Technical Appendix

A. Banking Sector Stability Map (BSSM)

Based on the methodology described by the IMF[198], the BSSM covers the risks faced by the banking sector in seven dimensions listed in Table 1. To gauge the magnitude of risk in each dimension, relevant indicators have been used.

Table 1: BSSM Dimensions and Corresponding Risk Indicators

Sr No.	Risk Dimension	Subcomponents	Judgment based Weights	Impact on Financial Stability
1	Capital Adequacy	Capital Adequacy Ratio	40%	Positive
		Tier I CAR	30%	Positive
		Capital to Total Assets	30%	Positive
2	Asset Quality	NPLs to Total Loans	30%	Negative
		Provision to NPLs	30%	Positive
		Net NPLs to Capital	30%	Negative
		Loss to NPLs	10%	Negative
3	Exposure to Public Sector	Public Sector Exposure/Total Assets	50%	Negative
4	Residual Growth (growth financed by non-core liabilities)	Growth in Investments	25%	Negative
		Growth in Advances	25%	Negative
		Growth in Borrowings	25%	Negative
		Growth in Deposits	25%	Positive
5	Interconnectedness	Call Lending and Borrowings/Total Assets	50%	Negative
		Financial Liabilities(SBP exclusive)/Total Liabilities	50%	Negative
6	Earnings	Return on Assets (Before Tax)	20%	Positive
		ROE (Avg. Equity& Surplus) (Before Tax)	20%	Positive
		NIM	20%	Positive
		NII/Gross Income	15%	Positive
		Cost / Income Ratio	15%	Negative
		Trading Income to Total Income	10%	Negative
7	Liquidity	Liquid Assets/Total Assets	33%	Positive
		Liquid Assets/Total Deposits	33%	Positive
		Earning Assets/Deposits	33%	Negative

In each dimension, historical annual series of selected indicator ratios (up to 20 years), as listed in Table 1, have been collected. Based on each series, percentile rank for the year under consideration is computed. The ranks are then

[198] For methodology please see Dattels, P., McCaughrin, R., Miyajima, K., & Puig, J. (2010). "Can you map global financial stability?" *IMF Working Papers*, 1-42.

normalized on a scale of 1 to 10; indicators with positive impact are subtracted from 10 since lower values indicate more stability, while indicators having negative impact are simply normalized. Based on the weights of each series, as given in Table 1, an average summary measure having a single value of risk is arrived at for each dimension. Lower value of the summary measure indicates lower risk to the banking sector stability while higher values signify higher risk in that dimension.

B. Financial Markets Stability Map (FMSM)

The FMSM measures risks in three dimensions i.e. Equity Market, Money Market and Foreign Exchange Market. Historical daily series of KSE-100 index since August 9, 2000, daily series of mid average interbank selling-buying PKR/USD exchange rate since June 23, 2005, and weekly series of weighted average overnight repo rates since July 15, 2005 are used to compute Exponential Weighted Moving Average (EWMA) volatility[199] for each series. The smoothing factor, λ, is taken to be 0.94 and initial volatility, σ_0, of 0.01 is used.[200,201]

Based on daily or weekly values (as the case may be), average volatility was computed for each completed calendar year since CY06. The percentile rank of a particular year's volatility (say CY14), in each of the three dimensions, is then computed relative to their respective history (since CY06). Higher ranking in a dimension represents higher riskiness. The percentiles were subsequently rescaled from 1 to 10 so as to make them presentable in the map.

C. CPV Model Results

The variant of the CPV model used for the macro-stress testing exercise is reproduced below:

$$GNPLR_t = \alpha + \sum_{i=1}^{4} \beta_i GLSM_{t-i} + \sum_{i=1}^{4} \gamma_i GEXP_{t-i} + \sum_{i=1}^{4} \eta_i PSE_{t-i} + \sum_{i=1}^{4} \delta_i DR_{t-i} + \epsilon_t$$

The estimation results[202] of the model are, generally, in line with prior expectations (**Table X**). All variables have the expected signs except discount rate at second lag. However, the combined effect of discount rate implies a positive relationship with the dependent variable, GNPLR. Model fit is also reasonable. The Durbin-Watson statistics is in the satisfactory range (above 2.0).

Table X

Regression Results of CPV Model

Dependent Variable: Gross Non-Performing Loans (GNPLR)

Variables	Coefficents
GLSM(-1)	-0.3584
	[0.0005]
GLSM(-3)	-0.4538
	[0.0000]
GEXP(-4)	-0.1623
	[0.0103]
PSE(-2)	-0.2237
	[0.0062]
DR(-1)	0.6074
	[0.0000]
DR(-2)	-0.7912
	[0.0024]
DR(-3)	0.3250
	[0.0351]
Intercept	-0.2984
	[0.0018]
Observations	51
R-squared	0.72
Adj R-sqaured	0.67
Durbin Watson stat	2.29

[199] The formula for computing EWMA volatility is: $\sigma_t^2 = \lambda * \sigma_{t-1}^2 + (1-\lambda) * \mu_t^2$, where, σ, is the standard deviation, λ, is the smoothing factor and μ, is the return.

[200] Riskmetrics (1996), J. P. Morgan Technical Document, 4th Edition, New York, J.P. Morgan.

[201] Chang, C. L., Jiménez-Martín, J. Á., McAleer, M., & Pérez-Amaral, T. (2011). Risk management of risk under the Basel Accord: Forecasting value-at-risk of VIX futures. *Managerial Finance*, *37*(11), 1088-1106.

[202] Since we estimated the model using step-wise OLS regression, lags of explanatory variables which are insignificant are dropped.