International Journal of Applied Economics, Finance and Accounting
ISSN 2577-767X
Vol. 21, No. 2, pp. 150-162
2025
DOI: 10.33094/ijaefa.v21i2.2130

Macroeconomic effects of quantitative easing in the United States: New evidence between the global financial crisis and the COVID-19 periods

Ichraf Ben Flah[1*]
Ramzi Farhani[2]
Amal Aloui[3]

[1]*College of Business, Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia.*
Email: itbenflah@imamu.edu.sa
[2]*Faculty of Economics and Management of Sousse, University of Sousse, Tunisia.*
Email: ramzi.farhani@gmail.com
[3]*OCRE EDC Paris Business School, France.*
Email: amalamaloui88@gmail.com

Keywords:
ARDL model
Crisis
Monetary policy
Quantitative easing
Unemployment.

JEL Classification:
E52; G01.

Received: *18 September 2024*
Revised: *23 December 2024*
Accepted: *8 January 2025*
Published: *21 January 2025*
(Corresponding Author)*

Abstract

This paper examines the impact of unconventional monetary policies, such as quantitative easing, on the U.S. unemployment rate during the financial crises and the Covid-19 pandemic. Most studies focus on the factors and monetary policies affecting unemployment during financial crises. Nevertheless, these policies may vary during health and social crises. In order to conduct our study, we used the ARDL (Autoregressive Distributed Lag) model, covering two distinct periods: from January 2007 to December 2018 for the first and from January 2019 to December 2022 for the second. The ARDL model is best suited for this study since it allows testing cointegration and estimating short- and long-term relationships when the series are not integrated of the same order. The study reveals that, during the Covid-19 period, the unemployment rate increases in the short and long term due to expansionary monetary policy. However, during financial crises, quantitative easing leads to a decrease in the unemployment rate over the same time horizons. The findings provide valuable insights into the effects of unconventional monetary policies and their influence on labour market reforms depending on the nature of the crisis.

Funding: This study received no specific financial support.
Institutional Review Board Statement: Not applicable.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Data Availability Statement: The corresponding author may provide study data upon reasonable request.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

1. Introduction

Since the summer of 2007, the international financial system has been dealing with one of the biggest crises since 1929. On July 17, the American financial institution Bear Stearns issued its first warning when it revealed a significant fall in the value of its funds due to subprime (low-quality credits). As the fear surrounding the financial markets increased, creditworthiness was reduced; additionally, many financial institutions were reluctant to provide loans to others. To ease the pressure on the financial markets, central banks all over the world have dramatically cut their benchmark interest rates. Following the collapse of the investment firm Lehman Brothers, there was an interbank freeze and a significant rise in the rate margins between LIBOR and EURIBOR. Major central banks implemented unconventional monetary policies (or quantitative easing programs) in response to the financial crisis of 2008–2009 in order to fix the transmission mechanism and provide monetary accommodation at the zero lower limit. They made large-scale asset purchases (LSAPs) to support monetary policy by purchasing government debt when interest rates were as low as they could go.

Beyond the health dimension, the seriousness of the Covid-19 pandemic must also be measured in terms of its economic impact. It was a critical economic situation that the government had to face. The Covid-19 crisis would cause a contraction in the global economy, leading to a significant rise in the unemployment rate. The pandemic led to widespread job losses, with an average increase in global unemployment rates of 1.1% in 2020 compared to the previous year. The growth in unemployment surpassed that during the Great Recession (Falk, 2020).

The specific nature of the crises necessitates the development of new treatments and global routes for solidarity. Restoring an economy to its pre-Covid-19 state once it has been in shock is difficult. To stabilize the bond market and prevent an increase in risk premiums on the debts of the States most affected by the crisis, both the American Federal Reserve and the European Central Bank reduced their key interest rates and made significant purchases of assets and sovereign debt. These behaviours emphasized how flexible their monetary policies were.

However, despite the significance of these monetary policies, few studies have analysed their direct impact on the unemployment rate, particularly by examining the relationship between the expansion of central bank balance sheets and labour market dynamics. This research gap is critical, as it would enhance our understanding of how unconventional monetary policies directly influence employment, an aspect that is often underexplored in the current literature. Therefore, the importance of this study lies in its potential to shed light on this essential relationship, with implications for the future design of economic and monetary policies.

The research questions addressed in this study are as follows: How does the growth of central bank balance sheets affect the unemployment rate in the United States? Do quantitative easing policies have different effects on employment in the short and long term?

The results issued from this research make three significant contributions to the literature. According to our knowledge, this is the first study to investigate the link between central bank balance sheet growth and the unemployment rate in the United States. Secondly, we extend the previous studies with our findings. Finally, we expand the literature methodologically by using the ARDL method. The remainder of this paper is organized as follows. We try to provide a selective literature review for this topic in Section 2. In Section 3, the methodology and data set used in our study will be discussed. In Section 4, we investigate an empirical analysis and interpretations for econometric results. Section 5 concludes the study and provides policy implications.

2. Literature Review

The macroeconomic implications of this unusual approach have been the subject of numerous studies. Starting with Peersman (2011) who showed that, for a specified policy rate, political measures aimed at increasing the monetary base or enlarging the central bank's balance sheet have a temporary effect on consumer prices and a spike-like influence on economic activity. To demonstrate that real Gross Domestic Product (GDP) and inflation increased by 3% and 1%, respectively, following the US LSAPs, Chung, Laforte, Reifschneider, and Williams (2011) used the macroeconomic model of the Federal Reserve Board. Kapetanios, Mumtaz, Stevens, and Theodoridis (2012) investigated the effects of Bank of England purchases using a variety of Bayesian Vector Autoregression (BVAR) techniques. Following the initial round of asset purchases in the UK, they found that GDP and CPI rose by 2.5% and 1.5%, respectively. According to Gambacorta, Hofmann, and Peersman (2014) an exogenous rise in central bank balance sheets near the lower bound of zero causes a brief boost in economic activity and the consumer price index but has a lesser and less long-lasting effect on the price level. According to Giannone, Lenza, Pill, and Reichlin (2012) the ECB's deployment of unconventional measures encouraged market operation and the translation of monetary policy into the real economy, thereby modestly but significantly boosting macroeconomic activity and employment. Fratzscher, Duca, and Straub (2013) separate developing countries from advanced economies when analysing the effects of Fed announcements and Large-Scale Asset Purchases (LSAPs) on global financial markets and capital flows. They demonstrate that QE had a major impact on global asset prices as well as boosting portfolio flows to emerging countries. Although their study is restricted to US corporate bond yields, Gilchrist and Zakrajšek (2013) conclude that quantitative easing programs considerably decrease corporate bond yields for non-financial enterprises. Weale and Wieladek (2016) demonstrated that a 1% of GDP announcement of asset purchases results in statistically significant increases in real GDP and CPI for the United States (UK) of 0.58% (0.25%) and 0.62% (0.32%), respectively. According to some studies analysing the dynamic effects of QE on exchange rates in VAR models Chen, Filardo, He, and Zhu (2016); Anaya, Hachula, and Offermanns (2017) and Dedola, Georgiadis, Gräb, and Mehl (2021) found that these shocks significantly appreciate emerging market economies currencies and Asian currency. According to Boeckx, Dossche, and Peersman (2017) an increase in the ECB's balance sheet is followed by an increase in the euro area's output and consumer price index. This confirms the potential for unconventional monetary policy measures that affect the size of the balance sheet of the central bank to stabilize the economy. According to the findings of Stefański (2022) QE is most likely to be effective only in nations with developed capital markets since it lowers the risk premium. While Chen, Chou, Lin, and Lu (2022) findings show that banks increased their risk exposure during the 2008 quantitative easing by loosening lending requirements to more risky borrowers. In the euro region, unemployment rates decline following shocks to an expansionary monetary policy, according to Hülsewig and Rottmann (2023). As shown by Evgenidis and Papadamou (2021) a shock to monetary policy that is unorthodox results in a decrease in the unemployment rate over the entire euro area. The labour markets in Germany, France, Italy, and Spain are in better shape after an expansionary monetary policy, as demonstrated by Lenza and Slacalek (2021). In the same line of research, Hachula, Piffer, and Rieth (2020) corroborated this decline in the unemployment rate in the euro zone following an expansionary monetary policy.

Unconventional monetary policies' effects on unemployment have received less attention in some previous studies. Therefore, by examining the impact of balance sheet expansion (a proxy for quantitative easing) on unemployment in the U.S. during both the financial crisis and the Covid-19 period, we add to the body of knowledge about the dynamics of the relationship between quantitative easing and unemployment. We also contribute to the body of literature from a methodological perspective by using an analysis based on the ARDL (Autoregressive Distributed Lag) technique to identify the symmetric influence of the various components.

In this study, we have shown that throughout the global financial crisis, the Federal Reserve, with its unconventional quantitative easing monetary policy, succeeded in lowering the unemployment rate in the short and long term, but during the Covid-19 period, the unemployment rate increased after expansionary monetary policy in the short and long term.

This appears to validate that quantitative easing can reduce the unemployment rate in times of economic turbulence, but with other health and social crises, it will be more difficult for central banks alone to limit unemployment with their unconventional monetary policies.

3. Econometric Framework, Summary Statistics, and Preliminary Analysis

3.1. Econometric Framework

To assess the sensitivity of unemployment rate in the United States to federal bank balance sheet growth as a proxy for quantitative easing conditioned on relevant auxiliary macroeconomic and financial variables for a time series dataset, we refer to Gambacorta et al. (2014); Giannone et al. (2012) and Weale and Wieladek (2016) studies. The observations' set is based on monthly data over two periods (the first subperiod is from 2007M1 to 2018M12, and the second subperiod is from 2019M1 to 2022M12), and the empirical model is specified as follows:

$$U_t = \delta_0 + \delta_1 BL_t + \delta_2 CPI_t + \delta_3 IPI_t + \delta_4 FF_t + \delta_5 MVI_t + \omega_t \quad (1)$$

Where $t = 1, \dots, T_1$ denotes the first time subperiod, and $t = 1, \dots, T_2$ indicates the second time subperiod. The two time dimensions were linked to financial crisis period and the Covid-19 period, respectively. At time *t*, U_t is the unemployment rate in the United States, BL_t is the log-natural transformation of the total assets (less eliminations from consolidation) from the federal bank balance sheet, CPI_t and IPI_t are the consumer price index and the industrial production index that define the macroeconomic variables set, FF_t and MVI_t are the federal funds effective rate and the financial market volatility indicator that describe the financial variables set, and ω_t refers to disturbance term.

In order to measure and analyze the short- and long-run associations between unemployment rate, federal bank balance sheet, and the auxiliary macroeconomic and financial variables in the United States, we assume the following general form of unrestricted Error Correction Model (ECM)[1]:

$$\Delta U_t = \lambda_0 + \lambda_1 t + \psi(U_{t-1} - \phi' X_t) + \sum_{i=1}^{p-1} \varrho_i^* \Delta U_{t-i} + \sum_{i=0}^{q-1} \varphi_i^{*\prime} \Delta X_{t-i} + \upsilon_t \quad (2)$$

Where Δ is the first difference operator, $X_t = (BL_t, CPI_t, IPI_t, FF_t, MVI_t)$ is the vector of independent variables previously defined, $[\lambda_0 + \lambda_1 t]$ indicates the linear trend form, υ_t is related to the stochastic error term, and the parameters describing the long-run and short-run relationships are defined, respectively, as follows:

$$\psi = \sum_{i=1}^{p} \varrho_i - 1 \qquad \phi = \frac{\sum_{i=0}^{q} \varphi_i}{1 - \sum_{i=1}^{p} \varrho_i}$$

$$\varrho_i^* = -\sum_{s=i+1}^{p} \varrho_s \qquad \varphi_i^* = -\sum_{s=i+1}^{q} \varphi_s$$

$(U_{t-1} - \phi' X_t)$ indicates the error correction term that upholds the long-run relationship between the variables. We expected that ψ as a speed of adjustment of the unemployment rate will be statistically significant and negative towards its long-run equilibrium state in case of any disturbance in the explanatory variables. It means that the statistical negative significance of the coefficient ψ exhibits a cointegration relationship between the unemployment rate and the set of independent variables. The parameters ϱ_i^* and φ_i^* traduce the short-run effects of the past unemployment rates and the explanatory variables on the current unemployment rate. According to Pesaran et al. (2001) the unconstrained regression (Equation 2) may indicate an ARDL model of orders (*p*,*q*). The two orders *p* and *q* are lag lengths selected automatically by the Schwarz Information Criterion (*SIC*).

3.2. Data and Summary Statistics

To examine the relationships between the short- and long-run unemployment rates, the federal bank balance sheet, and the auxiliary macroeconomic and financial variables in the United States, we adopt the methodology of Gambacorta et al. (2014); Giannone et al. (2012) and Weale and Wieladek (2016) in order to define all variables of interest for econometric estimates purposes.

The Federal Reserve Economic Data provided all the data used in this study. The unemployment rate (*U*), the consumer price index (*CPI*), the industrial production index (*IPI*), the federal funds effective rate (*FF*), and the financial market volatility indicator (*MVI*) are measured in percentage. However, the total assets (less eliminations from consolidation) (*BL*) are taken in millions of US dollars and transformed by the natural logarithm.

[1] An alternative proposal used by Pesaran, Shin, and Smith (2001) is conditional ECM.

Table 1 and Table 2. translate some summary statistics for all variables of interest for econometric estimates, (mean, median, maximum, minimum, standard deviation, skewness, kurtosis, Jarque-Bera (JB) statistic, and critical probabilities).

The following Table 1 refers to financial crisis period with monthly frequency from 2007M1 to 2018M12.

Table 1. Descriptive statistics of variables during the financial crisis period.

Variable	Mean	Median	Maximum	Minimum	Std. dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Observations
U	6.519	6.100	10.000	3.700	2.001	0.313	1.629	13.628	0.001	144
BL	14.837	14.897	15.321	13.666	0.547	-1.103	3.061	29.224	0.000	144
CPI	5.434	5.445	5.532	5.315	0.057	-0.182	1.981	7.020	0.030	144
IPI	4.582	4.596	4.646	4.439	0.050	-1.138	3.479	32.479	0.000	144
FF	0.923	0.180	5.260	0.070	1.436	2.030	6.079	155.796	0.000	144
MVI	19.584	17.290	62.640	10.125	9.074	2.318	9.760	403.117	0.000	144

According to Table 1, the entire dataset is relatively symmetric. The result shows that the unemployment rate has a mean of 6.52 and a relatively moderate dispersion with a standard deviation of 2.00. The mean of the federal bank balance sheet is equal to 14.84 with low dispersion (standard deviation of 0.55) and a negative skewness (-1.10). The federal funds rate's mean is 0.92 and indicates a strong positive skewness (skewness 2.03) and a heavy-tailed distribution (kurtosis 6.08). There is a lot of variation in the financial market volatility indicator, with a mean of 19.58, a standard deviation of 9.07, and a strong positive skewness of 2.32.

The following Table 2. refers to Covid-19 period with monthly frequency from 2019M1 to 2022M12. The results show a relatively symmetric dataset. The unemployment rate has a mean of 5.20 with a strong positive skewness (skewness 2.11) and a heavy-tailed distribution (kurtosis 7.20). The mean of the federal bank balance sheet is 15.68 with moderate dispersion (standard deviation 0.34) and a slight negative skewness (skewness -0.64). The federal funds effective rate exhibits a slightly right-skewed distribution (skewness 0.75) with fat tails (kurtosis 2.38), and its mean is 1.07. There is a lot of variation in the financial market volatility indicator; the mean is 22.45, the standard deviation is 7.93, and the skewness is 2.03.

Table 2. Descriptive statistics of variables during the Covid-19 period.

Variable	Mean	Median	Maximum	Minimum	Std. dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Observations
U	5.196	3.850	14.700	3.500	2.566	2.110	7.201	70.950	0.000	48
BL	15.680	15.809	16.007	15.143	0.337	-0.644	1.653	6.945	0.031	48
CPI	5.595	5.570	5.700	5.532	0.055	0.710	2.011	5.985	0.050	48
IPI	4.603	4.619	4.640	4.438	0.0432	-2.206	8.240	93.690	0.000	48
FF	1.074	0.265	4.100	0.050	1.174	0.750	2.383	5.264	0.072	48
MVI	22.446	21.814	57.737	12.524	7.935	2.031	9.634	121.046	0.000	48

As shown in the following figures set (Figure 1-Figure 6.), the 2008's financial crisis is seen to have caused a large increase in the unemployment rate (*U*).

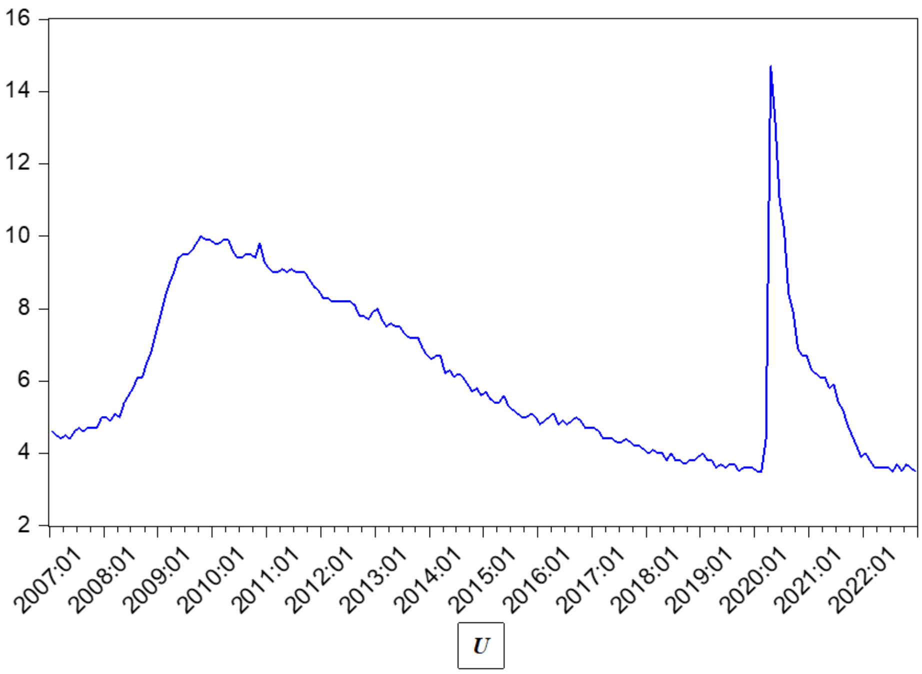

Figure 1. Percentage's evolution of the unemployment rate.

The financial market volatility indicator (*MVI*) and the total assets (less eliminations from consolidation) (*BL*) show an increase at the end of 2009. Nevertheless, for all variables this increasing tendency is followed by decreasing movement until the first quarter of 2020. In addition, we note that the health crisis Covid-19 caused a stronger increase than the first for the unemployment rate (*U*), the total assets (less eliminations from consolidation) (*BL*), and the financial market volatility indicator (*MVI*). After the two times of crises in 2008 and 2020, we continue to observe an exceptional fall in the industrial production index (*IPI*) and the federal funds effective rate (*FF*), whereas the consumer price index (*CPI*) increased continuously from 2008 until it reached its peak in 2022.

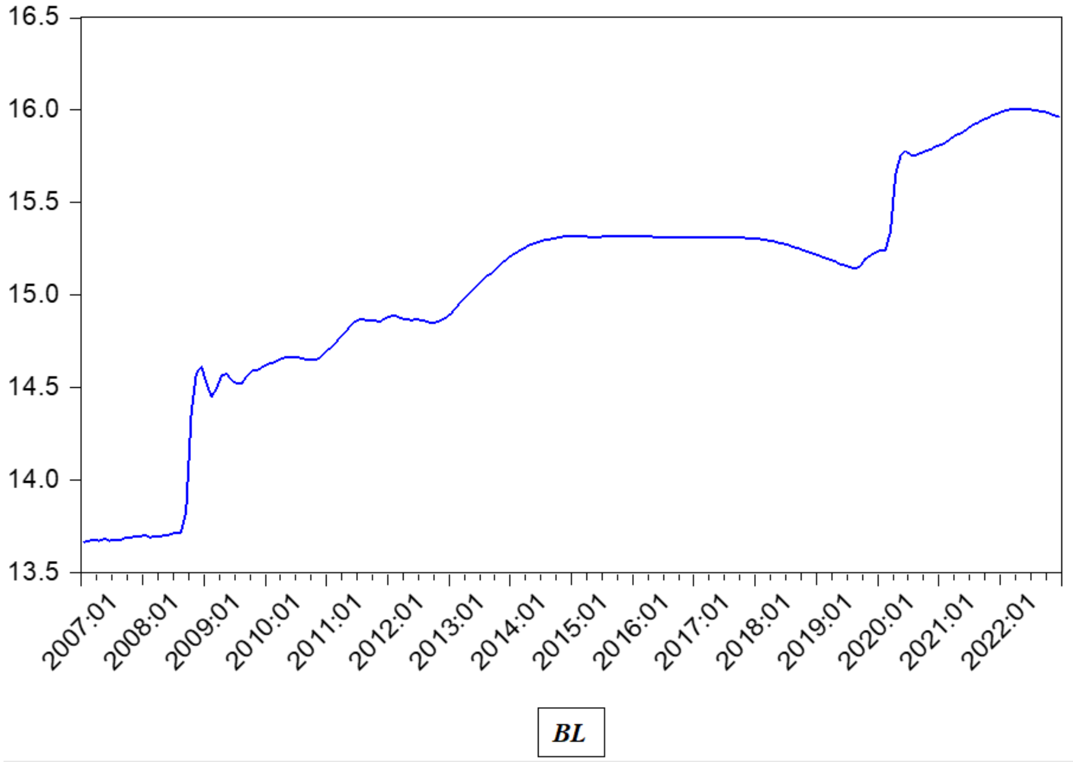

Figure 2. Evolution of the total assets (Less eliminations from consolidation).

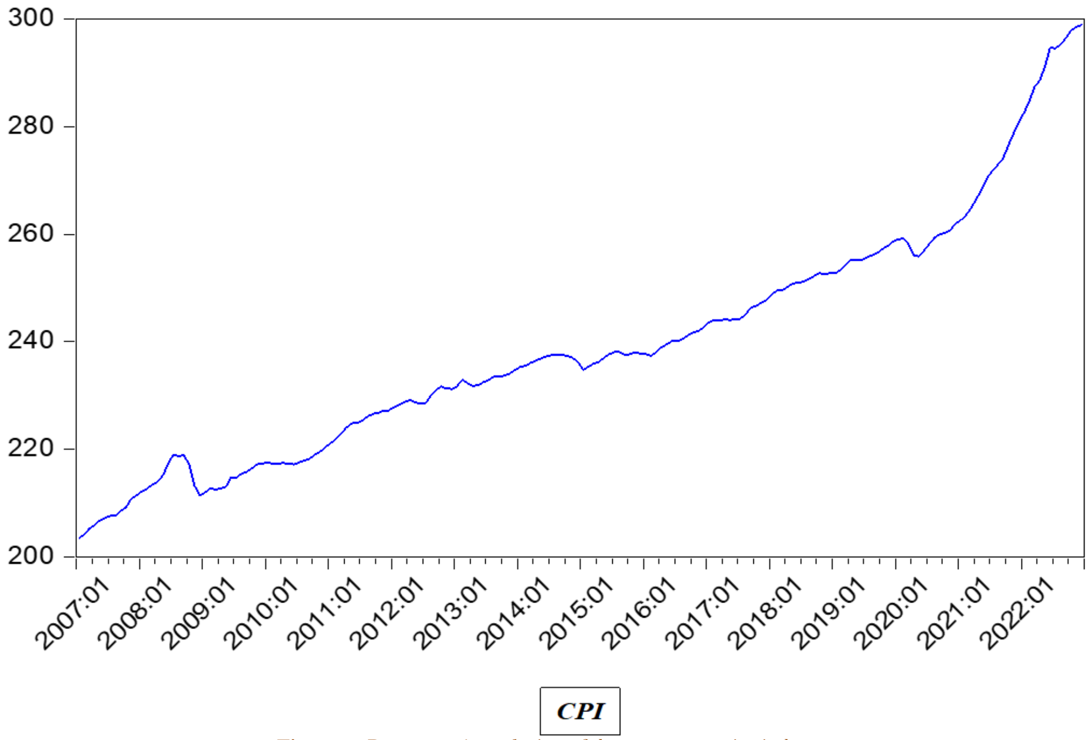

Figure 3. Percentage's evolution of the consumer price index.

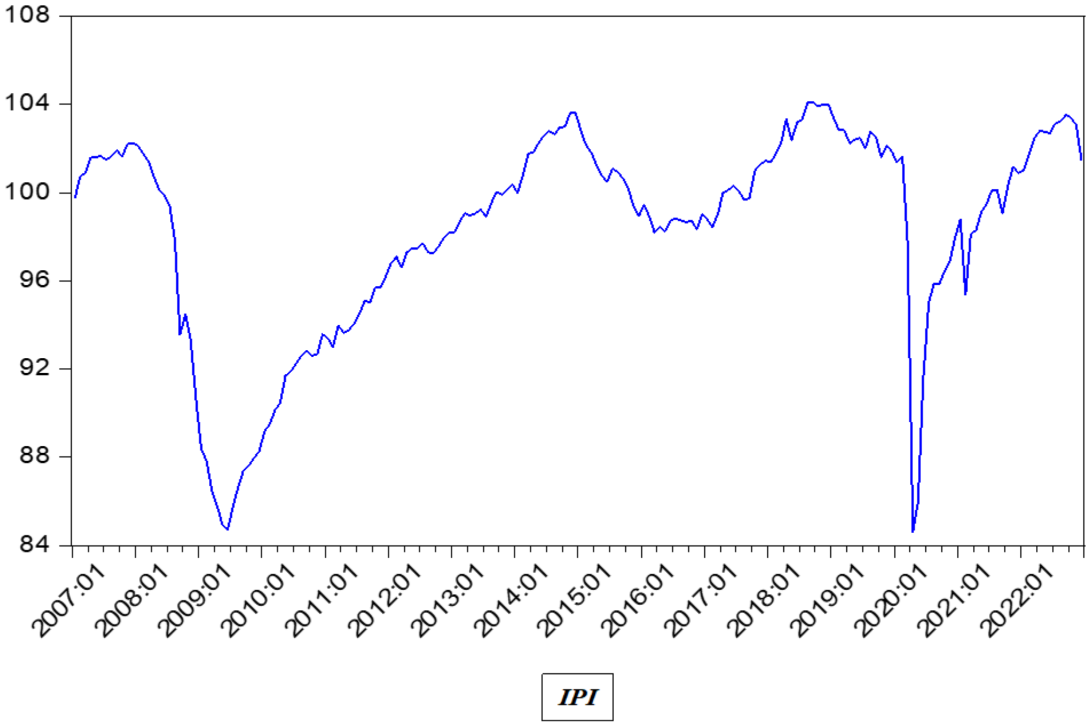

Figure 4. Percentage's evolution of the industrial production index.

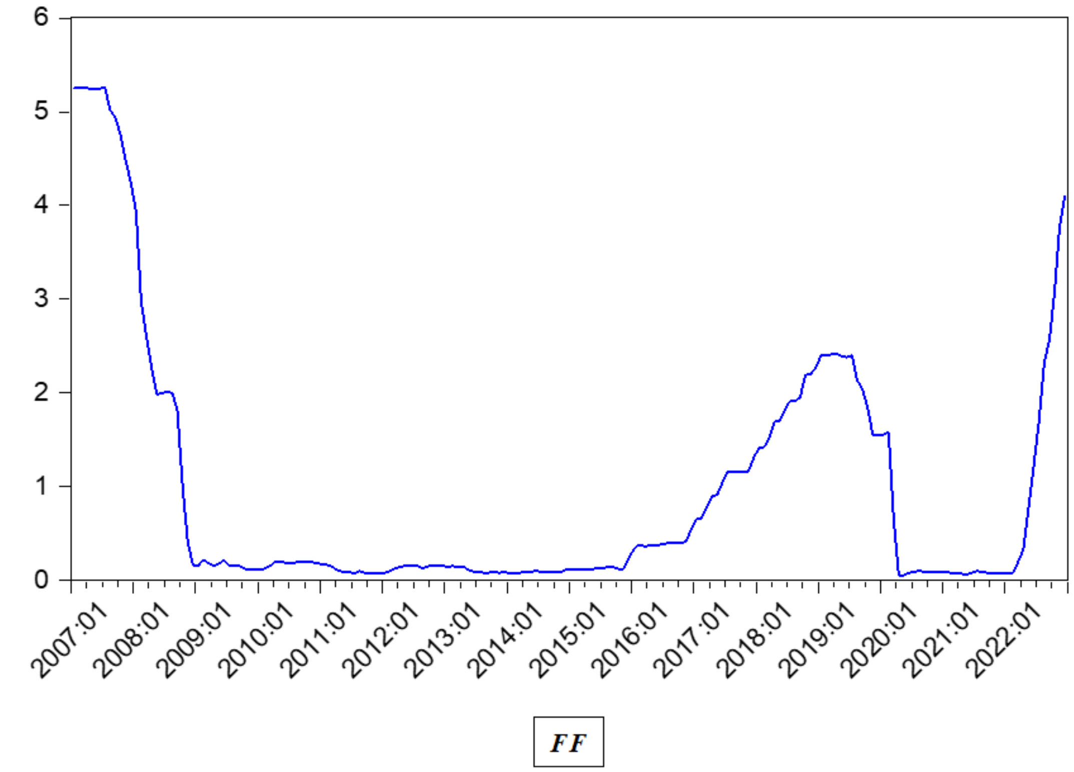

Figure 5. Percentage's evolution of the federal funds effective rate.

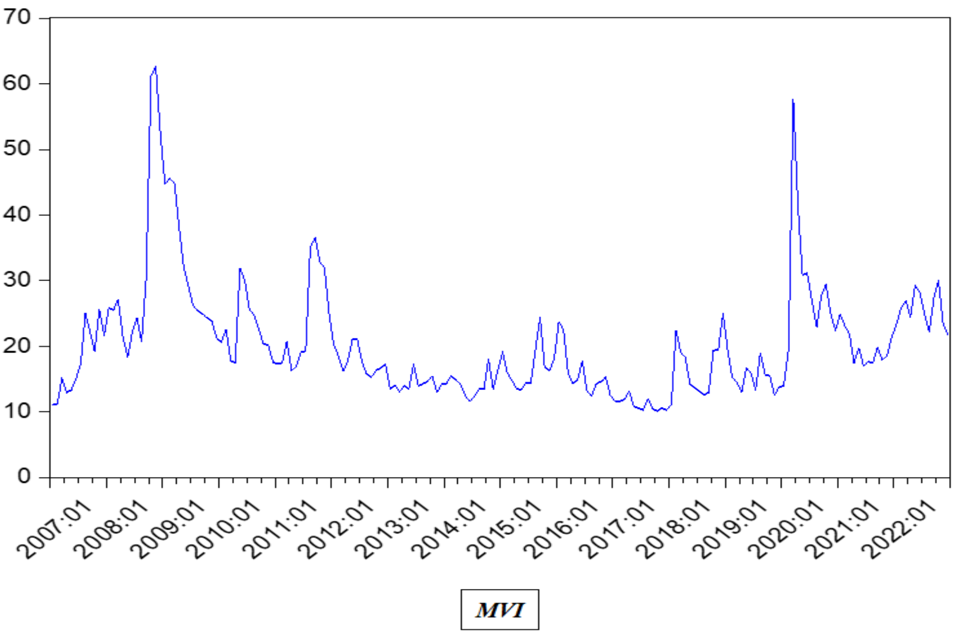

Figure 6. Percentage's evolution of the market volatility index.

3.3. Preliminary Analysis

The preliminary analysis is undertaken through the lens of stationarity. The unit-root test is necessary to corroborate or refute the non-stationary hypothesis. Furthermore, if the variables are given that they are not integrated of order equal to or greater than two, we examine both the short-term and long-term relationships concerning the unemployment rate, total assets (less eliminations from consolidation) from the federal bank balance sheet, and the auxiliary macroeconomic and financial variables in the United States. To reach this goal, two types of unit root tests are carried out, namely, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). The null hypothesis of ADF and PP tests involves the existence of a unit root. However, the alternative hypothesis disproves that variables have unit root.

To conduct a suitable econometric approach to study both short and long-run relationships among variables, we verify that all variables included in the econometric model must comply with the stationary hypothesis. Therefore, we undertake the testing strategy based on ADF and PP unit root tests with intercept only and with intercept and deterministic time trend.

Table 3 and Table 4 present the empirical statistics for both unit root tests, covering the financial crisis period and the Covid-19 period, respectively. According to the results induced by Table 3, we highlight that all series are integrated for order one (I(1)) except for the federal funds effective rate variable that is integrated for order zero (I(0)). Also, the analysis of the results issued from Table 4 corroborates the stationary hypothesis for all variables at their first difference with the exception of the market volatility index, which is I(0). In summary, we are certain that the tests fail to globally reject the non-stationarity hypothesis for the most level variables and lead to acceptance of the stationarity hypothesis for the corresponding first difference series.

Table 3. ADF and PP unit root tests for the financial crisis period.

Level	ADF		PP	
	Model 1.	**Model 2.**	**Model 1.**	**Model 2.**
U	-1.696	-2.398128	-0.806	-2.064
BL	-2.291	-1.381	-2.200	-1.272
FF	-4.871***	-5.415***	-3.085**	-2.055
CPI	-0.786	-3.570**	-0.871	-2.937
IPI	-2.527	-3.584**	-1.405	-2.028
MVI	-2.887**	-3.547**	-3.087**	-3.915**
First difference				
U	-4.024***	-5.874***	-10.536***	-10.821***
BL	-7.999***	-8.282***	-6.153***	-6.533***
FF	-3.054**	-4.483***	-5.329***	-6.379***
CPI	-6.847***	-6.894***	-6.652***	-6.633***
IPI	-3.959***	-4.118***	-9.802***	-9.864***
MVI	-9.784***	-9.743***	-10.402***	-10.352***

Note: The model 1. and model 2. indicate a model with only intercept and a model with intercept and deterministic time trend, respectively. *** P-value < 0.01, ** P-value < 0.05.

Table 4. ADF and PP unit root tests for the Covid-19 period.

Level	ADF		PP	
	Model 1.	Model 2.	Model 1.	Model 2.
U	-2.185	-2.244	-2.185	-2.244
BL	-1.262	-1.204	-1.051	-1.188
FF	-0.662	1.274	-0.510	2.855
CPI	0.995	-1.436	2.075	-1.048
IPI	-2.699*	-2.777	-2.168	-2.169
MVI	-3.265*	-3.339*	-3.265**	-3.339*
First difference				
U	-6.515***	-6.476***	-6.538***	-6.502***
BL	-4.110***	-4.191***	-3.463**	-3.336*
FF	-2.847*	-4.062**	-2.846*	-3.986**
CPI	-3.308**	-3.794**	-3.329**	-3.794**
IPI	-5.669***	-5.661***	-5.477***	-5.674***
MVI	-6.401***	-6.336***	-8.886***	-8.845***

Notes: The model 1. and model 2. indicate a model with only intercept and a model with intercept and deterministic time trend, respectively. *** P-value < 0.01, ** P-value < 0.05, and * P-value < 0.1.

4. Econometric Outcomes

As previously reported, we apply the ARDL strategy described by Pesaran et al. (2001) to investigate the short-run and long-run relationships between the unemployment rate, the log-natural transformation of the total assets (less eliminations from consolidation), the macroeconomic variables set (CPI and IPI), and the financial variables set (FF and MVI) in the United States. In contrast to traditional cointegration methods for small samples, order of integration of the series does not matter for applying the ARDL[2] bounds testing if no variable is found to be stationary at order two or more. The choice of the lag length affects the ARDL bounds test. To establish the appropriate lag order, we use the *SIC* criteria. Using an appropriate lag length, we will be ensured to seize the joint dynamic link between the series (Lütkepohl, 2006).

4.1. ARDL Bounds Test Methodology

We remind you that the cointegrating hypothesis begets that the statistical negative significance of the coefficient ψ exhibits a cointegration relationship between the unemployment rate and the set of explanatory variables such that described in the unrestricted regression (Equation 2). Thus, we need to compute the F-test applying for the financial crisis and the Covid-19 periods, such as $F(U/BL, CPI, IPI, FF, MVI)$. Table 5. summarizes these computed statistics and the respective statistics of the Breusch-Godfrey (Lagrange multiplier: LM) test for autocorrelation, the Autoregressive Conditional Heteroskedasticity (ARCH) test, the Jarque-Bera normality test, and the Ramsey RESET test statistics test, respectively.

Table 5. Diagnostic tests and F- test for.

Type model	LM	ARCH	JB	RESET	*F*-statistic	Selected model
Financial crisis period	1.392 [0.252]	1.554 [0.155]	0.246 [0.884]	0.512 [0.476]	7.447***	ARDL (2, 0, 1, 0, 2, 1)
Covid-19 period	0.717 [0.496]	0.531 [0.470]	0.778 [0.678]	2.517 [0.122]	12.060***	ARDL (1, 1, 0, 0, 2, 1)

Note: The values in brackets indicate the p-values. For F-statistics, the lower bound critical values are 2.08 (P-value < 0.1), 2.39 (P-value < 0.05) and 3.06 (P-value <0.01), and the upper bound critical values are 3.00 (P-value < 0.1), 3.38 (P-value < 0.05) and 4.15 (P-value < 0.01). ***P-value < 0.01.

Using ARDL approach as described previously, the calculated F-statistics for both periods are 7.4465 and 12.0595, confirm the long-run relationship between the variables at the 1 percent significance level for the financial crisis period and Covid-19 period, respectively. It allows for evidence on the sensitivity of each variable to changes of the other variable and to consider that unemployment rate lends the role of long-run forcing variable.

Also the results of the Breusch-Godfrey LM test and the Jarque-Bera normality test show that the residuals are separate and spread out normally. The ARCH statistic confirms the homoscedasticity hypothesis of the residuals. Lastly, the empirical statistic for RESET statistic accepts the hypothesis of the correct functional form of above Equation 2.

[2] An appropriate specification of the ARDL model is sufficient to simultaneously correct for residual serial correlation and endogeneity problems (Pesaran, Shin, & Smith, 1999).

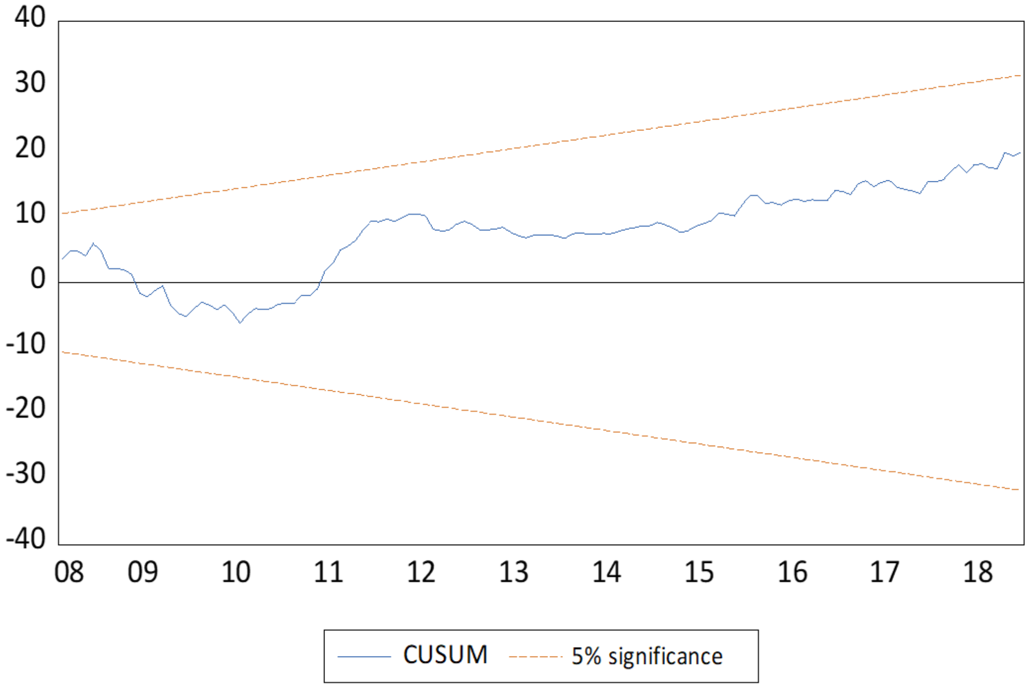

Figure 7. Plot of cumulative sum of recursive residuals for the financial crisis period.

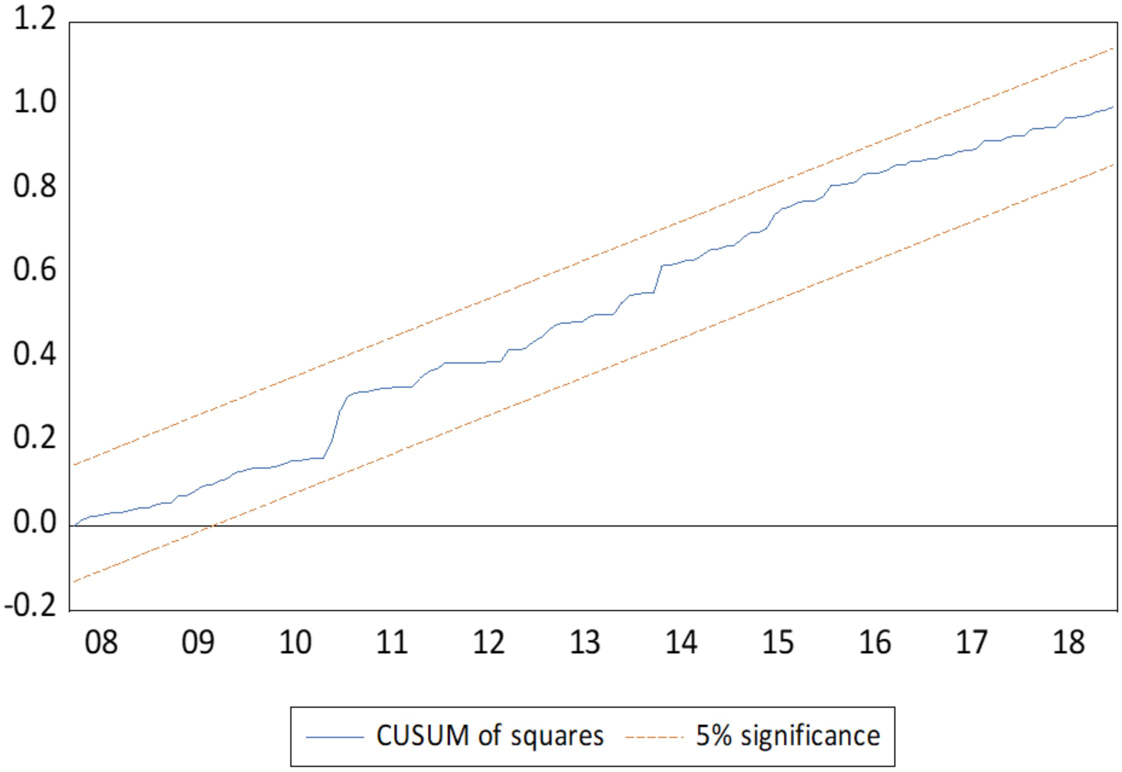

Figure 8. Plot cumulative sum of squares of recursive residuals for the financial crisis period.

Note: Financial crisis period. The straight lines represent critical bounds at the P-value < 0.05.

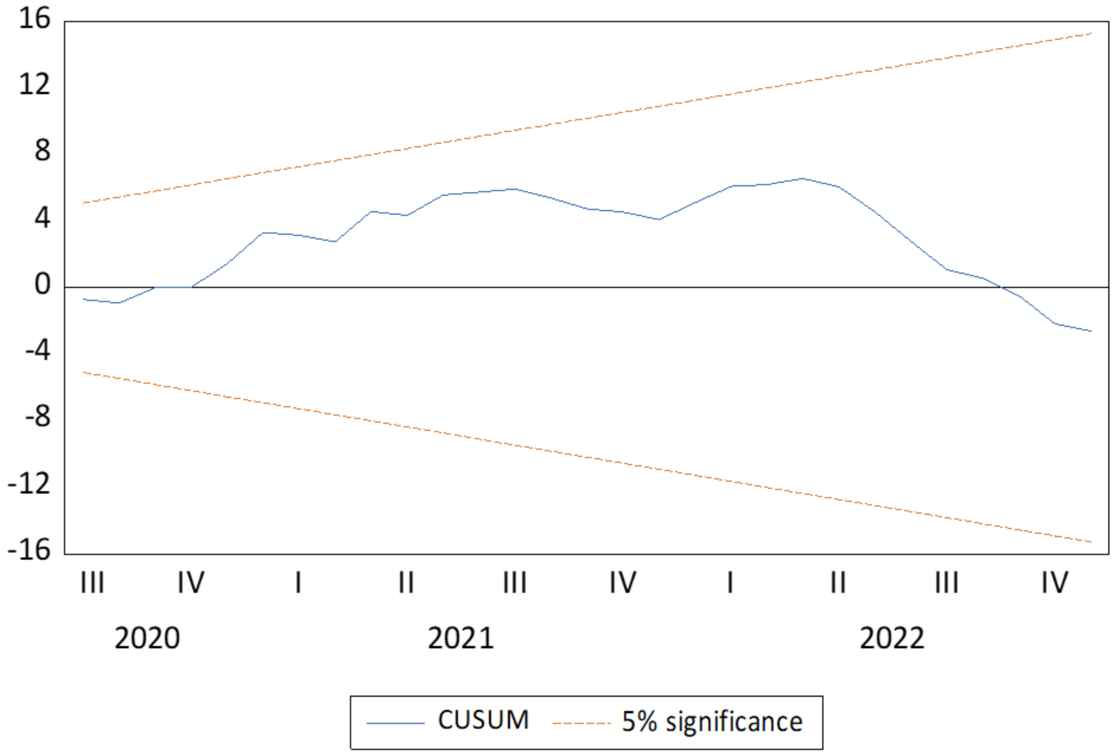

Figure 9. Plot of cumulative sum of recursive residuals for Covid-19 period.

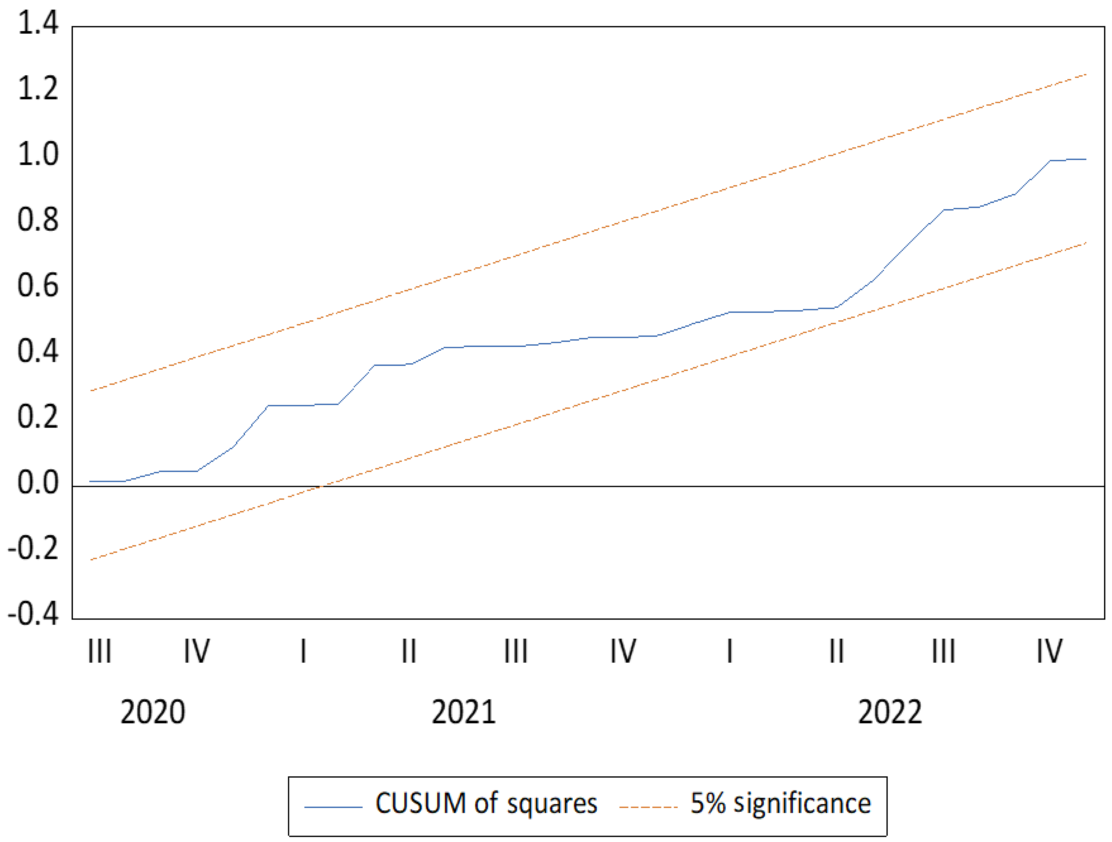

Figure 10. Plot cumulative sum of squares of recursive residuals for Covid-19 period.

Note: Covid-19 period. The straight lines represent critical bounds at the P-value < 0.05.

Figures 7 to 10 show that during both periods, the stability of the long- and short-term parameters is affirmed through cumulative sum (CUSUM) tests and cumulative sum of squares (CUSUMSQ) of recursive residuals. The graphs reveal that the CUSUM and CUSUMSQ tests lie within the 5 percent critical bounds. These tests translate that the relationship described in Equation 2 went through stability at least for each period.

In accordance with previous empirical results, we are able to start with appropriate ARDL representation for analysing cointegration among variables for the financial crisis period and the Covid-19 period, respectively.

4.2. Short and Long Run Estimates

According to the following Equation 3 that describes the cointegrating relationship through the ARDL (p, q) specification for the financial crisis period and the Covid-19 period, we try to estimate the short-run and long-run parameters only with intercept and without the deterministic time[3]:

$$\varrho(L,p)U_t = \lambda_0 + \varphi'(L,q)X_t + \upsilon_t \quad (3)$$

Where, $\varrho(L,p) = 1 - \varrho_1 L - \varrho_2 L^2 - \cdots - \varrho_p L^p$, $\varphi'(L,p) = \varphi'_0 + \varphi'_1 L + \varphi'_2 L^2 + \cdots + \varphi'_q L^q$, U_t is the dependent variable denotes the unemployment rate, $X_t = (BL_t, CPI_t, IPI_t, FF_t, MVI_t)$ is the vector of independent variables previously defined, υ_t indicates the stochastic error term. The sensitivity of the variation in the dependent variable to the changes of a long-run forcing variable associated with the appropriate ARDL is expressed as follows, in which the lag orders $(\hat{p}, \hat{q})$ are the estimated values of the lag orders(p, q):

$$\hat{\phi} = \frac{\sum_{i=0}^{\hat{q}} \hat{\varphi}_i}{1 - \sum_{i=1}^{\hat{p}} \hat{\varrho}_i} \quad (4)$$

From results summarized in the following Table 6, we confirm an existing and significant effect channeled from the log-natural transformation of the total assets (less eliminations from consolidation), the macroeconomic variables set (CPI and IPI), and the financial variables set (FF and MVI) to the unemployment rate in the United States for both financial crisis period and the Covid-19 period.

Table 6. Long-run coefficients for both periods.

Selected model	Financial crisis period		Covid-19 period	
	ARDL (2, 0, 1, 0, 2, 1)		ARDL (1, 1, 0, 0, 2, 1)	
	Coefficient	P-value	Coefficient	P-value
LBL	-2.793**	0.029	2.895*	0.083
FF	-0.752**	0.014	0.485**	0.034
CPI	-0.005	0.910	-0.082*	0.050
IPI	-0.221***	0.007	-0.272*	0.054
MVI	0.114**	0.015	0.090**	0.016
C	69.281***	0.000	6.015	0.825

Note: ***P-value < 0.01. **P-value < 0.05, and *P-value < 0.1.

For the financial crisis period, the *LBL* coefficient is significantly negative. It means that a 1% increase in *LBL* decreases the unemployment rate by 2.79%. This suggests a correlation between the growth or stability of economic assets and a decrease in the unemployment. An increase in net assets can stimulate investment and economic growth, thereby creating employment opportunities. Companies may be more inclined to hire when their assets increase, signaling increased confidence in the economy (Cascio, Chatrath, & Christie-David, 2021). In addition, *FF and IPI* are significantly decreasing functions of the unemployment rate. It shows that a 1% increase in *FF* and *IPI* is expected to decrease the unemployment rate by 0.75% and 0.22%, respectively. Thus, lower federal funds rates can encourage investment and spending, thereby stimulating economic activity and job creation. Similarly, a rise in labor demand may correlate with an increase in industrial production, leading to a decrease in unemployment. These findings suggest that policies or conditions conducive to lower interest rates and growth in industrial production can have a positive impact on the labor market by reducing unemployment (Campbell & Tawil, 2019). Moreover, the market volatility indicator (*MVI*) is significantly positive. It means that an increase in this indicator by 1% increases the unemployment rate by 0.11%. Nevertheless, through the Covid-19 period, the results identified that the coefficient of LBL is significantly positive. It indicates that a 1% increase in *LBL* positively changes the unemployment rate by 2.89%. Furthermore, the same impact is shown for *FF* and *MVI*. The results show that a 1% increase in *FF* and *MVI* increases the unemployment rate by 0.48% and 0.089%, respectively. An increase in market volatility, as well as specific variables like LBL, FF, and MVI, is associated with a rise in the unemployment rate. This connection can be seen as the job market's sensitivity to changes in the economy and certain financial indicators during the time period that was studied (Hartwell, 2018). However, *CPI* and *IPI* are significantly and reveal a decreasing function of the unemployment rate. It shows that a 1% increase in *CPI* and *IPI* is expected to decrease the unemployment rate by 0.081% and 0.272%, respectively.

The following table summarizes estimated results of the short-run parameters regarding both the financial crisis period and Covid-19 period. In the global financial crisis period, the *LBL* coefficient is significantly negative. A 1% increase in *LBL* generates a decrease of the unemployment rate by 0.19%. It is obvious that the unconventional measure of quantitative easing has succeeded in reducing the unemployment rate in the United States in the short term. Similarly, the impact of *FF* and *IPI* on the unemployment rate is found to be negative and significant at the 10% significance level. It shows that a 1% increase in *FF* and *IPI* is expected to decrease the unemployment rate by 0.051% and 0.015%, respectively. However, the coefficient of *MVI* is significantly positive. It shows that a 1% increase in *MVI* leads to an increase in the unemployment rate by 0.007%. During

[3] According to *SIC* criteria.

the period of global health crisis, *LBL* coefficient is found to be positive and significant. It means that a 1% increase in *LBL* increases the unemployment rate by 1.80%. The same positive effect is found for *FF* and *IPI*. Thereby, a 1% increase in *FF* and *IPI* generates an increase in the unemployment rate of 0.30% and 0.10%, respectively. Furthermore, *MVI* has a significant negative impact on the unemployment rate. A 1% increase in *MVI* reduces the unemployment rate by 0.05%.

Table 7. Cointegrating coefficients for both periods.

Type model	Financial crisis period		Covid-19 period	
	Coefficient	P-value	Coefficient	P-value
C	4.743***	0.000	3.748	0.830
U(-1)	-0.069***	0.000	-0.623***	0.001
LBL	-0.192**	0.027	-	-
LBL(-1)	-	-	1.804*	0.064
FF(-1)	-0.052*	0.076	-	-
FF	-	-	0.302**	0.026
CPI	-0.000	0.911	-0.051**	0.030
IPI(-1)	-0.015***	0.006	-0.170	0.138
MVI(-1)	0.008***	0.000	0.056***	0.006
D(U(-1))	-0.173**	0.040	-	-
D(FF)	0.182	0.112	-	-
D(LBL)	-	-	19.999***	0.000
D(IPI)	-0.010	0.672	-0.098	0.284
D(IPI(-1))	-0.048**	0.030	0.110***	0.002
D(MVI)	0.002	0.573	-0.030***	0.006
ECT(-1)	-0.069***	0.000	-0.623***	0.000

Note: ***P-value < 0.01. **P-value < 0.05, and *P-value < 0.1.

Furthermore, Table 7 shows that the error correction term associated with our model (2) is negative and is considered statistically significant at the 1 percent significance level. It means that there is a return to the long-term equilibrium for the model specified in Equation 2 for both periods. At time (t-1), the estimate error correction term (ECT_{t-1}) corroborates the established log-run equilibrium between the unemployment rate and the log-natural transformation of the total assets (less eliminations from consolidation), the macroeconomic variables set (CPI and IPI), and the financial variables set (FF and MVI) in the case of the United States. For the financial crisis (Covid-19) period, the ECT_{t-1} is -0.0685 (-0.6231). This engenders that about 6.9 percent (62%) changes in unemployment rate for the financial crisis (Covid-19) period are corrected by deviations in short run towards long run path in each month, ceteris paribus. This implies that the restoration of the long-run equilibrium will occur approximately 15(2) months into the financial crisis (Covid-19) period. The fact that the absolute value of the error correction term coefficients is between 0 and 1 allows that the relationships present a considerable potential predictability and that the spread movements are mean-reverting.

Finally, the estimated results show that during the financial crisis, an increase in the balance sheet of the Federal Reserve reduces the unemployment rate in both the short term and the long term. This means that the Federal Reserve succeeded with its unconventional monetary policy in improving the job market and reducing unemployment in the period of financial crisis. This is explained by the fact that reforms and exponential monetary policies should support investment and consumption to strengthen aggregate demand and production and reduce unemployment. Nevertheless, during the Covid-19 crisis, we show that increasing the Federal Reserve balance sheet positively affects the unemployment rate in the short and the long term. This means that the level of unemployment increases after an expansionary monetary policy, despite the massive injection of liquidity into the economy being three times higher than during the 2008 financial crisis. There are some possible reasons. On the one hand, a large part of workers is confined, which has reduced household resources and prevented them from purchasing products and services (demand shock). On the other hand, companies face supply issues as they no longer receive the necessary goods from foreign or even domestic suppliers. All these factors contributed to the failure of unconventional monetary policy to limit unemployment or even help increase the unemployment rate. These results suggest that the effectiveness of monetary policies can vary depending on the economic context and specific conditions surrounding a crisis and that there may be limits to the positive impact of such measures, especially in exceptional circumstances like the Covid-19 pandemic.

5. Conclusion

Since the 2008 crisis and then the Covid-19 crisis, central banks have engaged in completely new monetary policies with an explosion in the size of their balance sheets as well as some things that we have rarely seen: negative interest rates. We examine the relationship between the increase in the Federal Reserve balance sheet and the unemployment rate to reveal the effect of unconventional monetary policies (quantitative easing) on the unemployment rate during financial crises and pandemics.

This study reveals that the rate of unemployment and unconventional monetary policies demonstrated enormous power during the period of financial crises. We argue that the Federal Reserve succeeded in lowering the unemployment rate with its unconventional quantitative easing monetary policy in the short and the long term. Very low interest rates and expansionary monetary policy push investors to invest and encourage the revival of overall demand and spending, which stimulates the level of employment and reduces unemployment. However, during the Covid-19 epidemic, with a recession as severe as during the global financial crisis, the unemployment rate has increased in response to unconventional monetary policies in the short and in the long term. The failure of unconventional monetary policy to limit unemployment can be explained by the containment measures, which limit the population's movements, income, and consumption; the supply difficulties of businesses; and the lack of labor reducing production. It is true that we have seen that the various economies emerged from crises with the help of unconventional monetary measures, but the pace of recovery also depends on the return of household and business confidence in the future. This seems to support the idea that quantitative easing can reduce the unemployment rate in economic turbulence periods, but during other health and social crises, it will be more difficult for central banks alone to limit unemployment through their unconventional monetary policies.

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