Effect of fiscal expansion on inflation during the period of *unconventional* monetary policy

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Abstract: *Economic supply shocks and fiscal expansion coupled with monetary expansion are suspected causes of the rise in inflation that we observe in most of the developed and developing economies today. In this paper we look at the effect of the government budget deficit(surplus) or fiscal policy stance, and quantitative easing on inflation while controlling for economic shocks using the method of cointegration as we find data series in our model to be integrated of order one and having support of one cointegrating equation between the variables. Our analysis is performed using Federal Reserve monthly data from 1994 to 2022 using Two-Step Engle-Granger (1987) method and Fully Modified OLS by Phillips and Hansen (1990). We compare these models to Auto Regressive Distributed Lag model of Pesaran and Shin (1998) which allows for analysis irrespective of the order of integration to provide for more robustness regarding the estimated relationships in cases of misspecification of stationary properties in our time series. Both cointegrating models lend support to the initial postulated relationship where expansionary fiscal policy has significant positive impact on the price level during the long run but also enhances the effect of the Quantitative Easing on the price level as the interaction term between these variables is significant, indicating that during the periods of expansionary fiscal policy, expansionary monetary policy through Quantitative easing has bigger effect. Our analysis is performed controlling for effect of economic shocks and price of real exchange rate on the price level. Stability of the cointegration model tests reveal presence of structural breaks which when included in the cointegrating equation change the importance of the impact that fiscal stance has on inflation and reveal that inflation is mainly result of the expansion in central bank assets after 2008, which coincides with period of unconventional monetary policy.*

Keywords: *Aggregate Prices, Price Index, Determinants*

JEL classification: *E3, E32, E39*

Introduction

Periods of low and negative interest rates which have resulted from lowering of interest rates as a response to Global financial crisis of 2008 have had for an aim expansion in volume of economic activity. The lack of inflationary pressures from monetary expansion during this period has for some time disrupted the conventional belief that increase in money supply eventually leads to increase in the price level as postulated by the quantity theory of money. Subsequently, pandemics caused by COVID-19 and shocks to economic activity which were associated with it led many governments to undertake fiscal expansion on a scale not seen before. Economic policy makers have for long had comfort of having stable price levels irrespective of the low interest rates which have resulted from periods of expansionary monetary policy. The low interest rates eventually resulted in the Zero Lower Bound on interest rates as there was no more space for maneuver as nominal interest rates could not go below zero. According to the Federal Reserve, after 2008, unconventional monetary policy period started. Due to positive inflation rates, nominal interest rates adjusted for inflation went into negative territory resulting in negative real interest rates, hence calling for unconventional monetary policy, which has seen its manifestation in so called Quantitative Easing measures conducted by the Federal Reserve.

According to Williamson (2017, p.1), 'Quantitative easing (QE)—large-scale purchases of assets by central banks—led to a large increase in the Federal Reserve's balance sheet during the global financial crisis (2007-2008) and in the long recovery from the 2008-2009 recession.' According to Choulet, 2015) the trend of not replacing maturing securities in 2019, which helped unwind its balance sheet ended, so that Fed began purchasing assets at an average rate of 120 billion USD per month which increased Fed's balance sheet by more than 80 percent. The measure was designed to help reduce unemployment but it has also probably led to inflationary pressures.

The above-described policy came to be termed as quantitative easing, employed when interest rates are near zero. There is a gap in the literature concerning empirical work on the effectiveness of monetary policy tools and instruments prior to zero lower bound period and during zero lower bound period, but also there are other factors such as fiscal policy stance which could have, in combination, created a large spike in inflation, so that effect of combination of fiscal and monetary expansion could be of special concern to the policy makers, before and after the period of zero lower bound. This paper explores the effect of expansionary fiscal policy in combination with expansionary monetary policy during the zero lower bound and before this period while controlling for exogenous shocks.

Literature Review

Standard macroeconomic theory found in aggregate demand and aggregate supply model of the economy establishes price level in the economy as one of the key macroeconomic prices which adjusts to bring economy to internal balance. At the same time the internal balance influences directly the market for loanable funds through the saving and investment, so that these forces concurrently adjust with net capital outflow and real exchange rate through the mechanism of real interest rate, to bring the external equilibrium and ensure the internal and external equilibrium of the economy occur concurrently.

In Figure 1. below the saving and investment are indirectly outcome from the overall macroeconomic identity where output is given by Y=C+I+G+NX or where internal balance or balance in domestic market for goods and services is achieved where planned expenditure Y, equals consumption on goods and services by households (C), investment by firms (I), government consumption (G) and the net exports (NX). Rearranging this relationship, it follows from this condition for internal balance that national saving (S) is represented by Y-C-G. Rearranging the above macroeconomic identity also gives that S=I+NX. Since net exports (NX) are equal to net capital outflow (NCO) we can also express the internal goods balance condition which comes from the starting macroeconomic identity as: S=I+NCO. Since national Saving and Investment are key forces in the market for loanable funds, we have established the connection between these variables which define internal goods balance and the external markets for capital and national currency, which is shown in Figure 1.

Equilibrium in the open economy is therefore established when in panel (a), supply and demand for loanable funds determine real interest rate. This real interest rate then, as shown in panel (b) determines the Net Capital Outflow, which provides for supply of domestic currency in the foreign exchange market and determines the Real Exchange Rate, as shown in panel (c).

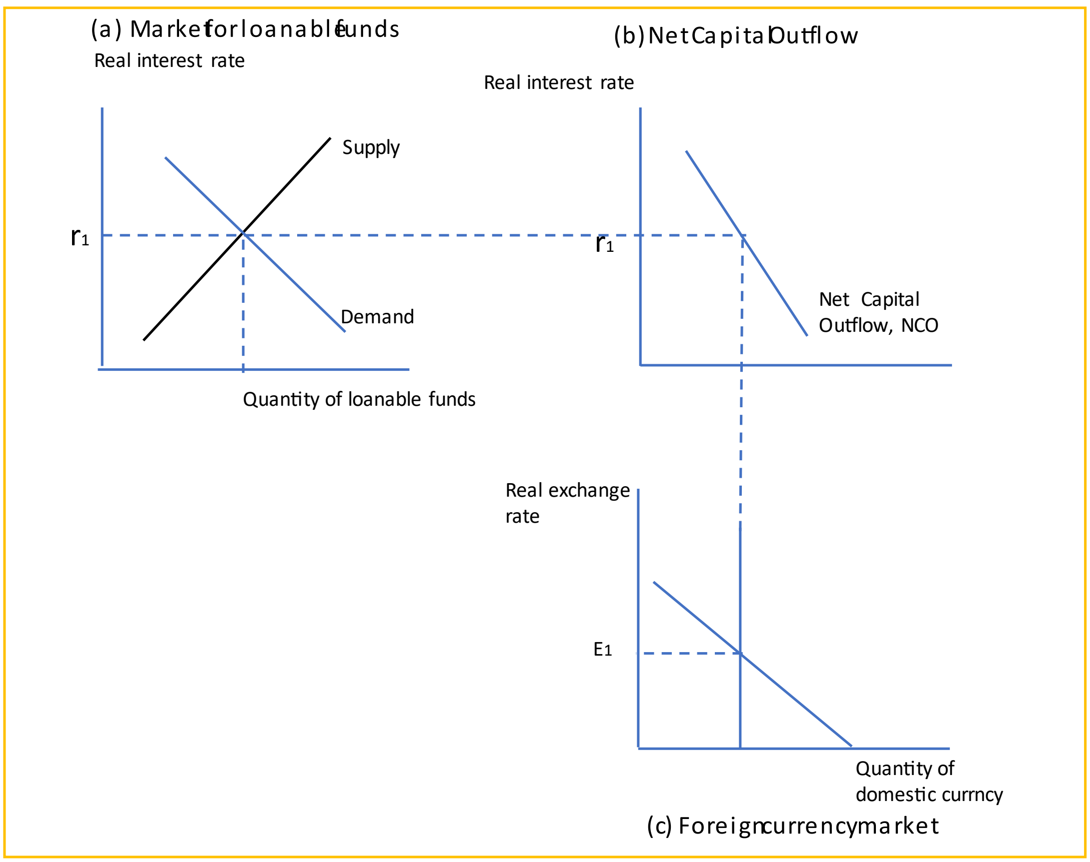


Figure 1. Equilibrium in Open Economy

Real interest rate from Figure 1. established in the market for loanable funds is also target of monetary policy stance as lower interest rate is associated with higher investment and hence higher aggregate demand and lower unemployment. This monetary policy framework is established by Monetary Policy curve which shows the relationship between inflation (price level) and the real interest rate arising from monetary authorities' actions. Monetary policy follows the Taylor principle, in which higher inflation results in higher real interest rates, as represented by a movement up along the monetary policy curve. Since the real interest rate is a nominal interest rate minus inflation, higher inflation requires higher nominal interest rate to keep the real interest rate unchanged. Therefore, higher inflation requires higher real interest rates in order to slow down inflationary pressures. (Blanchard, 2011:546)

There is large body of theoretical models which describe transmission channels of monetary policy to price level and according to Petursson (2001) the output gap arising from internal goods market and import prices, both contribute to the overall price level. Based on these theoretical postulations we expect to observe that quantitative easing will result in the overall price level increase.

The fiscal stance of the government adds to the overall aggregate demand, and we expect that increase in net government budget deficit will be associated with the overall increase in the price level. In macroeconomic theory fiscal expansion is associated with the increase in aggregate demand which given aggregate supply leads to increase in the overall price level.

Based on the theoretical framework above the higher real exchange rate is associated with a lower Net Capital Outflow, which means lower Net Exports, due to equality of these two, and therefore is associated with a higher real interest rate. A higher real interest rate in turn should lower the pressure in internal markets as it lowers consumption and investment and hence leads to lower inflation and price level. We therefore expect to see that a higher real exchange rate leads to lower inflation or price level, hence expecting a negative relationship between these two variables. We therefore control for these other variables which have connection with the price level while studying effect of quantitative easing and fiscal stance on inflation.

Empirical tests of the postulated relationships between quantitative easing and inflation are numerous using the Vector Error Correction and Vector Autoregression Models, which provide a mixed results in terms of the effect that quantitative easing has on the inflation rate. Sadahiro (2005) executed Vector Error Correction Model analysis, in which the impulse responses of the inflation to an increase in the monetary base, resulted in a fact that industrial production does increase, albeit the magnitude is minimal, while the inflation rate decreases. In order to identify the QE policy shock, Carrera et al. (2015) estimated a structural vector autoregressive (SVAR) model finding that in the US, a QE policy shock produces a positive and significant effect in prices (CPIUS) in the medium-term. According to Coenen and Wieland (2004) and Peersman (2011) and their analysis of coordinated monetary policy, quantitative easing causes an upshift in inflation.

According to Saadahiro (2005) the effect of the quantitative easing and relationship to the fiscal policy or government debt is working through the composition of the central bank's balance sheet changing the composition of the privately-held and public debt, what, in turn, affects the sensitivity of inflation to fiscal shocks. The price level increases to lower the real value of the debt, after a fiscal shock making fiscal surpluses. According to Reis (2016) the maturity of the combined government debt and bank reserves held by the public determines the size and time profile of inflation. Combination of public debt and quantitative easing is hypothesized to have a profound effect on inflation giving us motivation to study interaction of the variables of central bank balance sheet and government deficits. Bossone (2014) states that QE must be accompanied by fiscal expansion for the policy action to be successful in stimulating aggregate demand and raising inflation which should be captured by significance of the interaction term of these variables in our analysis.

Quantitative easing can also lead to government budget deficit increase as purchases or loans by the Fed lead to an increase of outstanding bank reserves that are not counted as part of deficit spending or as government debt (Fullwiller, 2010). However, the government's fiscal exposure to future interest-rate hikes represents a risk of prolonged QE activities. According to Rajan (2021) at the government debt at around 125% of GDP, every percentage-point increase in interest rates translates into a 1.25 percentage-point increase in the annual fiscal deficit as a share of GDP, therefore motivating further QE measures. This might have promoted overusing of QE and as warned by Rajan (2021) in case of overusing QE, government debt can quickly become stressful. In this context Bhattarai et al. (2014, p.32) suggest that 'reducing the duration of outstanding government debt or increasing the balance sheet size and duration of assets held by an independent central bank, provides an incentive for the central bank to keep short-term interest rates low in future in order to avoid balance sheet losses', hence supporting conclusion that this exercise might have been overused due to these motivations. According to Murphy and Hines (2010), the whole government deficit in the United Kingdom, in 2009/10, amounting £155 billion, was basically paid for by the quantitative easing programme of the Bank of England. As Chadha et al. (2013) states while explaining monetary policy and government debt management, large-scale purchases of bonds by the Federal Reserve, and other major central banks, have largely reduced the scale and maturity of public debt that would otherwise have been held by the private sector. This suggests that quantitative easing and fiscal deficit have in this episode been entwined together in a unique way and that this could have potentially been cause of the spike in inflation in addition to supply shocks after COVID-19 pandemics, motivating our research into the effect of their combined occurrence on inflation.

Following the above suggested relationships between quantitative easing and fiscal deficit on inflation motivates research of the long run relationship of these variables over the period which includes both period prior and after the quantitative easing measures have started while controlling for effect of external shocks observed through volatility in the stock market, real exchange rate and tightness of internal goods market.

Methodology

Relationship between the variables which are time series data can be studied using the Cointegration Regression in case when all data series exhibit nonstationary properties. That is, the relationship between nonstationary data series can still be undertaken using the cointegration method if all series are integrated of order one, and cointegrating equation is present. We test our data for stationarity using the standard Adjusted Dickey Fuller and Phillips Peron test statistics. (Stock and Watson, 2011:236)

The Cointegrating Regression form (Engle and Granger, 1987) tested is provided in Equation (1) where the disturbance term ε_t in is a mean-zero stationary random variable.

$$y_t^{*}=a_0+\sum_{j=1}^{k}\beta Xj \quad +\varepsilon_t \qquad (1)$$

where β is the cointegrating vector and ε_t is an uncorrelated random disturbance.

In presence of cointegration we can examine the short-term dynamics of our dependent variable, CPI, by estimating an error correction model of Equation (2) where residuals from static regression

(ε_t) in Equation (1), are used in place of the equilibrium error on the right hand side of the error correction equation to tie short-term behavior of y_t to its long-run value. (Lim ad Stain, 1995)

$$dy_t^{*}=a_0+\sum_{j=1}^{k}\beta dXj \quad +c\varepsilon_{t-1}+z_t \qquad (2)$$

For psychological, technological, and institutional reasons, a regressand (our dependent variable of price level which indicates inflation) may respond to a regressor(s) (our independent variables which measure government budget stance, quantitative easing) with a time lag, while controlling for the effect of exogenous economic shocks. We therefore use regression model that takes into account time lags, known as dynamic or lagged regression models. (Gujarati,2004:468)

Based on Pesaran and Shin (1998) and Pesaran, Shin and Smith (2001) we utilize ARDL models to take advantage of the fact that they are robust to misspecification of integration orders of relevant variables in our analysis. Auto Regressive Distributive Lag (ARDL) model is a linear time series model in which both the dependent and independent variables are related not only contemporaneously, but across historical (lagged) values as well. So that, if y_t is the dependent variable and x_1, ..., x_k are k explanatory variables, a general ARDL (p, q_1, ..., q_k) model is given by:

$$y_t = a_0 + a_1 t + \sum_{i=1}^{p} \psi_i y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_j} \beta_{j,l_j} x_{j,t-l_j} + \epsilon_t \qquad (3)$$

where, ϵ_t are the usual innovations, a_0 is a constant term, and a_1,ψ_i,, and β_j,l_j, are respectively the coefficients associated with a linear trend, lags of y_t, and lags of the k regressors x_j,t,t for j=1,…k_j=1,…k.

The exact form of Equation (3) tested takes CPI as independent variable and explanatory variables are fiscal stance (FISCAL) and Federal Reserve Assets (CBASSETS) and Real Exchange Rate (REER). The volatility of the stock market index (SHOCKS) is included as a control variable to capture the exogenous supply and demand shocks which have influenced the economy, while unemployment rate (UNRATE) is used to reflect tightness of the internal factor and goods markets.

We add the interaction term between the fiscal stance of the government and quantitative easing in Equation 1. and 2. to evaluate whether the effect of the monetary policy is significantly changed during the presence of the fiscal stimulus.

Data Analysis

Data is obtained from Federal Reserve Economic Data (FRED). The sampling frame includes below listed variables observed monthly during the period January 1994-January 2022, covering the period prior to zero lower bound, ZIRP (Zero interest-rate policy) period from December 2008 to December 2014, and post zero lower bound period.

Consumer Price Index (CPI) for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL); Units: Index 1982-1984=100, Seasonally Adjusted Unemployment Rate (UNRATE); Units: Percent, Seasonally Adjusted Interest Rates, Government Securities,

Government Bonds for United States (INTGSBUSM193N); Units: Percent per Annum, Not Seasonally Adjusted
CBOE Volatility Index: VIX, (VIXCLS); Units: Index, Not Seasonally Adjusted Real Broad Effective Exchange Rate for United States (RBUSBIS); Units: Index 2010=100, Not Seasonally Adjusted Federal Surplus or Deficit [-] (MTSDS133FMS); Units: Millions of Dollars, Not Seasonally Adjusted Central Bank Assets: Federal Reserve; Units: Millions of Dollars, Not Seasonally Adjusted

Results/Findings

Table 1. shows stationary properties of data. However, based on our discussion above which indicates appropriateness of ARDL methodology in case of different order of integration of the underlying variables we perform no transformation of the data series.

Table 1. shows results of Adjusted Dickey Fuller test and Phillips Peron test for dependent and independent variables used in our model representation in Equation (1) and (2).

Table 1. Tests for stationarity

	ADF	PP	Decision
CPI	1.1931	1.1112	I(1)
FISCAL	-2.5711	-14.6488	I(1); I(0)
CBASSETS	1.4617	1.5869	I(1)
SHOCKS	-4.4698	-4.4556	I(0)
REER	-1.7549	-1.7132	I(1)
UNRATE	-2.7251	-2.5742	I(1)

Notes: test assumption includes constant in test equation. Augmented Dickey-Fuller statistics (ADF) The MacKinnon critical values are 1%=-3.4589, 5%=-2.8740, 10%=-2.5735. Sample period is 2003M2 to 2022M01.

Omerbegović (2005, p.43) explains that Johansen (1988) cointegration test sets ‘the null hypothesis that the number of cointegrating vectors relating n nonstationary variables is less than or equal to r (where r<n).’ Reading the results of the Johansen maximum-likelihood procedure on the variables shown in Table 2. in a way so that we compare likelihood ratios (in column 2.) to the asymptotic critical values presented in column 3, leads us to conclude that the hypothesis of no cointegration (as postulated in the first raw in Table 2.) can be rejected in favor of at most one cointegrating vector. We do not reject the hypothesis of one cointegrating vector in favor of more than one (as postulated in the second raw in Table 2.). The Johansen maximum -likelihood procedure therefore supports cointegration analysis to be performed as it indicates the presence of one cointegrating vector at the 1% confidence level.

Table 2: Johansen maximum likelihood procedure for testing the number of cointegrating vectors

The variable set is (CPI, FISCAL, CBASSETS, REER, SHOCKS, UNRATE)

Null (1)	Likelihood Ratio (2)	Max. eig. Stat. [99% crit] (3)	Probability (4)
R=0	124.2740	104.9615	0.0001
R<=1	75.79004	77.81884	0.0154
R<=2	48.93141	54.68150	0.0395
R<=3	27.94093	35.45817	0.0806
R<=4	9.289273	19.93711	0.0510

Notes: Test assumption: linear deterministic trend in data. Intercept in cointegrating equation and test VAR.

Results of the estimating Cointegration Regression of the form defined in Equation 1. above are presented in Table 3.

Table 3: Cointegration Regression- Long Run Parameter Estimates using Fully Modified OLS method

Variable	Coefficient	t-stat	Probability
Coefficient	278.01	13.61	0.0000
FISCAL	-5.81E-05	-2.80	0.0055
CBASSETS	1.23E-05	19.96	0.0000
REER	-0.6852	-4.0673	0.0001
SHOCKS	0.18291	1.3041	0.1935
UNRATE	-3.2993	-4.4779	0.0000
FISCAL*CBASSETS	8.00E-12	13.6165	0.0333

Dependent variable: CPI
Notes: Adjusted R-Square=0.8893;

Table 4: Two-step Engle and Granger (1987)- Cointegration and Error Correction Mechanism-Long Run Parameter Estimates

Variable	Coefficient	t-stat	Probability
Coefficient	267.4797	26.05653	0.0000
FISCAL	-3.52E-05	-3.361239	0.0009
CBASSETS	1.18E-05	36.68749	0.0000
REER	-0.593877	-7.039496	0.0000
SHOCKS	0.160479	2.270816	0.0241
UNRATE	-2.802197	-7.562176	0.0000
FISCAL*CBASSETS	5.31E-12	2.758976	0.0063

Dependent variable: CPI
Notes: Adjusted R-Square=0.894413; Durbin-Watson statistics 0.19193

Table 5: Short Run Dynamics -(Two-Step Engle–Granger (1987) Cointegration and Error Correction Mechanism)

Variable	Coefficient	t-stat	2-tail significance
Coefficient	0.434724	9.868869	0.0000
ERR(-1)	-0.006482	-1.153300	0.2501
DFISCAL(-1)	-3.63E-07	-0.616487	0.5382
DCBASSETS(-1)	-3.11E-07	-0.750252	0.4539
DREER(-1)	-0.071528	-2.098660	0.0370
DSHOCKS(-1)	-0.059256	-6.087119	0.0000
DUNRATE(-1)	-0.099082	-1.219143	0.2241
D(CBASSETS*FISCAL)(-1)	6.61E-14	0.537572	0.5914

Dependent variable: DCPI
Notes: Adjusted R-Square=0.229298 Durbin-Watson=1.020732

Table 4 and 5 show results of the Two-Step Engle-Granger (1987) method. Error correction term is negative as postulated by the method. However, it is not statistically significant. Stability diagnostics on the long run cointegrating relationship from the Two-Step Engle-Granger (1987) procedure presented in Table 4. Indicate structural break in 2016M98 based on the Quand-Andrews unknown breakpoint test. Multiple breakpoint test confirms this and shows that additionally there is potential breakpoint in 2008M09, and 2011M07. We estimate the cointegrating relationship and show the results on the estimated coefficients on CBASSETS and FISCAL once the dummy variable is included in the regression analysis which takes value of one for periods after the suggested break in data series of 2016M08.

To additionally improve the robustness of our estimated long run relationships in cointegrating Equation (1) between CPI and its determinants, given the weakness in diagnostics which is indicated by Durbin Watson statistics, suggesting presence of autocorrelation, we estimate ARDL model defined in Equation 2, the results of which are presented in Table 5. below. The ARDL model diagnostics indicates a much better fit of the model. We therefore show comparative size of the effects of the independent variables and the CPI between cointegration regression models and ARDL in Table 7.

Table 6: ARDL Model

Selected Model: ARDL(3, 4, 1, 3, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Probability
CPI(-1)	1.475469	0.063593	23.20163	0.0000
CPI(-2)	-0.618788	0.105924	-5.841806	0.0000
CPI(-3)	0.127870	0.061658	2.073874	0.0393
FISCAL	-3.02E-07	3.79E-07	-0.796855	0.4265
FISCAL(-1)	-9.58E-07	3.55E-07	-2.701384	0.0075
FISCAL(-2)	-1.03E-06	3.86E-07	-2.659924	0.0084
FISCAL(-3)	-1.02E-06	3.69E-07	-2.768800	0.0061
FISCAL(-4)	-7.18E-07	3.51E-07	-2.046174	0.0420
CBASSETS	-1.35E-06	5.50E-07	-2.447926	0.0152
CBASSETS(-1)	1.53E-06	5.67E-07	2.694325	0.0076
UNRATE	0.193253	0.092220	2.095561	0.0373
UNRATE(-1)	-0.176195	0.083459	-2.111156	0.0360
UNRATE(-2)	-0.059534	0.077365	-0.769520	0.4425
UNRATE(-3)	-0.101415	0.059839	-1.694808	0.0916
REER	-0.073425	0.029598	-2.480797	0.0139
REER(-1)	0.047547	0.028921	1.644004	0.1017
SHOCKS	-0.008794	0.009144	-0.961671	0.3373
SHOCKS(-1)	-0.037778	0.012245	-3.085062	0.0023
SHOCKS(-2)	0.036569	0.010613	3.445663	0.0007
C	6.828624	1.673217	4.081134	0.0001

Adjusted R-Squared 0.9995, AIC =1.5253 SC=1.8289 HQ=1.6478 DW=2.005, Prob (F-statistic 0.0000)

*Note: p-values and any subsequent tests do not account for model selection.

Table 7: Regression Analysis of the Effect of Fiscal and Monetary Expansion Policies on the Price Level
Dependent variable: CPI (Index; 1982=100)

Regressor	(1) Cointegration Model	(2) Cointegration Model with Dummy Variable which takes value of 1 after 2016M98	(3) Cointegration Model with Dummy Variable which takes value of 1 after 2008M12 (after QE)	(4) ARDL Model Dynamic Coefficients	() Cumulative Coefficients of the ARDL Model
CPI(-1)				1.475469** (0.063593)	1.475469
CPI(-2)				-0.618788** (0.105924)	0.856681
CPI(-3)				0.127870* (0.061658)	0.984551
FISCAL	-5.81E-05** (2.07E-05)	-2.38E-05** (7.94E-06)	2.89E-07 (9.38E-06)	-3.02E-07 (3.79E-07)	-3.02E-07
FISCAL (-1)				-9.58E-07** (3.55E-07)	-1.26E-06
FISCAL (-2)				-1.03E-06** (3.86E-07)	-2.29E-06
FISCAL (-3)				-1.02E-06** (3.69E-07)	-3.31E-06
FISCAL (-4)				-7.18E-07* (3.51E-07)	-4.03E-06
CBASSETS	1.23E-05** (6.15-07)	9.32E-06** (3.09E-07)	7.32E-06** (5.20E-07)	-1.35E-06* (5.5.E-07)	-1.35E-06
CBASSETS(-1)				1.53E-06** (5.67E-07)	1.80E-07
UNRATE	-3.299361** (0.736807)	-1.844154** (0.288517)	-3.798162** (0.322826)	0.193253* (0.092220)	0.193253
UNRATE (-1)				-0.1762* (0.083459)	0.017058
UNRATE (-2)				-0.05953 (0.077365)	-0.04248
UNRATE (-3)				-0.10142+ (0.059839)	0.058939
REER	-0.685209** (0.168465)	-0.944924** (0.068994)	-0.398213** (0.072611)	-0.07343* (0.029598)	-0.07343
REER (-1)				0.047547 (0.028921)	-0.02588
SHOCKS	0.182911 (0.140255)	0.161391** (0.053209)	0.069776 (0.059294)	-0.00879 (0.009144)	-0.00879
SHOCKS (-1)				-0.03778** (0.012245)	-0.04657
SHOCKS (-2)				0.036569** (0.010613)	-0.01

FISCAL*CBASSETS	8.00E-12* (3.73E-12)	4.69E-12** (1.45E-12)	-3.63E-12* (1.83E-12)		
C	278.0123** (20.41721)	302.5092** (8.182943)	254.0025** (8.617501)	6.828624** (1.673217)	
Dummy=1 after 2008m12			19.77275** 1.964003		
Dummy=1 after 2016M08		19.88** (1.525934)			
Diagnostics					
F-Statistics All coefficients=0				26773 (0.000000)	
Adjusted R^2	0.889331	0.937589	0.927387	0.999560	
ADF statistic – error term	-3.285040 (0.0168)	-2.927673 (0.0438)	-3.485330 (0.0092)		

Notes:
t statistics and p-values are given under the coefficients; the individual coefficient is statistically significant at the +10%, *5%, or *1% significance level.
p-values are given in parenthesis under the F-statistics and ADF test statistics.
Sample included: 2003M01 to 2022M01

Discussion

We find a significant relationship between the size of the central bank assets and inflation in both Cointegration and ARDL models. Long run relationship established through Cointegration Regression indicates that there is positive relationship between central bank assets and CPI (price level). The size of the estimated regression coefficient suggests that the increase in central bank assets by one million US dollars increases CPI index by 12.3 points (0.0000123*1000000=12.3), which is relatively large impact given the size of the price index. However, the ARDL model predicts the size of this effect to be only 0.18 points.

The effect of the fiscal stance is measured by the government budget surplus/deficit so that increase in the FISCAL variable indicates movement towards the surplus of the government budget. Our estimated coefficient on the variable FISCAL indicates that there is a negative relationship of this variable with the CPI or price level. Increase in government budget surplus by one million leads to decrease in the CPI index by 58.1 points, which is a large impact and confirms our suspicion that fiscal policy stance has a very large impact on the price level. However, ARDL model which is superior in terms of its diagnostics estimates this effect to be only 4.03 points. Our estimated relationship between the government budget and inflation suggests that fiscal policy has a very significant influence on the price level in the long run, which is much more important in terms of the size of the effect compared to quantitative easing. Increase in government spending increases aggregate demand and hence adds to inflationary pressure. Also, increased government spending sends signal of a need for an increase in future taxes and government borrowing to finance this spending, raising inflationary expectations, and eventually resulting in higher inflation associated with the increase in government deficit.

Interaction term CBASSETS*FISCAL is statistically significant at 95% confidence interval and indicates the additional effect of increases the CPI index by 0.000008 points in addition to a unit change in variables CBASSETS and FISCAL, indicating that the combined effect of these two variables is significant. However, interpretation of the size of the effect is somewhat complicated given the opposite signs of the relationship of these variables with the CPI. So that eventually increase in government deficit by one million and increase in central bank assets by one million eventually increase CPI by more than 60 points, indicating very large and sizable effect that these two forces coupled together would have in terms of the long-term inflationary pressures. More importantly, the significance of the interaction term could mean that the most inflationary pressure come in situations when government budget deficit is coupled with monetary expansion episodes, which have occurred in the recent post pandemic years, and indicates that government budget deficits could have contributed significantly to rise of inflation we observe today.

The estimation of the cointegrating regression using the dummy variable which takes value of one after December 2008, the time which Federal Reserve marks as the period of zero interest rate policy, or zero lower bound, changes the effect of the fiscal policy variable to the large extent. In fact, it makes fiscal variable insignificant and with much smaller size of its estimated effect on CPI. This break in data could have a profound influence on the estimation of the cointegrating relationship between CPI and quantitative easing as the size of the estimated inflationary effect of the central bank assets is now indicating that one million dollars increase in balance sheet of the central bank increases CPI index by 7.32 points whereas increase in government budget deficit by one million would decrease index by 0.289 points. However, once we allow for the structural break inflation is during the period of unconventional monetary policy most significantly influenced by central bank assets expansion.

The unemployment rate (UNRATE) is taken in this study to represent tightness of the economy and we find that increase in unemployment rate by 1% is associated with decrease in CPI index by 3.3 points, which is a relatively small size effect compared to the effect of the fiscal stance (FISCAL) but is in accordance to the theoretical models where increase in unemployment rate leads to the deflationary pressures as the slackness in the labor market leads to lower price of labor but also deflationary pressures in the factor and product markets. The size of this effect is even smaller in ARDL model. We employ this variable to measure the state of the domestic economy while observing the effect of quantitative easing and fiscal policy stance on the price level and inflation, as measured by the CPI index.

The effect of the real exchange rate (REER) which measures the degree of external competitiveness of the economy indicates a relatively small size of the effect on CPI as increase in real exchange rate index causes a -0.68, or reduction in CPI index, however, it is statistically significant at 99% confidence interval. The REER variable was included to capture the external balance conditions and effect on the CPI of real exchange rate increase shows that real exchange rate appreciation which indicates worsening of the terms of trade for the US has been associated with a slight decrease in inflationary pressures, but the size of the effect is indicated to be even smaller in ARDL model estimation.

We use SHOCKS to the economy as a control variable, so we do not interpret the meaning of the size of the coefficient, but we find that SHOCKS variable is not significant at the 90% confidence interval in Cointegration Regression while being statistically significant at the first and the second lag in the ARDL model.

Cumulative effect of the coefficients on FISCAL and CBASSETS are much smaller when estimation is performed using ARDL model and in terms of the size of the effect they appear to be less important, while FISCAL is not significant at level of variable while CBASSETS is having an immediate and significant effect at level and the first lag of the variable. This indicates potential issues arising from estimation method in terms of the size of the effect, but direction of influence still corresponds to the theoretical postulations.

More importantly the sensitivity of the estimated coefficients once we allow for structural break in data in accordance to the Quant Andrew unknown breakpoint tests which suggests the first break 2016M08, then 2008M09, and finally 2011M07, which suggests that shocks induced by COVID-19 pandemics and start of the zero interest rate period have very important implications on the estimated relationship of FISCAL and CBASSETS and inflation. Graphic examination of our data series shows that these suggested breaks correspond to the breaks in data of central bank balance sheet as seen below in Figure 2.

The 2016M08 break is also a period of potential structural break in variable FISCAL indicating large increase in government budget deficit after this period as shown as a move into large negative values in Figure 3. below which shows moving average of the government budget surplus/deficit in millions of dollars.

Figure 2: Central bank balance sheet (millions of US dollars) (FRED data series RESPPANWW)

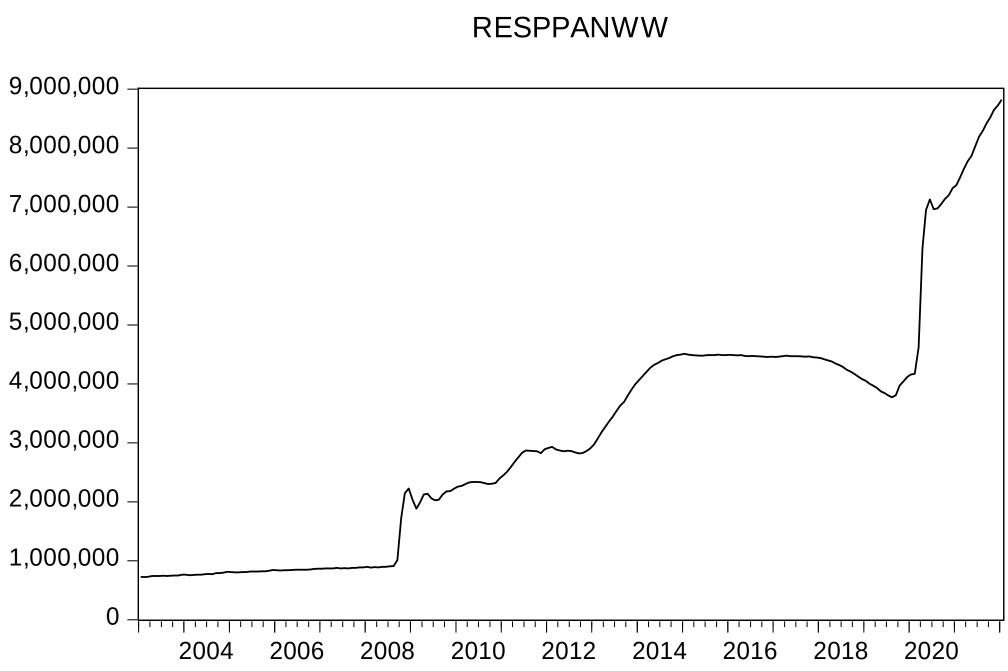
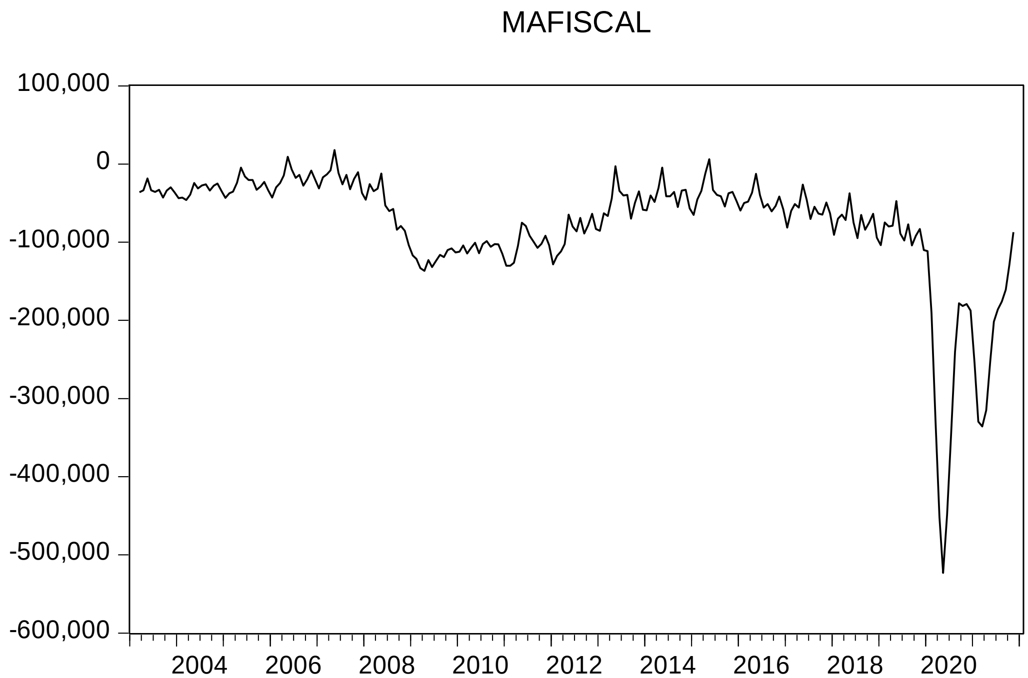


Figure 3. US Government budget surplus/deficit in US dollars



Conclusion

In this paper we estimate cointegrating equation between the price level and government budget deficit and central bank assets, while controlling for effects of internal and external shocks to the economy through the variables of unemployment rate, real exchange rate and volatility of the stock market index. We find support for one cointegrating equation using Johansen (1988) likelihood procedure and find that government budget deficit has strong inflationary pressure. The effect of quantitative easing on the price level is also exacerbated in the presence of the fiscal expansion as the interaction between these two independent continuous variables is found to be statistically significant. Estimation of the long run relationship between the price level and the fiscal stance and monetary expansion variables using ARDL model which is more appropriate in cases of time series variables of different order of integration confirms the significant influence of the quantitative easing on the price level but reveals much smaller effect of the fiscal expansion on the price level compared to the cointegration regression. We therefore show that the size of the effect of both cointegrating regression coefficients for variables reflecting fiscal and monetary stance is much smaller once the price level is regressed on its past values. Our estimation of cointegration with time trend did not alter results significantly. Inclusion of structural breaks into analysis changes results to the large extent in terms of the importance of the fiscal stance and its influence on inflation so that further research will benefit from testing the effect of structural break in data series in cointegration method. Our study therefore confirms the importance of the role of extreme shocks of pandemics and subsequent fiscal policy in the USA on inflationary pressures.

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