The effect of non-performing loans on the LMICs with a focus on the macroeconomy and institutional quality

Suranjit, K

Australian National University

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K Suranjit[2]

Abstract

This paper investigates the effects of the bank's non-performing loans (NPLs) as a percentage of gross private sector credit in the 21 Lower Middle-Income Countries (LMICs) including the four major South Asian economies during 1998 to 2015, with a focus on the macroeconomy and institutional quality. The static and dynamic country Fixed Effect (FE) and the Generalised Methods of Moments (GMM) approach are used to analyse the impact of the macroeconomic and institutional qualities on NPLs. Whereas, the Panel-Vector Autoregressive (PVAR) approach is used to examine the reverse impact of NPLs on the real economy. It is found that the NPLs attributes to both macroeconomic conditions and institutional quality, moreover, it is affected significantly by around 70% by previous year's NPLs. On the other hand, NPL has an adverse impact on GDP, employment, credit and exchange rate. Therefore, this paper suggests that the high NPLs in LMICs would adversely affect their sustainable growth which recalls the early Schumpeterian (1911; 1917) advocacy for taking a balanced position considering the demand and supply sides of the credit for the policy modelling.

1. Introduction

The non-performing loans (NPLs) as a percentage of the gross loans is decreasing at the global level with slight increases in 2015, remaining almost stable after the global financial

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crisis (GFC). It is a striking feature that growing GDP of major LMICs increases total credit dramatically; however, it could not even reduce the NPLs. After the 2008 financial crisis, on average, NPLs in the LMICs increased from 4.9% in 2008 to 6.1% in 2010. However, after 2012, from 4.8% it fluctuates and increases to 5.6% in 2015, with a very high rate of the NPLs in many LMICs.

Although NPLs are not usually viewed as an immediate destabilising factor, the feedback effects from the banking system to economic activity undermine a sustained recovery, for which growth may carry significant vulnerabilities for the near future. The higher NPLs reflect in part the consequences of increasing internal unemployment across the economy which, together with appreciated currency and tight financial conditions, weaken the borrower's repayment capacity as well. Acknowledging the gravity of the problem, policymaker emphasises the resolution of the NPLs problem as a priority through the macroprudential mechanism (BIS 2011 & 2016) which also recalls some significant criticism (McKibbin 2016).

Graph 1: Average NPLs on the global (World) and LMICs level
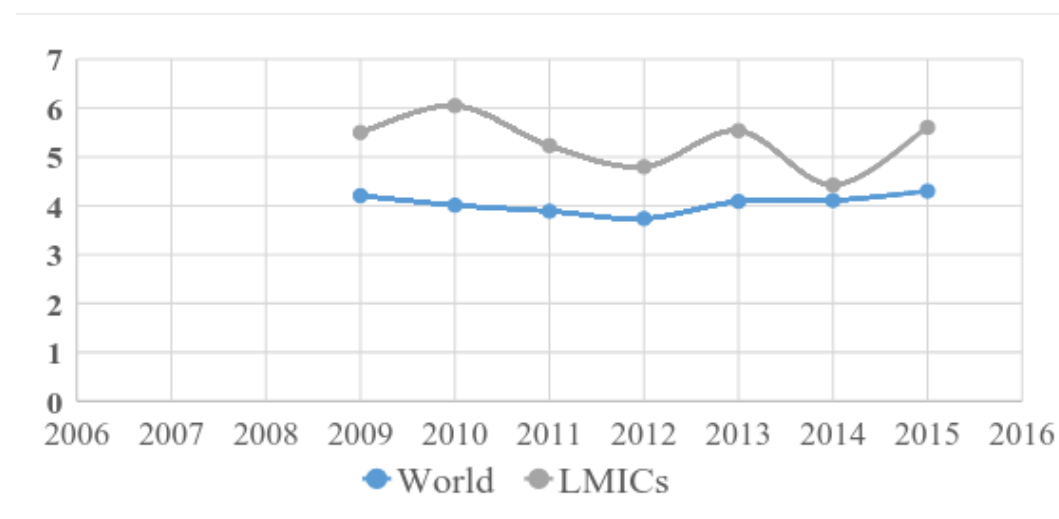
Source: WDI (2016)

Many countries are in the middle-income trap (for example, Thailand) for an extended period and the LMICs are usually concerned about their sustainable growth. According to Rodrik (2014), growths in emerging markets have been unsustainably high in the last decade and will come down by a couple of points. Although there is some country-specific or regional research on the macroeconomic and bank determinants of the NPLs, as per available

literature, no research on feedback effects of NPLs on the real economy, using panel data for LMICs, has been conducted yet. However, for the causality relations like reverse causality between the macroeconomics variables and the banking system, panel data analysis provides superior results compared to the time-series analysis (Hsiao & Hsiao 2006). Therefore it is important to investigate the standard feature of the determinants of the NPL and its reverse impact on the real economy.

Filling in the gap as mentioned earlier, this paper has two purposes, which are:

- *to evaluate the determinants of NPLs in the LMICs by looking at both macroeconomic indicators and institutional quality*; and,

- *to measure the reverse impacts from the NPLs to the real economy that are likely to affect LMICs' economic activity and growth down the road.*

1.1. Outline

By evaluating the determinants of non-performing loans in the major LMICs economy, considering the macroeconomic indicators over 1998–2015, present research would be useful not only to assess the importance of macroeconomic factors and institutional quality but also to investigate how the relative significance has changed for the impact of financial crisis. On the other hand, the PVAR analysis, which includes six endogenous variables (NPLs, GDP, unemployment rate, domestic credit as a percentage of GDP, exchange rate and inflation) measures how the NPLs increase in the LMICs region is likely to affect economic performance in the coming years.

The remainder of the paper is structured as follows: Section 2 provides a brief literature review on both the macroeconomic factors and institution quality as the determinants of NPLs and the feedback effects of NPLs to the real economy. Section 3 describes the data, methodology and major arguments on econometric models. Section 4 analyses the NPLs' determinants and discusses the findings from FE and GMM models in detail. Section 5 investigates the reverse effects from the NPLs to the real economy through a PVAR approach, with discussion regarding the robustness of the models and alternative specification results; and finally, Section 6 concludes with a brief discussion regarding the policy implication and future research.

2. Background and Literature Review

The growth pattern of the LMICs is fundamentally based on the investment in the agriculture or manufacturing sectors along with proper utilisation of their natural and human capital. Credit is a comparatively active channel of the monetary transmission mechanism in LMICs. Considering these realities, the Schumpeterian growth model still has its legacy which also strongly advocates for quality lending.

According to Schumpeter (1911), bank credit is crucial to introduce the innovations and consequent developments within every technological change. Discussing the endogeneity regarding the credit supply and demand, he also asserts that banks not only decide about granting the borrowers but also they have to determine the volume of credit they wish to give and what demand to call forth (Schumpeter 1917). From the demand side view, as the economy expands, demand for financial services increases, leading to the growth of these services (Robinson 1952). Friedman and Schwartz (1963) and Demetriades and Hussein (1996) support this view empirically. The interactions between the macroeconomic performance and financial fundamentals are discussed through the models proposed by King and Plosser (1984), Bernanke and Gertler (1989) and Kiyotaki and Moore (1997).

However, analysing the asymmetric information between the agents, Stiglitz and Weiss (1981) and Stiglitz (1985) investigate the function of the credit market, the nature of loan agreements and about the determination of interest rates, the credit rationing. Bond et al. (2008; 2015) also conclude that credit market efficiency improves the competence of entrepreneurs partly by inducing the dynamic entrepreneurs to flourish and partly by discouraging the incentive of the inefficient firms. In a sense, it plays like the good rules of the game which are likely to improve the market payoffs.

The impact of the economic performance on NPLs is usually for weakening debtors' ability to repay their loan, whereas the reverse effects from NPLs to the economic performance could be explained mainly through the credit channel of the monetary transmission mechanism. High NPLs also increase the uncertainty about banks' capital adequacy and therefore restrict their competence of financing (Diwan & Rodrik 1992) which affects the lending rate and credit growth. This also increases costs generated from the management of

the higher NPLs, decreases the capital position in the balance sheet due to the increases in the provision and affects the supply side of the credit that finally impacts the economic performance. It is found from the literature that GDP growth is negatively related with NPLs, while unemployment and inflation are positively correlated with NPLs. Some empirical studies on the NPLs determinants and impacts to the economy with longitudinal data are: Keeton et al. (1988) for Latin America using panel OLS; Olivaeres (1993) in East Europe using HP filter and Panel OLS; Cheong (2005) for South East Asia using Panel – GMM; Fofack (2005) for some African countries, Baboušek and Jančar (2005) for the Czech Republic; Keeton (1999) for the USA; Boudriga et al. (2009) for 12 Middle East and North Africa (MENA) regional countries; Espinoza and Prasad (2010) for the Gulf Cooperation Council (GCC) region; Klein (2013) for Central, Eastern and South-Eastern European countries using FE, GMM and PVAR models; and Roman and Bilan (2015) for EU28 countries using FE and GMM method. Studies on some LMICs also found similar correlations between the macroeconomic variables and NPLs.

The present research also investigates the impacts of the macroeconomic and institutional conditions on the NPLs. There is very little research which covers the institutional quality as a determinant of the NPLs. However, according to North (1990), institutions are the 'humanly devised constraints' that shape human interactions. Boudriga et al. (2009) reveal that in the Middle East and North Africa (MENA) region, the institutional environment has a significant impact on the level of non-performing loans. In the Asia Pacific Region adverse macroeconomic consequences along with a higher cost of capital raise scope of NPLs, and in some contexts of Indonesia, loan borrowings are easily approved and even worse, when political pressure and family ties are closely related to loan approval (Endut et al., 2013). A similar case may be found in Bangladesh as well. Therefore, following the literature of institutional economics, the rule of law in percentile is used as a proxy variable of the institutional quality in this paper.

Some contemporary research (Espinoza & Prasad 2010; Nkusu 2011; De Bock & Demyanets, 2012; Klein 2013; Filip 2014) claim that the relationship between macroeconomics performance and NPL is bidirectional. The feedback effects from NPLs to the real economy could also be explained by the principal-agent problem. For example, debt overhang can discourage investors to take the risk for investment since gains from the projects will be

shared with the lender (Myers 1977). Households may become indifferent to improving their assets if they predict to lose it in the period ahead (Meltzer 2010). NPL has a high likelihood to deepen the severity and duration of a financial crisis. Moreover, it also makes macroeconomic management complicated (Woo, 2000). Demirguc-Kunt (1989) and Barr et al. (1994) uncover that average banks have a higher NPL prior to their collapse.

3. Data and descriptive statistics

3.1. Data with sources

This research has short panel data with a comparatively large number of the country (n) and small no of years (t). The main variable is NPL as a percentage of the gross bank credit to the private sector. The LMICs' NPLs data has been available in the World Development Indicators (WDI, 2016) only since 1998. Based on the availability of this major variable and considering countries' GDP weight, 21 countries are finally selected.

Table 1: Comparison between the before and after interpolation of the four variables

Variable	Obs. No		Mean		Std. Dev.	
	Before	After*	Before	After*	Before	After*
NPLs	358	378	11.564	11.652	9.526	9.613
Credit	376	378	34.812	34.790	18.994	18.975
Unemployment	357	378	7.735	7.683	4.874	4.841
Rules of law	315	378	33.840	34.177	15.429	15.476

* After interpolation (Chow & Lin 1971)

Data from the year 1998 to 2015, covers 21 major lower middle-income economies including, Armenia, Bangladesh, Bolivia, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Indonesia, Kenya, Kyrgyz Republic, Moldova, Morocco, Nigeria, Pakistan, Philippines, Sri Lanka, Tunisia and Ukraine. Concerning the consistency of the sample, most of the variables are used from the World Development Indicators (World Bank, 2016). However, nominal effective interest rate data are from Bruegel (2016) whereas rules of law data are from Worldwide Governance Indicators (WGI) (WGI 2015) along with the Transparency International (2016).

Table 2: Descriptive statistics of the NPLs

SL	Country	Mean	Std. Dev.	Min	Max
1	Armenia	6.485	5.803	1.900	24.400
2	Bangladesh	**18.323**	**11.741**	5.850	**41.100**
3	Bolivia	7.192	5.804	**1.500**	17.700
4	Egypt, Arab Rep.	14.850	6.048	7.000	26.500
5	El Salvador	3.340	1.400	1.900	6.700
6	Ghana	14.048	4.292	6.400	22.700
7	Guatemala	4.206	3.073	**1.190**	8.700
8	Honduras	6.288	3.436	2.940	11.400
9	India	6.581	4.383	2.210	14.700
10	Indonesia	12.191	**14.883**	1.690	**48.600**
11	Kenya	**16.300**	11.422	4.430	34.900
12	Kyrgyz Republic	11.028	7.941	3.600	30.900
13	Moldova	13.093	9.614	3.700	41.000
14	Morocco	11.156	5.570	4.800	19.400
15	Nigeria	15.001	9.745	2.960	37.250
16	Pakistan	14.547	5.087	7.300	23.400
17	Philippines	9.431	7.856	1.890	27.700
18	Sri Lanka	9.638	4.759	3.240	16.600
19	Tunisia	18.061	3.582	13.000	24.200
20	Ukraine	**27.922**	**15.694**	3.880	**59.760**
21	Vietnam	5.023	3.804	**1.380**	13.000

Table A in the Appendix describes the missing data of NPLs. There are also missing data for the rule of law in percentile for two years for all countries that are not available in the Transparency International database as well. The interpolation approach proposed by Chow and Lin (1971) is therefore used to fill up some missing samples (see Table 1 for the summary of interpolation). Vietnam's data is collected from different sources (Kousted et al. 2005, pp. 43-49) and the State Bank of Vietnam (2007; 2009; 2016). Central bank's reports are used for missing data of Sri Lanka whereas, for Bangladesh that similar data is used to

check the trends with the interpolated data to maintain more consistency. The summary of the interpolated data is almost the same as that of the original sample.

Variables that used for the six specifications to analyse the macroeconomics and institutional determinants of NPL are: bank nonperforming loans to total gross loans (%), domestic credit to the private sector (% of GDP), GDP growth (annual %), unemployment, total (% of total labour force) (modelled ILO estimate), nominal effective exchange rate (CPI-based 172 trading partner considered), Inflation (consumer prices in annual %), and rule of law (percentile rank). However, for the PVAR model, instead of the GDP growth, the GDP is used and excludes the rule of law variable.

3.2. Descriptive statistics

The brief description of the NPLs data across the country and first to third positions (see Figures in bold) of the countries in the sample are shown in Table 2. On average, Ukraine holds the first position followed by Bangladesh based on highest NPLs during the sample time. Intuitively, higher standard deviation indicates the financial policy break of the particular economy which has been confirmed by the Ukraine, Indonesia and Bangladesh by holding first to third positions respectively.

Table 3: Correlation matrix

Variables	NPLs	Bank's Credit	GDP Growth	Unemployment	Exchange Rate	Inflation	Rules of Law
NPLs	1.000						
Bank's Credit	-0.183	1.000					
GDP Growth	-0.162	-0.151	1.000				
Unemployment	0.143	-0.156	0.074	1.000			
Exchange Rate	0.184	-0.119	-0.062	-0.047	1.000		
Inflation	0.281	-0.187	-0.149	-0.119	0.012	1.000	
Rules of Law	**-0.040**	**0.324**	**0.086**	**0.209**	**-0.024**	**-0.120**	1.000

Correlation matrix

The correlation matrix (see Table 03) roughly supports the expected signs of one to one relationship available in the literature. NPLs reveal a positive correlation with unemployment, nominal effective exchange rate and inflation whereas negatively correlated

with the bank's credit to GDP ratio, GDP growth and the rule of law in percentile.

Overall, the data for every variables includes 357 observations, which are divided over the sample's period and region basis for the robustness test: the first half of the sample from 1998 to 2007 includes 209 observations and the second half from 2008 to 2015 includes 143 observations whereas Asian LMICs sample has 126 observations for each variable.

4. Macroeconomic condition and institutional quality as the determinants of NPLs

4.1. Methodology

Following the first part of the research questions, two econometrics, that is, the FE and the GMM models are used. Panel data techniques have some key advantages over time series as it can capture the country specific feature as well as unobservable deviations among countries while it can minimise the biases of potential heterogeneity.

Unit root test (Fisher)

Unit root test is used to investigate the panel stationarity. Maddala and Wu (1999) argue that the Fisher unit root test for panel data performs best since, unlike most other tests, it does not need a balanced panel data set. This paper, therefore, applies the Fisher tests using an augmented Dickey-Fuller and the Phillips-Perron tests.

Table 4: Results of the Fisher unit root tests

Variables		Fisher-ADF	Fisher-PP
NPLs	Level	91.546***	65.654***
Credit	Level	27.618	36.149
GDPg	Level	124.681***	251.175***
Unemployment	Level	54.667*	75.941***
Exchange rate	Level	107.972***	230.874***
Inflation	Level	95.021***	139.674***
Rules of Law	Level	163.046	184.605

Panel unit root tests reject the null hypothesis of a unit root for five variables excluding the credit and the rule of law variables (see Table 4). However, after differential, the change in bank credit and the change in the rule of law in percentile become statistically highly significant by rejecting the null hypothesis at 1 percent significance level.

Dynamic panel regression

The baseline Fixed Effect panel data model used in this paper can be written as:

$$y_{i,t} = \alpha + X_{i,t} + \upsilon_i + e_{i,t} \qquad \text{(Equation 1)}$$

Deriving from Equation 1 including the lag of the dependent variable itself and other particular variables two more specifications' model are generated:

$$y_{i,t} = \alpha + \beta y_{i,t-1} + X_{i,t} + \upsilon_i + e_{i,t} \qquad \text{(Equation 2)}$$

$$y_{i,t} = \alpha + \lambda z_{i,t-1} + X_{i,t} + \upsilon_i + e_{i,t} \qquad \text{(Equation 3)}$$

Where:

- y is the dependent variable (Bank's nonperforming loans as percentage of gross credit to private sector)
- i refers to the country ($i = \overline{1,21}$)
- t refers to year ($t = \overline{1,18}$)
- X are the explanatory variables
- γ are the coefficients of the explanatory variables
- α is the constant term
- β is the coefficient of the lagged depended variable
- λ is the coefficient of other lagged variables except NPL
- υ_i are the country-specific intercepts
- $e_{i,t}$ are the observation-specific errors

The baseline model is the static Fixed Effect Model which uses Equation 1. This paper uses three other Specifications for FE model by imposing previous years NPLs as an explanatory variable and in Specification 3 with one lag of GDP growth by using the Equation 2 and Equation 3 respectively. The Specification 4 looks at the changes in the results by excluding the 2008's data by using the baseline model.

To check the robustness of the results revealed from the FE models and to fix the problem of fixed effects regarding the endogenous explanatory variables difference GMM and system GMM are used. The Arellano and Bond (1991) difference GMM estimator which was

proposed by Holtz-Eakin et al. (1988) uses first-differences to convert the baseline model into the following equation:

$$\Delta y_{it} = \beta_1 \Delta y_{i,t-1} + \lambda \Delta x_{i,t-1} + \gamma \Delta X_{it} + \Delta u_{it} \qquad \text{(Equation 4)}$$

Where:

- y is the dependent variable (Bank's non performing loans as percentage of gross credit to private sector)
- i refers to the country ($i = \overline{1,21}$)
- t refers to year ($t = \overline{1,18}$)
- X are the explanatory variables
- γ are the coefficients of the explanatory variables
- β is the coefficient of the lagged dependent variable
- λ is the coefficient of the other lagged variables except NPL
- $u_{i,t}$ are the observation-specific errors

The system GMM is derived from this difference GMM model with residuals kept in level. Following the literature and theories regarding the NPL and credit channel of the monetary transmission mechanism described earlier in section 2, one lag for the NPL, credit, GDP growth and inflation are all used in the two models of the GMM.

4.2. Empirical Results and discussion

The result of the baseline FE model (column S1 in Table 05) where NPLs is the dependent variable, and the explanatory variables are bank credit to GDP ratio, GDP growth, total unemployment as a percentage of the total labour force, nominal effective exchange rate, inflation and proxy variable of the institutional quality, the rule of law, indicates that there are negative effects of the bank's credit and GDP growth to the NPLs however, there are positive correlation with unemployment, appreciation of the local currency and inflation. Out of the four FE specifications, in three specifications credit, GDP growth, exchange rate and inflations' impacts are statistically significant and consistent.

Table 5: FE models with 4 specification and difference and system GMM models

Variables	S1: FE(i) baseline	S2:FE with NPL $_{t-1}$	S3: FE with GDPG$_{t-1}$	S4: S1 excluding 2008	S5: Difference GMM	S6: System GMM
NPL $_{t-1}$		0.693***			0.079	0.735***
		(0.036)			(0.071)	(0.029)
Bank credit	-0.201***	-0.036	-0.194***	-0.187***		
	(0.035)	(0.026)	(0.036)	(0.035)		
Bank credit $_{t-1}$					-0.487***	0. 001
					(0.062)	(0.020)
GDP growth	-0.338***	-0.223***	-0.118	-0.265**		
	(0.115)	(0.079)	(0.116)	(0.116)		
GDP growth $_{t-1}$			-0.312***		-0.351***	-0.263***
			(0.110)		(0.088)	(0.073)
Unemployment	0.186	0.059	0.184	-0.580	0.241	0.099*
	(0.201)	(0.138)	(0.200)	(1.719)	(0.183)	(0.054)
Exchange rate	0.035***	0.012	0.059***	0.038***	0.056***	0.013
	(0.010)	(0.011)	(0.015)	(0.010)	(0.018)	(0.010)
Inflation	0.265***	0.016	0.139**	0.375***		
	(0.068)	(0.050)	(0.072)	(0.073)		
Inflation $_{t-1}$					0.103*	0.063
					(0.053)	(0.041)
Rules of Law	0.229***	0.108**	0.248***	0.225***	0.196***	0.010
	(0.069)	(0.049)	(0.070)	(0.070)	(0.073)	(0.018)
No of Obs.	378	357	357	357	336	357
No of Group	21	21	21	21	21	21
Instrument No					67	136
Sargan p-value					0.000	0.000
AR(1) p-value					0.946	0.000
AR(2) p-value					0.007	0.037
p value	0.000	0.000	0.000	0.000	0.000	0.000

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

When the previous year's GDP growth rate is considered as another explanatory variable, the bank credit and exchange rate's correlation coefficients with NPLs remain highly significant. This paper could not investigate deeply why correlation coefficient of unemployment is not statistically significant in FE model (which becomes significant in specification six where the system GMM model is used) although the relation signs support the underlying theory about

the impact on NPLs. It is interesting that although the rule of law's correlation coefficient is highly significant and consistent in all FE specifications, the sign of the coefficient is contradictory to the theory. Therefore, a deeper investigation of the data is required, which is beyond the scope of this short period research. However, the negative correlation which is theoretically expected is found in another modified specification that has been discussed in the *Robustness of the result* part of this section.

In the difference GMM (Specification 5 in Table 5) the correlation among variables is almost remaining consistent with the results of the FE specifications regarding sign and statistical significance. However, compared to the baseline model difference GMM provides more than double correlation coefficient of the Bank's credit whereas the coefficient of the NPLs in one lag becomes around ten times smaller compared to the Specification 2.

Finally, the system GMM (Specification 6 in Table 5) reveals some changes regarding the sign of the correlation and significance level. It is fascinating that the correlation coefficient of unemployment becomes statistically significant at 10 percent whereas the rule of law's correlation coefficient becomes insignificant with a dramatically lower value. These two changes recall the superiority of this model compared to other models used for the results in Table 5.

4.3. Robustness of the result

This paper uses the Hausman test to choose the model between random effect and fixed effect, where the null hypothesis (H0) refers to random effect whereas alternative (Ha) would be the fixed effect (Green 2003, chapter 13). As it tests whether the unique errors are correlated with the regressors, the null hypothesis is they are not. Our data rejects the null hypothesis in less than 1% (Prob>chi2 =0.0000) statistically significant level. The results of the fixed effect model (Specification 1 in Table 5) are also verified with the other alternative two OLS models (LSDV and AREG model), and all dependent variables' coefficients remain consistent in the three models with the same statistically significant level.

Breusch-Pagan LM test of independence found chi-square equal 749.556 and probability equal 0.000, hence, rejects the null hypothesis, and there is cross-sectional dependence. While using the Pasaran CD (cross-sectional dependence) test of cross-sectional independence is 12.323, the probability is 0.000. Hence, it also rejects the null hypothesis.

Modified Wald test for groupwise heteroskedasticity test rejects the null so, heteroscedasticity is present. Finally, Wooldridge test for autocorrelation in panel data is conducted and found F (1, 20) equals 116.692 and Prob>F is 0.0000, hence, rejects the null hypothesis, therefore, data has first order autocorrelation.

Following the reality of the global nature of the financial market along with the globalising world economy, the impact on LMICs of the 2007-2009's global financial crisis is also remarkable which is supported by the result already found from the Specification 4. To address these effects and to check results sample data is divided by two ways which have been explained in the ending part of section 3. In the post-2008 period, the correlation coefficient of rules of law (the proxy variable of institutional quality) became negative as per the difference GMM (using the same model as Specification 5). Therefore it is complicated to make a conclusion without proper investigation about the robustness of data for the rule of law.

5. Non-performing loans and their effects on the macroeconomic factors

5.1. Methodology

Panel-Vector Autoregressive approach seems to be the perfect model to address the second objective of this research since PVAR particularly able to "(i) capture both static and dynamic interdependencies, (ii) treat the links across units in an unrestricted fashion, (iii) easily incorporate time variations in the coefficients and in the variance of the shocks, and (iv) account for cross-sectional dynamic heterogeneities" (Canova & Ciccarelli 2013).

PVAR model

Basically in the macroeconomic analysis following the origination of Sims (1980), SVAR, is a commonly used econometric method to assess the impact of independent monetary policy shocks on other macroeconomic variables. Following the extended contribution of Holtz-Eakin et al. (1988), PVAR becomes a standard tool for analysing multivariate time-series in a panel context. A PVAR model evaluates the magnitude and duration of the effects which incorporate the traditional VAR's endogenous variable approach (Lof & Malinen 2014) along with a panel data technique which altogether allows the unobserved individual heterogeneity (Klein 2013).

PVARs have the potential to become as important as VARs to answer relevant economic questions that do not require specification of the entire structure of the economy. However, structural panel VAR models would be liable to similar criticism of structural VAR models (Canova & Pina 2005) and thus need to be considered with care. Moreover, the significant dimension of PVARs typically makes the curse of dimensionality an issue especially when researchers are interested in examining the input-output links of a region or an area, where the time series dimension of the panel is short (Canova & Ciccarelli 2013).

PAVR does not require any theoretical assumptions as it is a parameter-based method. However, impulse response functions (IRFs) and variance decompositions (VDCs) produced from the PVAR technique are very useful to analyse the interaction of the macroeconomic fluctuations. A PVAR holds three characteristics, i.e., "dynamic interdependencies", "static interdependencies" and "cross-sectional heterogeneity" (Canova & Ciccarelli 2013). Although PVAR addresses both static and dynamic endogeneity issues as VAR, it has an additional feature as cross-sectional heterogeneity generates a distinguished structure for the covariance matrix of the error terms.

PVAR model for feedback effect of NPLs

The PVAR model is computed with the program written by Love and Zicchino (2006) and Abrigo and Love (2016) and the underlying equation can be written as:

$$Y_{it} = \alpha_i + \Gamma(L)Y_{i,t} + \varepsilon_{i,t},$$
$$Y_{it} = npl_{it}, \ lcredit_{it}, \ lune_{it}, \ lgdp_{it}, \ lneer_{it}, \ lpai_{it}$$

(Equation 5)

Where i ($i = \overline{1, \ 21}$) indicates the country and t ($t = \overline{1, \ 18}$) means time. Y_{it} is the vector of endogenous stationary variables, $\Gamma(L)$ signifies the matrix polynomial in the lag operator L, α_i is the vector of country fixed effects and $\varepsilon_{i,t}$ is a vector of errors. The variable npl_{it} is the NPLs as a percentage of the bank's l, $lcredit_{it}$ is in the logarithm of the credit to GDP ratio, $lune_{it}$ is the logarithm of unemployment rate, $lgdp_{it}$ is the logarithm of GDP, $lneer_{it}$ is the logarithm of the nominal effective exchange rate and $lpai_{it}$ is the logarithm of inflation rate.

Methodologically, the VAR approach for panel data needs to impose the same underlying structure for each country, a restriction that would usually be violated in exercise (Love & Zicchino 2006). The country fixed effects are a way to overcome the constraint on the

parameters to the extent that they capture individual heterogeneity. Following Abrigo and Love (2016) and others, estimating the coefficients with the GMM method, the IRFs and VDCs using the Cholesky decomposition are computed. Similar order for the endogenous variables used by Klein (2013) is followed as a baseline model (Equation 5). However, the robustness of the results is tested with modified specifications with changes in order. Following most of the literature with PVAR model, the stata programs (pvar) which use GMM method written by Abrigo and Love (2015; 2016) is used for calculation, however, the similar program that is "xtvar", which uses LSDV method developed by Cagala and Glogowsky (2015) is also used to check the consistency of the result found by using the "pvar" program. The impulse response functions presented in section 5 is from the result found by using the program of Cagala and Glogowsky (2015) as this program is handy in producing graphs by default if the "pvar" program provides the same results (see Graph A in Appendix). It has to be mentioned that compared to the "xtvar" this paper prefers "pvar" as the last program uses the GMM method.

Lag selection

Out of the six types of lag selection approaches four approaches (AIC, BIC, J pvalue and QIC) refer to one lag for baseline PVAR model. It is also remarkable that as yearly data is used one year lag is theoretically rational. This paper also checked the consistency of the IRFs by imposing one more lag.

Table 6: Summary of the six kinds of lag selection criteria

Lag	CD	J	J pvalue	MBIC	MAIC	MQIC
One	1.000	128.853	0.028*	-418.374*	-71.147*	-211.086*
Two	1.000	82.773	0.252	-327.648	-67.227	-172.181
Three	1.000	41.453	0.800	-232.160	-58.547	-128.516
Four	1.000*	28.746*	0.275	-108.061	-21.254	-56.239

Granger Causality test:

The assumption of null hypothesis that log inflation does not Granger-cause the equation variable, NPL as a percentage of gross credit, is rejected at 5 percent significance level. The same hypothesis states that the NPL does not Granger-cause the equation variables log exchange rate and log inflation are rejected at 5 percent and 10 percent significance levels

respectively. However, if the variables are used in the normal form then all null hypotheses for each Granger-causality (NPL does not Granger-cause 'credit', 'unemployment', 'GDP', 'exchange rate' and 'inflation') are rejected at 1 percent or 5 percent significance level. It may be mentioned that most of the LMICs' monetary policy has no significant impact on the economy as most of the LMICs' economy depends largely on the other sector, mainly consumption for which significant parts of it are funded by remittances. Because the common feature of the major LMICs is their large pool of human capital. However, the present research focuses on the comparatively effective channel for the monetary policy transmission mechanism, the credit channel. NPLs not only affect GDP, inflation and unemployment but also affect the credit market which may accelerate the financial crisis from within the systems as an endogenous variable.

Cointegration Test:

The Pedroni tests are based on the residuals obtained from a static relationship. Simulation studies have shown that residual based tests have less power compared to those based on a dynamic model. Hence this paper uses Westerlund to test the cointegration.

*Unit root test:*

Graph 2: Eigenvalue stability condition
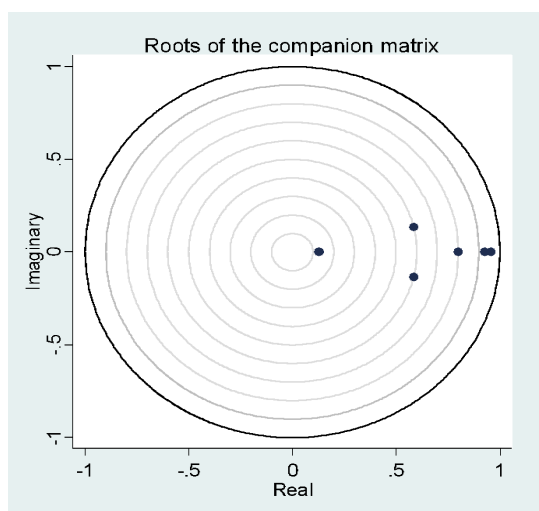
It reveals that the model satisfies the stability condition as all the eigenvalues lie inside the unit circle as shown in Graph 2. Although the credit-to-GDP ratio in logarithm form does not reject the null hypothesis of the Fisher unit root test however, all variables within the group

used in baseline PVAR model satisfy the stability condition.

5.2. Result and discussion

The impulse response function (Graph 3(a)) of the model (Equation 5) demonstrates that an NPLs shock initially changes NPLs as a percentage of the total credit by approximately 4.5 percentage points higher than the steady state level, while ratio of the bank credit to GDP decreases from the steady state level, gradually by 4 percent in the subsequent year, but continues to increase the deviation from the steady state level further up to next four years and slowly converges to the initial level after a long time. NPLs shock leads to the credit-to-GDP ratios decreases, which indicates its strong impact on the credit as NPLs is a subset of the credit, which affects the recovering rate of the loan and by turn affect the credit rationing, as there is the agent-principal problem raised for the asymmetric information between the two parties (that are the bank and borrowers).

**Graph 3(a):** IRFs from the PVAR model (Equation 5)
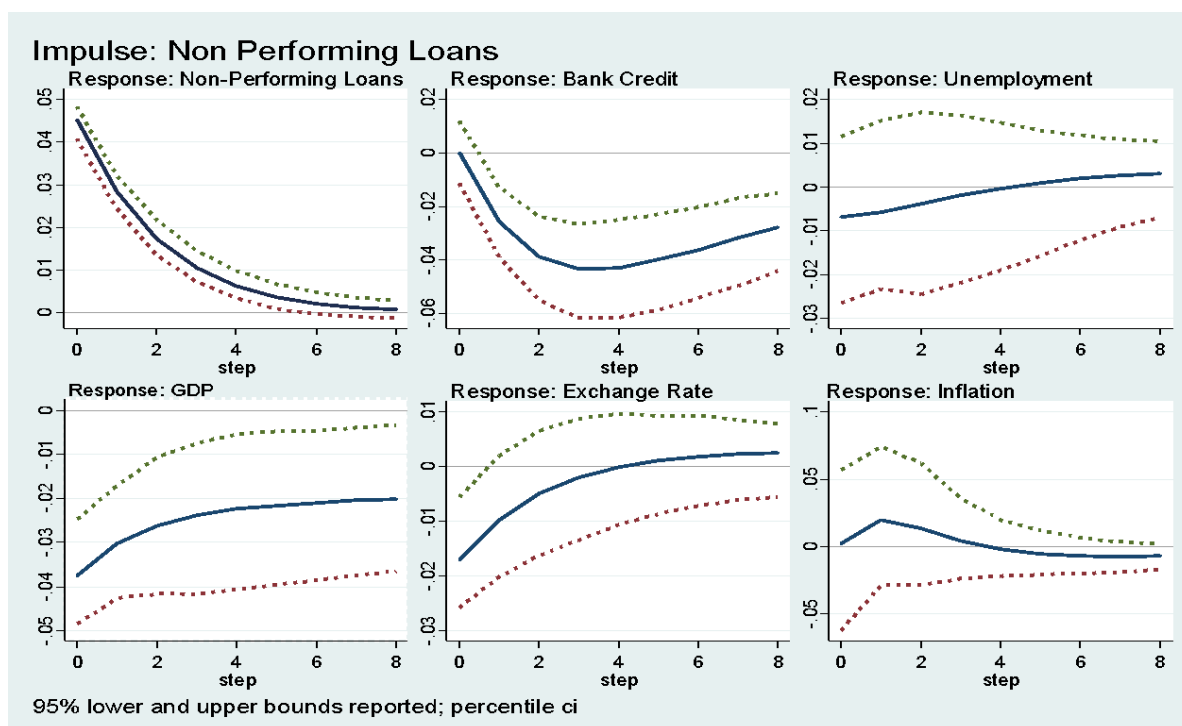
GDP contemporaneously falls negatively by 3.8 percent and remains at nearly 2 percent lower level from its steady state level for a long time, and returns to the initial steady state level very slowly. This finding is also significant as it indicates very concerning facts for the LMICs as GDP level decreases from its steady state level. That would be explained as NPLs

increase that credit has not been used or could not be productive for other macroeconomic conditions explained in Section 4 of this paper. However, on average, the GDP and credit increased dramatically in most of the observed countries, but the NPLs as a percentage of the total credit also increased. Hence, this response of the GDP to the NPLs shock intuitively indicates the less caring about the lending to the dynamic entrepreneurs as well on which Hayek (1945) and Schumpeter's early literature was focussed.

For the same shock unemployment level, however, decreases by 0.8% and increases gradually from the steady state level after some time. It may also indicate the lagged impact of the GDP or other real sectors to the employment sector. Over time, unemployment increases, meaning that higher from the steady state level that indicates a very concerning point for the LMICs economy. As crisis and employment are closely related which is a major compelling topic of the political economy. The policy break due to the financial market infrastructure development may also affect the result. Exchange rate index (CPI-based 172 trading partner considered) decreases instantaneously by about 1.7 percent from the steady state level meaning that local currency depreciates further. This shock also leads to an increase in the inflation rate by nearly 2 percent and returns at the steady state level by the end of the third year.

Graph 3(b): IRFs from the PVAR model (equation 5)
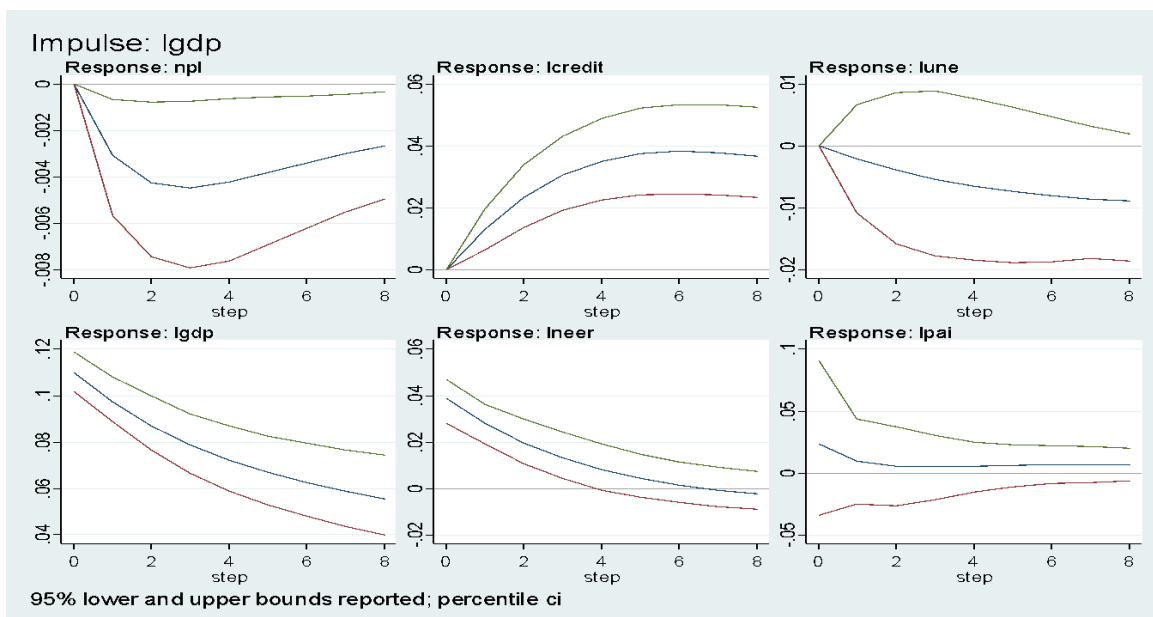
Related to the results as mentioned earlier, the effects of the GDP growth shock to the

impulse response of the endogenous variables of the model requires analysing. The result of this research supports the findings of the other cross-country research on the European economies.

In the observed LMICs it is found (see Graph 3(b)) that 1.1 percent higher GDP from its steady state level leads NPLs as the percentage of the total credit decreases dramatically by 0.02-0.04 percentage points in the first year but continues to decrease up to 3.5 years by 0.04-0.08 percentage point and returned to the steady state level very slowly. Bank credit to GDP ratio raises gradually by 0.4-0.5 percent over the next six years, and the unemployment rate falls steadily, local currency appreciates contemporaneously as output grows but returns to the steady state level by six years. However, inflation rate positively increases by 2.5 percent contemporaneously but rapidly returns to the steady state level and remains almost stable although there is a tendency to stay at a little bit higher degree in the longer period. Intuitively, it is clear that higher GDP means in general, higher consumption, higher investment and higher trade of LMICs which requires more credit that is consistent with the theory that discussed in Section 2 on the demand side of the credit. That all macroeconomic performance affects the productive sector positively and generates new opportunities that reduces unemployment level.

Variance decomposition:

Table 7: Variance Decomposition (Raw variable's percentage explained by column variable)

	NPL	Credit	Unemployment	GDP	Exchange Rate	Inflation
NPL	0.86	0.01	0.01	0.02	0.06	0.04
Credit	0.05	0.84	0.00	0.06	0.04	0.01
Unemployment	0.01	0.03	0.78	0.07	0.10	0.01
GDP	**0.11**	0.02	0.11	0.45	0.30	0.02
Exchange Rate	0.06	0.08	0.04	0.15	0.64	0.03
Inflation	0.04	0.02	0.11	0.04	0.06	0.73

Variance decomposition indicates the error variance of one variable in the model represented by the exogenous shock to other endogenous variables. GDP contributes the largest percentage of the NPLs shock followed by the exchange rate, credit, inflation and

unemployment respectively by five years (horizon 5). Whereas, unemployment (following the exchange rate) and credit contribute a significant percentage to the real GDP shock.

5.3. Robustness tests

There are some contemporary arguments that methodologically PVAR is usually perfect in measuring the similar economy and groups or regional interdependency (Canova & Ciccarelli 2013). Following this, the present paper checked the same model with the regional data and found similar results like research conducted on other groups of economies of the world.

As NPLs and all other macroeconomics factors are affected by the Global Financial Crisis, and following Klein (2013), the sample of this paper is segregated into two segments from 1998 to 2007 (Graph 4), and another group is from 2008 to 2015 (Graph 5). Furthermore, Asian LMICs are segregated and measured with the same model.

**Graph 4:** IRFs from the model with only pre 2008 period (1998-2007)
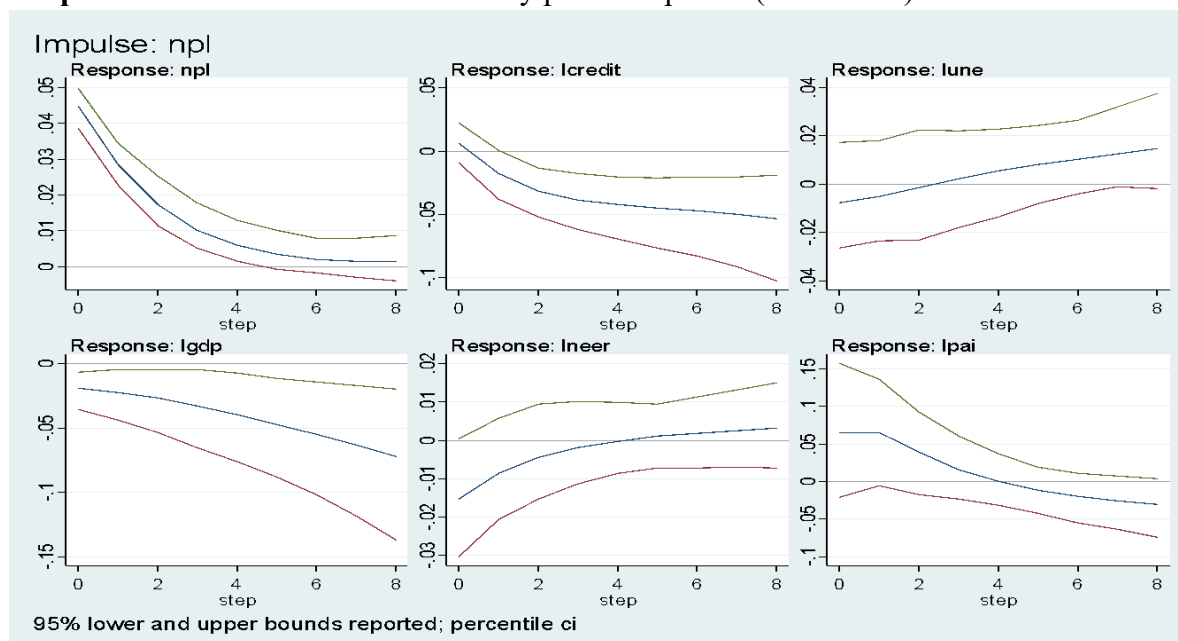
It is fascinating that in the post-2008 (2009-2015) period the non-performing loans contemporaneously affects unemployment whether in other specifications of the PVAR it takes time (see Graph 5). The adverse fluctuation of GDP by 0.35 percent as a contemporaneous response to the about 0.17 percentage point shock in NPLs higher from the steady state level decreases its variance rapidly which indicates the strength of the economy compared to the previous pre-2008 period.

Graph 5: IRFs of the model with post 2008 (2009-2015)
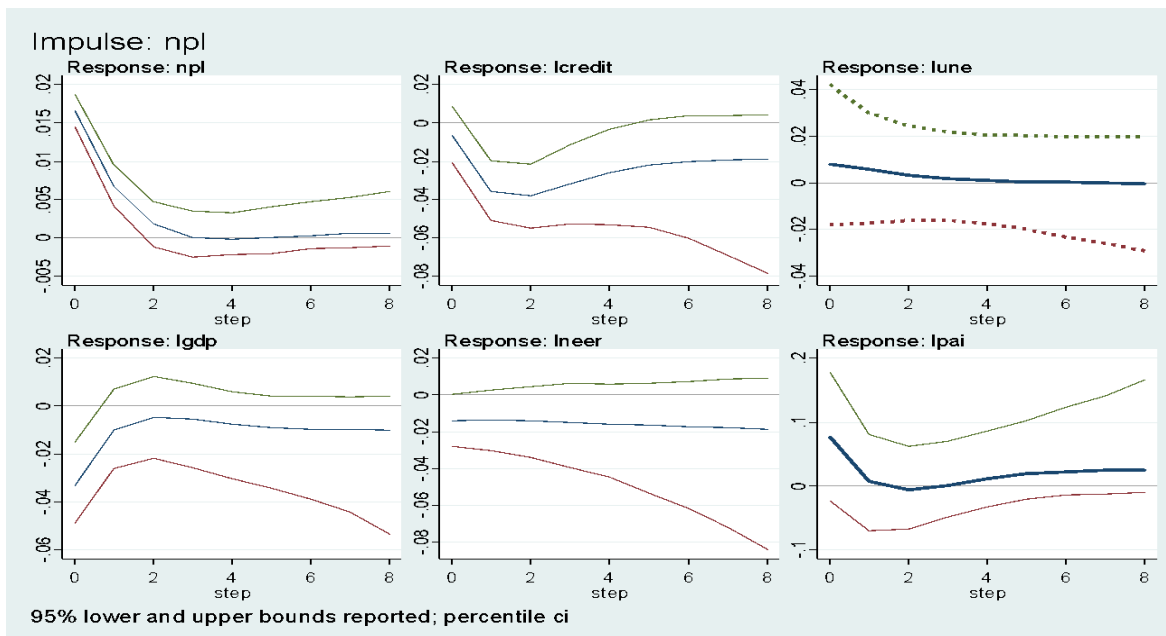
In the Asian LMICs, although the contemporaneous fluctuation of GDP, credit and exchange rate is similar as a response to the NPLs shock in other specifications, however, this shock leads unemployment increase contemporaneously from its steady state level. Around 2.8 percentage point increases of the NPLs from its steady state level leads unemployment increases contemporaneously by more than 1 percent from which it stays around this level for next four years (see Graph 6).

Graph 6: IRFs from the model with Asian LMICs
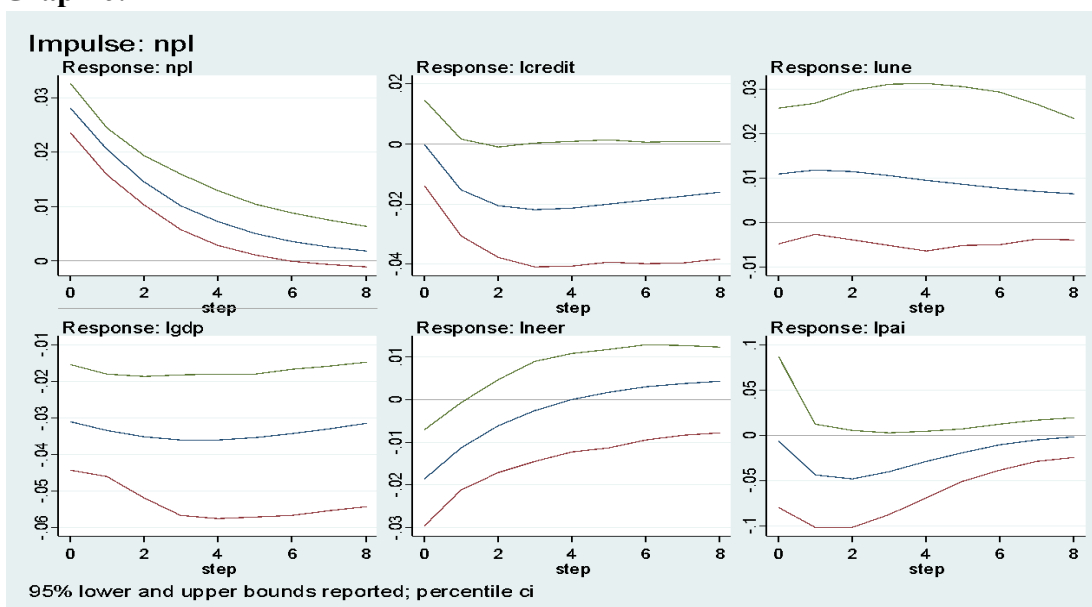
Overall, the main result of the baseline model of the PVAR is consistent with all Specifications with some deviation and intuitively, relevant periods and effects of the structural break would be for financial market development including the macroprudential policy initiatives through BASEL 2 and BASEL 3 implementation in the LMICs that need country specific further investigation.

6. Conclusion, policy recommendation and future research

This paper found strong macroeconomic-institutional-financial linkages in LMICs' economy, whereas, NPLs attributes to both macroeconomic conditions and institutional quality. NPLs have negative impacts on the real economy, therefore, suggesting that high NPLs lead economic activity negatively. It is crucial to strengthen supervision, implement macroprudential policy and maintain credit standards (that is "rationing").

During the time of this research, the NPLs feedback impact on the real economy attempted to be explained by the entrepreneurship and productive investment which can create the situation to go forward to the technological frontier through the line of the productive used of the credit with emphasis on the balanced treatment of both the demand and supply-side approaches of the credit. Though manufacture and agricultural value added to the GDP are assumed as a good proxy variable to investigate towards the Schumpeterian model of growth considering the context of the LMICs growth pattern. Primarily that addional research does not find any robust result. However, it is also critical to investigate the creative destruction with a firm econometrics model considering the scope and time constraint of the present research; hence, this paper focused on the primary objective of this study.

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Appendix

Table A: Missing data of NPLs in WID (2016)

<u>Country</u>	<u>Years</u>
Bangladesh	2008 to 2010
Egypt	1998 to 1999
El Salvador	1998 to 2000
Guatemala	1998 to 2000
Kyrgyz Republic	2005
Moldova	1998 to 1999 and 2005
Morocco	2015
Nigeria	2007
Sri Lanka	2006 to 2010
Tunisia years	2008 and 2015
Ukraine	1998
Vietnam	1998 to 2007, 2015

Graph A: IRFs of the PVAR model by using "pvar" program (Abrigo & Love, 2016)