Box 3
**Establishing the Financial Vulnerability Index of Taiwan**

From 2008 onwards, the Bank has compiled and published Taiwan's FSIs after taking reference from the FSI compilation guidelines published by the IMF.[1] These indicators, regularly disclosed in the *Financial Stability Report* and on the Bank's website, are used to monitor changes in individual sectors as well as financial markets. However, given that the FSIs currently comprise as many as 58 indicators and cover multiple sectors, it is not meant to promptly gauge the overall stability or vulnerability of the financial system. Against this backdrop, in collaboration with domestic academics,[2] the Bank endeavored to establish the Taiwan Financial Vulnerability Index (TFVI) based on the existing framework of the FSIs. The TFVI aims to provide a comprehensive measurement of financial system vulnerabilities, which helps the Bank to identify the source of vulnerabilities and take response measures in a timely manner. In this Box, we would like to briefly introduce the methodology applied to establish the TFVI, and the interpretation of the preliminary research results.

1. Compilation methodology for the TFVI

The TFVI, built on the basis of the FSIs compiled by the Bank, is divided into six sectors, including domestic banks, life insurance companies, bills finance companies, non-financial corporate sector, household sector and real estate market. The banking sector is further classified into seven subsectors, while the corporate sector is split into two (Chart B3.1). Finally, each sector or subsector consists of a different number of indicators.[3] The methodology for compiling the TFVI is as follows:

(1) After computing the differences of the FSIs, we employ sequential principal component analysis to estimate a hierarchical common factor model. This methodology allows us to decompose the trend and variance of each FSI

Chart B3.1 The structure of the TFVI
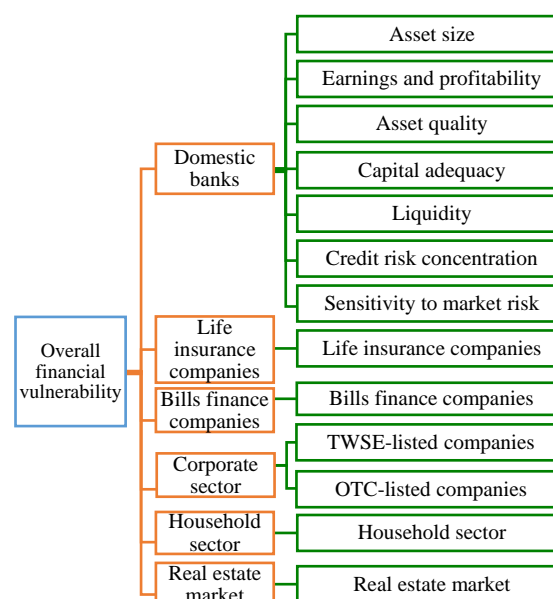
Note: For more details about the indicators, please refer to the "Appendix: Financial soundness indicators," in the *Financial Stability Report*, May 2023.
Source: CBC.

into two parts - one affected by multilevel common factors and the other capturing the variable-specific variation.

(2) Via a linear regression analysis of the FSIs treated as explained variables, together with the previous period's value of the hierarchical common factors constructed in the above step as explanatory variables, we obtain the residuals corresponding to each FSI.[4] The residuals, representing uncertain information that cannot be captured by previous hierarchical common factors, serve as the basis for establishing the vulnerability index.
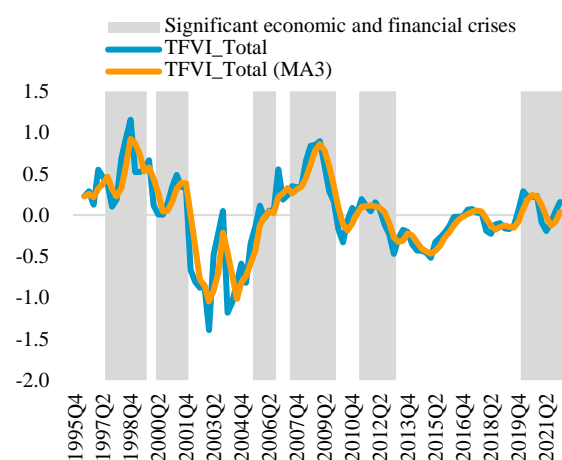
Chart B3.2 The movement of the TFVI

Notes: 1. TFVI_Total is the original FVI, and TFVI_Total (MA3) is the moving average of the TFVI from time t to t - 3.
 2. For more detailed information about significant economic and financial crises, please see Note 7.
Source: CBC.

(3) After adjusting the signs of the corresponding residuals in respect of the correlation between each FSI and financial vulnerability,[5] we aggregate the weighted residuals in every subsector so as to acquire the respective financial vulnerability index. The weighted subsectoral indices are then summed up to create sectoral indices. Lastly, the overall financial vulnerability index can be calculated by combining the six sectoral indices.[6]

2. Preliminary TFVI research results

2.1 The movement of the TFVI and its association with financial crises

In order to assess whether the TFVI is capable of accurately reflecting changes in the vulnerability of Taiwan's financial system, this study defines eight material economic and financial events domestically and globally since 1995 Q4,[7] and explores their relationship with the TFVI. As shown in Chart B3.2, the TFVI shows a trend highly correlated to the aforementioned events. Furthermore, with regard to the smoothed TFVI,[8] points in time where the index exceeded 1.65 times standard deviation coincide with the periods of domestic financial distress (from 1998 Q4 to 1999 Q3) and the global financial crisis (from 2008 Q4 to 2009 Q2). These results exhibit that the TFVI compiled in this study should have the ability to identify notable changes in domestic and international financial conditions.
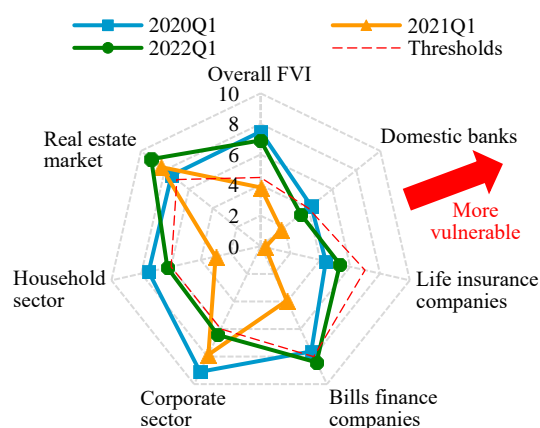
2.2 Visualization analysis of the TFVI

Apart from the overall TFVI, this study further adopts visualization analysis to present the variations in vulnerability for each sector. The main approach involves specifying optimal thresholds by applying the Youden index. Subsequently, we transform these threshold values and subsectoral indices into a scale ranging from 0 to 10. These figures are depicted on a radar chart, aiming to compare the extent of adverse impacts across different sectors.

Chart B3.3 The radar chart of the TFVI

Source: CBC.

Taking the period of the COVID-19 crisis for example, the subsectoral indices for the household sector, corporate sector and real estate market were more significantly affected by the pandemic than the others (see Chart B3.3). The result suggests that the COVID-19 pandemic had a more profound impact on household income and corporate profits, thereby disturbing the supply-demand balance in the real estate market. By contrast, domestic banks and life insurance companies have generally maintained TFVI levels well below the threshold values over the past three years, showing relatively less vulnerability.

3. Conclusion

This study uses the FSIs compiled by the Bank to construct the TFVI. A hierarchical common factor model is introduced to filter the co-movement and common trends between variables and to subsequently build the TFVI for each sector and total TFVI from the bottom up. In sum, the TFVI is able to broadly reflect changes in Taiwan's financial vulnerability and possesses an early warning capacity. Thus, it can be a vital supplementary tool for the Bank to monitor the financial stability landscape.

Notes: 1. For more details about the FSIs of the Bank, please see the "Appendix: Financial soundness indicators" in the *Financial Stability Report*, May 2023.
2. See Hsu, Shih-Hsun (2023), "Taiwan Financial Vulnerability Index," commissioned research report by the Bank, February.
3. The construction of the TFVI utilized a total of 63 FSIs, including the current 58 indicators and the other five indicators removed according to the 2019 IMF compilation guide (i.e., household loans to total loans, corporate loans to total loans, large exposure to capital, gross asset positions in financial derivatives to capital, and gross liability positions in financial derivatives to capital).
4. Baker, Scott R., Nicolas Bloom, and Steven J. Davis (2016), "Measuring economic policy

uncertainty," *Quarterly Journal of Economics*, March.

5. Positive/negative values represent an increase/decrease in financial vulnerability caused by movement of the indices. For example, a higher return on assets (ROA) of financial institutions indicates better profitability and lower financial vulnerability. Therefore, ROA and financial vulnerability tend to move in opposite directions, and a negative sign should be applied when aggregating its residuals for subsector indices.

6. All indices are aggregated using equally-weighted averages owing to various starting points for each FSI, and only indices available at specific points in time are summed up when calculating the corresponding vulnerability index. Furthermore, under the current methodology for compiling financial soundness indicators, only domestic banks and the corporate sector have subsectoral indices.

7. The eight material economic and financial events refer to the Asian financial crisis (from 1997 Q3 to 1998 Q3), the domestic financial crisis (from 1998 Q4 to 1999 Q3), the bursting of the dot-com bubble (from 2000 Q2 to 2001 Q4), the credit card crisis in Taiwan (from 2005 Q3 to 2006 Q3), the subprime mortgage crisis (from 2007 Q3 to 2008 Q2), the global financial crisis (from 2008 Q3 to 2009 Q4), the European sovereign debt crisis (from 2011 Q2 to 2013 Q1), and the COVID-19 pandemic (from 2020 Q1 onwards).

8. TFVI_Total (MA3) refers to the moving average of the TFVI over the past three quarters.