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INDUSTRY SPECIFIC SHOCKS AND NON-PERFORMING LOANS IN BARBADOS

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Abstract. Despite the vast body of literature on the relationship between the macroeconomic environment and non-performing loans (NPLs), an area which has been neglected thus far, is a comparative study of the response of NPLs to industry-specific income shocks. Using panel VAR methods, this study investigates the sensitivity of NPLs to shocks to six industries in Barbados. The results suggest that there is some degree of heterogeneity in the response of NPL to these shocks. For instance, there is no evidence to suggest that shocks to the agriculture and manufacturing sectors – the two smallest sectors – affect NPLs. In contrast, our results suggest that positive shocks to the output of the distribution, professional and tourism industries lead to an overall reduction in the level of stress in the financial system – though the timing of responses differs across each industry.

1. Introduction

The non-performing loan (NPL) ratio of commercial banks is one of the most closely monitored financial indicators. This is not surprising given that high NPL ratios are considered to be one of the most common precursors of bank crises (see for instance, Demirgüç-Kunt and Detragiache, 1998; Bar et al., 1994;). Moreover, Hou (2007) argues that NPLs are a major cause of economic stagnation, even if the bank does not fail. The author points out that "each non-performing loan in the financial sector is viewed as an obverse mirror image of an ailing unprofitable enterprise. From this point of view, the minimisation of non-performing loans is a necessary condition to improve the economic status. If the non-performing loans persist, the resources continue to be locked up in unprofitable sectors; thus, hindering the economic growth and impairing economic efficiency." Given the problems associated with high NPLs, bank managers and regulators try to keep the NPL ratio below the prudential limit of five per cent.

In their attempt to keep the NPL ratio below the prudential standard, bank managers have traditionally undertaken rigorous screening processes of potential borrowers. But, even with the most efficient evaluation processes and policies in place, the NPL ratio can still exceed the banks' desired level, as NPLs tend to be responsive to factors outside the control of the bank. One such factor is the state of the macroeconomic environment.

The macroeconomic environment has been traditionally viewed as a primary determinant of NPLs. According to the "business cycle-NPL" literature, the expansionary phase of the cycle is characterized by a low NPL ratio, as the capability of borrowers to repay their stock of debt

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increases. As the boom continues, additional risks are realized as credit is extended to "lower quality debtors" and consequently, when the contractionary phase sets in, NPLs rise (Louzis et al., 2010).

In general, much of the empirical work seems to support this view. Bikker and Metzemakers (2005) for example find evidence of a negative relationship between growth in Gross Domestic Product (GDP) and provisioning for 29 Organisation for Economic Cooperation and Development (OECD) countries. Similar results are reported by Gavin and Hausmann (1996), Greenawalt and Sinkey (1988, 1991), Arpa et al. (2001), Blejer et al (2002), de Lis et al. (2001), Laeven and Majnoni (2001) and Quagliarello (2007).

Against this backdrop, the adverse impact of the recent global crisis on the asset quality of commercial banks is by no means surprising. For instance, in the US, the NPL ratio climbed from 1.4 percent in 2007 to 5.4 percent in 2009; in the UK the NPL ratio moved from 0.9 percent in 2007 to 3.5 percent 2009; while in Italy, the ratio rose 2.4 percentage points between 2007 and 2009 to reach 7.0 percent[1]. Like these advanced nations, the asset quality of commercial banks in Barbados has significantly deteriorated since 2007, albeit at a much more dramatic rate: between 2007 and 2010, the NPL ratio more than doubled, moving from under 4% to over 10%.

This significant increase in the NPLs of commercial banks could pose risks to the financial sector and the Barbadian economy. Banks in Barbados accrue over 50% of deposits among deposit taking institutions and approximately 75% of total loans and advances, making them the focal channel through which capital is funnelled from savers to investors. They strongly impact the investment and consumption decisions of individuals and firms in the island and by extension, cyclical developments and economic growth. For this reason, the prevention of systematic banking problems has been a chief objective for policy makers in island. Thus, a full understanding of how the macroeconomic environment impacts NPLs is imperative.

But, while the relationship between the macroeconomic environment and NPLs has been well established, an issue – which to the best of our knowledge – has been neglected thus far is a comparative study of the response of NPLs to shocks in specific economic sectors. Most studies focus on shocks to the aggregate economy, for instance, real GDP. However, in this paper, it is assumed that a shock to, say, the tourism industry may induce a different NPL response than a shock to manufacturing. As such, this paper adopts an alternative approach to modelling the response of NPLs to macroeconomic economic shocks. The authors analyse the sensitivity of NPLs to shocks to six economic industries in Barbados – the agriculture and fishing; construction, mining and quarrying; distribution; manufacturing; professional and other services; and tourism. Together, these sectors account for over 70 per cent of output in the Barbadian economy and over 80 per cent of loans to the business sector on average (see Figures 1 and 2) and so, can be taken as the key sectors in the Barbadian economy.

The authors believe that such an undertaking can make a contribution to the existing literature. First, as noted earlier, the current body of literature on the macroeconomic environment lacks a comparative study of the response of NPLs to shocks in specific economic industries. Thus, by focusing on shocks to individual industries, the study fills the aforementioned gap in the literature. Secondly, a survey of the related literature revealed that most of the studies published on the stability and soundness of banking systems are within the metropole economies of the US and Europe. With the exception of the work of Greenidge and Grosvenor (2010) and Khemraj and Pasha (2009), there is a lack of evidence and discussion regarding the effects of the macro-economy on bank soundness in small island developing states (SIDS). Indeed, the results for SIDS – who tend to be highly bank-centric – may differ substantially from those focused on the developed world. Hence, by investigating the case of Barbados, this study enhances the understanding of bank fragility in a small island state, and thereby contributes to better informed and higher quality decisions by policymakers in these countries. Finally, the

[1]Data on the NPL ratios for the US, UK and Italy were taken from the World Development Indicators online database.

paper investigates the impact of economic shocks on NPLs within the context of a panel VAR. Thus, this takes care of issues such as endogeneity and also allows one to study the dynamic responses of NPLs to macroeconomic shocks.

The rest of the paper is organised as follows: Section 2 describes the empirical approach. This is followed by a brief description of the data (Section 3), the presentation of the empirical results (section 4) and finally, section 5 concludes.

2. Empirical Approach

2.1. **Model Specification.** The primary objective of this study is to investigate the relationship between shocks to specific economic industries and NPLs in Barbados. As such, a simple model of NPLs – consisting of both systematic (macroeconomic) and idiosyncratic (bank-specific) factors are augmented with industry-specific variables – represented by the growth rate of each industry's real output. The industry variable is used to simulate the effect of shocks to the output of specific industries on NPLs in Barbados.

Our macroeconomic control variables include the unemployment rate and real interest rate (see for instance, Keeton and Morris, 1987; Kent and D'Archy, 2000; Louzis et al., 2010). As suggested by the literature, higher unemployment and interest rates negatively affect the ability to service debt and thus should be positively correlated with the number of NPLs.

Aside from the macroeconomic fundamentals, some researchers have also noted the linkages between realized risk and bank specific variables (see Keeton, 1999; Salas and Saurina, 2002; Rajan and Dhal, 2003; Jimenez and Suarina, 2005; Fofack, 2005; Hu et al., 2007, Podpiera and Weil, 2008; Rossi et al., 2009). Hence, the final set of variables captures how the distinctive features of each bank affects the evolution of non-performing loans. These include the bank's efficiency, moral hazard, bank size and aggressiveness in lending.

The efficiency and moral hazard variables attempt to capture the bad management and moral hazard hypotheses proposed by Berger and DeYoung (1997). The bad-management hypothesis advocates that causality runs from poor management skills – reflected in low cost efficiency or low profitability – to NPLs. The rationale here is that bad-managers may not practice adequate loan monitoring, underwriting or control and as a result, tend to extend credit to low quality debtors. Meanwhile, moral hazard presumes that banks with relatively low capital respond to moral hazard incentives by increasing the riskiness of their loan portfolio, which results in higher NPLs on average. Against this back-drop, moral hazard should be positively related to NPLs, while efficiency should be negatively correlated with the dependent variable.

With respect to the aggressiveness in lending, periods of rapid credit expansion are usually associated with higher loan losses. The size of the bank may also be a relevant factor. While large players usually have superior management strategies and by extension, lower NPLs, it is also plausible to assume that larger banks take on greater risks and as such, encounter higher NPL ratios. Hence, there is no consensus on an appropriate sign for the size variable.

2.2. **Estimation Technique.** Over the last three decades, various techniques have proposed for modelling panel data. The most popular in the literature are the pooled OLS, fixed effects and random effects models. However, a major problem which exists in modelling NPLs using the aforementioned techniques is that of endogeneity. A second issues lies in studying the dynamic response of one variable to changes in another. For instance, one may not be interested in the average responses of changes of variable Y to changes in variable X alone, but rather the response of $Yt{+}s$ to an impulses in Xt.

Hence, in this paper, a panel vector autoregressive (panel VAR) model is utilised. The VAR deals with the issue of simultaneity bias, by assuming all variables under study are endogenous. It also describes the dynamic evolution of a number of variables from their common history. The model can be written as:

$$y_{i,t} = \mu_i + A\,(L)\,Y_{i,\ t-1} + B\,(L)\,X_{t-1} + \varepsilon_{i,t'} \tag{2.1}$$

where $y_{i,t}$ is a $k \times 1$ vector of all variables under consideration (Y_t and X_t), $i = 1, \ldots, N$ represents bank i. $Y_t = (y'_{1,t},\ y'_{2,t}, \ldots,\ y'_{i,t})$ collects the bank-specific data, X_t collects the systematic variables (which do not vary across banks), μ_i is a bank-specific intercept and $A(L)$ and $B(L)$ are the lag polynomials of the VAR coefficients. The disturbances $\varepsilon_{i,t'}$ have zero mean and a bank specific variance σ_i^2.

Innovation accounting is used to determine the dynamic responses of the variables. The impulse response functions are used to trace how NPLs respond over time to a shock in industry-specific incomes. To estimate the impulse response function, the study employs a generalised forecast error variance decomposition similar to Koop et al. (1996) and Pesaran and Shin (1998), as the results of this method are not sensitive to the ordering of the variables in the VAR.

3. Data

The impact of specific industry-income shocks on NPLs is investigated using panel data on individual banks in Barbados and data on macroeconomic variables. The database employed consists of quarterly observations for the period 1996:1 to 2010:4. All data were obtained from the Central Bank of Barbados.

Following much of the literature on credit risk (see for instance, Espinoza and Prasad, 2010), a logit transformation of the NPL ratio is used i.e. $log\left(\frac{NPL}{1-NPL}\right)$. This transformation ensures that the dependent variable spans over the interval (-8, +8) – as opposed to between 0 and 1 – and is symmetrically distributed. Our bank-specific variables include bank's efficiency, moral hazard, size and aggressiveness in lending. Here, efficiency is the ratio of a bank's income to operating cost, while our proxy for moral hazard is the loan to deposit ratio of each bank (see Louzis et al, 2010). The size variable is defined as a bank's share of assets in the banking system and lending aggressiveness is captured by the growth in Bank i's credit in each quarter

The macroeconomic variables include the rate of unemployment in Barbados and the real interest rate – which is calculated as as the weighted average lending rate in Barbados minus the rate of inflation. Finally, to capture industrial sector specific shocks, an industry growth variable is constructed as the percentage change in the real income of each industry (i.e. agriculture and fishing; construction, mining and quarrying; distribution; manufacturing; professional services and tourism).

4. Empirical Results

As a first step of the empirical analysis, the order of integration of the variables is determined. A collection of panel unit root test (for the variables which vary by bank) and time series unit root tests (for the macroeconomic variables) are used. The panel unit root tests employed are the Hadri (2000), Levin et al. (2002) and Im, et al. (2003) unit root test. The Hadri and Levin et al. tests both assume that there a common unit root i.e, the persistence parameters are common across cross-sections. However, while the Hadri test uses a null of "stationarity", the null hypothesis of Levin et al. is that there is a unit root. The Im et al. test allows for individual unit root processes so that the persistence parameter may vary across cross-sections and is characterised by combining individual unit root tests to derive a panel-specific result.

The systematic variables (i.e. industry income growth, unemployment rate, real interest rates and industry growth variables) are not bank-specific, and only vary over time. As such, the familiar augmented Dickey–Fuller (ADF) test by Dickey and Fuller (1979, 1981), the Phillip-Perron (PP) test by Phillips and Perron (1988) and the KPSS test by Kwiatkowski et al. (1992) are employed. Under the ADF and PP test, the series is assumed to be non-stationary. Hence, failure to reject the null hypothesis implies that the time series has a unit root. Conversely, the KPSS test assumes that the series is stationary under the null against the alternative of a unit root.

The results of the various unit root tests are presented in Tables 1 and 2. These suggest that there is a mixture of I(1) – size, moral hazard, unemployment and real interest rates – and I(0) variables – NPLs, efficiency, credit growth and the "growth of industry" variables. Hence, to investigate the potential impacts of shocks to each industry on NPLs, the VAR is estimated with the size, moral hazard, unemployment and real interest rates variables in first differences. It should be noted that the optimal lag length is determined by the Akaike Information Criteria.

As our main interest lies in the relations between NPLs and industry-specific income shocks, the impulse responses of NPLs to shocks to the other variables (Table 3) are only briefly discussed. There is no evidence that size or moral hazard affect NPLs in Barbados. But, in line with our a-priori expectations outlined in Section 2.1, hikes in the interest and unemployment rates in Barbados are positively related to NPLs, but their effects are lagged. Finally, the effects of lending aggressiveness and efficiency also conform to our a-prior expectations and both have a contemporaneous effect on the dependent variable. But, the effect of efficiency is very short-lived – only lasting one quarter.

Figure 3 plots the impulse responses of NPLs to industry-specific shocks. Looking first at the case of the agriculture and fishing sector, the results are quite interesting. While one would expect that a positive shock to total income should reduce NPLs, the impulse response functions suggests that shocks to these industries have no statistically significant impact on the NPL ratios. However, these results may be due to the relatively small scale farming that has been undertaken in Barbados since the 1990s. In fact, out of the all the industries examined in this study, the agriculture and fishing industries account for the smallest proportion of GDP (about 5 per cent) and business loans (about 3 per cent) over the time period (see Figures 1 and 2). Thus, given the small size of this sector, this finding is not surprising. Similar findings are found for shocks to the manufacturing sector, which is the second smallest sector (in terms of GDP and loans) under investigation.

Interestingly, income shocks to the larger economic industries have a significant effect on NPLs in Barbados. Regarding tourism, the impulse responses indicate that shocks to this industry have a strong, but lagged effect on NPLs. The impact after a positive shock to tourism only occurs about four quarters later – NPLs fall about 0.06 percentage points below their pre-shock value; and this effect persists throughout the entire forecast horizon. It should be noted that tourism has the largest impact on NPLs. This is somewhat expected given the extensive role tourism plays in the Barbadian economy (see Jackman and Greenidge, 2010; Worrell et al, 2011). Particularly, tourism directly accounts for about 15 percent of total employment and GDP, and has a total contribution (direct and indirect) of 47.0 percent of employment and 46.6 percent of GDP. With respect to the professional and other service industries, results suggest that NPLs generally fall after a shock to their income. However, like the case of shocks to tourism, the response of NPLs to an income hike in the professional and other service industries is lagged, only having a statistically significant effect from quarter five.

While shocks to the distribution and construction, mining and quarrying industries impact the NPLs in Barbados, the empirical findings are quite unexpected. There is some lag in the response of NPLs to shocks to the construction, mining and quarrying income: NPLs only seem to significantly respond to shocks to this sector about three-quarters after the shock occurred. However, the nature of the relationship is quite puzzling. A-priori, one would expect that positive shocks to an industry's output should result in lower NPLs, whilst negative shocks should increase NPLs. In contrast, results suggest that there is positive association between these two variables – i.e. an unexpected increase in the income of the construction, mining and quarrying industry can lead to a rise in NPLs. But, this effect is very short-lived only lasting for one quarter and thereafter becomes insignificant. With respect to the distribution sector, a shock to the output of this industry leads to a statistically significant jump in NPLs. However, this positive impact is short lived; quarters 2-4 are insignificant and by quarter 5, the expected negative and significant effect emerges.

In summation, these results suggest that there are some distinct differences in the direct response of NPLs in Barbados to specific income shocks. But, a point hitherto unexplored in this study is the fact that the various sectors may be linked. For instance, while neither manufacturing nor the agriculture and fishing industries may have a direct effect on NPLs, an indirect effect may occur through their impact on another sector. To explore this claim, the linkages between these two sectors and all other industries are investigated. The authors rely on the Granger-causality test developed from the seminal paper of Granger (1969). Basically, this test seeks to ascertain whether or not the inclusion of past values of a variable x help in the prediction of present values of another variable y. If variable y is better predicted by including past values of x than by not including them, then, x is said to Granger-cause y. The results are presented in Table 4. Overall, the test only provides support for the existence of causality running from manufacturing to distribution and from manufacturing to construction. In contrast, developments in the agriculture industry appear to have no impact on the other industries. From these findings, we conclude that shocks to the income of the manufacturing sector may impact NPLs in Barbados, through its impact on the construction and distribution industries.

5. Concluding Remarks

Economists have long been intrigued with the relationship between macroeconomic shocks and NPLs. However, unlike the previous literature, this study investigates the impact of specific shocks to industrial sectors on NPLs in1 Barbados. Specifically, six industries in the Barbadian economy – agriculture and fishing; construction, mining and quarrying; distribution; manufacturing; professional services and tourism – are analysed.

Results suggest that there is some degree of heterogeneity in the response of NPL to shocks to these six industries. For instance, results indicate that positive shocks to the aggregate output of the distribution, professional and tourism industries leads to an overall reduction in the level of stress in the financial system – though the timing of responses differ across each industry. An unexpected result was that there was positive relationship between shocks to the construction, mining and quarrying industries and NPLs. In contrast, there is no evidence of a direct relationship between shocks to the agriculture and manufacturing sectors – the two smallest sectors – and NPLs throughout the entire forecast horizon. But, shocks to the income of the manufacturing sector may indirectly impact NPLS in Barbados, through its impact on the construction and distribution industries.

In summation, our findings indicate that a shock to one industry may induce a different NPL response than a shock to another. This suggests that studies based on aggregate output shocks for Barbados could conceal differences in NPL behaviour and can even lead to erroneous conclusions. Also, the evidence indicates that the significance of the direct impacts largely depends on the size of the sector – in terms of GDP and total loans. For instance, statistically significant impacts were found for the tourism, distribution, construction and professional services industries, each of which account for over five percent of GDP and 10 percent of business loans, while the impact of the smaller industries – manufacturing and agriculture – were negligible.

Taken at face value, these findings point to the need for adequate monitory and customized forecasting of the individual economic sectors. Knowledge of the future performances of each sector may aid banks in identifying potentially problematic loans and thus limit losses caused by the underperformance of a sector. The established relations between sectors and NPLs can then be used for forecasting and stress-testing exercises by regulators and to conduct various scenarios of how the evolution of a particular industry's output may affect financial stability. Moreover, banks can structure their loan portfolio based on the expected performance of each economic sector to boost a bank's profitability as well as reduce the incidence of non-performing loans.

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Appendix

Table 1: Panel Unit Root Tests

A.

Variable	Level			Decision
	Levin, Lin & Chu	Im, Pesaran & Shin	Hadri Z-statistic	
NPL	-3.752	-3.549	6.697	I(0)
	(0.000)	(0.000)	(0.000)	
Size	-0.990	-2.791	3.309	I(1)
	(0.161)	(0.003)	(0.000)	
Moral Hazard	0.504	0.924	5.307	I(1)
	(0.693)	(0.822)	(0.000)	
Efficiency	-8.476	-8.619	3.969	I(0)
	(0.000)	(0.000)	(0.000)	
Credit Growth	-14,841	-14,841	-14,841	I(0)
	(0.000)	(0.000)	(0.000)	

B.

Variable	1^{st} Difference			Decision
	Levin, Lin & Chu	Im, Pesaran & Shin	Hadri Z-statistic	
NPL	n.a.	n.a.	-1.133	I(0)
			(0.871)	
Size	-16.788	n.a.	-1.028	I(1)
	(0.000)		(0.848)	
Moral Hazard	-19,295	-18.129	0.174	I(1)
	(0.000)	(0.000)	(0.431)	
Efficiency	n.a.	n.a.	0.628	I(0)
			(0.265)	
Credit Growth	n.a.	n.a.	1.046	I(0)
			(0,148)	

Note: The test statistics are reported along with the probability values in parentheses.

Table 2: Individual Unit Tests for Macroeconomic Variables

A.

Variable	Level			Decision
	ADF	Phillips-Perron	KPSS	
Unemployment	-2.611	-2.064	0.175**	I(1)
Real Interest Rates	-3.730**	-2.487	0.130*	I(1)
Agriculture and Fishing	-3.447**	-3.213**	0.307	I(0)
Construction, Mining and Quarrying	-3.201**	-3.917***	0.256	I(0)
Distribution	-4.195***	-3.177**	0.080	I(0)
Manufacturing	-4.283***	-3.630***	0.266	I(0)
Tourism	-6.231***	-2.829*	0.345	I(0)
Professional Services	-3.741***	-3.314**	0.056	I(0)

B.

Variable	1^{st} Difference			Decision
	ADF	Phillips-Perron	KPSS	
Unemployment	-13.371***	-12.863***	0.343	I(1)
Real Interest Rates	n.a.	-3.659***	0.071	I(1)
Agriculture and Fishing	n.a.	n.a.	n.a.	I(0)
Construction, Mining and Quarrying	n.a.	n.a.	n.a.	I(0)
Distribution	n.a.	n.a.	n.a.	I(0)
Manufacturing	n.a.	n.a.	n.a.	I(0)
Tourism	n.a.	n.a.	n.a.	I(0)
Professional Services	n.a.	n.a.	n.a.	I(0)

Note: ***, ** and * denote significance at the 1, 5 and 10 per cent levels respectively. The unit root test for the shock variables in levels are run on intercept only.

Table 3: Impulse Responses – Point Estimates

A.

Forecast Horizon	Agriculture and Fishing	Construction, Mining and Quarrying	Distribution
1	0.018	0.030	0.033**
2	-0.003	0.036	0.015
3	0.008	0.058**	0.009
4	0.033	0.036	-0.003
5	0.017	-0.004	-0.028
6	0.021	0.008	-0.053**
7	0.014	-0.014	-0.078**
8	0.004	-0.019	-0.081**
9	0.017	-0.017	-0.092**
10	0.015	-0.027	-0.012**

B.

Forecast Horizon	Manufacturing	Professional and Other Services	Tourism
1	0.022	-0.014	-0.029**
2	0.017	-0.020	-0.023**
3	0.008	-0.031	-0.031**
4	-0.007	-0.061	-0.064**
5	-0.035	-0.071**	-0.106**
6	-0.043	-0.075**	-0.118**
7	-0.039	-0.074**	-0.130**
8	-0.044	-0.091**	-0.131**
9	-0.032	-0.080**	-0.133**
10	-0.039	-0.083**	-0.136**

Note: ** indicates that the point estimate is at least twice as large as the associated standard error.

Figure 1: Distribution of Barbados Output by Industry

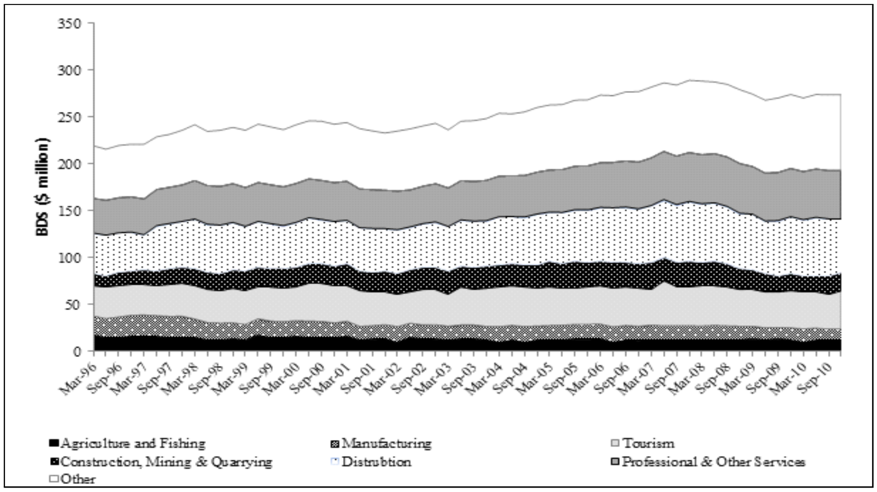

Figure 2: Distribution of Business Loans by Industry

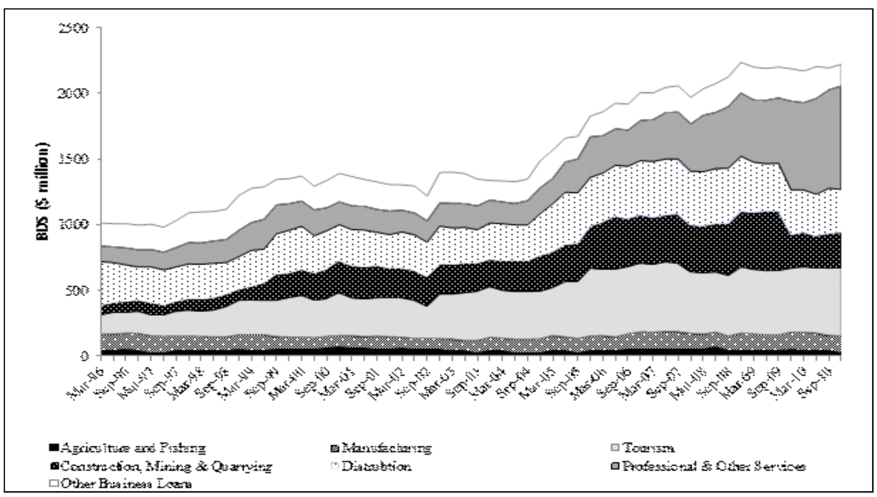

Figure 3: Response of NPLs to Industry Specific Shocks