

R-squared	0.452194	Mean dependent var	-0.238126
Adjusted R-squared	0.446240	S.D. dependent var	76.73921
S.E. of regression	57.10553	Akaike info criterion	10.94873
Sum squared resid	300015.8	Schwarz criterion	11.00284
Log likelihood	-512.5901	Hannan-Quinn criter.	10.97058
F-statistic	75.94276	Durbin-Watson stat	1.965462
Prob(F-statistic)	0.000000		

Figure 22 1st Difference EUPI Unit Root

Null Hypothesis: D(CPI) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.691436	0.0050
Test critical values:	1% level	-3.467205	
	5% level	-2.877636	
	10% level	-2.575430	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI,2)
Method: Least Squares
Date: 06/23/21 Time: 11:51
Sample (adjusted): 1976Q3 2020Q4
Included observations: 178 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CPI(-1))	-0.358328	0.097070	-3.691436	0.0003
D(CPI(-1),2)	-0.364273	0.108043	-3.371563	0.0009
D(CPI(-2),2)	-0.252808	0.098069	-2.577848	0.0108
D(CPI(-3),2)	-0.332452	0.087734	-3.789302	0.0002
D(CPI(-4),2)	0.289765	0.072191	4.013877	0.0001
C	0.182451	0.055482	3.288451	0.0012

R-squared	0.734765	Mean dependent var	-0.002411
Adjusted R-squared	0.727055	S.D. dependent var	0.583633
S.E. of regression	0.304914	Akaike info criterion	0.495555
Sum squared resid	15.99131	Schwarz criterion	0.602806
Log likelihood	-38.10438	Hannan-Quinn criter.	0.539048
F-statistic	95.29641	Durbin-Watson stat	1.994209
Prob(F-statistic)	0.000000		

Figure 23 1st Difference CPI Unit Root

Dependent Variable: LPRICES
Method: Least Squares
Date: 07/01/21 Time: 11:40
Sample (adjusted): 2004Q1 2020Q4
Included observations: 68 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI	-1.790304	0.467344	-3.830809	0.0003
LEUPI	-0.040936	0.009442	-4.335470	0.0001
LEURO_INTERBANK	0.099569	0.015910	6.258132	0.0000
LFIXED	0.312325	0.079810	3.913378	0.0002
LGDP	0.383207	0.101795	3.764485	0.0004
LINTERBANK	-0.024059	0.009123	-2.637274	0.0107
LPOP	10.12930	1.373725	7.373603	0.0000
LUNEMP	-0.039676	0.016923	-2.344468	0.0224
C	-34.16834	3.493620	-9.780211	0.0000

R-squared	0.968574	Mean dependent var	5.884090
Adjusted R-squared	0.964313	S.D. dependent var	0.128497
S.E. of regression	0.024274	Akaike info criterion	-4.476050
Sum squared resid	0.034766	Schwarz criterion	-4.182292
Log likelihood	161.1857	Hannan-Quinn criter.	-4.359654
F-statistic	227.3031	Durbin-Watson stat	0.785591
Prob(F-statistic)	0.000000		

Figure 24 OLS Output Results

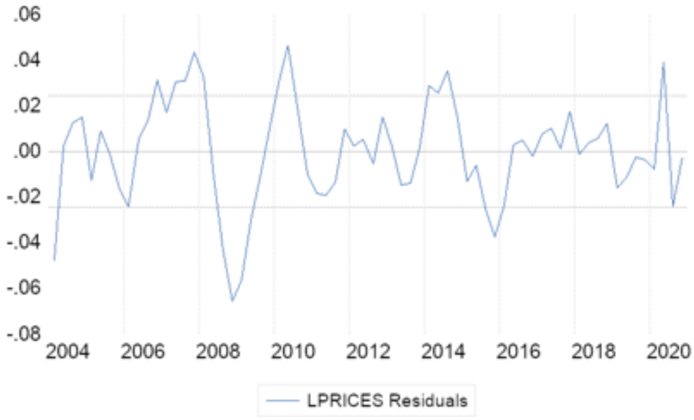


Figure 25 OLS Residuals

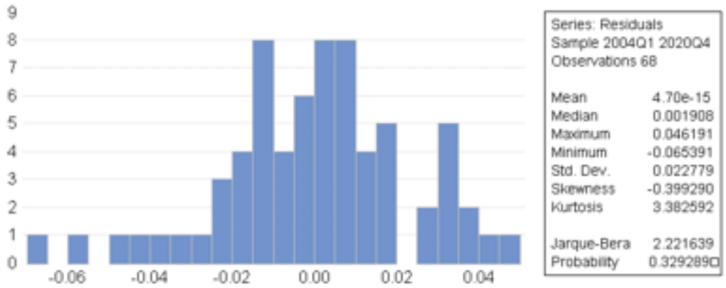


Figure 26 Residual Distribution

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 4 lags

F-statistic	15.64728	Prob. F(4,55)	0.0000
Obs*R-squared	36.19434	Prob. Chi-Square(4)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/30/21 Time: 17:20
Sample: 2004Q1 2020Q4
Included observations: 68
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	0.821729	1.235028	0.665353	0.5086
EUPI	0.003129	0.009255	0.338107	0.7366
EURO_INTERBANK_RATE	1.403220	2.714221	0.516988	0.6072
FIXED_MORTGAGE_RATES	0.428722	0.494965	0.866165	0.3902
INTERBANK_RATE	-2.557140	3.467219	-0.737519	0.4639
POPULATION	-2.731249	5.093853	-0.536185	0.5940
REAL_GDP	-8.19E-05	5.78E-05	-1.416538	0.1623
UNEMPLOYMENT_RATE	-1.513201	1.680871	-0.900248	0.3719
C	109.1990	196.1783	0.556631	0.5800
RESID(-1)	0.766382	0.134787	5.685867	0.0000
RESID(-2)	0.113945	0.161110	0.707249	0.4824
RESID(-3)	-0.341044	0.163378	-2.087458	0.0415
RESID(-4)	0.063108	0.147229	0.428638	0.6699

R-squared	0.532270	Mean dependent var	5.15E-13
Adjusted R-squared	0.430219	S.D. dependent var	7.781281
S.E. of regression	5.873607	Akaike info criterion	6.548993
Sum squared resid	1897.459	Schwarz criterion	6.973311
Log likelihood	-209.6658	Hannan-Quinn criter.	6.717121

Figure 27 OLS Autocorrelation

VAR Lag Order Selection Criteria
Endogenous variables: CPI EUPI EURO_INTERBANK_RATE FIXED_MORTGAGE_...
Exogenous variables: C
Date: 08/23/21 Time: 15:35
Sample: 1975Q1 2020Q4
Included observations: 64

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1854.919	NA	1.60e+14	58.24746	58.55106	58.36707
1	-1020.790	1407.592	9843.171	34.71220	37.74813*	35.90820*
2	-911.8974	153.1307	4748.117	33.84054	39.60881	36.11296
3	-825.9817	96.65511	6096.455	33.68693	42.18753	37.03575
4	-684.4933	119.3809*	2259.898*	31.79667*	43.02960	36.22189

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Figure 28 Lag Selection

Date: 06/24/21 Time: 11:52
Sample (adjusted): 2005Q2 2020Q4
Included observations: 63 after adjustments
Trend assumption: Linear deterministic trend
Series: LPRICES LCPI LEUPI LEURO_INTERBANK LFIXED LGDP LINTERBANK LP(
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.953375	652.8766	197.3709	0.0000
At most 1 *	0.880222	459.7430	159.5297	0.0000
At most 2 *	0.779617	326.0497	125.6154	0.0000
At most 3 *	0.713753	230.7691	95.75366	0.0000
At most 4 *	0.656590	151.9624	69.81889	0.0000
At most 5 *	0.479156	84.62604	47.85613	0.0000
At most 6 *	0.309276	43.53082	29.79707	0.0007
At most 7 *	0.215692	20.21990	15.49471	0.0090
At most 8 *	0.075034	4.913861	3.841465	0.0266

Trace test indicates 9 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.953375	193.1336	58.43354	0.0000
At most 1 *	0.880222	133.6933	52.36261	0.0000
At most 2 *	0.779617	95.28054	46.23142	0.0000
At most 3 *	0.713753	78.80675	40.07757	0.0000
At most 4 *	0.656590	67.33633	33.87687	0.0000
At most 5 *	0.479156	41.09523	27.58434	0.0005
At most 6 *	0.309276	23.31092	21.13162	0.0243
At most 7 *	0.215692	15.30604	14.26460	0.0341
At most 8 *	0.075034	4.913861	3.841465	0.0266

Max-eigenvalue test indicates 9 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Figure 29 Unrestricted Cointegration Rank

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 06/24/21 Time: 11:16
Sample: 1975Q1 2020Q4
Included observations: 63

Dependent variable: D(LCPI)

Excluded	Chi-sq	df	Prob.
D(LEUPI)	11.86343	4	0.0184
D(LEURO_INTERBANK)	10.36614	4	0.0347
D(LFIXED)	2.492037	4	0.6461
D(LGDP)	6.948335	4	0.1386
D(LINTERBANK)	6.925062	4	0.1399
D(LPOP,2)	7.011895	4	0.1353
D(LPRICES)	4.089627	4	0.3940
D(LUNEMP)	4.674904	4	0.3223
All	38.15117	32	0.2099

Dependent variable: D(LEUPI)

Excluded	Chi-sq	df	Prob.
D(LCPI)	1.112393	4	0.8923
D(LEURO_INTERBANK)	4.419086	4	0.3522
D(LFIXED)	3.831940	4	0.4292
D(LGDP)	2.244278	4	0.6909
D(LINTERBANK)	0.628712	4	0.9598
D(LPOP,2)	0.372802	4	0.9846
D(LPRICES)	1.130695	4	0.8894
D(LUNEMP)	0.168982	4	0.9966
All	15.91802	32	0.9921

Dependent variable: D(LEURO_INTERBANK)

Excluded	Chi-sq	df	Prob.
D(LCPI)	9.344025	4	0.0531
D(LEUPI)	2.683194	4	0.6122
D(LFIXED)	3.462971	4	0.4835
D(LGDP)	9.977149	4	0.0408
D(LINTERBANK)	2.823890	4	0.5877
D(LPOP,2)	2.907925	4	0.5734
D(LPRICES)	1.664734	4	0.7971
D(LUNEMP)	0.992234	4	0.9110
All	47.45726	32	0.0386

Figure 30 Granger Causality

Vector Error Correction Estimates
Date: 06/24/21 Time: 16:15
Sample (adjusted): 2005Q2 2020Q4
Included observations: 63 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LPRICES(-1)	1.000000
LCPI(-1)	-13.41354 (0.70420) [-19.0480]
LEUPI(-1)	0.103497 (0.01593) [6.49572]
LEURO_INTERBANK(-1)	-0.099275 (0.02546) [-3.89874]
LFIXED(-1)	-3.493350 (0.19130) [-18.2612]
LGDP(-1)	-2.800013 (0.30559) [-9.16255]
LINTERBANK(-1)	0.188984 (0.01800) [10.4991]
LPOP(-1)	35.39956 (2.18945) [16.1682]
LUNEMP(-1)	-0.329858 (0.02365) [-13.9454]
C	-41.00175

Figure 31 VECM

VEC Residual Serial Correlation LM Tests
Date: 06/24/21 Time: 11:59
Sample: 1975Q1 2020Q4
Included observations: 63

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	73.92298	81	0.6986	0.803679	(81, 54.2)	0.8158
2	77.39134	81	0.5930	0.859217	(81, 54.2)	0.7351
3	103.0637	81	0.0496	1.340932	(81, 54.2)	0.1255
4	78.63359	81	0.5538	0.879614	(81, 54.2)	0.7031

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	73.92298	81	0.6986	0.803679	(81, 54.2)	0.8158
2	1183.961	162	0.0000	13685.90	(162, 1.0)	0.0070
3	NA	243	NA	NA	(243, NA)	NA
4	NA	324	NA	NA	(324, NA)	NA

*Edgeworth expansion corrected likelihood ratio statistic.

Figure 32 VECM Serial Correlation Test

VEC Residual Portmanteau Tests for Autocorrelations
Null Hypothesis: No residual autocorrelations up to lag h
Date: 07/01/21 Time: 15:41
Sample: 1975Q1 2020Q4
Included observations: 63

Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	61.98346	---	62.98319	---	---
2	123.6972	---	126.7203	---	---
3	194.6961	---	201.2691	---	---
4	253.4836	---	264.0423	---	---
5	319.0223	0.0000	335.2308	0.0000	153

*Test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution after adjustment for VEC estimation (Bruggemann, et al. 2005)

Figure 33 VEC Autocorrelation Test

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 07/01/21 Time: 15:40
Sample: 1975Q1 2020Q4
Included observations: 63

Component	Skewness	Chi-sq	df	Prob.*
1	0.362095	1.376680	1	0.2407
2	-0.004068	0.000174	1	0.9895
3	-0.334506	1.174887	1	0.2784
4	0.014757	0.002286	1	0.9619
5	-1.456622	22.27836	1	0.0000
6	-1.578380	26.15848	1	0.0000
7	-0.321250	1.083617	1	0.2979
8	-0.580155	3.534089	1	0.0601
9	-0.371531	1.449370	1	0.2286
Joint		57.05795	9	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	4.858685	9.068616	1	0.0026
2	3.492665	0.637138	1	0.4247
3	3.128893	0.043610	1	0.8346
4	3.134085	0.047194	1	0.8280
5	6.577069	33.58798	1	0.0000
6	9.263374	102.9784	1	0.0000
7	3.120358	0.038026	1	0.8454
8	5.348638	14.47976	1	0.0001
9	3.204844	0.110147	1	0.7400
Joint		160.9908	9	0.0000

Component	Jarque-Bera	df	Prob.
1	10.44530	2	0.0054
2	0.637312	2	0.7271
3	1.218497	2	0.5438
4	0.049481	2	0.9756
5	55.86635	2	0.0000
6	129.1368	2	0.0000
7	1.121643	2	0.5707
8	18.01385	2	0.0001
9	1.559518	2	0.4585
Joint	218.0488	18	0.0000

*Approximate p-values do not account for coefficient estimation

Figure 34 VEC Normality Test