

4 Resilience of the Banking Sector

A stress scenario is not a forecast of macroeconomic and financial conditions. It is a hypothetical but coherent tail-risk simulation that is designed specifically to stress test the resilience of the financial system to deterioration in macroeconomic conditions. Based on the simulation results, banking sector is found resilient to adverse domestic scenario but in case of extremely adverse global scenario the capital adequacy falls below the benchmarks. Further, sectoral level default analysis suggests that Textile and Sugar sectors are relatively vulnerable to global shocks.

4.1 Background & Developments

In continuation of FSR 2015, which had underpinned certain challenges for the banking sector's resilience under hypothetical stress conditions; this year's resilience assessment has been built on similar premises but extends the analysis in a number of ways.

With rising interconnectedness of global markets, no economy can operate in silos and is immune from global economic shocks. Likewise domestic events, such as natural calamities, have a history of disrupting economic growth and banking sector's performance. Keeping this in mind, three separate scenarios have been designed to assess the resilience of the banking sector in the coming three years (Q1CY17-Q4CY19).

In terms of shock distribution, apart from analyzing the *baseline* (business as usual) scenario or *Scenario 0*, two separate adverse scenarios are considered. *Scenario 1*, the domestic scenario, assumes crystallization of idiosyncratic shocks (such as, natural disasters, floods, earthquake etc.) to the macroeconomy of the country. *Scenario 2*, on the other hand, assumes disruptions to the global economy including Pakistan i.e. it assumes systemic events. Scenario 2 is, therefore, considered to be more severe than Scenario 1.¹⁸⁰

In terms of methodology, global adverse scenario (i.e. Scenario 2), this year, is based on detailed quantitative forecasts of key variables. Also, to enhance the forecasting accuracy, the estimates of multivariate linear regression (*using OLS*) are complemented by Vector Auto-Regression (VAR) Models and Vector Error Correction Models (VECM), where appropriate. VARs and VECM ensure taking contemporaneous correlations among chosen variables into account and VECMs also consider cointegrating relationships, if existing.

In terms of coverage, besides assessing the credit and interest rate risks that were also considered in the last year's FSR, exchange rate risk has also been evaluated. Importantly, banks' resilience against sectoral level (textile, sugar, cement and agriculture) credit losses has also been estimated. The resilience of the sectors has been tested under the same scenarios but using additional sector specific explanatory variables.

Below the design elements of all three stress scenarios are discussed followed by both system-wide and sectoral results. Technical details of the methodologies and model equations along with selected estimation results are given in Box 4.1.

¹⁸⁰ In Stress Testing, usually three types of scenarios, based on the length of the shock events, are considered: V-shaped, L-shaped and

U-shaped. Under this terminology, Scenario 1 is V-shaped and Scenario 2 is L-shaped.

Scenario Design Overview:

The stress testing simulation exercise considers a period of 3-year (12 quarters), starting in Q1CY17 and ending in Q4CY19, for the three simulations.

The *Scenario 0* assumes the business as usual, in the global and domestic economy, and is largely based on recent macroeconomic forecasts published by global observers¹⁸¹. *Scenario 1* has been designed, primarily, on the basis of adverse domestic events such as the 1992 floods, which have disrupted the output growth (particularly, the agriculture growth). *Scenario 2*, the extremely adverse scenario, assumes severe shocks to the global economy, on the pattern of GFC of 2008, which are also assumed to disrupt the domestic economy.

For all the three scenarios, stress test models are designed keeping in view the linkages between the real sector, external sector and the monetary (*and banking*) sector. It is also assumed that government may act through changes in prices (e.g. Interest Rates, Inflation, and Exchange Rate).

The basic underlying assumption of the exercise is that the Macroeconomic variables (MVs), such as Gross Domestic Product (GDP), Large Scale Manufacturing (LSM) Index, Inflation (CPI), Interest Rates (KIBOR) etc. have implications for the financial variables, such as Gross Non-Performing Loans Ratio (GNPLR), Profitability (ROA) and Solvency (CAR). This is because economic downturns and upturns influence borrowers' capacity to service their debts (say, through changes in employment status and income levels) and banks' earnings (say, through changes in default levels and risk appetite). A variant of the

Credit Portfolio View (CPV) model¹⁸², estimates this one-way causation.

Under this approach, in case of Pakistan, it is assumed that the Gross Non-Performing Loans Ratio (GNPLR) is a function of industrial output (LSM index), Exports (XP), developments in stock market (PSX index), inflationary pressure (CPI Index) and prevailing risk pricing (6 months KIBOR).

Financial sector also influences the real economy. Certainly, the GFC of 2008, is a testament to the cross correlations existing between the two. Therefore, to account for the two-way correlations, VARs and VECMs have also been estimated for all the three scenarios, mostly using same macrofinancial variables as in CPV.

The weighted average of these estimations is taken in accordance with their in-sample precision, while arriving at the final forecasts.

Besides credit risk, the resilience of the banking system has also been assessed against market risk (interest rate and exchange rate) and operational risk. Any fluctuations in interest rates, generally, impact not only the composition of rate sensitive assets and liabilities but also banks' profitability through revaluation gains/losses. Likewise, external factors have stronger influence on economic soundness and exchange rate movement can affect the banking sector's profitability on account of its net open position (NOP) in foreign currency.

In the simulations it has been assumed that the long term interest rates are a linear function of expected short term rates¹⁸³. Therefore, any changes in the

¹⁸¹ The forecasts are largely based on IMF's recent forecasts (World Economic Outlook April 2017)

¹⁸² Based on Blaschke, W., M. T. Jones, G. Majnoni, and S.M. Peria (2001), "Stress testing of Financial System: An Overview of Issues, Methodologies, and FSAP Experiences" IMF Working Papers WP-01/88

¹⁸³ Expectation Hypothesis- *Predictions of Short-Term Rates and the Expectations Hypothesis of the Term Structure of Interest Rates*. Massimo, Thornton-ECB Working paper series (No. 977/December 2008)

market risk premia (KIBOR) would shift (parallel) the yield curve accordingly. The exchange rate (ER) forecasts are estimated using the uncovered interest rate parity (UIP) condition.

For operational risk assessment, the Basic Indicator Approach in accordance with Basel II standards has been applied. (see Box 4.1)

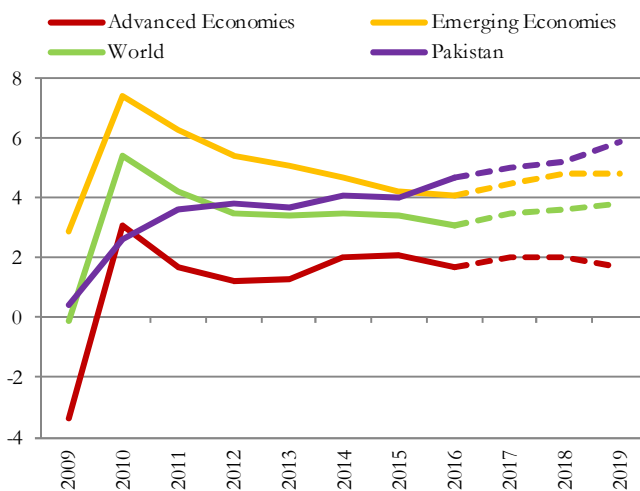
Scenario 0: Baseline

In *Scenario 0* it is assumed that the domestic and world economies are going to grow broadly consistent with the IMF's WEO forecasts of April 2017. No disruptions of any kind arising from idiosyncratic or systemic shocks are considered. Under this scenario, it is largely expected that the economic and banking performance will likely maintain its current growth path or would improve.

Figure 4.1

IMF annual Real GDP Growth Forecast

Percent GDP growth Actual and Forecast (Dotted lines)



Source: IMF World Economic Outlook April 2017

Note: Average GDP growth for 2019-2022 is reported, which is the value taken for 2019

Given the recent performance, most of the international observers are forecasting better position of the economy of Pakistan in the coming

years¹⁸⁴ (Figure 4.1). It can be seen that the major economies recovered from the GFC with faster pace than Pakistan; however, the growth in our GDP surpassed others in 2016.

Similarly, Moody's (February 2017) has projected Pakistan's growth at 4.9 percent and 5.0 percent (as against 5.0 percent and 5.2 percent by the IMF) in 2017 and 2018. They have added that the CPEC project will continue to support manufacturing and structural development activities, and will be a key driver of this growth.

The projected GDP growth of Pakistan is then assumed to map into LSM growth, proportionately. In view of the upcoming elections in 2018, it is assumed that government spending would increase as the structural development programs and mega projects are initiated and projects pick pace towards completion. As the demand in the economy grows, inflation is also expected to rise, somewhat. The point forecasts of inflation are obtained using exponential smoothing, assuming that it follows recent trend.

Exports are expected to rise along with better stock market performance, while interest rates are expected to provide the enabling environment. All these three variables are assumed to be largely reactionary; therefore, appropriate linear OLS models have been used to obtain their forecasts.

Scenario 1: Domestic

Historically, domestic events like natural calamities, political uncertainties and deteriorations in law and order cause disruptions in the domestic economy and shake the investor's confidence. For example, agriculture output growth experienced a steep fall after the 1992 flood. As a result, industrial production (large scale manufacturing) also

¹⁸⁴ IMF's latest projections (WEO of April 2017) suggest an upward growth trend till 2022.

witnessed negative growth with some lags. A brief summary of natural disasters in the country is given in Table 4.1 below:

Table 4.1

Major Natural Disasters in Pakistan

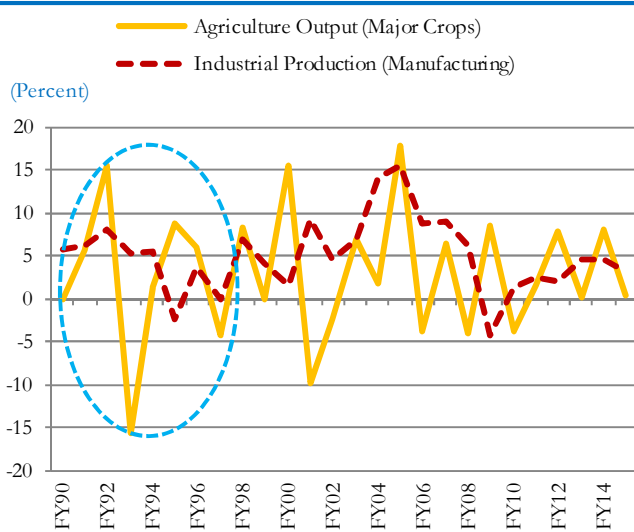
Disasters Type	Date	Human Death Toll
Earthquake	October 8, 2005	78,000.0
Flood	June 1, 1977	10,354.0
Wind Storm	December 15, 1965	10,000.0
Earthquake	December 28, 1974	5,300.0
Flood	1950	2,900.0
Flood	July & August 2010	1,645.0
Flood	September, 1992	1,334.0
Flood	March 3, 1998	1,000.0

Source: Pakistan National Disaster Management Authority (NDMA)

In scenario 1 it is assumed that domestic economy experiences some natural shock, similar to 1992 flood, at the beginning of the simulation period. Agriculture output, primarily due to crops, is assumed to fall substantially at the end of CY17, but will recover in CY18 and later.

Figure 4.2

Growth trend in Agriculture Output and Industrial Production



Source: S&DWH (SBP)

Industrial production is also assumed to come under stress and the manufacturing sector is assumed to follow growth pattern of 1993-1995 in CY17-CY19 (Figure 4.2).

In view of the post disaster relief initiatives and higher raw material imports, it is assumed that government's current expenditures would rise. The expansionary fiscal policy, in addition to supply shock, is expected to contribute to higher inflation.

As the growth in manufacturing declines, the growth in exports is also expected to decline. With low investor confidence, in this adverse scenario, the stock market is assumed to be bearish.

Moreover, in view of rising inflationary and external sector's pressures, it is hypothesized that the interest rates in the economy would rise. The forecasts of these key variables are obtained using the same linear models as in scenario 0.

As the macroeconomic conditions, in this assumed scenario, deteriorate initially and then recover the pressure on repayment capacity of the borrowers is likely to be transitory. The non-performing loans are, therefore, assumed to increase moderately under this scenario.

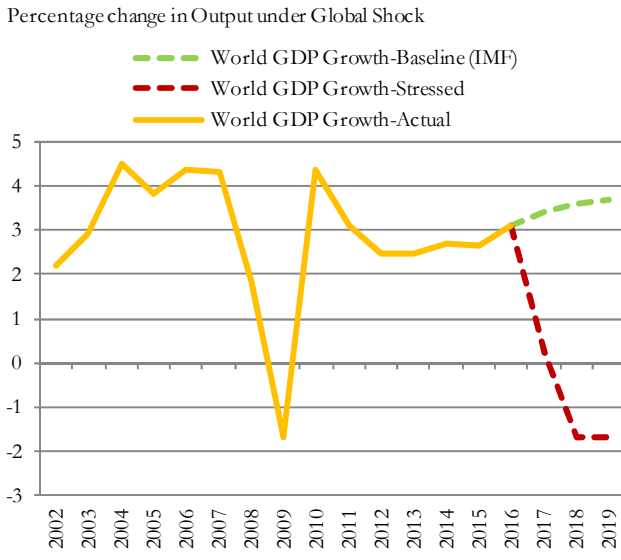
Scenario 2: Global

As per IMF's WEO, April 2017, the performance of the World economy has been deteriorating. From the level of 5.4 percent in 2010, the global real output has dropped to 3.1 percent in 2016 (a drop of 2.3 percentage points).¹⁸⁵ As per fund's statistics, major economies of the world (such as US, EU, Japan, China and Russia) are all facing decline in their outputs. Lowered and uncertain oil and commodity prices, euro-zone distress, political uncertainties, and US potential trade policy shift have added fuel to this decline. This has triggered a rapid deterioration of market sentiments globally and market

¹⁸⁵ Table A1. Summary of World Output, IMF, WEO, April 2017

participants have attempted to de-risk their portfolios by moving away from emerging markets and going towards less risky assets e.g., US treasuries.

Figure 4.3
Annual Growth in World Real GDP



Source: IMF World Economic Outlook April 2017 & Staff calculations

The key vulnerabilities of world economy such as US Government’s trade policy and its propositions towards revision of major trade agreements¹⁸⁶, uncertainties in oil prices and the political turmoil in the middle east, slower growth in China and Euro-zone etc. are assumed to put pressure on Pakistan’s trade, exchange rate, remittances and output. The global shocks are assumed to crystallize in scenario 2.

Amid this backdrop, the scenario 2 assumes that real world GDP growth will fall in the simulation period i.e. 2017-2019. From the current level of 3.1 percent World GDP is assumed to fall to 0.2 percent in 2017 and negative 1.7 percent in 2018 and 2019. This drop is consistent with the fall observed during the GFC of 2008 (Figure 4.3). This postulation is in

line with the adverse scenarios considered by other Central Banks (such as Bank of England).¹⁸⁷

It has been observed that in a crises situation, correlation among GDP growth rates across countries is significantly higher and closer to one.¹⁸⁸ It has also been found that factors such as heightened uncertainty and wake-up call that change investors’ perceptions, in addition to financial inter-linkages, are important in explaining the co-movement of output observed during 2008 crises. The scenario assumes that these channels would again operate strongly and would trigger global crises situation. Resultantly, global trade business is assumed to drop manifolds.

With the contraction of global trade, oil prices are susceptible to a decline on account of weaker demand. To ascertain the extent of drop in global oil prices in this stress scenario, simulated tail random values have been drawn from Wald distribution¹⁸⁹.

These additional factors, however, justify scenario’s assumption that the decline of world GDP would not show any sign of recovery in subsequent years of the scenario (against the actual event of 2008 where the start of recovery was observed in 2009).

As a consequence, Pakistan’s GDP is assumed to face a gradual decline as was observed during GFC 2008. The path of domestic GDP is forecasted using a linear model (See Figure 4.4). Given the path of GDP, LSM, a proxy for GDP, has been assumed to drop proportionately.

In the wake of declining global demand and domestic output, exports are also assumed to decline in this hypothetical scenario. This would in turn put pressure on the external sector which is

¹⁸⁶ NAFTA, TIFA, WTO etc.

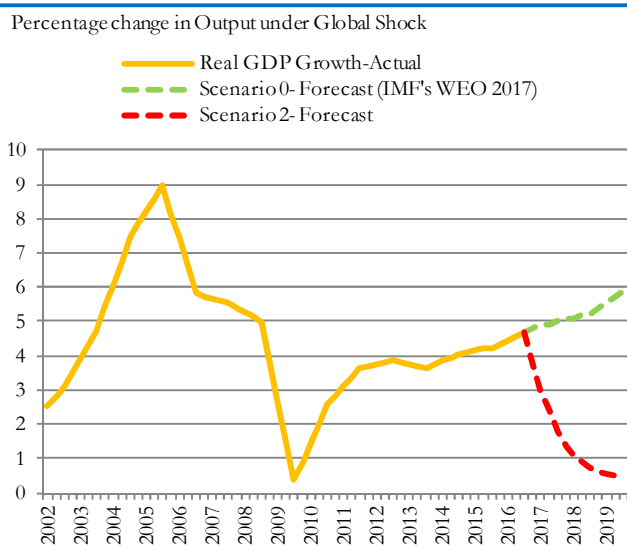
¹⁸⁷ Stress testing the UK banking system: 2015 results

¹⁸⁸ IMF October 2013, World Economic Outlook, Chapter 3

¹⁸⁹ Crude Oil Prices, trends & forecast, Nouredine Krichene (IMF, 2008, Working Paper No. 08/133)

likely to result in appreciation of foreign currencies. Domestic prices are then assumed to rise due to imported inflation. The extent of fall in exports is forecasted using the same linear model as previously (scenario 0), while the level of inflation has been assumed to be similar to its level during GFC of 2008.

Figure 4.4
Growth in Pakistan's Real GDP



Source: IMF World Economic Outlook April 2017 and SBP staff calculations

The tremors in the world economy are expected to further dent the confidence of the investors who are assumed to take refuge in safe heaven assets. Resultantly, stock markets of emerging economies, including Pakistan, are assumed to experience substantial and prolonged dip. Given the assumed inflationary pressures and external sector vulnerabilities, interest rates are likely to respond accordingly.

Stress Testing Results: System Level

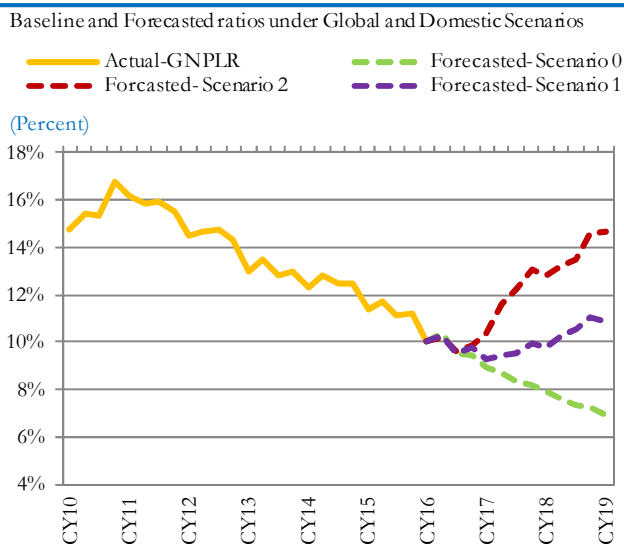
The stress test indicated that under the baseline scenario, the GNPLR ratio may decline from 10.06 percent in Q42016 to 8.94 percent by Q42017 and may further reduce to 6.88 percent by Q42019.

If the macroeconomic conditions deteriorate, the GNPLR may increase. GNPLR under baseline, global and domestic scenarios is given in **Figure 4.5**.

Under the scenarios, it can be seen that the banking sector is more vulnerable to the global shocks and the ratio shows an upward trend and reaches to the level of around 15 percent by Q42019. This increase however, remains below the worst level of GNPLR observed in recent past. This shows that the assumed crisis, erupted under global shocks, does not pose strong stability threat for the banking system of Pakistan.

Similarly, domestic led vulnerabilities (*sudden shocks like flood or earthquake*) or political change/uncertainties might not affect the banking sector stability that much and the system shows resilience against the assumed shocks.

Figure 4.5
Comparison of Quarterly GNPLR under different scenarios



Source: SBP and staff calculations

Capital Adequacy Ratio (CAR)

CAR of the system is a useful metric to assess the solvency profile since it captures credit, market and

operational risks simultaneously. However, it is assumed that the balance sheet structure would largely remain static, and so does the market risk and operational risk dynamics. CAR has been derived using effects of all the three major risks both on eligible capital and risk weighted assets of the banking system¹⁹⁰.

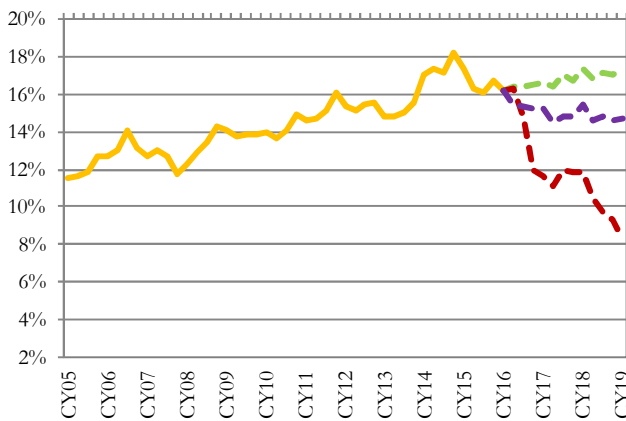
Under normal business conditions, the CAR of the banking system tends to increase by around 1 percentage point by the end of scenario period (2019Q4) which shows a healthy solvency profile of the banking sector (**Figure 4.6**).

Figure 4.6

Quarterly CAR- Forecast under different scenarios

Baseline and Forecasted under Global and Domestic Stressed Scenarios

— CAR-Banking System - - - Forecasted-Scenario 0
- - - Forecasted-Scenario 2 - - - Forecasted-Scenario 1
 (Percent)



Source: SBP and staff calculations

In global shock scenario, the impact seems to deteriorate banking sector's CAR significantly. It may be noted that the decline in CAR in CY17 and CY18 are almost near to what has been observed during GFC 2008, though it remains above local

¹⁹⁰ Increase in credit risk weighted assets has been mapped with the incremental rise in gross loans (net of provisions and taxes). Market risk weight is assumed to have been captured in scenario 0 projections for risk weighted assets. Operational risk weighted assets have been calculated using *Basic Indicator Approach* of the Basel II/III.

and global benchmark CAR levels.¹⁹¹ Additional assumption that no recovery occurs during post crisis, however, may result in further decline in CAR in 2019, which falls below local and global standards. For the domestic shock, the decline in CAR is observed but the fall is not extreme and remained above global and local CAR standards.

Stress Testing Results- Sectoral Level Default Analysis

In line with the system level default analysis, sectoral level infection ratio has been estimated for four (04) key sectors in this FSR which include *Textile, Cement, Sugar and Agriculture*. These sectors have been chosen keeping in view their contribution in overall domestic output (*such as textile and agriculture*) and also their sizeable borrowings from the banking channel and historical loan infection ratios.

For GNPLR, forecasts have been made using in-house time-series models which include sectors' specific variables to explain the infection ratio. Other macro variables are the same as forecasted in system-level simulations. This sectoral level assessment has made general observations regarding impact on profitability or solvency as both have not been quantified at sector level.

Textile Sector

Textile is one of the major industrial sectors and foreign exchange earners for the country. It also constitutes a significant portion of corporate lending of the banking sector. To forecast its loan infection ratio, under hypothetical scenarios, it is assumed that the sector's GNPLR depends upon its export

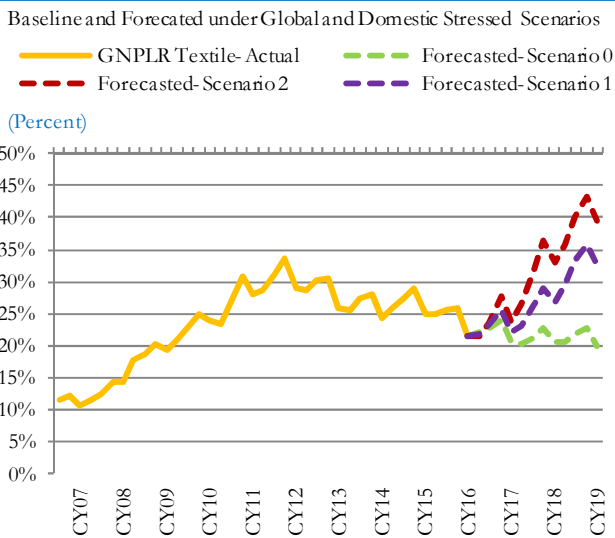
¹⁹¹ Global CAR requirement (including conservation buffer) is 9.25 percent, 9.875 percent and 10.5 percent in 2017, 2018 and 2019 respectively. Source: BIS (www.bis.org/bcbs/basel3). Local CAR requirement is 11.275 percent, 11.90 percent and 12.5 percent in December 2017, 2018 and 2019, respectively. Source: SBP (www.sbp.org.pk)

performance, output, prevailing interest rates and capital market fluctuations.

In scenario 1, it is assumed that textile manufacturing (LSM Textile) and textile exports are likely to suffer from disrupted input flows due to natural disaster. Therefore, GNPLR is expected to rise. In Scenario 2, the sector is likely to have rising default ratio because of the contraction of the global trade and a feedback effect of reduction in textile production. Rising interest rates and dip in stock market index is likely to add to this rise (**Figure 4.7**).

Figure 4.7

Comparison of Quarterly GNPLR under different scenarios



Source: SBP and staff calculations

The resulting forecasts for the GNPLR in scenario 1 is slight higher than its level observed recently and it is likely that with little government relief, the sector may sustain this shock. However, it can be seen from the figure that the sector is most vulnerable to the global shock. The rise in infection ratio is significantly higher than its historically adverse level. If the scenario assumptions materialize, the industry may experience sizeable shut-downs, large credit defaults and possible businesses migration. In that case, government bailout to sustain the sector seems

to be the likely outcome. Under this scenario, the banking sector may experience some rise in infection and reduction in profitability (**see Annexure B4.2 of Box 4.1.**)

Cement Sector

Cement sector has positive association with infrastructure development domestically as well as in neighboring countries.

The sector’s loan infection ratio increased recently. To forecast the sector’s credit infections under stressed scenarios, it is assumed that the sector’s GNPLR is largely explained by its exports, capital formation (*constructions*), inflation and interest rates.

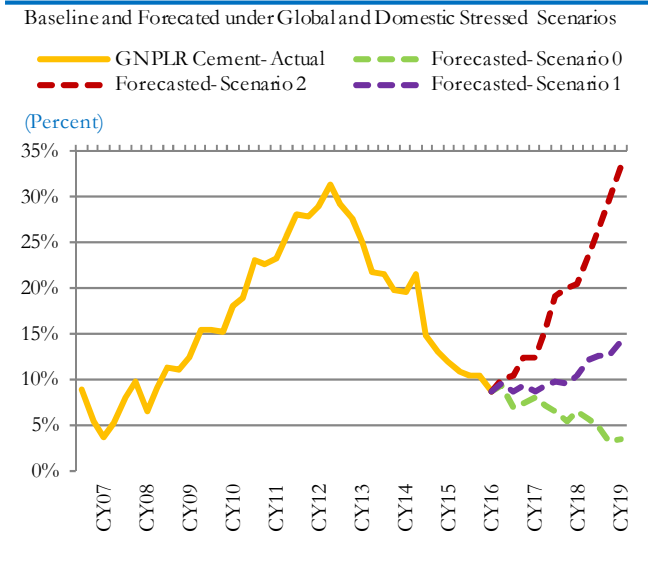
Cement export is one key factor affecting the sector’s performance. Similarly, the real estate development (*gross fixed capital formation-construction*) is another key determinant of the sector’s performance. Rising prices may, however, have a negative impact due to rise in input material cost.

In scenario 0, mega developmental projects are expected to increase use of cement due to CPEC and pre-election rising developmental expenditures. This would result in lower level of infection ratio. In scenario 1, a mild decline in cement export is assumed while structural projects are likely to slow-down; however government relief initiatives are expected to somewhat cool down the rise in infection ratio. In scenario 2, however, the contraction in global trade, rising interest rates, slowdown of CPEC related projects, is expected to result into an increase in GNPLR (**Figure 4.8**).

The result under scenario 1 indicates lower infection than historical default levels and doesn’t appear to dent banking sector’s resilience. Under scenario 2, however, infection ratio increases significantly as compared to other scenarios as well as historical levels (CY2012). However, due to cash rich nature of the industry, small size of its exposure and the

sector's experience with similar level of defaults recently; it is expected that it will sustain this shock (see Annexure B4.3 of Box 4.1.)

Figure 4.8
Comparison of Quarterly GNPLR under different scenarios



Source: SBP and staff calculations

Sugar Sector

Pakistan's major agri-products, besides cotton and wheat, include sugarcane. Sugarcane production is mostly consumed by industry to produce sugar which is also exported. This makes Sugar industry as an important sector of the economy.

To forecast its infection ratio, it is assumed that the sector's NPLR is a function of sector's exports, agriculture output¹⁹², prevailing risk premium (KIBOR), and capital market developments.

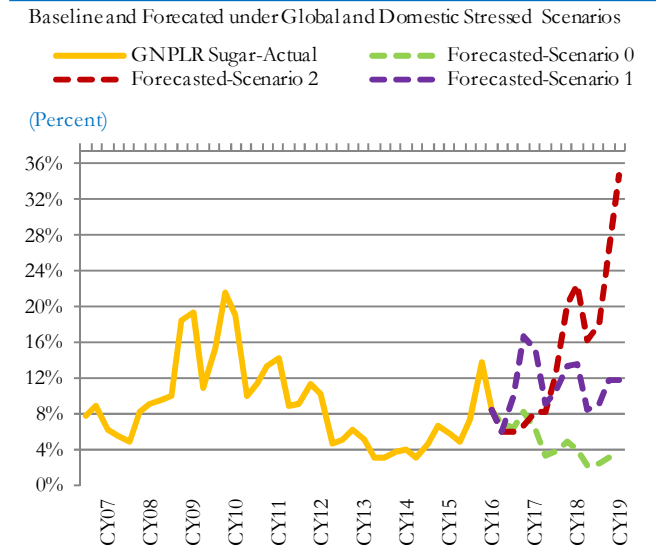
In scenario 0, the existing conducive business environment and rising domestic output would restrict GNPLR. However, in Scenario 1, the fall of agriculture output (including sugarcane) added with decline in sugar exports is likely to negatively impact the sector's performance initially. However, the

¹⁹² Major Crops only-Since overall agriculture output include livestock, fisheries, forestry etc. which have no direct relationship with the sector's input (sugarcane).

transitory shock is expected to decay quickly and the infection ratio is expected to improve.

In scenario 2, global trade retrenchment and rising interest rates may result in significant rise in delinquencies (Figure 4.9).

Figure 4.9
Comparison of Quarterly GNPLR under different scenarios



Source: SBP and staff calculations

It can be seen from the results that the sector is less vulnerable to scenario 1 (i.e. domestic shock) and the infection ratio remains close to its existing trend. Under scenario 2, however, the level of GNPLR surges significantly. As historically the domestic sugar prices are higher than global prices and the industry usually requires subsidies for exports, sector's exports may be affected and may require Government intervention. The banking sector, earnings may, come under pressure in this case (see Annexure B4.4 of Box 4.1.)

Agriculture Sector:

Agriculture is the one of the major sectors contributing in Pakistan's GDP growth. Besides, the output of the sector is a key source of input for a number of industries. To test the sector's resilience

against credit risk, it is assumed that the GNPLR of the agriculture sector is explained by the agriculture output, overall exports, inflation and interest rate (SBP target rate).

Under existing economic conditions, rising exports, increasing industrial production and low interest rates, the sector is expected to perform better.

In scenario 1, the flood disaster is assumed to disrupt agriculture output as was observed during the 1992 flood event. A slowdown in industrial production is likely to impact the exports, while inflationary pressure may affect the repayment capacity of the borrowers resulting in rise in GNPLR. However, historically, the government has been intervening after such disasters and credit relief programs are initiated. This would help restrict or ease sector's rising GNPLR.

Under scenario 1, the GNPLR is showing a declining trend initially but gradually moves upwards. The reason for this initial improvement could be the flood relief programs (*including credit relaxations*) initiated by the government in the immediate aftermath of the disaster. But as the impact of relief dies down, the infection ratio starts inching up but remains manageable.

Overall the sector appears to be resilient in all the three scenarios and no significant adverse impact on the banking sector is anticipated (**see Annexure B4.5 of Box 4.1**).

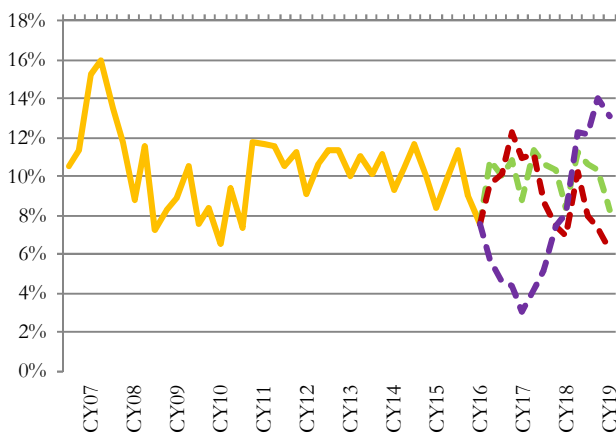
Figure 4.10

Comparison of Quarterly GNPLR under different scenarios

Baseline and Forecasted under Global and Domestic Stressed Scenarios

- GNPLRAgri- Actual
- Forecasted-Scenario 0
- - - Forecasted-Scenario 2
- - - Forecasted-Scenario 1

(Percent)



Source: SBP and staff calculations

In scenario 2, the sector is likely to be less vulnerable to global shocks. The slowdown in exports may pose some pressure on the sector's output; however, domestic consumption is expected to largely nullify some of this impact (**Figure 4.10**).

Box 4.1: Technical Details

Models and Estimation Results:

System level models:

There are three scenarios i.e. *0-Baseline, 1-Adverse-domestic, 2- Severely adverse-global*. In all the three scenarios, different set of assumptions have been made while keeping the models consistent throughout the scenarios.

Credit Risk

The system level gross non-performing loan ratio (GNPLR) has been projected using three different econometric approaches: *multivariate regression, Vector Autoregression (VAR)* and *Vector Error Correction Model (VECM)*.

- *Multivariate Regression Technique:*

Ordinary least square (OLS) is considered as the best linear unbiased estimator (BLUE) of unknown parameters if it complies with the certain conditions. A step-wise regression model¹⁹³ using a satellite Credit Portfolio View model (CPVM) has been used assuming that the GNPLR of the banking system can be explained by macro-economic variables including, large industrial manufacturing, export volume, price level, risk premium or prevailing market interest rates and stock market performance.

All variables are in logs and the dependent variable is logit transformed to avoid non-Gaussian errors¹⁹⁴. Stationarity is ensured by taking the appropriate differences.

- *VAR model*

While multivariate regression allows evaluating the impact of selected macroeconomic variables on the GNPLR, the VAR model takes into account the

feedback effect and correlations among all endogenous variables.

In notational form, mean-adjusted VAR of order p (VAR(p)) can be written as:

$$\mathbf{y}_t = \mathbf{A}_1\mathbf{y}_{t-1} + \dots + \mathbf{A}_p\mathbf{y}_{t-p} + \mathbf{u}_t \quad ; t = 1, 2, 3, \dots \quad (2)$$

Where, $\mathbf{y}_t = (y_{1t}, \dots, y_{kt})'$ is a (K×1) vector of variables at time t, the \mathbf{A}_i ($i=1,2,\dots,p$) are fixed (K×K) coefficient matrices and $\mathbf{u}_t = (u_{1t}, \dots, u_{kt})$ is a K-dimensional white noise errors or innovation process.

In order to estimate the VAR model, the same variables used in multivariate regression are chosen and appropriate order is selected based on minimum information criteria (*Schwarz or Akaike Information Criterion*) coupled with other diagnostics such as *no-autocorrelation (via LM test)*, *stability (via AR characteristic polynomial test)*, *normality (via multivariate Jarque-Berra test)*, etc.

- *VECM:*

The VAR concept can be extended to the VECM, when there is an evidence of cointegration¹⁹⁵ among two or more series. While in case of cointegration, VAR model produces reliable results in levels and is commonly used by the regulatory agencies for stress testing (*such as Bank of Canada*); however, theoretically, VECM produces better results as it estimates the long run relationships in addition to short-run dynamics.

After testing and identifying co-integration relationship in variables using *Johansen Co-integration Tests*, VECM has been estimated as well. The model is estimated using the first differences of the non-stationary variables, but a lagged error-correction term is added to the relationship.

In all these methods, the conditional mean of nonperforming loan ratios is estimated. It is, however, assumed that the impact of macro-variables on credit quality will remain the same irrespective of the level of

¹⁹³ Parameters are estimated using OLS

¹⁹⁴ Vazquez, F., Tabak, B. M., & Souto, M. (2012). A macro stress test model of credit risk for the Brazilian banking sector. *Journal of Financial Stability*, 8(2), 69-83.

¹⁹⁵ X_t and Y_t are non-stationery and are said to be co-integrated if there exists a long term relationship which makes them stationary in long-term.

the credit quality, which, however, may not always be true in practice.

The weighted average projections of GNPLR derived from the three approaches are then used to forecast System level CAR for each scenario and is reported at **Annexure B4.1**.

Assumptions and methodology in scenarios:

The explanatory variables used in multivariate and VAR and VECM techniques are individually forecasted under each scenario explained in the main report. We understand that for macroeconomic variables, there is no single method for forecasting. Therefore, certain linear models have been designed and used to capture causal relationship of all variables under the baseline, and shock scenarios. While forecasting the variables, it has been ensured that the model meets the regularity conditions. For example, besides ensuring stationarity of the variables, the model residuals have also been checked for serial correlation and heteroskedasticity. Similarly, to maintain consistency in the results, models so applied in one scenario (*such as baseline*) have been kept the same for other scenarios (*adverse scenarios*).

Market Risk:

To capture the impact of fluctuations in Interest rates (IR) and Exchange Rates (ER) on the banking sector's profitability, it is assumed that the expected medium to long term interest rates are the function of short term rates. Proportionate parallel shift of yield curve, upto next 12 quarters, have been made in accordance with the changes in six-month Kibor (*forecasted under each of the three scenarios*). Similarly, the exchange rate is forecasted using uncovered interest rate parity (UIP) condition, i.e.,

$$E[S_{t+k}] = S_t \times \frac{(1+r_d^k)}{(1+r_f^k)} \quad ; \text{where } r_d \text{ is six-month Kibor and } r_f \text{ is six-month US treasury bill rate.}$$

The r_f is forecasted using empirical kernel density function¹⁹⁶. The impact of both IR and ER has been translated to the profitability of the banking sector.

System Level CAR Estimation:

For CAR calculation, it has been assumed that the risk weighted assets (RWAs) would grow in accordance with the increase in advances portfolio (adjusted for non-performing loans) and rise in operational risk weighted assets¹⁹⁷. The advances and NPLs have been forecasted using VAR and VECM methodologies. For eligible capital, it is assumed that the capital growth will follow existing trend and hence is estimated using exponentially weighted moving average method *i.e. Holt-Winters*.

Sectoral Level Default Analysis:

In addition to the system level forecasting of CAR under three scenarios, sectoral level default analysis has also been carried for four (04) sectors, viz., Textile, Cement, Sugar and Agriculture. For each of these sectors, multiple linear regression models have been designed to include sector specific variables, in addition to the macro-financial variables. Point estimates for GNPLR for each sector have been forecasted and reported in **Annexure B4.2 – B4.5**.

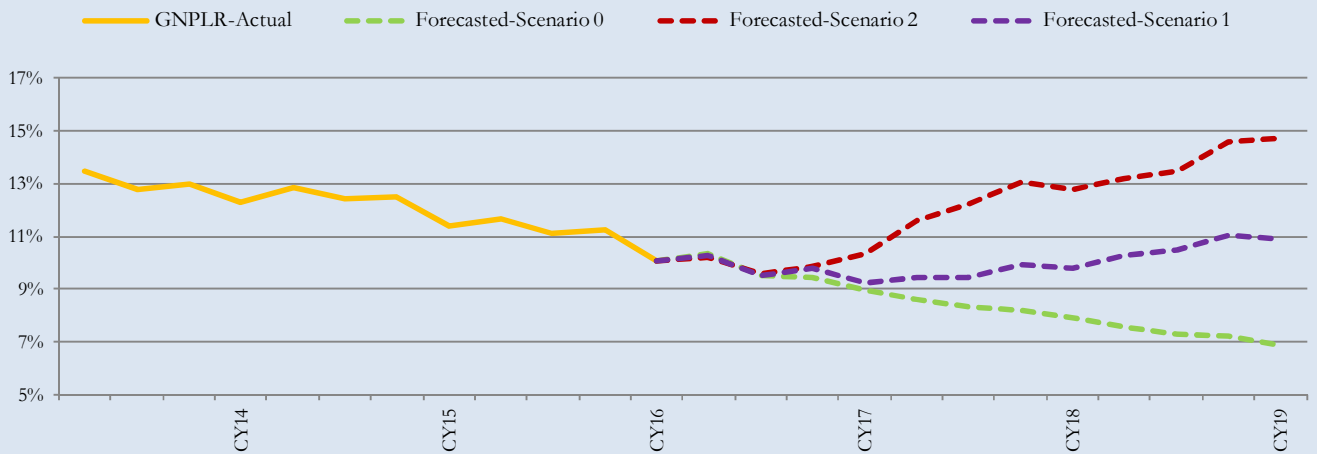
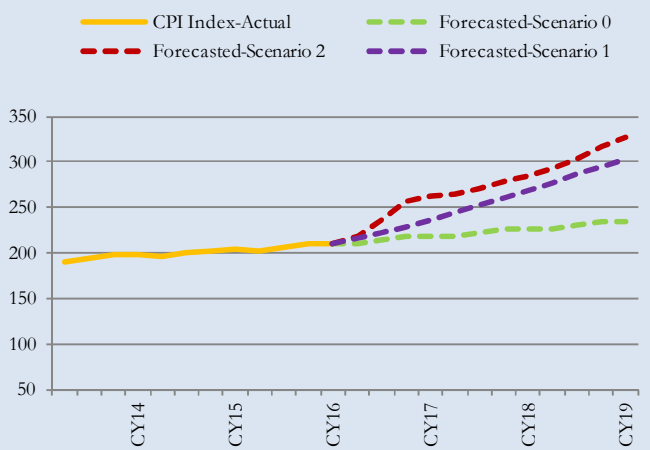
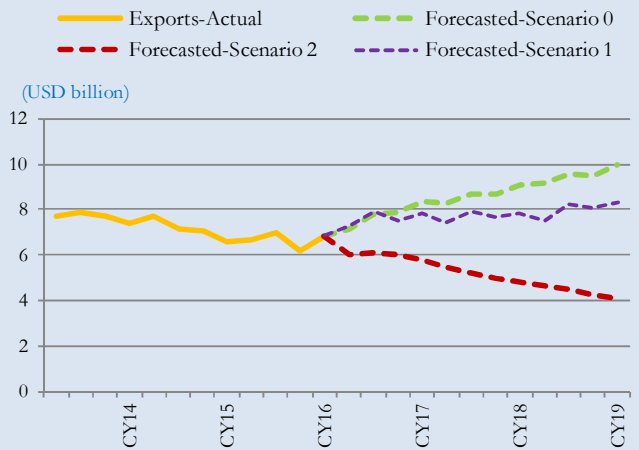
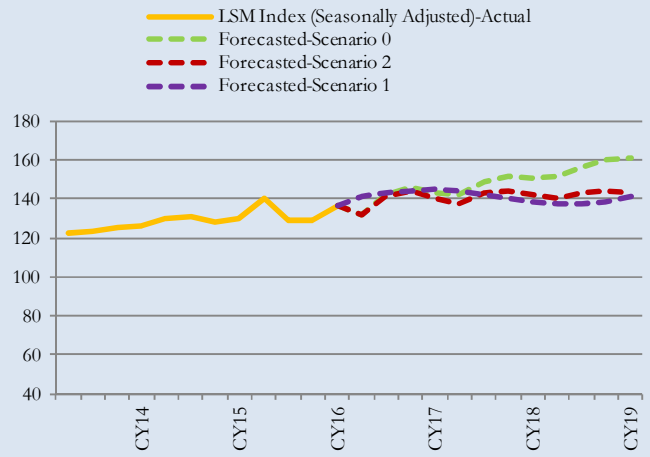
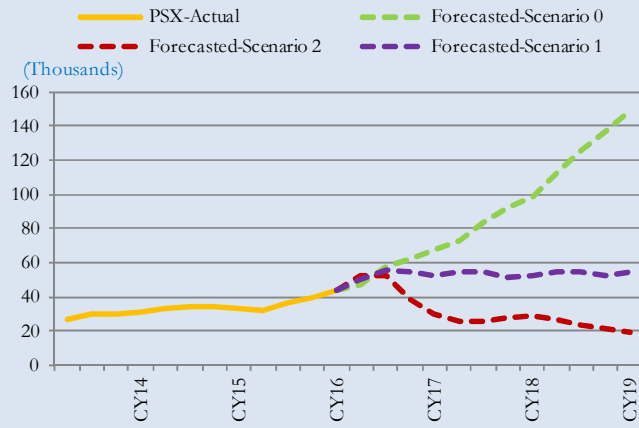
¹⁹⁶ To draw tail-values or stressed values, the kernel density function has been used to approximate distribution of the USD Tbill rates in scenario 2 (*global shock*) only. For other scenarios, simply smoothing technique has been employed.

¹⁹⁷ Estimated as per Basic Indicator Approach of the Basel II/III instructions.

Annexure B4.1

Trend of Macroeconomic Variables and System Level GNPLR

(Quarterly Forecast under different Scenarios)



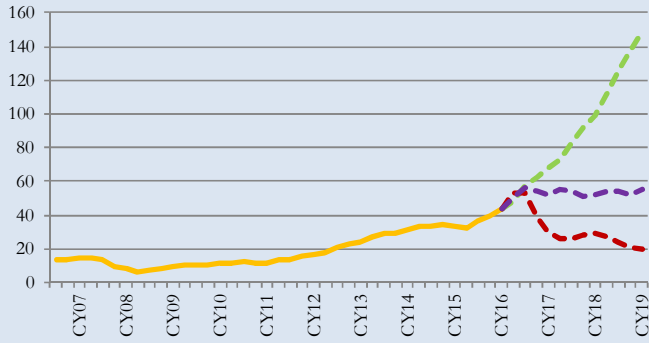
Annexure B4.2

Trend of Macroeconomic Variables & Textile Sector's GNPLR

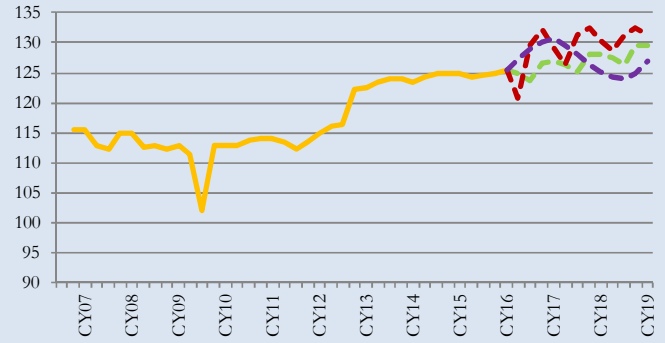
(Forecasts under different Scenarios)

PSX-Actual Forecasted-Scenario 0
 Forecasted-Scenario 2 Forecasted-Scenario 1

(Thousands)

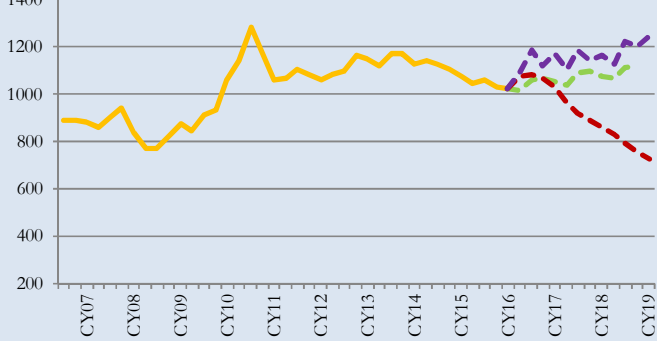


LSM Textile-Actual Forecasted-Scenario 0
 Forecasted-Scenario 2 Forecasted-Scenario 1

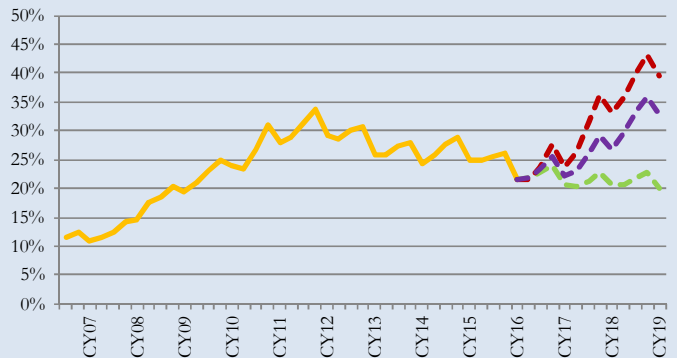


Textile Exports- Actual Forecasted-Scenario 0
 Forecasted-Scenario 2 Forecasted-Scenario 1

(PKR in million)



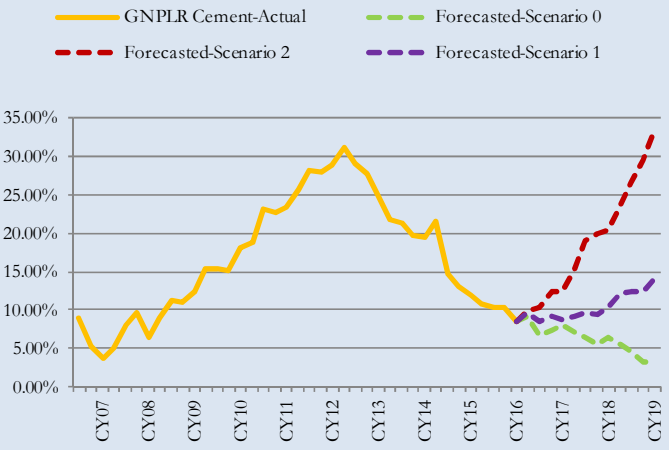
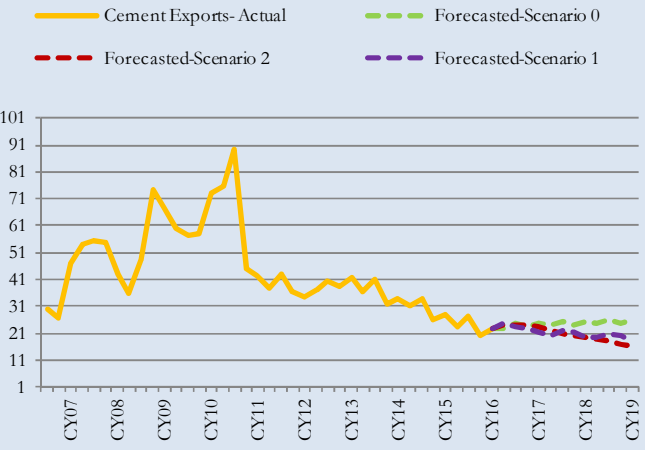
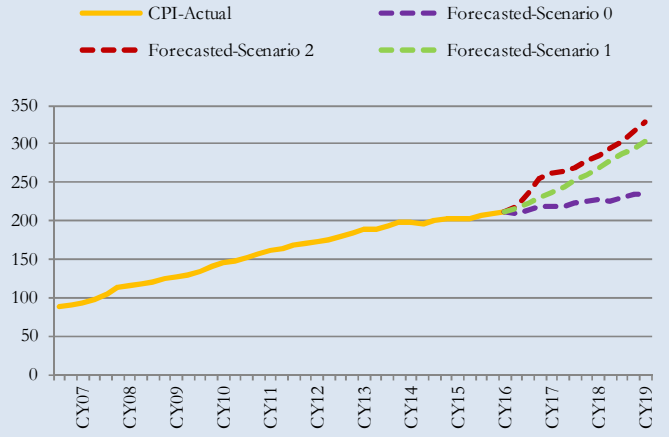
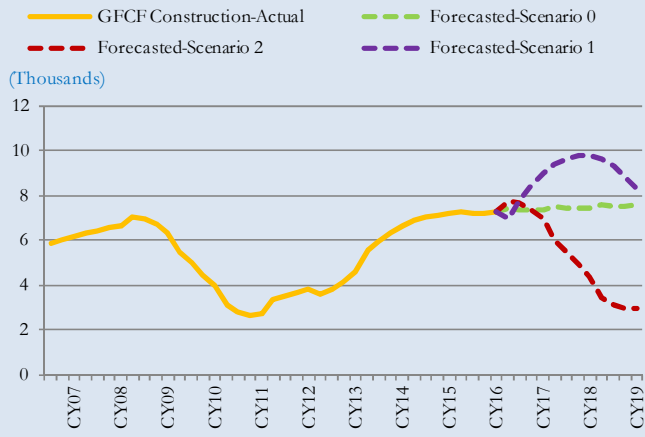
GNPLR Textile-Actual Forecasted-Scenario 0
 Forecasted-Scenario 2 Forecasted-Scenario 1



Annexure B4.3

Trend of Macroeconomic Variables & Cement Sector's GNPLR

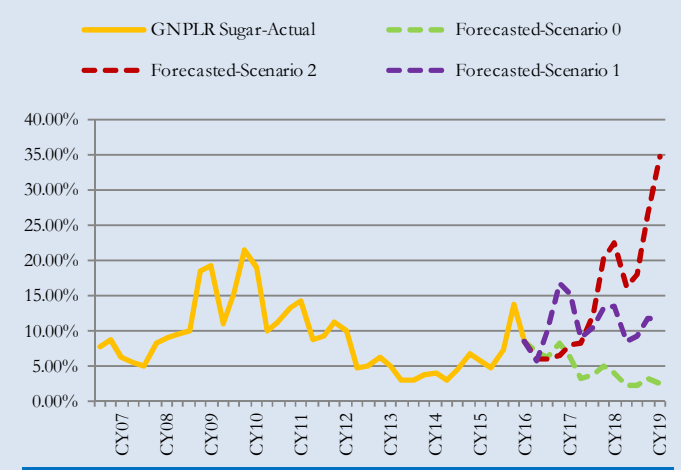
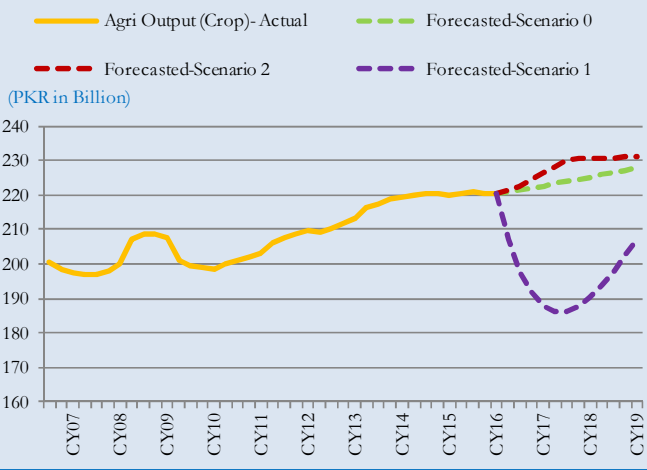
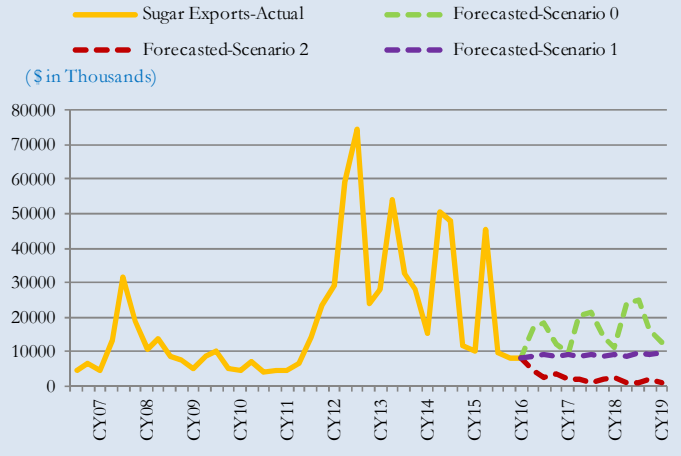
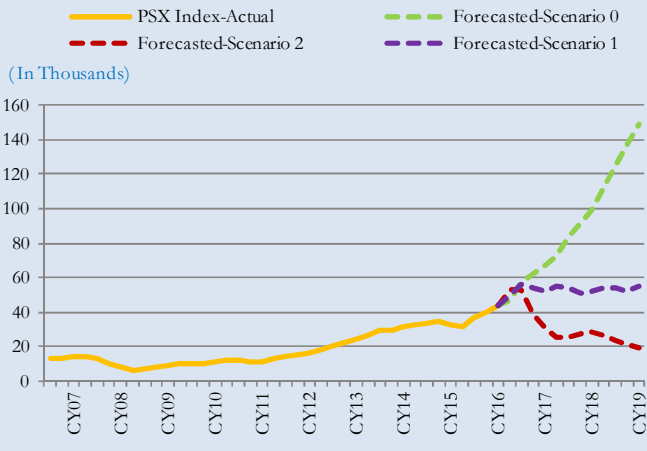
(Quarterly Forecasts under different Scenarios)



Annexure B4.4

Trend of Macroeconomic Variables and Sugar GNPLR

(Quarterly Forecast under different Scenarios)



Annexure B4.5

Trend of Macroeconomic Variables and Agriculture Sector GNPLR

(Quarterly Forecasts under different Scenarios)

