Macrofinancial Effects of Non-performing Loans

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Abstract

We investigate the macrofinancial impacts of non-performing loans using a global non-performing loan dataset constructed from the Financial Stability Indicators database of IMF. We adopt two approaches: the panel VAR approach and the episodic approach. The post-estimation impulse response functions based on panel VAR models reveal that an increase in the NPL ratio significantly lowers the GDP growth rate and raises the unemployment rate. The episodic approach focuses on the episodes of a sharp drop in the NPL ratio followed by a sustained and substantial reduction in the NPL ratio. The macrofinancial effects of sharp drops in the NPL ratio is measured by estimating the average treatment effect on the treated with propensity score matching. The results demonstrate that a sharp drop in the NPL ratio significantly enhances the macrofinancial performance of an economy, raising the GDP growth rate, the investment growth rate, and the growth rate of loans and lowering the unemployment rate.

Keywords: non-performing loan, macrofinancial effect, panel vector autoregression, average treatment effect on the treated

JEL Classification: G2, G33, G40

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First received, September 23, 2021; Revision received, October 17, 2021; Accepted, October 27, 2021.

1 Introduction

Non-performing loans (hereafter NPLs) cast various kinds of burden on banks and financial institutions. They require a larger capital for banks and thereby reduce banks' capacity to make loans to new and more profitable customers. They deplete earnings of banks by making them lose revenues from unpaid interest and by the need to set aside a portion of current income as provisions against potential losses. Besides, NPLs have negative impacts on bank management as their resolution takes up time and resources that could be better used on core banking activities. They also strain banks' liquidity and increase their funding costs.

NPLs not only inflict direct damage on banks but eventually cast a burden on the entire economy by keeping banks from adequately performing the role of financial intermediation and thereby slowing down overall economic activities. The adverse effects of NPLs on overall macroeconomic activities are grounded on theoretical models as well as empirical regularities. The financial accelerator theory as discussed by Bernanke and Gertler (1989), Bernanke and Gilchrist (1999), and Kiyotaki and Moore (1997) has become the most prominent theoretical framework for thinking about macrofinancial linkages of NPLs. Empirical studies also confirm the adverse macrofinancial feedback effects of NPLs. Espinoza and Prasad (2010), Nkusu (2011), De Bock and Demyanets (2012), Klein (2013), Lee and Rosenkranz (2019), and Huljak, Martin, Moccero, and Pancaro (2020) estimate panel vector autoregression (hereafter PVAR) models and find that a change in the NPL ratio has significant, albeit short-lived, macrofinancial impacts.

More than anything else, a large and sustained NPL buildup could raise the possibility of a banking crisis, which usually levies a heavy toll on the entire economy. Noting the key role that NPLs play in banking crises, Caprio and Klingebiel, (1996), Drees and Pazarbasioglu (1998), and Kaminsky and Reinhart (1999) suggest that a large increase in NPLs could be used as a variable that might directly or indirectly help predict financial crises. Credit crunches that accompany banking crises in general affect small and medium-sized enterprises, households, and infrastructure financing more heavily and as a result hinder inclusive growth.

Consequently, NPL resolution has been one of the core measures adopted by governments in restructuring their financial sector during the Asia Currency Crisis and the Global Financial Crisis.

One of the difficulties in identifying the macrofinancial feedback effects of NPLs is the endogeneity problem arising from NPLs and macrofinancial variables simultaneously affecting each other. Most of the previous empirical studies on the macrofinancial feedback effects of NPLs adopted the PVAR approach to address this problem. In the PVAR approach, ordering of variables within the VAR system is adopted to identify NPL shocks and the magnitude of the macrofinancial effects of NPLs is measured through impulse response functions.

Recent studies on NPLs, however, focus on episodes of sharp drops in the NPL ratio to measure the macrofinancial impacts of NPLs. These studies, including Balgova, Plekhanov, and Skrzypinska (2017) and Park, Lee, and Rosenkranz (2021) pay attention to the fact that changes in the NPL ratio, particularly sharp drops in the NPL ratio, are often driven by active policy efforts to resolve NPLs. To prevent a systemic banking crisis or to resolve a financial crisis, governments experiencing a high and rising NPL ratio tend to adopt NPL resolution measures such as NPL transfer to asset management companies (hereafter AMCs) and injection of bailout funds. For example, the four countries directly hit by the 1997-98 Asian Currency Crisis, namely Indonesia, Malaysia, South Korea, and Thailand established central public AMCs to acquire NPLs from ailing banks. In contrast, most of the European countries with the exceptions of Ireland and Spain[1] relied on bank restructuring and unconventional monetary policy rather than NPL resolution during and in the aftermath of the Global Financial Crisis. Rhee (2013) argues that this is why recovery of the banking sector from the Global Financial Crisis has been slow in Europe.

The effectiveness of NPL resolution measures, however, should be evaluated by the eventual macrofinancial effects rather than by the reduction in the NPL ratio. While transferring NPLs to AMCs is effective in removing NPLs from the banking sector, it remains to be empirically verified that removal of NPLs from the banking sector actually enhances the macrofinancial performance of an economy. This is why Balgova,

[1] Ireland and Spain established centralized AMCs, namely NAMA and SAREB, to help banks resolve NPLs. The EU restriction, however, requires that AMCs should not be public entities.

Plekhanov, and Skrzypinska (2017) adopt an episodic approach to measuring macrofinancial effects of NPLs, focusing on episodes of sharp drops in the NPL ratio. They evaluate the macroeconomic impacts of a sharp drop in the NPL ratio by estimating the average treatment effect on the treated (hereafter ATET) using episodes of sharp drops as the treatment group and episodes of persistently high NPLs as the control group. Using propensity score matching analysis, they find that a sharp drop in the NPL ratio is associated with extra GDP growth in excess of 1.5 percentage points per annum over several years. Using a new country-level panel dataset of NPL ratios constructed by aggregating the bank-level data from S&P Global Market Intelligence, Park, Lee, and Rosenkranz (2021) also estimate the ATET and find that a sharp drop in the NPL ratio has significantly positive feedback effects on financial variables as well as on growth and unemployment.

In this study, we investigate the macrofinancial feedback effects of NPLs using two approaches: the PVAR approach and the episodic approach. In the PVAR approach, we estimate a PVAR model with four endogenous variables and investigate the macrofinancial effects of NPLs using the post-estimation impulse response functions. We construct and use a global panel dataset of NPLs constructed by combining the Financial Soundness Indicators database of IMF with various other sources such as the World Development Indicators database of World Bank and national sources. The dataset is an unbalanced panel comprising of 181 countries covering the period from 1990 to 2019. In contrast, previous studies adopting the PVAR approach have relied on samples with limited coverage of countries. For example, Espinoza and Prasad (2010) use a dataset consisting of six countries in the Gulf Council, Nkusu (2011) uses a dataset of 26 advanced economies, De Bock and Demyanets (2012) use a dataset of 25 emerging economies, Klein (2013) uses a dataset of 16 Central and Eastern and South-Eastern (CESEE) countries, and Lee and Rosenkranz (2019) use a dataset of 32 countries in emerging Asia. While limiting the sample to countries with similarities in the region or in the development stage is meaningful, these studies show that the magnitude and the duration of the macrofinancial feedback effects of NPLs differ with the country sample, necessitating a PVAR analysis with a global sample of countries.

In the episodic approach, we follow Balgova, Plekhanov, and Skrzypinska (2017) to identify episodes of a sharp drop in the NPL ratio

that leads to a substantial and persistent reduction in the NPL ratio. Using these episodes of sharp drops as the treatment group and the episodes of high and persistent NPLs as the control group, we estimate the ATET as the measure of the macrofinancial effects of NPL reduction.

This paper is organized as follows. Section II presents a brief survey of the previous empirical literature on the macrofinancial feedback effects of NPLs. Section III estimates the PVAR model and analyzes the macrofinancial effects of NPLs through the post-estimation impulse response functions. Section IV investigates the macrofinancial effects of a sharp drop in the NPL ratio by estimating the ATET with episodes of sharp drops in the NPL ratio as the treatment group and episodes of high and persistent NPL ratios as the control group. Section V concludes.

2 Literature Review

One of the difficulties researchers encounter in evaluating the macrofinancial feedback effects of NPLs is the endogeneity problem arising from NPLs and macrofinancial variables simultaneously affecting each other. Several previous empirical studies adopted the PVAR approach to circumvent the endogeneity problem. In the PVAR approach, Cholesky decomposition with ordering of variables within the VAR system is adopted to identify NPL shocks and the magnitude of the macrofinancial effects of NPLs is measured through impulse response function.

Espinoza and Prasad (2010) investigate the macrofinancial effects of NPLs using a sample consisting of 6 countries in the Gulf Cooperation Council region over the period 1995-2008. Estimating a PVAR model consisting of GDP growth rate, credit growth rate, and NPL ratio, they find that an increase in the NPL ratio significantly reduces credit growth as well as GDP growth. They find, however, that the effect on GDP growth is short-lived, albeit strong.

Nkusu (2011) investigates the feedback between NPLs and their macroeconomic determinants using a PVAR model and examines the interaction among these variables using generalized impulse response functions. The results of the impulse response functions attribute to NPL a central role in the linkages between credit market frictions and

macrofinancial vulnerability. A sharp increase in the NPL ratio cripples the macrofinancial performance of an economy over a long period.

De Bock and Demyanets (2012) estimate a fixed effect PVAR model using a sample of 25 emerging market economies over the period 1996–2010. Their PVAR model consists of five variables, namely the NPL ratio, the growth rate in the ratio of private credit as a share of GDP, the foreign portfolio and bank flows as percentage of GDP, the real GDP growth, and the change in exchange rate. Post-estimation impulse response functions reveal that economic growth falls significantly when NPLs increase or when credit contracts, thereby confirming the feedback effects from the financial sector on the wider economy.

Klein (2013) uses a dataset comprising 16 Central and Eastern and South-Eastern (CESEE) countries over the period 1998–2011 to look into the macrofinancial impacts of NPLs. Estimation of a PVAR model consisting of five variables including NPL ratio, change in the private sector credit-to-GDP ratio, change in real GDP growth, unemployment rate, and inflation rate broadly confirms the strong feedback effects from the banking system to the real economy. More specifically, the results suggest that an increase in the NPL ratio has a significant impact on credit, real GDP growth, and inflation, thus validating the notion that a healthy and sustainable growth cannot be achieved without a sound and resilient banking system.

Endut, Syuhada, Ismail, and Manhood (2013) use dynamic panel data methods to examine the macroeconomic implications of NPLs in Asia and the Pacific region. Applying annual data from 2000 through 2008 for twelve countries, the results show that significant adverse macroeconomic implications coupled with higher cost of capital are associated with a rising NPL ratio.

Lee and Rosenkranz (2019) examine the determinants of NPLs and the macrofinancial feedback effects of NPLs in Asia. Using annual data covering 1994–2014 for 32 countries in emerging Asia, they estimate a PVAR model consisting of NPL ratio, bank loans, GDP (or unemployment rate), and policy interest rates. The post-estimation impulse response functions reveal that one standard deviation shock in the NPL ratio leads to about 0.18 percentage point contraction in GDP growth, 3.61 percentage point decline in loan growth, and 0.21 percentage point rise in unemployment rate after one year. Using a dynamic panel model, they also

find that macroeconomic conditions and bank-specific factors such as rapid credit growth and excessive bank lending contribute to the buildup of NPLs.

Huljak, Martin, Moccero, and Pancaro (2020) investigate the impact of NPL ratios on aggregate banking sector variables and the macroeconomy by estimating a panel Bayesian VAR model for 12 Eurozone countries. The model is estimated assuming a hierarchical prior that allows for country-specific coefficients. The VAR model includes a large set of variables and is identified by Cholesky decomposition. The impulse response analysis shows that an exogenous increase in the change in the NPL ratio tends to depress bank lending volumes, widen bank lending spreads, and lead to a fall in real GDP growth and residential real estate prices.

Meanwhile, Ozili (2019) investigates the influence of financial development on NPLs in addition to macroeconomic factors. Using a global sample of country level panel data, he finds that two financial development proxies, foreign bank presence and financial intermediation, are positively associated with NPL ratios.

Unlike these studies, Balgova, Plekhanov, and Skrzypinska (2017) focus on episodes of sharp NPL reduction to evaluate the macrofinancial effects. They note that episodes of NPL reduction usually begin with a sharp drop in the NPL ratio. Using a panel dataset consisting of 190 countries, they also note that a sharp drop in the NPL ratio usually results from policies to resolve NPLs, namely establishment of public AMCs, injection of public funds in the banking sector, and loosening of the criteria for NPL recognition. They measure the macrofinancial effects of NPL resolution policies by estimating the ATET. They use the episodes of sharp drops in NPL ratios as the treatment group and the episodes of persistently high NPLs as the control group. Using propensity score matching to estimate ATET, they find that sharp reductions in NPL ratios lead to extra growth in per capita GDP exceeding 1.5 percentage points per annum over several years.

Park, Lee, and Rosenkranz (2021) also adopt the episodic approach to investigate the macrofinancial impacts of a sharp drop in the NPL ratio. They construct a country-level panel dataset of NPL ratios by aggregating the bank-level data from S&P Global Market Intelligence. They find that among the 41 episodes of NPL reduction, 24 episodes start with a sharp

drop in the NPL ratio, confirming the finding of Balgova, Plekhanov, and Skrzypinska (2017) that episodes of NPL reduction tend to start with a sharp drop in the NPL ratio. Estimating panel probit models, they find that implementation of NPL resolution measures such as establishing central public AMCs significantly raises the likelihood of occurrence of a sharp drop in the NPL ratio. They estimate the ATET using these episodes of sharp drop in the NPL ratio as the treatment group and find evidence for improved macroeconomic performance in terms of higher GDP growth and lower unemployment rate during the 4 years after the treatment. The estimates for ATET demonstrate sharp drops in the NPL ratio have positive feedback effects on financial variables as well. In particular, a sharp currency appreciation and a larger increase in M2/GDP ratio are achieved after a sharp drop in the NPL ratio. These positive feedback effects, however, do not last long. They also investigate the macrofinancial feedback effects using the Asian country panel data and find that a sharp drop in the NPL ratio has significant feedback effects on the macrofinancial performance of an economy.

Besides the studies investigating the macrofinancial impacts of NPLs, there is a large body of literature studying the determinants of NPLs. Much of the this literature investigates macroeconomic factors and bank-specific factors as determinants of NPLs. Bank-specific factors focus on the variables that can possibly signal or influence risk-taking practices of banks. On the other hand, macroeconomic factors focus on the variables that are expected to affect borrowers' debt servicing ability. These studies find that deteriorating macroeconomic conditions such as lower economic growth, higher unemployment rate, higher inflation rate, higher degree of currency depreciation, sudden reversals of portfolio flows, and higher global financial volatility tend to raise NPL ratios.

3 The Panel VAR Approach

3.1 Data

We construct a NPL dataset by combining country level NPL ratio data from a few different sources. Our primary source of country level data is

the Financial Soundness Indicators database of IMF. One of the caveats of this dataset is that the time series of the NPL ratio is rather short beginning in the 2000's for most of the countries. Consequently, we extend the time series of the NPL ratio by complementing the Financial Soundness Indicators database with the NPL ratio data from the old version of the World Development Indicators database of World Bank and national sources such as central banks and statistical bureaus.

We exclude the year 2020 from the sample because this is an extraordinary year affected by the COVID-19 pandemic. As the COVID-19 pandemic has devastating effects on real economic activities such as growth and unemployment, it is likely that the asset quality of financial institutions has worsened. Deterioration of asset quality, however, hardly shows up in official statistics as countries implemented several extraordinary measures through regulatory forbearance: freezing the classification status of all credit exposures before the pandemic, extending the number of past-due days after which credit is considered nonperforming, and allowing banks to postpone adequate provisioning (IMF and World Bank, 2020). The resulting dataset is an unbalanced panel with 181 countries covering the period from 1990 to 2019, although the coverage of the time series differs widely with countries.

Table 1. Sources of Data

Variable	Source
NPL Ratios	IMF, FSI and DSBB WB, WDI National Sources
Gross Loans	IMF, FSI and FAS National Sources
GDP Growth Rates	IMF, WEO WB, WDI
Unemployment Rate	IMF, WEO WB, WDI National Sources
Policy Rate	IMF, IFS WB, WDI National Sources

FSI = Financial Soundness Indicators, DSBB = Dissemination Standards Bulletin Board, WDI = World Development Indicators, WEO = World Economic Outlook databases, FAS = Financial Access Survey, IFS = International Financial Statistics.
Note: National sources include central bank and statistics bureau.

Besides the NPL ratio, the following data on macroeconomic variables are used: loans growth rate defined as the year-on-year growth rate of loans of the banking system, real GDP growth rate, policy interest rate, and unemployment rate. To maximize coverage of countries and years, the data for these variables are collected from various sources. Table 1 summarizes the sources of data for these variables.

3.2 Methodology

To investigate the macrofinancial feedback effects of NPLs, we estimate a PVAR model. In this model, all variables are endogenous and have potential influence on each other. The VAR framework and the impulse response functions allow us to identify the dynamic effects of an exogenous shock in each variable on other variables. Following Lee and Rosenkranz (2019), the model is specified as follows:

$$Y_{i,t} = \Gamma_0 + \sum_1^p \Gamma_k Y_{i,t-k} + \varepsilon_{i,t}, \quad (1)$$
$$\varepsilon_{i,t} = u_i + v_{i,t},$$

where $Y_{i,t}$ is the vector of endogenous variables of country i in year t and $\varepsilon_{i,t}$ is the composite error term consisting of the country fixed effect and the independently and identically distributed idiosyncratic error $v_{i,t}$.

In the baseline specification, $Y_{i,t}$ consists of four endogenous variables, namely change in the NPL ratio ($\Delta nplr$), growth rate of loans ($\Delta loans$), GDP growth rate (Δgdp) and change in policy rate ($\Delta policy$). In the alternative specification, GDP growth rate is replaced by change in unemployment rate ($\Delta unemp$).

Table 2 presents the descriptive statistics for these variables. Table 2 reveals that the NPL ratios display a significant variation with the maximum value of 74.1% and the standard deviation of 8.4%. Macroeconomic variables such as GDP growth rate and unemployment rate also demonstrate high variability. However, it is the loan growth rate that has the greatest variability.

We use Fisher-type panel unit root test to determine stationarity of these variables (Choi, 2001). As Table 3 shows, the panel unit root tests using both augmented Dickey-Fuller and Phillips-Perron tests suggest that all the variables tested are stationary. Table 4 presents the correlation among the

variables included in the PVAR model as endogenous variables. Table 4 reveals that change in the NPL ratio is significantly correlated with all the endogenous variables. This, however, does not mean a causal relationship, which will be investigated through a PVAR analysis.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
nplr	3,426	8.277	8.398	0.010	74.100
Δnplr	3,228	-0.231	3.982	-47.400	49.401
Δloans	2,700	14.154	21.573	-99.991	375.930
unemp	4,917	8.134	6.322	0.091	38.400
Δunemp	4,744	-0.044	1.284	-20.000	17.600
Δgdp	5,211	3.604	5.251	-41.890	82.809
policy	2,514	6.673	8.242	-0.750	183.200
Δpolicy	2,405	-0.560	10.346	-178.000	175.000

Source: Authors' calculations based on data from IMF. FSI, IFS, FAS, and WEO; World Bank. WDI; and national sources: central banks and statistics bureaus.

Table 3. Panel Unit Root Tests (Fisher-type Unit Root Test)

	Fisher-ADF	Fisher-PP
nplr	1155.89***	754.61***
Δnplr	1531.40***	2182.40***
Δloans	1086.37***	1134.47***
unemp	659.54***	520.15***
Δunemp	1839.88***	2548.18***
Δgdp	1870.40***	2805.66***
policy	819.11***	877.67***
Δpolicy	1641.75***	2384.55***

Note:
1. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.
2. Empirical results have been derived using Stata 14 software.
3. Reported unit root tests were conducted with one lag.

Table 4. Correlation among Endogenous Variables

	Δnplr	*Δloans*	*Δunemp*	*Δgdp*	*Δpolicy*
Δnplr	1.00				
Δloans	-0.07***	1.00			
Δunemp	0.17***	-0.11***	1.00		
Δgdp	-0.22***	0.33***	-0.27***	1.00	
Δpolicy	-0.09***	0.16***	-0.08***	0.01	1.00

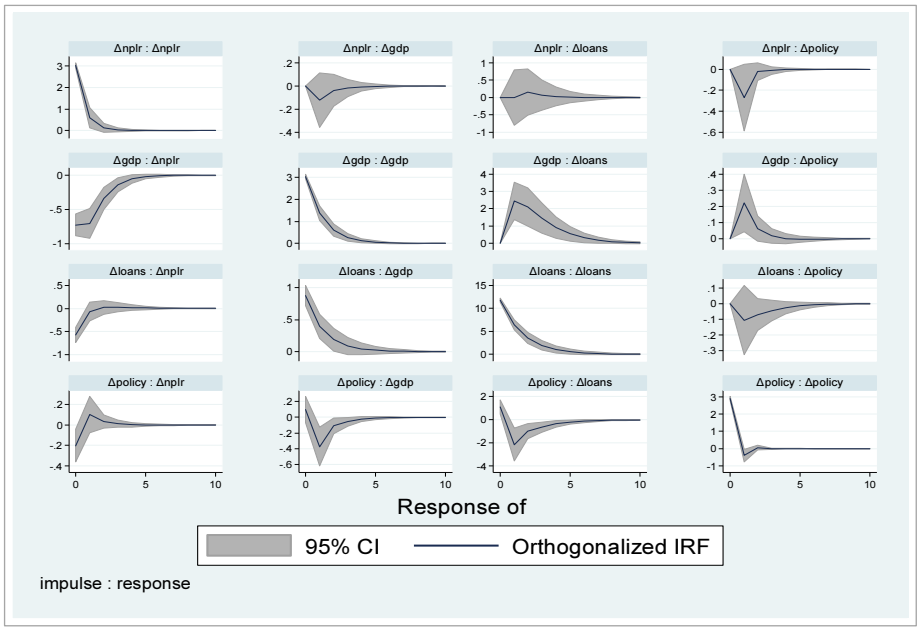
Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

3.3 Results and Discussion

The PVAR model given by equation (1) is estimated using the Stata program developed by Abrigo and Love (2015). Various estimators based on general method of moments (hereafter GMM) have been proposed to calculate consistent estimates of the PVAR model. Abrigo and Love (2015) adopt the forward orthogonal deviation procedure proposed by Arellano and Bover (1995).

Following Espinoza and Prasad (2010) and Lee and Rosenkranz (2019), the identification procedure is based on a Cholesky decomposition with change in policy rate (Δ*policy*) ordered first, followed by Δ*loans* and Δ*gdp*, and change in the NPL ratio (Δ*nplr*) ordered last. This ordering assumes that causality runs from the policy rate to loans growth and GDP growth, and finally to NPLs.[2]

Figure 1. Orthogonalized Impulse Response Function: Baseline Model



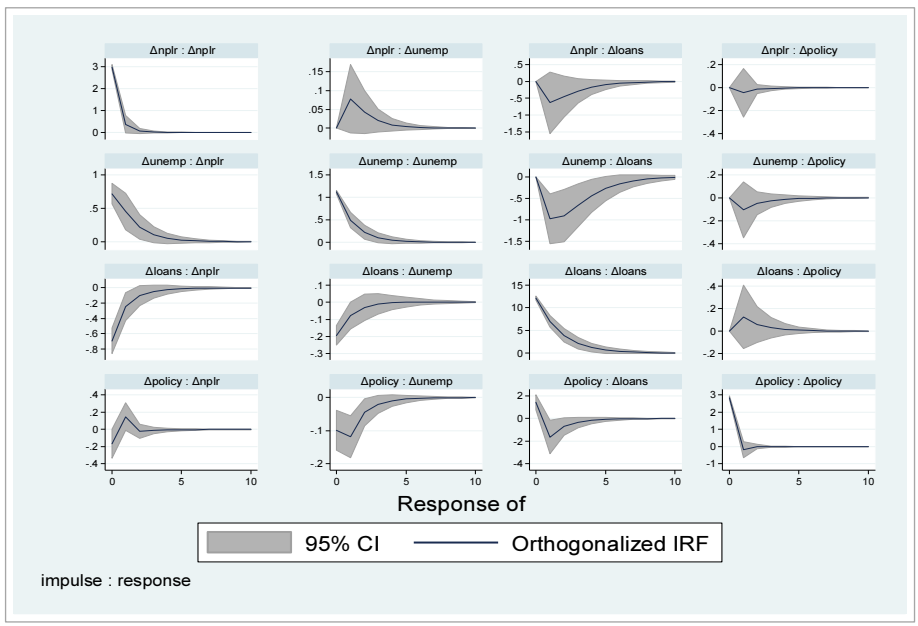
Note: The 95% confidence interval is generated by Monte Carlo draws with 500 replications.

[2] We also adopted different orderings of endogenous variables to calculate impulse response functions. However, there was no significant difference in the estimated impulse response functions.

Figure 1 presents the post-estimation impulse response functions for the baseline specification. The impulse response functions are generally in line with the prediction of theoretical models. Most importantly, they demonstrate that an increase in the NPL ratio has a significantly negative, albeit short-lived, effects on GDP growth. It also has significantly negative effects on the growth rate of loans, confirming the theoretical prediction that an increase in NPL affects the macroeconomy by undermining banks' ability to extend loans.

Figure 2 shows the impulse response functions for the alternative specification. The impulse response functions are also in line with the prediction of theoretical models. Most importantly, they demonstrate that an increase in NPL ratio raises unemployment rate. It also has significantly negative effects on the growth rate of loans.

Figure 2. Orthogonalized Impulse Response Function: Alternative Model



Note: The 95% confidence interval is generated by Monte Carlo draws with 500 replications.

4 The Macrofinancial Effects of Sharp Drops in the NPL Ratio

In this section, we adopt the episodic approach to measure the macrofinancial effects of NPLs focusing on the episodes of sharp drops in the NPL ratio. We focus on sharp drops in the NPL ratio because an episode of NPL reduction, defined as a period of sustained and substantial reduction in the overall NPL ratio of an economy, tends to start with a sharp drop in the NPL ratio. Actually, Balgova, Plekhanov, and Skrzypinska (2017) find that 143 episodes out of the 178 episodes of NPL reduction identified in their dataset start with a sharp drop in the NPL ratio, which is defined as a drop of at least 5 percentage points in the NPL ratio occurring within a single year. Park, Lee, and Rosenkranz (2021) also find that 24 out of the 41 episodes of NPL reduction identified in their dataset start with a sharp drop in the NPL ratio, which they define as a more than 4-percentage-point drop in the NPL ratio in a single year.

Focusing on sharp drops in the NPL ratio is also meaningful because it is likely that a sharp drop in the NPL ratio is the result of implementation of NPL resolution policies as well as improvement of macroeconomic conditions. As a matter of fact, Balgova, Plekhanov, and Skrzypinska (2017) and Park, Lee, and Rosenkranz (2021) find that NPL resolution measures enhance the likelihood of achieving a sharp drop in the NPL ratio. Balgova, Plekhanov, and Skrzypinska (2017), estimating a two-part model, demonstrate that public AMCs not only enhance the probability of a sharp drop in the NPL ratio but are effective in enlarging the size of a sharp drop. They show that establishing public AMCs is more effective in achieving a sharp drop when combined with injection of public funds. Park, Lee and Rosenkranz (2021), estimating a panel probit model, also find that establishment of a public AMC significantly increases the likelihood of achieving a sharp drop in the NPL ratio. This implies that analyzing the macrofinancial effects of a sharp drop in the NPL ratio also casts light on whether NPL resolution policy measures are effective in enhancing the overall macrofinancial performance of an economy.

The discussion so far motivates us to evaluate the macrofinancial effects of NPL reduction by focusing on episodes of sharp drops in the NPL ratio.

Following Balgova, Plekhanov, and Skrzypinska (2017), we define an episode of NPL reduction as a period of consecutive drops in the NPL ratio, with the cumulative reduction exceeding 7 percentage points. A relatively small rise in the NPL ratio, however, is not regarded as interruption in the episode as long as it is confined to a single year. We also adopt the operational definition of a sharp drop in the NPL ratio as a more than 5-percentage-point drop in the NPL ratio in a single year. Such operational definition gives us 133 episodes of NPL reduction starting with a sharp drop in the NPL ratio.

Our question is whether these 133 episodes of sharp drops in the NPL ratio were capable of enhancing the macrofinancial performance of the economy. This analysis looks for the answer by estimating the ATET. As equation (2) shows, ATET is defined as the expected difference between the observed outcomes in the treatment group (X_{1i}) and the counterfactual economic outcomes that would have occurred in the treatment group in the absence of treatment.

$$ATET = E[X_{1i}|D_i = 1] - E[X_{0i}|D_i = 1] \quad (2)$$

The episodes of NPL reduction that start with a sharp drop in the NPL ratio are regarded as the treatment group in estimating the ATET. Episodes of persistently high NPL ratios are regarded as the control group. An episode of persistently high NPL ratios is defined as one in which higher than a 7 percentage point NPL ratio persists for at least 3 consecutive years.

Since the second term in equation (2) is not observable, the analysis selects episodes from the control group that closely resemble an episode in the treatment group. The selection of matching episodes from the control group is based on the estimated propensity of an episode to belong to the treatment group conditional on a set of economic characteristics.

We use different sets of economic characteristics, including the GDP growth rate, the debt-to-GDP ratio, the M2-to-GDP ratio, and the inflation rate of the year of the sharp drop.[3] We focus on four macroeconomic outcomes, namely GDP growth rate, unemployment rate, growth rate of

[3] We also added such economic characteristics as inflation rate and per capita GDP at purchasing power parity but the results were quite robust.

investment, and growth rate of savings, and two financial outcomes, namely credit to GDP ratio and rate of currency depreciation. It is expected that resolution of NPLs will contribute to higher growth rate in GDP, investment, and savings, lower unemployment rate, higher credit to GDP ratio, and currency appreciation.

Table 5 presents the estimated ATET for five years after the sharp drop in the NPL ratio. According to Table 5, a sharp drop in the NPL ratio significantly raises the GDP growth rate and lowers the unemployment rate in all the five years following the sharp drop. A sharp drop in the NPL ratio also increases the growth rate of investment but the effects are short-lived, lasting only for two years. In the case of the savings growth rate, the estimated ATET is positive but not significant.

Table 5. Average Treatment Effects: Macroeconomic Variables

Variable/Effect	Year 1	Year 2	Year 3	Year 4	Year 5
GDP Growth Rate	3.0513***	2.1767***	1.6332**	1.4902**	3.4051***
	(0.7027)	(0.6889)	(0.7448)	(0.6579)	(0.7000)
Unemployment Rate	-2.0716***	-2.9278***	-2.3109**	-1.9468*	-1.6577
	(0.6940)	(1.1087)	(1.1121)	(1.1338)	(1.2619)
Investment Growth Rate	1.0944*	1.1774*	0.7558	-0.6048	0.2298
	(0.6032)	(0.6734)	(0.8475)	(0.6215)	(0.7653)
Savings Growth Rate	0.0476	1.6534**	0.4550	-0.7814	-1.5682
	(0.9210)	(0.7909)	(0.6815)	(0.8135)	(1.2864)
Control Group	128	128	128	122	113
Treated Group	133	133	123	119	114

Note: *, **, and *** denote that the ATET is different from zero at the 10%, 5% and 1% significance levels, respectively.

Table 6 shows the estimated ATET for two financial variables. The results demonstrate that a sharp drop in the NPL ratio significantly raises the credit growth rate although the effects on credit growth are not significant during the first two years following the sharp drop. On the other hand, a sharp drop in the NPL ratio does not affect the rate of currency depreciation at all. In contrast, Park, Lee, and Rosenkranz (2021) find that currencies tend to appreciate after a sharp drop in the NPL ratio, although the effects on exchange rates are short-lived.

Table 6. Average Treatment Effects: Financial Variables

Variable/Effect	Year 1	Year 2	Year 3	Year 4	Year 5
Credit Growth Rate	-1.3325	0.0487	1.2201*	2.0689***	2.3601***
	(1.0329)	(0.7853)	(0.7110)	(0.7844)	(0.9056)
Rate of Currency Depreciation	-1.6197	9.1331	1.4545	8.1034	-0.1079
	(3.1114)	(10.9529)	(5.5822)	(11.1931)	(3.4826)
Control Group	128	128	128	122	113
Treated Group	133	133	123	119	114

Note: *, **, and *** denote that the ATET is different from zero at the 10%, 5% and 1% significance levels, respectively.

5 Conclusion

This paper investigates the macrofinancial feedback effects of NPLs using a global NPL dataset consisting of 181 countries and covering the period from 1990 to 2019. The episodic approach as well as the PVAR approach is adopted to measure the impacts of NPL reduction on macrofinancial variables. The post-estimation impulse response functions based on PVAR models reveal that an increase in the NPL ratio significantly lowers the GDP growth rate and raises the unemployment rate, although these effects do not last long. The episodic approach focuses on the episodes of a sharp drop in the NPL ratio followed by a sustained and substantial reduction in the NPL ratio. The estimated ATET demonstrates that a sharp drop in the NPL ratio significantly raises the GDP growth rate and lowers the unemployment rate and these effects last long. These results can be interpreted to imply that policy actions to resolve NPLs can significantly improve the macrofinancial performance of an economy. These findings are important because it is likely that financial stability conditions of countries including the NPL ratio have deteriorated due to the COVID-19 pandemic.

The COVID-19 pandemic is likely to push the issue of financial instability and NPL resolution to the forefront. Governments around the world implemented measures and strategies to cope with the adverse economic and financial impacts, but the COVID-19 pandemic still had devastating economic effects, especially on the most vulnerable parts of the economy. Although the global economy is showing signs of recovery, the

pace of recovery is uneven across and within countries and the downside risks are likely to have negative spillover on their financial stability conditions. Besides, the emergency policy measures adopted by countries to address the adverse impacts of the COVID-19 pandemic on the real economy and the financial sector may have unintended consequences of intensifying financial vulnerabilities as the regulatory forbearance and excessive liquidity may have contributed to stretched asset valuation and excessive indebtedness (IMF, 2021). Before the breakout of the COVID-19 pandemic, financial stability conditions in many countries were already weak with NPLs rapidly rising among banks and nonbank financial institutions. It is likely that financial conditions have worsened during the pandemic crisis although the real extent of NPL problems is not yet evident as governments implemented temporary regulatory forbearance to enhance liquidity.

Besides, as demonstrated by ADB (2017), the cross-border linkage of Asian financial markets has grown both within the region and across the globe, making Asian financial markets more vulnerable to cross-border spillover of financial shocks. Policymakers in Asia should pay attention to the fact that NPLs play an important role in the bank balance sheet channel of cross-border contagion of financial crises in Asia and that NPL resolution frameworks and NPL markets are needed to prevent the negative spillover of high and rising NPL ratios.

Considering the fact that banks are the key source of financing in most of the countries in Asia and the Pacific region and that banks are likely to be an important channel of cross-border spillover of financial crises, there is no doubt that developing active NPL markets and NPL resolution frameworks will greatly benefit Asian countries. However, NPL markets are not well developed in Asia. Even in Europe where financial markets and institutions are well advanced, NPL markets are not well developed. These observations demonstrate that there are inherent difficulties in developing NPL markets. As a matter of fact, various factors such as information asymmetry, tax and accounting impediments, and inefficiency in debt and collateral enforcement, hinder development of active NPL markets. Unless these factors are taken care of, one cannot expect NPL markets to emerge and evolve by themselves. Thus, as Lee et al (2021) suggests, developing NPL markets require implementation of national strategies designed to take care of these impediments.

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