Stress testing with incomplete data: a practical guide

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1. Introduction

With the ever-increasing diversification and inter-connectedness of financial systems, regulators have been dedicating more resources to understanding the relationships within their financial systems and investigating any inherent vulnerability. As such, a number of methodologies have been developed to analyse the stability of the financial sector. One of the more popular ways in which financial stability is assessed is through the use of stress tests. Stress tests, in the commercial banking literature, refer to assessing the impact of a rare but plausible shock to the financial system. Countries have to determine whether the financial institutions to be included in the analysis would conduct their own individual stress tests and then the regulator would aggregate the submitted data to arrive at a macro stress test; or whether the regulators would collect the necessary data and conduct one stress test based on the information received. Based on the stability reports published by various regulatory bodies throughout the world, the preference seems to be to collect the data to perform the stress test rather than rely on individual institutions to submit their results.

The first step is usually to determine what risks will be stressed and specifying the scenarios, as this will assist in determining the methodology to be used and the data requirements. In most instances historical data is employed to evaluate the sensitivity of commercial banks' balance sheets to various shocks to macro fundamentals and then utilising the estimated coefficients to simulate the impact on the financial system of possible stress scenarios in the future. Three broad techniques have been used to implement the stress testing approach: (1) time series analysis; (2) panel data regressions, and, (3) structural models (see Sorge and Virolainen, 2006 for more details).

Time series models are perhaps the simplest technique to apply. Kalirai and Schicher (2002), Hoggarth and Zicchino (2004) and Delgado and Saurina (2004) estimate models of the determinants of loan write-offs or non-performing loans. The coefficients from these regression equations were then employed to assess by how much one of the macro fundamentals would have to change before the system experiences severe stress. Rather than focus on one or two indicators of financial stress, Hanschel and Monnin, (2005) develop a stress index using market price, aggregate balance sheet, non-public information and other structural data. After estimating the stress index, the authors then try to forecast the index by using macroeconomic imbalances.

One of the drawbacks of aggregate or time series models is that they aggregate the microeconomic defaults that lead to financial stress. Panel data regressions can account for bank-specific factors that may be highly correlated with financial stress at a particular institution. Bangia et al. (2002) use credit migration matrices (which show the expected changes in credit quality of borrowers) to provide the linkage between macroeconomic conditions and asset quality. Using the credit ratings history of 7328 borrowers between 1981 and 1998, largely corporate institutions, the authors attempt to estimate the migration matrix, or the probabilities of being in a particular debt-rating grade. The stress test is therefore done

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by analysing how the portfolio value distribution changes during expansions and recessions. During recessions, Bangia et al. (2002) estimate that the level of economic capital needed is 30 percent higher than during an expansion year.

Panel regression approaches have also be been employed to evaluate the effects of the introduction of new regulatory approaches. One of the main concerns regarding the Revised Framework on bank's capital agreed by the Basel Committee on Banking Supervision is that it could potentially impact the level of lending to small- and medium-sized enterprises. Since small and medium-sized enterprises have higher probabilities of default, banks would have had to charge higher rates of interest of reduce the amount of lending to these firms in order to comply with higher capital requirements. Using a large sample of Italian firms, Fabi, et al. (2005) perform stress tests to compare the change in the overall risk of lending operations using the new internal ratings based approach and previously utilised techniques. The authors report that the two measures tend to be highly correlated, suggesting that the new capital adequacy framework should not significantly influence lending to small- and medium-sized enterprises. In contrast, Peura and Jokivuolle (2004), also using a stress testing framework to evaluate the effects of the new rating-sensitive capital charges of the Revised Framework on bank's capital, argue that the new framework is indeed likely to have a significant impact. The simulation-based approach conditions the rating transitions on the business-cycle phase, and provides estimates of actual bank capital and minimum capital requirements simultaneously. The joint dynamics of these determine the necessary capital buffers, given a confidence level for regulatory capital adequacy chosen by bank management. The numerical results indicate that the introduction of rating sensitive capital requirements will oblige banks to hold higher bank capital buffers than are currently observed due to the increased volatility of the minimum capital requirement.

de Bandt et al. (2008), in contrast to previous studies, apply the stress testing framework to investigate the effects of macroeconomic shocks on the corporate segment of the debt market. The study derives the equilibrium in the corporate debt market in terms of the interest rate and the volume of debt of non-financial corporations by simultaneously estimating a supply and demand schedule for debt. The model is estimated using data on corporate firms in France, Germany, Italy and Spain between 1993 and 2005. Two scenarios are considered: (1) a significant reduction in world demand and (2) a significant increase in oil prices. The results from the stress test suggest that the equilibrium depends to a large degree on the change in the default rate: in the second scenario the real debt burden is about 25 basis points higher relative to the recession scenario, as higher oil prices lead to higher short-term interest rates and second round effects on inflation trigger a reduction in real GDP growth.

Structural models attempt to embed loan default models into structural macroeconometric models. Basu et al. (2006), for example, outline a framework for augmenting the IMF's financial programming approach with a module to stress test the financial sector. The proposed framework can also be used to conduct sensitivity analysis of the aggregated financial sector to various types of risks, including foreign exchange, interest rate, and credit risk. Similarly, Drehmann et al. (2005) develops the Bank of England's Medium-Term Macroeconometric Model to explain the relationship between the between write-off rates and liquidation rates for the corporate and household sector based on various macroeconomic fundamentals.

As a complement to the techniques described above, Čiják, (2007) proposes a framework that allows the clear mapping of the macroeconomic shock onto the balance sheets of financial institutions but could also stand on its own and rely more heavily on the judgement of the analyst. In this way, if econometric techniques are difficult to implement, analysts are still able to map the impact of a macroeconomic shock and arrive at reasonable results. Furthermore, this framework permits contagion and feedback analysis, areas that are often overlooked by other models.

It is clear based on this preceding summary that the conduct of stress tests, regardless of the methodology chosen, requires a great deal of data to adequately examine the various risks identified for a given financial system. Quite a bit of work has already been done on the methodologies that may be employed to conduct stress tests of the financial system (see Blaschke et. al. (2001) and Sorge (2004) for good surveys of existing methodologies). There is, however, a dearth of work related to the data itself. Often what prevents a country from including stress tests within their surveillance tools or, if included, prevents a comprehensive stress test with useful results, is some form of data constraint. For example, the information needed may not be collected, there are inconsistencies or there are concerns regarding the accuracy of the data. Countries are often forced to compromise when it comes to data and this can have a negative impact on the results. For those countries now introducing stress tests to their supervision operations, there is limited advice available on how to work around the data constraints. The main goals of this study are to address some of the data problems encountered when conducting a stress test as well as suggest some possible solutions.

Following this introduction, section 2 of the paper outlines the minimum data requirements of stress testing. Its seven sub-sections provide discussions of the most common macroeconomic shocks considered as well as the various risks commonly analysed when conducting stress tests (namely, interest rate, exchange rate, country, credit, interbank and liquidity risks). Each sub-section offers a brief description of the methodology used, the resulting data requirements and constraints and the solutions suggested (wherever possible). Section 3 uses the example of the country of Barbados to show how some of the common data deficiencies were surmounted. The final section concludes by offering suggestions on the direction of future work in the area.

2. Minimum data requirements

2.1 Macroeconomic Shocks

Before delving into the specifics, there is information that forms the basis of stress testing, regardless of methodology, without which the entire process becomes next to impossible: (1) macroeconomic data, and; (2) commercial bank financial statement data. In terms of the macroeconomic data, the minimum the approach requires are estimates of aggregate nominal or real GDP. Depending on the methodology to be employed, the explanatory variables to be stressed and the level of preciseness required for the exercise, information could also be collected on the following commonly used variables:

- National Accounts data by economic sector
- National Accounts by expenditure
- Inflation
- Nominal exchange Rates
- International reserves
- Unemployment
- Current account balance
- Nominal interest rates
- Foreign direct investment
- Money supply

The impact of these shocks should be transferred onto the financial statements of the institutions included in the stress test exercise. As such, the analyst would also need to

collect financial statement data for the financial system; the level of disaggregation needed would once again depend on the risks to be analysed. As a guide, the minimum data from the financial statements should include:

- Economic Capital
- Capital Adequacy Ratio
- Net Income

The remainder of this paper assumes that at least either the economic capital, capital adequacy ratio or net income figure is available, as any one of these could form the basis of evaluating the impact of the shock on the viability of the financial institution. The preference is to use either a capital adequacy ratio or economic capital because there are international guidelines set forth by the Bank for International Settlements, and this allows for comparison across countries.

2.2 Interest Rate Risk

Once the basic information requirements have been fulfilled, the main goal of stress testing is assess the impact of various risks on the financial system. One of the most fundamental risks to be assessed is interest rate risk. Stress testing for interest rate risk attempts to determine the impact on financial stability of a change in interest rates through the consequent effect on interest income/expenses as well as the interest sensitive components of the balance sheets of financial institutions. Blaschke et. al. (1988) explains that interest rate risk develops as a result of other risks, namely repricing risk, yield curve risk, basis risk and options risk. As indicated in Čiják (2007), interest rate risk can be sub-divided into direct and indirect impacts, with direct interest risk occurring when a change in rates results in a mismatch of interest rate sensitive assets and liabilities (mainly the risks identified in Blaschke et al (1988)) and indirect risk referring to the impact of the change in rates on the creditworthiness of borrowers and their ability to repay. Given this aim, information must therefore be available on interest rate sensitive assets and liabilities within either individual portfolios or on aggregate basis as well as fairly detailed information on the clients of the financial institutions.

In order to address direct risk, a number of frameworks exist ranging from Excel spreadsheets (see Čiják (2007)) to econometric models (see Sorge, 2004). Nonetheless, the following information, at a minimum, should be collected from the reporting institutions:

- interest rate sensitive assets, broken down into maturity buckets determined by time to maturity (including loans, long- and short-term fixed income assets, interest bearing deposits owned by the institution, etc.);
- interest rate sensitive liabilities, broken down into maturity buckets determined by time to maturity (including outstanding loan obligations, long- and short-term fixed income obligations, interest bearing deposits liabilities, etc.), and;
- the settlement date, maturity date, coupon, yield, frequency of coupon payment of each fixed-income asset held by reporting institutions in order to determine the average duration of the fixed income assets.

To successfully investigate indirect risk, econometric models would probably be necessary to do justice to the exercise (see Basu et. al 2006) and further information would need to be sought on:

- credit ratings for corporate borrowers (Standard & Poors, Moodys and other rating agencies as well as reporting financial institutions);
- default rates for loan customers, broken down into useful categories (reporting financial institutions);

- historical data on nonperforming loans (reporting financial institutions);
- income growth rates (national labour organisations, trade unions, etc.);
- measures of indebtedness (national surveys, consumer advocacy institutions, etc.);
- degree of collateralisation of loans (reporting financial institutions), and;
- real interest rates.

2.3 Exchange Rate and Country Risk

Exchange rate risk is defined by Papaioannou (2006) as *"the possible direct loss (as a result of unhedged exposure) or indirect loss in the firm's cash flows, assets and liabilities, net profit and, in turn, its stock market value from an exchange rate move"*. The definition offered by Blaschke et al (1988) differentiates between direct and indirect impact of exchange rate risk – a direct impact would result from the institution holding a position in a foreign currency whereas an indirect impact would result from the effect on the creditworthiness of the institution's borrowers or counter-parties – and explains that institutions could also be impacted if they hold local currency assets that are indexed to foreign exchange rates.

The data requirements for exchange rate measurement are summarised below:

- For each currency
  - all asset items, including accrued interest, denominated in the currency in question
  - all liability items, including accrued interest, denominated in the currency in question
  - all amounts to be received under forward exchange transactions, including futures and the principal on currency swaps not included above
  - all amounts to be paid under forward exchange transactions, including futures and the principal on currency swaps not included above
  - guarantees (and similar instruments) that are certain to be called and are likely to be irrecoverable
  - all other items representing a profit or loss in foreign currencies
- Exchange rates for each currency

Country risk is tied to exchange rate risk and is often not tested separately to exchange rate risk. Nonetheless, it is worth noting because some countries issue debt in a currency other than their national currency. An institution holding this debt on their books, therefore, becomes exposed to both the risk associated with the country issuing the debt as well as the risk emanating from the currency in which the debt is denominated.

2.4 Credit Risk

Credit risk is perhaps the most studied form of financial risk and a number of methodologies have developed to measure an institution's exposure. Credit risk can be considered as the risk of default of the financial institutions' debtors. An important distinction must be made between expected and unexpected losses when measuring credit risk, as expected losses (which are uncertain but occur on average) are covered by provisioning arrangements within the institution and unexpected losses (which occur with unknown frequency) are not. The main concern when stress testing, therefore, is the extent of the credit risk stemming from unexpected losses and some frameworks (such as Čiják (2007)) consider evaluating the

provisioning arrangements for expected losses as creating the foundation for the remainder of the analysis.

Assessing credit risk varies from country to country with the changing characteristics of the financial system. Accordingly, the data requirements would be broader with highly developed financial markets than with less developed markets. The variables listed below do not attempt to address every possible scenario; rather, they represent only those variables likely to be necessary even in the more underdeveloped financial systems.

- Non-performing loans, preferably by sector
- Performing loans, preferably by sector
- Values for top 5 (minimum) large exposures

2.5 Contagion Risk

Contagion risk refers to "the risk that an initial (bank) failure may spill over to the rest of the (banking) industry and cause further (bank) failures" (see Schoenmaker). A number of studies have been dedicated to measuring the extent of contagion risk in the banking sector. Chan-Lau et al (2007) attempted to determine the likelihood of a large shock to one major bank causing stress to another large bank using a binomial LOGIT model. They first established the extent of an individual bank's default/solvency risk and then calculated percentage changes in this risk. Banks with corresponding changes were interpreted as being interdependent and this measure was assumed to have incorporated all potential channels of contagion. This methodology avoids the need to explicitly identify the various interbank links and channels of contagion.

Other methods, however, are more data intensive, such as that proposed by Degryse and Nguyen (2007), where they tested contagion risk using a $(N \times (N + M))$ matrix of interbank bilateral exposures, X. Čiják (2007) also relies on quite granular data on interbank exposures in order to simulate the likely impact of the failure of one institution. The information needed for these types of studies include:

- Interbank exposures, by bank
- Interbank exposures, by instrument

2.6 Liquidity Risk

According to the Bank for International Settlements, "liquidity is ability of a bank to fund increases in assets and meet obligations as they come due, without incurring unacceptable losses".[2] Given this definition, liquidity risk is the risk of not meeting obligations as they come due without incurring unacceptable losses. From the point of view of an institution conducting its own internal investigation into liquidity risk, all of the necessary information on obligations as well as expected increases in asset categories would be available. From a supervisory perspective, however, much of this detail is absent and would be time consuming to collect and analyse on a frequent basis. As such, examiners often have to rely on the institution to adequately account for liquidity risk, based on authority-determined definitions of liquid assets. Assumptions are then made in order to deal with the varying methodologies that may be employed by different institutions. It is difficult to streamline these definitions across countries given the varying market structures; however, the International Monetary Fund

[2] *Principles for Sound Liquidity Risk,* Basel Committee on Banking Supervision, BIS.

(IMF) considers liquid instruments as those that can be sold at, or close to, full market value on short notice.[3] The information that should be collected would therefore depend on the national definition of liquid assets/liabilities, but at a minimum would include:

- Cash
- Treasury bills
- Transferable deposits

3. A case study of Barbados

3.1 Introduction

Barbados is a small island economy in the Caribbean of about 274,000 inhabitants. It is an open economy and therefore is fully exposed to the risks tied to international developments. In addition, its membership of the CARICOM Single Market and Economy (CSME) exposes the country to the risks common in high levels of regional integration. The existence of both international and regional financial institutions in the country's financial sector also adds another level of global exposure. As with many countries in the world, the Barbadian financial sector is heavily bank-based, with commercial banks accounting for 66 percent (2006) of total financial system assets. In addition to the commercial banks, there are merchant banks, trust and finance companies, mortgage finance companies, credit unions, pension funds, insurance companies, asset management companies and a stock exchange. The activities of these institutions are monitored by four regulatory bodies: the Central Bank of Barbados (commercial banks, merchant banks, trust and finance companies and mortgage finance companies), the Department of Cooperatives (credit unions), the Supervisor of Insurance (insurance companies and pension funds), and, the Securities Commission of Barbados (the stock exchange and associated brokerage firms).

The country of Barbados was chosen as the case study for a number of reasons. Firstly, it is one of the highest ranked developing countries in the world (as per the Human Development Index of the UNDP) and, as such, is dealing with some of the financial problems faced in advanced economies while still hampered by the institutional framework of many developing countries. In the opinion of the author, this offers a good example of what the average developing country is facing, or could face in the near future, in their financial systems. Secondly, it is a small open economy and is therefore exposed to international financial developments with limited scope to impact global developments. Stress testing such an economy requires a slightly different approach than commonly found in the existing literature and often calls for additional data that may not be incorporated in the stress tests of advanced economies. Thirdly, as part of a common market with goals of a monetary union – the CARICOM Single Market and Economy (CSME) – it is part of a regional integration movement similar to that of the European Union and this presents its own set of challenges, especially with respect to the financial sector. Fourthly, the country is currently involved in an effort to improve its monetary and financial statistics, with the assistance of the International Monetary Fund, and the findings thus far may be of use to other countries.

As part of its surveillance of the financial systems, the CBB conducts stress tests in conjunction with the IMF and World Bank during the Financial Sector Assessment Programmes (FSAP) conducted by these international financial institutions. For the last FSAP (in 2008), two different stress tests frameworks were utilised by the CBB: (1) a macro

[3] *Monetary and Financial Statistics Manual,* International Monetary Fund.

framework using the top-down approach, and; (2) a more micro stress test using an adaptation of the framework developed by Martin Čiják. The *macro* framework is linked to the CBB's financial programming model and so is dependent on the forecasts in the financial programming model. This obviously allows for a consistent view of the future of the economy as a whole, with the stress test model operating like a satellite model; but it also presented some challenges because it becomes dependent on the forecasts. The *micro* framework has the advantage that it could be linked to the financial programming model, but it could also stand alone and still present solid results.

While the first framework was used by the CBB in previous FSAP missions, the second framework was tested internally for the first time in 2008 and its results compared with the first methodology to check for robustness. Both methodologies called for some of the same data but the *"micro"* framework had additional data requirements. Although the more information available the more all-encompassing the results are likely to be, regardless of framework, a trade-off must be made between accuracy and computational difficulty and this balance must be borne in mind by countries when designing their data collection process. For the purpose of this paper, more attention will be paid to the micro framework given that it had the greater data requirements.

3.2 Description of stress test framework

3.2.1 Introduction

The framework chosen is adapted from Čiják (2007) and is built in Microsoft Excel.

This basic analysis was augmented using a technique formalised in Worrell (2008). For each macroeconomic shock, the variable was stressed until the system failed to ascertain how long or how much stress it would take before systemic failure. This is a useful exercise because it permits policymakers a further gauge of the resilience of the financial system as well as contributing to the development of early warning systems.

The Barbadian banking sector has six banks, none of which are domestically owned. For three of the institutions, there was no useful estimate of capital, with the largest bank (measured by total assets) included. Given that the results of stress tests tend to be expressed in terms of their impact on capital, the absence of this information for half of the institutions and more than half of the assets of the banking sector presented a significant challenge. In order to surmount this problem and still arrive at useful results, the results of the stress tests were expressed in terms of their impact on the return on assets of the institutions and as a percentage of nominal GDP. In this way, the macroeconomic as well as profitability impacts of the various vulnerabilities could be easily identified, communicated and understood. It, still however, does not allow for an assessment of whether the stress was sufficient to cause the bank to fail. Therefore, comparisons were made to times in the past when similar levels of loss or bank failures were experienced to give an idea of the severity of the stress.

3.2.2 Interest rate risk

The tests for interest rate risk incorporated maturity gap analysis, net interest income impact and repricing impact of various changes in the level of nominal interest rates. It required information on:

Interest rate sensitive assets, broken down by time to maturity

The existing data collection forms utilised by the CBB only requested a breakdown of loans by time to maturity. A breakdown of the other interest rate sensitive assets by time to maturity was not available from the reporting institutions. The maturity dates of government securities, however, were available from the department of the CBB that deals with

government debt (this information could also be sourced directly from government either through statistical digests or a direct request). Other interest rate sensitive assets were not available by time to maturity so, in order to be as conservative as possible, these assets were originally assumed to fall into the most liquid category. This gave an unrealistically pessimistic view of the interest rate risk of the banks, given the proportion of these assets to total assets, and so adjustments were made following discussions with bank examiners to give a more realistic approximation.

Interest rate sensitive liabilities, broken down by time to maturity

The existing data collection forms utilised by the CBB requested a breakdown of deposits by original maturity and this was used as a proxy for deposits by time to maturity. A breakdown of the other interest rate sensitive liabilities by time to maturity was not available from the reporting institutions. Therefore, in order to be as conservative as possible, these assets were assumed to fall into the most liquid category. Similar to the treatment of similar missing asset data, discussions were held with the Bank Supervision Department and adjustments were made to give a more realistic approximation.

The settlement date, maturity date, coupon, yield and frequency of coupon payment of each fixed-income asset held by reporting institutions

As corporate bonds are rare in the Barbadian financial system, the data focused on government paper as it represented the vast majority of fixed income assets of the banks (based on conversations with commercial banks). As such, the information was sourced from the department within the CBB that deals with government debt but this information could also have been sourced directly from either government or the financial institutions included in the sample. The settlement date, maturity date, coupon, yield and frequency of coupon payment were collected for each fixed income asset and each bank. Based on this data, the duration was calculated for each instrument, and then averaged for each bank.

3.2.3 Credit risk

The tests for credit risk incorporated tests for underprovisioning, broad-based increases in non-performing loans, sectoral shocks to non-performing loans and default of large exposures. It required information on:

Performing loans (pass loans and special mention loans) and non-performing loans (substandard loans, doubtful loans and loss loans)

This data was already being collected by the CBB.

Provisioning rates for each category of loan

This data was already being collected by the CBB.

Sectoral distribution of total loans (eg agriculture, tourism, manufacturing etc.)

This data was already being collected by the CBB.

Sectoral distribution of non-performing loans (eg agriculture, tourism, manufacturing etc.)

A framework to collect this data had been distributed to the reporting institutions, but data had not yet been received from all of the institutions.[4] However, information had been

[4] The CBB requested reporting institutions to submit this information from the beginning of their financial year. This date varied from one institution to another.

received from two institutions up to the time of conducting the stress test and was included. The information for the remaining four institutions was estimated based on the figure submitted for total non-performing loans and discussions with the bank examiners.

Values of top five large exposures

This data was already being collected by the CBB.

3.2.4 Liquidity Risk

The tests for liquidity risk incorporated tests for a liquidity run on all banks and a flight to safety test. It required information on:

Total deposits, divided into demand (demand and savings deposits) and time deposits

This data was already being collected by the CBB.

Total liquid assets

In the case of Barbados, the CBB currently defines commercial banks' liquid assets as cash, assets due from the CBB, assets due from other local banks and government treasury bills. All of this information was already being collected by the CBB. A framework to collect more precise data on liquid assets (ie all assets with a maturity of less than 12 months) is being designed within the CBB and would provide a more accurate estimate of liquid assets.

3.2.5 Exchange Rate Risk

The tests for exchange rate risk incorporated tests for both direct and indirect exchange rate risk. It required information on:

Total foreign currency denominated assets, by currency

The CBB only collected information on assets by country. This was used as a proxy for assets by currency since most of the assets by country are denominated in the currency of the country. A framework has been developed to collect both a country as well as a currency breakdown given that there are some assets that are denominated in a currency other than the national currency of the country.

Total foreign currency denominated liabilities, by currency

The CBB collected information on total foreign currency deposits. Given the fixed exchange rate regime of the country – the Barbados dollar is pegged 2:1 to the US dollar – the vast majority of foreign currency deposits are held in US dollars. Therefore, all foreign currency deposits were assumed to be held in US dollars as a breakdown was not available. Information on total liabilities by country was available and this was used as a proxy for liabilities by currency since most of the liabilities are denominated in the currency of the country. Similar to foreign assets, a framework has been developed to collect both a country as well as a currency breakdown given that there are some liabilities that are denominated in a currency other than the national currency of the country.

Foreign Currency Loans

This data was already being collected by the CBB.

3.2.6 Contagion Risk

The tests for contagion risk incorporated tests for pure contagion risk (this would result from selected institutions failing to meet their interbank obligations) and macro contagion risk

(which would result from the negative impact of a macroeconomic shock). It required information on:

Interbank borrowing and lending by creditor and debtor

This data was already being collected by the CBB.

4. Conclusion

The data requirements of stress testing are one of the main hindrances for many countries when trying to assess the vulnerabilities within their financial systems. This paper attempted to outline the main variables for which data needed to be collected in order to measure the most commonly analysed risks. In addition, it gave examples of how some data constraints could be surmounted using Barbados as a case study. Further work, however, needs to be done in the area of coming up with proxies for missing data, especially financial statement data, as the implementation of new data collection forms is a complicated process that often takes more time than is available. In addition, measurement of equity and commodity price risks should be incorporated into future work.

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