Resilience Indicators: Measuring an Economy’s Ability to Withstand Financial Shocks

Introduction
In the aftermath of the financial crisis in 1997–98, international financial institutions, central banks, and academia have devoted a lot of research efforts to the development of forward-looking early warning systems (EWS) for predicting the likelihood of financial crises. An EWS usually involves the use of a consistent framework to analyse high-frequency macro-prudential indicators. Experience so far suggests that there are limitations to the predictive power of most EWS. For instance, while the two core EWS of the International Monetary Fund correctly predicted that a crisis was impending in Turkey one year before the crisis broke out in February 2001, the models did not issue any warning signals for the January 2002 crisis in Argentina. It is generally acknowledged that predicting the occurrence of financial crises is not easy, given the increasing volatility of financial markets, the scale of contagion, and the magnitude of the damage that the crises may cause. Also, as the markets become more globalized, it would be difficult to isolate the impact of external events on the domestic economy.

Because of the difficulty in predicting (financial) crises, there may be some merit in developing models that can assess the level of resilience of an economy to supplement the EWS. The Hong Kong Monetary Authority (HKMA) and the Risk Management Science Programme of The Chinese University of Hong Kong have jointly developed a statistical model for this purpose. The HKMA has also provided a research grant to CUHK to fund this research, which began in early 2002. The conceptual framework and preliminary findings were disseminated to the central banks of the Asian-Pacific region through the Workshop on Resilience Indicators held on 29th January 2003 by the HKMA.

Early Warning Systems vs. Resilience Framework

The major difference between an EWS and a resilience framework is that the latter does not predict crisis, but only assesses the current state of health of an economy and hence its ability to withstand financial shocks should one occur. The concept of EWS is based on the premise that an economy and its financial markets would behave differently prior to an imminent financial (banking, currency, or debt) crisis. The ‘abnormal’ behaviour has a systemic and recurrent pattern, which is discernible. Therefore, one could judge whether a crisis is coming from the movement of particular economic and financial indicators.

The concept of resilience on the other hand is based on the hypothesis that different states of a system involve different equilibrium. It is believed that if an economic system is resilient, it should be able to withstand new challenges and sudden qualitative shifts. Conversely, if the economy is not resilient, the chances that it will change from the current state to other states would be higher.

In the context of economic and financial systems, resilience can be interpreted as a measure of a system’s ability to remain stable, without undergoing catastrophic changes in basic functioning, in the event of financial shocks. It should be noted that measuring resilience does not involve anticipating financial shocks.

EWS tend to focus on high-frequency market data. Indicators commonly used in EWS include (i) Financial Market Data (interest rates, exchange rates, equity prices); (ii) Monetary Aggregates (money supply, loan and deposits); Capital Flows Data (foreign direct investment flows, portfolio and other investment flows, imports and exports, current account balance); Basic Macroeconomic Data (GDP growth, government budget and official foreign exchange reserves).

The basic conceptual framework on resilience indicators comprises the assessment of the resilience of five sectors: external, public, banking, corporate and household. The framework also includes an assessment of the degree of restriction on
capital flows into and out of an economy. This affects the resilience of the economy in the face of speculative short-term capital flows.

In each of these sectors, three to five key indicators are selected which will reflect the state of strength and weakness of the sector. Most of the indicators are developed from the financial soundness indicators (FSI) recommended by the IMF, but the researchers have also included new indicators that are statistically significant, such as net international investment positions in the assessment of the resilience of the external sector. The structure of the resilience framework is given in Figure 1.

To understand this process, consider the external sector for example. The sector consists of five indicators, E1 to E5. Each indicator is assigned a range of percentile values to identify ‘strong’ or ‘weak’ signals. This assignment is based on the expert opinions of economists and the distribution of the data. This is illustrated in Figure 2. In this example, the 20th percentile of E5 is ‘–36%’ and the 80th percentile is ‘+7%’. An observed value higher than or equal to ‘+7%’ is regarded as a ‘strong’ signal (the green region) and hence, the probability of this value being a ‘strong’ signal is ‘1’ and the probability of its being a ‘weak’ signal is ‘0’. Similarly, an observed value less than or equal to ‘–36%’ is regarded as a ‘weak’ signal (the red region) and hence, the probability of this value being a ‘weak’ signal is ‘1’ and the probability of this value being a ‘strong’ signal is ‘0’. For an observed value between the two thresholds (the yellow region), a probability of this value being a ‘strong’ signal is assigned based on the relative closeness of this observed value to the two thresholds using the Mamdani inference of fuzzy logic systems of artificial intelligence techniques.

The next step is to combine the five signals of E1 to E5 into one resilience score on a scale of 1 to 5 for the external sector of an economy. A resilience score of ‘5’...
denotes a state of strongest resilience while a score of ‘1’ denotes least resilience. The five signals can generate 32 possible combinations of the ‘strong’ and ‘weak’ signals. Each combination will be given a resilience score presented in a decision matrix. For instance, a combination of 5 strong signals will be given a resilience score of 5 while a combination of 5 weak signals will be given a resilience score of 1 and so on. In the construction of this decision matrix, expert opinions from economists on the relative importance of various indicators are incorporated to assess the resilience level of the sector. The aggregated resilience score is then computed by taking a probability-weighted average of resilience scores given to each indicator. The probability is obtained from the artificial intelligence engine used in the preceding step.

Next, the classification and regression tree (CART) approach is used to develop a series of decision rules through which resilience scores will be assigned to the observation, in such a way that the number of observations falling into the five score groups of ‘1’ to ‘5’ will match as much as possible the number of observations originally classified into the groups in the previous step. The product of the CART process is a decision tree, which will be used for assigning ratings to future observations. Some key findings are summarized in the box below.

### Some Key Indicators of Resilience

**External sector**

▲ ‘Short-term external debt cover’ emerged as the most important indicator of external sector resilience as reflected by the number of times it appeared on the tree. This indicator is crucial as it reflects an economy’s ability to repay short-term external obligations, especially in times of financial shock.

▲ The ‘net international investment position (IIP)’ is the next most important factor in assessing the resilience of the external sector, as it is an indication of an economy’s stock of wealth, or the size of cushion available in times of financial crisis. While a negative IIP does not necessarily suggest high vulnerability, a strong IIP will suggest a large cushion to absorb financial shocks.

▲ ‘Export growth’ is also a significant factor in determining external sector resilience as reflected by the indicator appearing at the top of the decision tree. It provides an indication of income flowing into an economy.
Applicability of Findings

The resilience level of the external and fiscal sectors of a number of emerging market economies in Asia and Latin America have been assessed in this manner, and the degree of restrictions these economies imposed on foreign exchange transactions and capital mobility have been studied. The results indicate that all relevant economies had very low levels of resilience during the 1990s when the crises struck. For example, the overall resilience scores of Argentina, Mexico, and Turkey were consistently below ‘3’. Similar situations were observed in a number of Asia economies during the financial crises in 1997–98. The results also indicate improvements in the resilience levels observed in some Asian economies in recent years.

Way Forward

Although the development of the resilience framework is still at a very preliminary stage, this study has so far suggested that it can be a useful framework for complementing the EWS. Individual economies can refine the framework to make it more applicable to their own economies by adding in more indicators, especially in the household and the corporate sectors, or adjusting the relative weight of indicators. The technical aspects can also be improved to enhance the ability of the framework to assess the resilience of individual economies.

Researcher Profiles

Prof. Chan Ngai-hang is professor of statistics and chairman of the Department of Statistics at The Chinese University of Hong Kong. He was the founding director of studies of the Risk Management Science Programme. Before joining the University in 2000, Prof. Chan was professor of statistics at Carnegie Mellon University, USA. He is a renowned expert in time series, econometrics, and risk management. He is an elected fellow of the Institute of Mathematical Statistics and editorial board member of the Journal of the American Statistical Association and Econometric Theory.

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