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The Macro-economy and Non-Performing Loans in Ghana: A BVAR approach

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ABSTRACT

Purpose
The purpose of the paper was to estimate the interdependence between selected macroeconomic variables and non-performing loans in Ghana using a Bayesian Vector autoregressive approach.

Design/methodology/approach
This paper used annual series from 2008-2017 which was interpolated into quarterly frequencies to estimate how macroeconomic shocks affects quality of loan portfolio using a Bayesian Vector Autoregressive approach. Our Bayesian VAR system satisfied the stability condition where the inverse root polynomial is within the unit root circle hence our VAR system was deemed stable. The model was estimated at levels with 1 lag as indicated by the AIC and the SBIC

Findings
The findings were that shocks to gross domestic product , consumer price index , credit to private sector, imports and monetary policy rate leads to an increase in the NPL ratio at varying magnitudes and quarters. On the other-hand a shock to government debt lead to a fall in the NPL ratio in the short-run but it rebounded later in the tenth quarter.

Originality/value
This study concludes that the macroeconomic environment is a big influence on the performance of bank loan portfolio which translates into the NPLs. A shock to CPI seems to be highest in affecting the NPL ratio hence the Bank of Ghana should endeavour to keep a low inflation environment such that the policy rate will not be revised upwards which will put more strain on the _NPL ratio.

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1. Introduction

The financial sector in any economy plays a substantial role in economic growth by means of financial-intermediation which includes savings' mobilization, risk management, project evaluation and facilitating transactions (Schumpeter, 1934). In this vein, the stability of the banking sector dwells on banks' macro-environment, exposure to risk, and banks' ability to be resolute if an adverse shock hits the sector or the economy. The banking sector determines economic growth by offering varied services such as facilitating the movement of money across borders and ensuring a formalised way of borrower-lender interactions (Murithii & Louw, 2017). In the recent past the Ghanaian[1] economy has seen the collapse of seven (7) indigenous commercials banks; namely UT-Bank, Capital Bank, Sovereign Bank, Royal Bank, Beige Bank, Construction Bank and Uni-Bank, primary due to non-performing loans and other managerial and board-level breaches. Most of the bad debts were as a result of non-performing loans which is treated as a balance sheet cost which eventually derails the financial performance of a bank (Amuakwa-Mensah & Boakye-Adjei, 2015). The GFC[2] of 2008 which was later amplified by the Lehmann shock has given us a stark reminder of a link between the financial sector and the real sector of an economy. Behind this backdrop, it has become imperative for policy makers to examine the performance of the macro-economy and its transmission of shocks to the banking system or the reverse scenario. Globally, NPLs[3] has been the widely used measure of financial health of banks in the banking sector of any economy; in effect this metric measures the ratio of non-performing loans (NPLs) to total loans hence policy makers should consider its relevance for macroeconomic stability. This ratio is often used to evaluate and compare bank loans portfolio quality (Festic, Repina, & Kavkler, 2009), (Mendoza & Terrones, 2008), (Podpiera & Weill, 2008) to analyse banking sectors efficiency to foretell forthcoming failures.

[1] The Country Ghana was chosen because the NPL ratio rose to about 17.6% in 2009 giving an indication of some macroeconomic instability.

[2] The Great financial crisis

[3] *The non-performing loans are facilities which payments of principal and interest are past due by three months or more. The 90-day criterion is the time period that is most widely used by countries to determine whether a loan is non performing (see Cortavarria et al 2000).*

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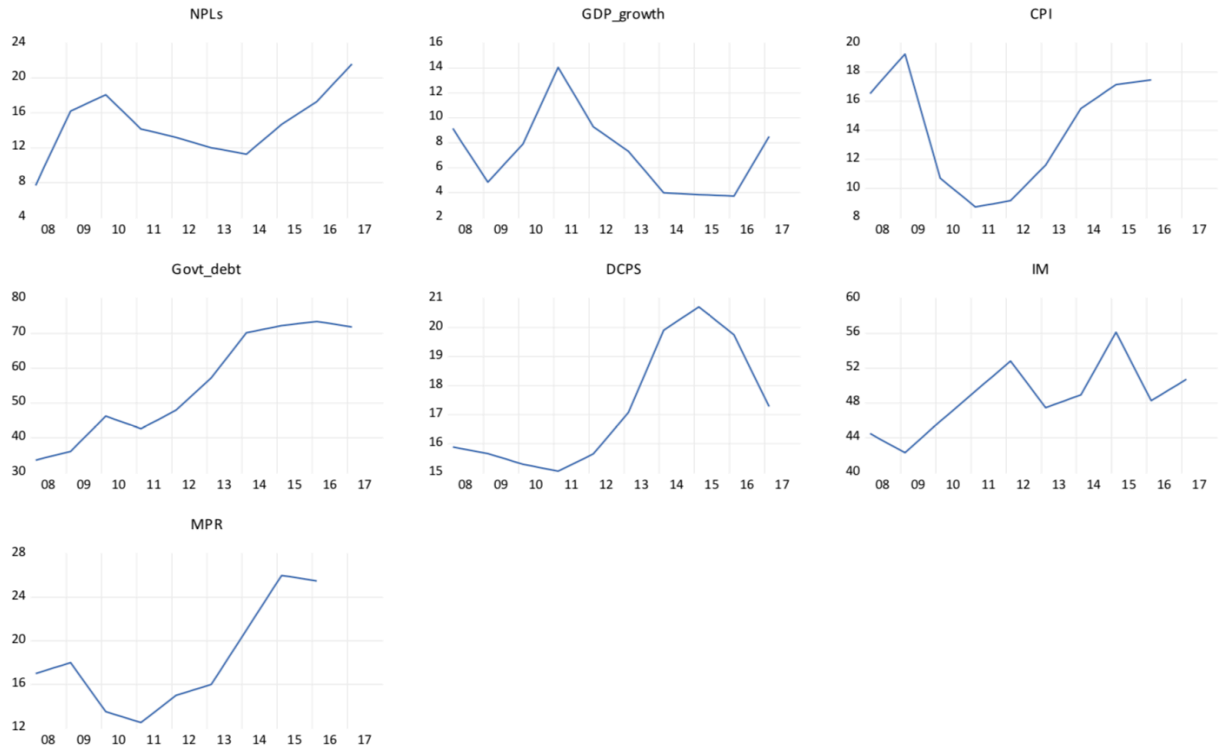
The present work contributes to this literature by estimating a Bayesian Vector Autoregressive model on the dynamics between non-performing loans as a financial fragility indicator and total credit to private sector and government debt. The Bayesian method detailed in the VAR literature is currently at the forefront of empirical macroeconomics, and is adopted here for use. Because VAR models are highly parametrised, the shrinkage prior in the Bayesian method will help the VAR system achieve parsimony. The approach is an update on AMEDIKU, 2006, where a traditional VAR model was used to stress test the Ghanaian banking sector. Our findings buttress what has been found in the VAR literature, that a negative shock to GDP deteriorates bank loan portfolio hence increases the NPL ratio. Alternatively, an inflationary environment also increases the rate of loan default which will translate into the NPL. Our Impulse response functions indicated that a GDP shock will increase the NPL ratio by 1%, likewise a shock to CPI, monetary policy, credit to private sector which increases the NPL ratio by 11%, 3% and 2% respectively. On the other-hand, a shock to government debt initially decreases the NPL ratio but it later rebounds about 2% in the tenth quarter.

To the best of my knowledge this is the first paper to use a Bayesian procedure to estimate interdependence between Ghana's banking industry's NPL, a key financial fragility index, and macro-economic shocks. The rest of the paper is as follows; section 2 discusses the NPL and macroeconomic variables literature review, section 3 discusses the VAR methodology, section 4 discusses the data and its sources, section 5 discusses the estimation and analysis using impulse response functions and section 6 has the concluding remarks.

A look at the time series plotted in (Figure 1) shows that NPL rose to 17% in 2009 during the financial crisis but it later fell in 2013, perhaps when Ghana was enjoying some oil growth due to the discovery of oil in commercial quantities. The NPL ratio later fell but rose again to about 22%. That could also be likened to the fall in commodities prices which affected the Ghana's foreign exchange leading to a fall in GDP. Clearly, we could see GDP falling in the latter part of 2013 when NPL was increasing. Government debt and private sector domestic credit has also been increasing. The policy rate and imports has also shown an upward trend.

Figure 1: A Graphical look at the endogenous variables



Source: Constructed from the data

2. Literature Review

There is no doubt that there exists some link between non-performing loans and macroeconomic variables. Principally the literature identifies those macroeconomic determinants as GDP, CPI, real interest, real exchange rate, money supply and unemployment rate (Sims, 1980). Seminal work of using VAR to estimate monetary policy shocks has preceded a myriad of studies which used the VAR models to investigate the monetary policy transmission mechanism across the field of applied macro research. Amuakwa-Mensah & Boakye-Adjei (2015) found a significant negative effect of real GDP per capita on NPLs. In addition, they concluded that real GDP per capita has a significant effect on NPLs of large banks, but no effect is observed for small banks (Alhassan, Kyereboah-Coleman, & Andoh, 2014). They also found a significant negative effect of real GDP

growth on asset quality and that a real depreciation of the local currency increases NPLs of banks in Ghana.

Arpa, Guilini , Ittner, & Pauer (2001) present a single-equation regression analysis focusing on the risk provisions and operating income of Austrian banks, and conclude that the share of risk provisions in the total loans of the Austrian banking sector varies indirectly with real GDP growth and real interest rates and directly with CPI inflation and real estate price inflation. Gambera (2000), using bivariate VAR models, investigated the influence of the development of the US economy on the loan portfolio quality of a large sample of US banks. The empirical result suggests that a limited number of regional and national macroeconomic variables are often good predictors for problem-loan ratios, and that simple, bivariate VAR systems of one bank variable, one macroeconomic variable, and seasonal dummies can be quite effective. Shu (2002) examined the impact of macroeconomic developments on the asset quality of the Hong Kong banking sector and concludes that the increase in non-performing loans between 1995 and 2002 was largely attributable to changes in macroeconomic conditions. The single-equation regression analysis indicates that the NPL ratio rises with increasing nominal interest rates and faster growth in bankruptcies, but decreases with higher CPI inflation, economic growth and property price inflation. Louzis, Vouldis, & Metaxas (2010), in a dynamic panel model, examined the determinants of NPLs for each category of loan in the Greek banking sector. Studying real gross domestic product growth rate, rate of unemployment and real interest rate from 2003 to 2009, the study concluded that bad or doubtful loans were related to these macroeconomic factors and to how well they were managed. They further indicated that the sensitivity of non-performing loans on mortgages was less to macroeconomic conditions.

Keeton (1999) investigated the relationship between the growth of business loans granted by US banks on the one hand and banks credit standards and the share of NPLs in business loans. The VAR model involves growth in business loans, the share of NPLs in business loans and non-farm earnings. It supports the hypotheses that faster loan growth leads to higher loan losses, that an increase in earnings reduces the delinquency rate and that an increase in the delinquency rate causes a decrease in loans. In addition, deterioration in the quality of loan portfolio causes a subsequent increase in the ratio of NPLs. Hoggarth, Logan, & Zicchino, (2005) apply the VAR approach to investigate the link between loan write-offs and the UK output gap, retail and house price inflation, the nominal short-term interest rate and the real exchange rate.

Adebola, Sulaiman, Yusoff, & Dahalan (2011) used an ARDL[4] in exploring the factors that explain NPL and concluded that long run relationship between macroeconomic variables and interest rate has a positive long-term effect on bad loans. The authors further stated that the producer prices were inversely related to bad loans. Jimenez, Salas, & Saurina (2006) presented evidence from Spain and suggested that GDP growth, real interest rate and a credit condition explain NPL. Khemraj & Pasha (2009) asserts that banks giving out loans excessively and charging high levels of interest rate are most likely to have higher bad debts.

3. Methodology

In econometric analysis the VAR models starts with the reduced form where each dependent variable is regressed on its own lags and on the lags of the other variables. The vector
notation is given as:

$$y_t = \alpha + \varphi_1 y_{t-1} + \ldots + \varphi_p y_{t-p} + u_t$$

where y_t is a vector of endogenous variables that is: GDP growth rate, CPI inflation, non-performing loans, government debt, domestic credit to private sector, imports and monetary policy rate at all at quarter t, α is a vector of constants and φ_1 and φ_p is a matrix of parameters, u_t is reduced form error term with zero mean and covariance matrix $\sum$. We include 1 lag of the endogenous variable as recommended by SBC and AIC as the best lag to explain the dynamics in the VAR system (see Table1.)

Prior to the model specification our Baysian VAR system has satisfied the stability condition that modulus of the Eigenvalue is less than 1 in absolute terms (see Table 2).

3.1 Model Specification

In our empirical specification, the reduced form VAR will be estimated with the Bayesian procedure because it is well suited for shorter datasets. To evaluate how shocks to macro- economic variables affect the quality of loan portfolio which translate into the NPL, the empirical model is specified in the following way:

$$NPLS_t = \alpha_1 + \phi_1 NPLS_{t-1} + \phi_2 GDP\ GROWTH_{t-1} + \phi_3 CPI_{t-1} + \phi_4 GOVT\_DEBT_{t-1} + \phi_5 DCPS_{t-1} + \phi_6 IM_{t-1} + \phi_7 MPR_{t-1} + \varepsilon NPLS_t \quad (1)$$

$$GDPGROWTH_t = \alpha_2 + \phi_8 NPLS_{t-1} + \phi_9 GDP\ GROWTH_{t-1} + \phi_{10} CPI_{t-1} + \phi_{11} GOVT\_DEBT_{t-1} + \phi_{12} DCPS_{t-1} + \phi_{13} IM_{t-1} + \phi_{14} MPR_{t-1} + \varepsilon GDP\ GROWTH_t \quad (2)$$

$$CPI_t = \alpha_3 + \phi_{15} NPLS_{t-1} + \phi_{16} GDP\ GROWTH_{t-1} + \phi_{17} CPI_{t-1} + \phi_{18} GOVT\_DEBT_{t-1} + \phi_{19} DCPS_{t-1} + \phi_{20} IM_{t-1} + \phi_{21} MPR_{t-1} + \varepsilon CPI_t \quad (3)$$

$$GOVT\_DEBT_t = \alpha_4 + \phi_{22} NPLS_{t-1} + \phi_{23} GDP\ GROWTH_{t-1} + \phi_{24} CPI_{t-1} + \phi_{25} GOVT\_DEBT_{t-1} + \phi_{26} DCPS_{t-1} + \phi_{27} IM_{t-1} + \phi_{28} MPR_{t-1} + \varepsilon GOVT\_DEBT_t \quad (4)$$

$$DCPS_t = \alpha_5 + \phi_{29} NPLS_{t-1} + \phi_{30} GDP\ GROWTH_{t-1} + \phi_{31} CPI_{t-1} + \phi_{32} GOVT\_DEBT_{t-1} + \phi_{33} DCPS_{t-1} + \phi_{34} IM_{t-1} + \phi_{35} MPR_{t-1} + \varepsilon DCPS_t \quad (5)$$

[4] Autoregressive Distributed Lag Model I used to estimate time series with different orders of integration.

$$IM_t = \alpha_6 + \phi_{36}NPLS_{t-1} + \phi_{37}GDP\ GROWTH_{t-1} + \phi_{38}CPI_{t-1} + \phi_{39}GOVT\_DEBT_{t-1} + \phi_{40}DCPS_{t-1} + \phi_{41}IM_{t-1} + \phi_{42}MPR_{t-1} + \varepsilon IM_t \quad (6)$$

Where
NPL: aggregate of non-performing loans to total gross loans.
GDP GROWTH: refers to growth rate of output
CPI: denotes the consumer price index
GOVT_DEBT: refers to stock of Government debt
DCPS: Total stock of credit to the private sector.
IM: Imports of goods and services
MPR: refers to Monetary policy rate.
$\varepsilon NPLS_t$ *= shocks to non performing loans equation*
ε*GDP GROWTH: shock to GDP equation*
εCPI: shock to CPI equation
εGOVT_DEBT: shocks to government debt equation
εDCPS: shocks to DCPS equation
εIM_t: Shock to imports equation
εMPR: shock to monetary policy rate equation

3.2 Choice of Macro-Economic Variables

The choice of the macroeconomic variables is based on the literature and some degree of intuitive arbitrariness (see Blake and Westaway, 1996). The selection of import is due to the fact that Ghana is a high import economy and since importation requires a huge outlay, the assumption is that most of the importers will opt for a bank credit. Secondly, due to Ghana's high debt/GDP ratio the country enrolled in an International Monetary Fund extended credit facility to ensure policy credibility and good fiscal governance. According to Louzis, Vouldis, & Metaxas (2010) there are two transmission channels through which public debt or sovereign debt crisis can affect the banking system. Reinhart & Rogoff (2010) found that when public debt increases, it places a form of "ceiling" on the market evaluation of credibility for the national banks and consequently banks struggle for liquidity. As a result, banks would have to cut lending and debtors cannot also refinance their debts. In addition, an increase in public debt, according to Perotti (1996) may lead to fiscal measures where, for example, social expenditure on the wage component of government consumption are cut. This results in outstanding loans and unpaid interest, as households' income experiences a negative shock.

3.3 Shock Identification

In order to generate the impulse response functions, the identification of shocks is carried out via Cholesky's decomposition of the covariance matrix, which assumes a recursive exogeneity structure. Therefore, the first variable in the VAR is only affected contemporaneously by the shock to itself; the second variable in the VAR is affected contemporaneously by the shocks to the first variable and the shock to itself, and so on. The number of lags to explain the model dynamics is set to 1 as indicated by the AIC and SBIC.

4. Data

Annual time series data spanning from 2008-2017 was interpolated into quarterly series using the Denton procedure. All datasets enter into the model as quarterly series after interpolation. NPLs is taken as a percentage of non-performing loans to total gross loans, GDP Growth enters the model as quarterly growth of output,

$$MPR_t = \alpha_7 + \phi_{43}NPLS_{t-1} + \phi_{44}GDP\ GROWTH_{t-1} + \phi_{45}CPI_{t-1} + \phi_{46}GOVT\_DEBT_{t-1} + \phi_{47}DCPS_{t-1} + \phi_{48}IM_{t-1} + \phi_{49}MPR_{t-1} + \varepsilon MPR_t \quad (7)$$

CPI enters as quarterly growth rate of prices, GOVT_DEBT is government receipts and spending taken as a percentage of gross domestic product, DCPS enter the model as quarterly stock of domestic credit to private sector as a percentage of output, IM enters as quarterly imports of goods and services as a percentage of output and MPR is the central bank's monetary policy rate (used as the benchmark lending rate). The data sources are Federal Reserve Economic Data (FRED), World Development Indicators of the World Bank, Banking Supervision and Research Departments of the Bank of Ghana and the Ghana Statistical Service.

5. Estimation and Analysis

This paper examined the interdependence of macroeconomic shocks and non-performing loans in Ghana. Table 3: displays the statistics of the Bayesian VAR results as it was specified in equations in the model specification section. Figure 20 display the impulse responses to a Cholesky one standard deviation shock to NPLS, GDP growth, consumer price index, Government debt, domestic credit to private sector, imports and monetary policy rate respectively. The empirical findings of this paper corroborates what has been found in the literature on the inverse relationship between GDP and NPL ratio and the positive relationship between CPI and NPL ratio. Our findings show a shock to GDP growth leads to a 1% increase in NPL ratio in the first quarter, to a peak of 3% in the fifth quarter, and later falls to the baseline. This finding implies that when GDP growth falls, the NPL ratio increases and vice versa. Additionally, a one standard deviation shock to CPI leads the NPL ratio to increase as much as 11% in the second quarter to a peak of about 25% in the fifth quarter. This gives an indication that the influence of inflation on financial variables is very immediate and effective hence the central bank's target of inflation is in line with financial stability objectives. Furthermore, the NPL ratio initially decreased after a shock to government debt but it rebounded by 2% in the tenth quarter. This could mean that whilst the government is increasing the deficit by taking on more debt, the NPL ratio falls in the short run. It could mean that the banks in the short-run were buying Government of Ghana treasury bonds which paid higher returns, hence they were able to diversify their books against the huge bad debts on their books. The hypothesis that credit growth leads to higher loan losses could be explained by the findings that a one-standard deviation shock to total domestic credit to the private sector will make NPL ratio increase as early as the second quarter by 2% to a peak of about 5% in the sixth quarter. The NPL ratio also increased by 4% in the second quarter with a shock to imports and later peaked by 7% in the fourth quarter.
The monetary policy rate is the rate at which the Bank of Ghana lends to the commercial banks. A shock to this policy rate increased the NPL ratio by 3% in the second quarter, later reached a peak of about 6% in the fourth quarter.

6. Concluding Remarks

This paper applied the BVAR methodology to estimate the variations in macroeconomic variables and their effect on the NPL ratio in Ghana. The importance of financial fragility for macroeconomic stability has gained lots of momentum in recent policy debates leading to the intensification of bank directives. Annual series was interpolated into quarterly frequencies to estimate the interdependences of macro-economic variables and NPL ratio. We include NPL ratio as a measure of financial fragility, GDP growth as a measure of economic growth, CPI growth to measure the rate of change of prices, government debt stock to measure government's fiscal position, domestic credit to private sector to capture the amount of credit circulating from the banks to private sector, imports and monetary policy rates. Impulse response findings show that NPL ratio reacts early to a CPI inflation shock by 11% followed by a shock to Imports shock by 4% and finally the monetary policy rate shock by 3%. Findings also show that the peak responses of NPL ratio was higher with CPI at 25% in the fifth quarter with monetary policy peaked by 6% in the fifth quarter and GDP growth also peaked by 3% in the fifth quarter. Overall, finding support the literature in that shocks to GDP growth, CPI and MPR increases the NPL ratio. By extension, a shock to domestic credit to private sector also increased the NPL ratio whilst a shock to Government debt initially reduces the NPL ratio but later rebounded. It is recommended that for Ghana's economy to reduce the deterioration of loan portfolio, policy makers should endeavour to keep a low inflation environment that will also render the Bank of Ghana to revise downward the policy rate. In addition, there should be measures to curb the excessive credit growth to the private sector since findings shows that the higher the rate of growth of credit, the higher the default rate.

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Annex

Table 1: Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: NPLS GDP_GROWTH CPI GOVT_DEBT DCPS IM MPR
Exogenous variables: C
Date: 09/09/18 Time: 18:35
Sample: 2008Q1 2017Q4
Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-353.034...	NA	28.87739	23.22804	23.55185	23.33359
1	223.4055...	855.3628*	5.23e-14*	-10.80036*	-8.209928*	-9.955942*
2	261.6757...	39.50478	1.78e-13	-10.10812	-5.251062	-8.524837

* 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
Source: Authors Calculation

Table 2: Table 2: Stability of BVAR system

Roots of Characteristic Polynomial
Endogenous variables: NPLS
GDP_GROWTH CPI GOVT_DEBT
DCPS IM MPR
Exogenous variables: C
Lag specification: 1 1
Date: 09/09/18 Time: 18:33

Root		Modulus
0.950930		0.9509302876271893
0.863126	- 0.210082i	0.8883245353476471
0.863126	+ 0.210082i	0.8883245353476471
0.524685	- 0.031673i	0.5256402748798472
0.524685	+ 0.031673i	0.5256402748798472
0.335176		0.3351762852074857
0.023020		0.02301981394283...

No root lies outside the unit circle.
VAR satisfies the stability condition.
Source: Authors Calculation

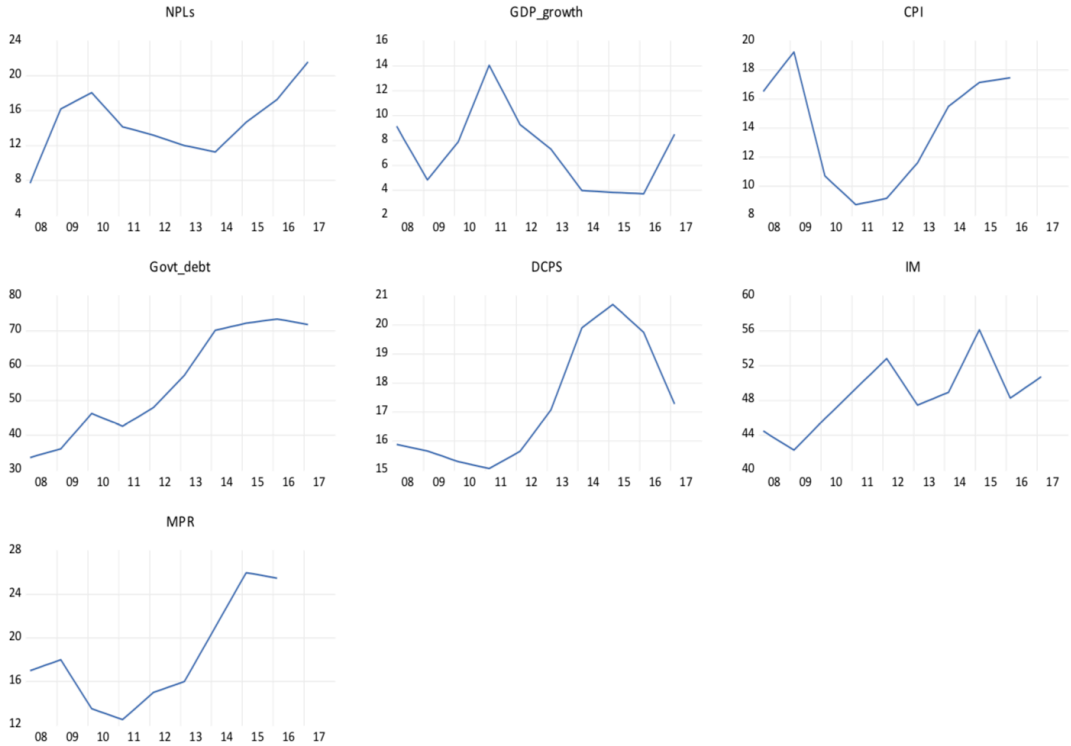
Table 3: Estimated BVAR Results

Bayesian VAR Estimates
Date: 09/09/18 Time: 18:32
Sample (adjusted): 2008Q2 2016Q1
Included observations: 32 after adjustments
Prior type: Litterman/Minnesota
Initial residual covariance: Diagonal VAR
Hyper-parameters: Mu: 0, L1: 0.1, L2: 0.99, L3: 1
Standard errors in ( ) & t-statistics in [ ]

	NPLS	GDP_GRO...	CPI	GOVT_DEBT	DCPS	IM	MPR
NPLS(-1)	0.79334979...	0.22320305...	-0.2495398...	-0.0568250...	-0.0989268...	0.12177749...	-0.1235000...
	0.03016328...	0.04582669...	0.04446850...	0.07541695...	0.00964015...	0.06922653...	0.03169913...
	[26.3018]	[4.87059]	[-5.61161]	[-0.75348]	[-10.2619]	[1.75912]	[-3.89601]
GDP_GROWTH(-1)	-0.0133921...	0.52333429...	-0.1141432...	-0.3927774...	-0.0423395...	0.21517815...	0.01582969...
	0.04313976...	0.06588297...	0.06369516...	0.10792100...	0.01378641...	0.09913449...	0.04536597...
	[-0.31044]	[7.94339]	[-1.79202]	[-3.63949]	[-3.07111]	[2.17057]	[0.34893]
CPI(-1)	0.09121991...	-0.1717010...	0.38189639...	-0.3663536...	0.01999607...	-0.2769592...	0.15671538...
	0.05072834...	0.07717143...	0.07528338...	0.12701258...	0.01621735...	0.11663106...	0.05340326...
	[1.79820]	[-2.22493]	[5.07278]	[-2.88439]	[1.23300]	[-2.37466]	[2.93457]
GOVT_DEBT(-1)	-0.0342957...	-0.0532508...	-0.1104591...	0.78994306...	0.05764030...	-0.0206767...	0.00348474...
	0.02181791...	0.03317627...	0.03224775...	0.05473302...	0.00699015...	0.05011329...	0.02294163...
	[-1.57191]	[-1.60509]	[-3.42533]	[14.4327]	[8.24593]	[-0.41260]	[0.15190]
DCPS(-1)	-0.1582370...	0.18984956...	0.58152542...	1.42255921...	0.58988084...	1.26485405...	0.84642602...
	0.18930258...	0.28777546...	0.27941489...	0.47443321...	0.06070843...	0.43476227...	0.19919516...
	[-0.83590]	[0.65971]	[2.08123]	[2.99844]	[9.71662]	[2.90930]	[4.24923]
IM(-1)	-0.0023340...	0.04635433...	-0.1327521...	0.01641899...	-0.0053686...	0.49277553...	0.06865849...
	0.02904964...	0.04418710...	0.04291146...	0.07266564...	0.00928378...	0.06703591...	0.03056701...
	[-0.08035]	[1.04905]	[-3.09363]	[0.22595]	[-0.57828]	[7.35092]	[2.24616]
MPR(-1)	0.18163097...	-0.1524205...	0.39513037...	-0.1758896...	-0.0082641...	-0.1069291...	0.51356826...
	0.05863474...	0.08915270...	0.08665219...	0.14666486...	0.01875280...	0.13477978...	0.06189626...
	[3.09767]	[-1.70966]	[4.55996]	[-1.19926]	[-0.44069]	[-0.79336]	[8.29724]
C	3.41226693...	2.56755202...	8.04655969...	-1.0334606...	5.90857061...	6.66542986...	-9.6073879...
	2.25685329...	3.43177682...	3.33001294...	5.64896725...	0.72255917...	5.18690733...	2.37589607...
	[1.51196]	[0.74817]	[2.41637]	[-0.18295]	[8.17728]	[1.28505]	[-4.04369]
R-squared	0.97398554...	0.94740741...	0.98100773...	0.99197054...	0.99588912...	0.90200549...	0.99320304...
Adj. R-squared	0.96639800...	0.93206791...	0.97546833...	0.98962861...	0.99469011...	0.87342375...	0.99122060...
Sum sq. resids	3.95469876...	15.0946638...	7.55763575...	47.4633981...	0.58453862...	39.3917717...	4.33803641...
S.E. equation	0.40592993...	0.79306010...	0.56116084...	1.40628645...	0.15606337...	1.28114160...	0.42514881...
F-statistic	128.366309...	61.7625843...	177.096095...	423.570449...	830.595574...	31.5588117...	500.999062...
Mean dependent	14.1567987...	7.12211341...	13.6511848...	53.8694238...	17.2040384...	48.7164280...	18.0390625
S.D. dependent	2.21446350...	3.04276642...	3.58281024...	13.8087830...	2.14169917...	3.60098274...	4.53741585...

Source: Authors Calculation

Figure 2: Impulse Response Functions for the Estimated BVAR model, 2008q1-2017q4
Response to Cholesky One S.D. (d.f. adjusted) Innovations



Source: Authors Calculation