Journal of Financial Stability 8 (2012) 174–192

Contents lists available at SciVerse ScienceDirect

Journal of Financial Stability

journal homepage: www.elsevier.com/locate/jfstabil

Macro stress testing of credit risk focused on the tails☆

Ricardo Schechtman[a,*], Wagner Piazza Gaglianone[a,b]

[a] Research Department, Central Bank of Brazil, Brazil
[b] Fucape Business School, Brazil

ARTICLE INFO

Article history:
Received 1 April 2010
Received in revised form
28 September 2011
Accepted 4 October 2011
Available online 4 November 2011

JEL classification:
C14
C15
E32
G28

Keywords:
Macro stress test
Credit risk
Financial system
Quantile regression

ABSTRACT

This paper investigates macro stress testing of system-wide credit risk with special focus on the tails of the credit risk distributions conditional on adverse macroeconomic scenarios. These tails determine the ex-post solvency probabilities derived from the scenarios. This paper estimates the macro-credit risk link by the traditional Wilson (1997a,b) model as well as by an alternative proposed quantile regression (QR) method (Koenker and Xiao, 2002), in which the relative importance of the macro variables can vary along the credit risk distribution, conceptually incorporating uncertainty in default correlations. Stress-testing exercises on the Brazilian household sector at the one-quarter horizon indicate that unemployment rate distress produces the most harmful effect, whereas distressed inflation and distressed interest rate show higher impacts at longer periods. Determining which of the two stress-testing approaches perceives the scenarios more severely depends on the type of comparison employed. The QR approach is revealed more conservative based on a suggested comparison of vertical distances between the tails of the conditional and unconditional credit risk cumulative distributions.

1. Introduction

Macro stress testing of the credit risk of banking book exposures has attracted an increasing interest from market participants in the last years due to three main reasons. First, the Basel II capital accord (Basel Committee on Banking Supervision, 2006), more specifically the internal models approach contained therein, has led commercial banks and supervisors to focus attention on credit risk stress-testing exercises as a way to further test the reliability of internal models derived capital measures. Furthermore, commercial banks are likely to use stress testing of their banking exposures for a variety of other purposes, including economic capital management, planning of contingent measures and risk transfer transactions. Second, the increasing role of financial stability as a policy goal of central banks has promoted increasing interest in system-wide exercises of credit risk macro stress testing, often using data aggregated at a higher level than the analysis performed in commercial banks. Cihák (2007) and Foglia (2009) discuss and review general methodologies for implementing stress tests in financial systems. Such tests may help central banks evaluate existing capital adequacy of commercial banks and foresee the consequences of unexpected macro shocks to the stability of the banking system. This paper focuses on this system-wide version of credit risk stress testing. Third and finally, the outbreak of the recent financial turmoil, coupled with lack of more warning signals raised before the crisis, has, if anything, reinforced the two previous points and stimulated further research on the theme and its limitations (e.g. Alfaro and Drehmann, 2009). As a response to the crisis, regulation has once more devoted new attention to the area of stress testing (e.g. Basel Committee on Banking Supervision, 2009).

☆ This paper is an extended and improved version of the Working Paper no. 241 of the Central Bank of Brazil (available at http://www.bcb.gov.br/pec/wps/ingl/wps241.pdf). The views expressed herein are those of the authors and do not necessarily reflect those of the Central Bank of Brazil. We would like to thank two anonymous reviewers, the editor (Iftekhar Hasan) and participants of the Basel Committee's RTF workshop on models and tools for macro-prudential supervision (October, 2010), of the 2010 CREDIT conference (September 2010), of the BCB conference "The Financial Crisis of 2008, Credit Markets and Effects on Developed and Emerging Economies" (August, 2010), of the BIS conference on systemic risk, bank behaviour and regulation over the business cycle (March, 2010), of the XXXI Brazilian Econometric Society Meeting (December, 2009) and of the Central Bank of Brazil research seminars, for all comments and suggestions. We are also grateful to Sergio Firpo, Jonathan Jones, Thomas Kick, Sergio Koyama, Paul Kupiec, Luiz Renato Lima, Simone Manganelli, Mirco Rubin and Boris Vujcic for helpful comments and conversations, and Tito Nícias for providing his reconstructed series of the unemployment rate. Any remaining errors are ours.

* Corresponding author at: Av. Presidente Vargas, 730, 14th floor, Centro, 20071-900, Rio de Janeiro, Brazil. Tel.: +55 21 21895384; fax: +55 21 21895092.
E-mail addresses: ricardo.schechtman@bcb.gov.br (R. Schechtman), wagner.gaglianone@bcb.gov.br (W.P. Gaglianone).

1572-3089/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.jfs.2011.10.003

While the relation between the macroeconomy and the volume of credit is relatively well studied, e.g. the credit channels of monetary policy (Bernanke and Gertler, 1995), the economic theory is still incipient to explain the link between macro variables and credit risk. In the absence of well-established theoretical models to explain the macro-credit risk link, the majority of macro stress-testing approaches currently in use by central banks or supervisory agencies are non-structural.[1] One reduced-form approach widely employed in the applied literature is Wilson (1997a,b). This paper discusses and estimates Wilson model and uses it to perform macro stress testing of the credit risk of the Brazilian household sector. Wilson model, originally conceived basically as a credit risk portfolio model, has the interesting built-in feature that macroeconomic surprises affect the macro-credit risk relationship, which is maybe a reason for its popularity in stress-testing applications. On the other hand, Sorge and Virolainen (2006) perform a critical review of stress-testing methodologies, including approaches of Wilson type, pointing to the potential instability of reduced-form parameter estimates, due to the break-down in historical patterns derived from extreme shocks (e.g. in default correlations). That motivates us to also consider an alternative model for the macro-credit risk link that incorporates stochastic macro sensitivity of the credit risk indicator. In estimating and applying these models on a system level, this paper situates itself amid a recent but fast growing literature on credit risk stress-testing applications by central banks and supervisory agencies (e.g. Kalirai and Scheicher, 2002; Boss, 2003; Lehman and Manz, 2006; van den End et al., 2006; Jiménez and Mencía, 2007; Breuer et al., 2009; Simons and Rolwes, 2009; Vazquez et al., in press).

The basic idea behind macro stress testing of credit risk is to relate a macro scenario or shock to measures of financial loss or risk indicators. In a probabilistic stress-testing exercise, an entire distribution conditional on the macro scenario is generated. This paper proposes examining the right tail of the conditional distribution to gauge the impact of the macro scenario. In light of the recent financial turmoil, many authors have reminded that, once crises emerge, we should expect the unexpected (Alfaro and Drehmann, 2009). Besides the warning embedded, such notice, if literally interpreted, could also suggest the focus of the stress-testing analysis be shifted from the usual conditional mean to the conditional tail. The conditional right tail represents what worse may still happen to the credit risk outcome in light of an assumed harmful macro scenario and is the relevant part of the distribution for determining the *ex-post* solvency probability of the system derived from the scenario. This conditional tail focus is not without precedents in the applied financial risk literature. Adrian and Brunnermeier (2008), for example, propose a risk measure, named *covar*, that is similar to the risk concept used in this paper but conceived there for the analysis of systemic risk. The conditional tail focus in stress-testing exercises could be further motivated based on the presumption that credit risk conditional right tails are more robust to deviations from historical patterns than the remaining parts of the conditional distribution, precisely because the former are likely to have been generated under those deviations.

Consistently with the conditional tail focus, our alternative approach of stress testing, is based on a quantile regression (QR) model for the macro-credit risk link (Koenker and Xiao, 2002). Contrary to Wilson model, that, although generating the whole credit risk distribution is still a model focused on the conditional mean, the quantile regression explicitly models the tail of the conditional distribution. Further, the QR approach has a feature that is appealing to stress testing: the relative importance of the macro variables changes according to the quantile of credit risk distribution, therefore partly addressing the criticism of Sorge and Virolainen (2006) about the potential instability of reduced-form parameters. In particular, macros that have small relative effect on the median of the distribution may gain relevance in explaining a high quantile of the credit risk indicator. Also, as a semi-parametric model, QR relaxes a normality central assumption used in Wilson model. Non-normality is more realistic for stress-testing exercises.[2]

The preference for using a particular stress-testing approach is usually subjectively grounded. Given the typically long credit risk horizon (months or years), few data is usually available to conduct statistically meaningful back-testing exercises of credit risk models. That point is further aggravated in the stress-testing context, because the macro data that would be more relevant for back-testing here corresponds to macro crises, which are rare by definition. Consequently, the policy maker is likely to work with a set of stress-testing approaches, rather than a single tool, and analyze their results at its own judgment. A discussion on how to analyze these several results and how to compare different approaches should then be of great interest but is largely absent in the applied literature.[3] Thus, besides the proposed QR macro-credit risk link, this paper contributes to the stress-testing literature by proposing a novel measure for the analysis and comparison of stress-testing results, namely, the vertical distance between the tails of the unconditional and the distressed conditional credit risk cumulative distributions. It has the interesting interpretation as the change in solvency probability due to the occurrence of the distressed scenario and is investigated in the paper through the use of pp-plots.

A final note about macro scenarios is due: stress-testing exercises usually take them as given. The construction of severe, yet plausible, and economically consistent macro scenarios is an important preliminary step for stress-testing tasks, but is not within the main interest of this paper.[4] We use a rather simple econometric model to build our macro scenarios, that are plugged in both Wilson and QR models in the same fashion. In many central banks, the macro scenario is built by means of a macroeconomic model (e.g. DSGE model) that projects distressed macro variables given more fundamental shocks (e.g. oil price shocks).[5] Therefore, given the simple nature of our scenarios, the results of this paper should not be interpreted in an absolute way but rather illustrative of the stress-testing approaches employed.

This paper is organized as follows. Section 2.1 discusses the properties and the estimation of Wilson and QR models for the macro-credit risk link. Section 2.2 explains the use of the estimated link models to perform stress testing and discusses how to analyze stress-testing results. Section 3 introduces the macro and credit data used in the estimations. Section 4.1 estimates and interprets different specifications of the macro-credit risk link for the Brazilian household sector, while Section 4.2 presents and analyzes the results of the stress-testing exercises. Section 5 concludes.

[1] An exception is represented by de Bandt et al. (2008), who work with a more structural approach in trying to distinguish explicitly between demand and supply in the corporate debt market in the euro area.

[2] Though not explored in this article, QR approach also lends itself to reverse engineering techniques, in which the set of macro variables that produce specific quantiles of the conditional distribution can be easily recovered.

[3] Here, comparison of approaches refers to comparison of their outputs in the form of credit risk distributions.

[4] On this issue, see for example Breuer et al. (2009).

[5] Most of these macroeconomic models have, however, no representation of a financial sector or of financial risk, so that the transmission of macro distress to the system credit risk remains carried out in the same fashion as here, through a reduced-form macro-credit risk link (e.g. Wilson).