Joint effect of financial fragility and macroeconomic shocks on bank loan losses: Evidence from Europe

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Abstract

A reduced-form model including nonlinearities is estimated from pooled data from nine European countries during 1982–2004 to show the effects of macroeconomic shocks and financial fragility on bank loan losses. The main ingredients of the model are unanticipated-output and interest-rate shocks estimated from published macroeconomic and naïve forecasts. The model fits the data well, capturing the extremely high levels of loan losses witnessed in different financial crises.

1. Introduction

The swift and sizable downsizing of the real economy in the aftermath of the recent global financial crisis has given rise to massive loan losses for banks and a deterioration of the bank balance sheets in many countries. The underlying macroeconomic account set forth in this paper is that loan losses seem essentially to be generated by strong adverse aggregate shocks under high exposure of banks to such shocks—just as witnessed in the recent crisis.

Large GDP forecast errors well demonstrate such a deep adverse macroeconomic surprise or shock. For example, the IMF World Economic Outlook forecast for world output was revised downwards in just 3 months, from January to April 2009, by 1.8% points. In the case of Finland, OECD forecasters in June 2008 predicted 2.3% real GDP growth in 2009, only to see Finnish GDP actually shrink by 8% that year.

The severity of such adverse growth shocks on corporate defaults, and thus on credit losses, appears to have been exacerbated by the increased financial fragility of the corporate sector, which saw its aggregate indebtedness soar in pre-crisis years. The ratio of corporate sector debt to operating profits in Europe, for example, increased from 316% in 2000 to 406% in 2007. The fragility of the European household sector also increased with the debt/income ratio rising from 95% to 112% between 2000 and 2007.¹

This paper considers empirical macroeconomic modelling of bank credit risk, giving special attention to the effects of extreme surprise events that arguably characterize also the latest crisis. The empirical model developed here builds on two ideas: (1) the joint effect on loan losses from aggregate indebtedness (a measure of fragility) and macroeconomic shocks, and (2) the use of macroeconomic forecasts as proxies for expectations in the construction of surprise variables, where the unexpected shock is the implied forecasting error, i.e., the difference between realized and expected outcome.

We propose an econometric specification that allows testing for the statistical and economic significance of the joint effect of indebtedness and macroeconomic shocks on bank loan losses. The panel data on loan losses at the banking-sector level have been provided by nine European central banks specifically for this study. Our central question is whether bank loan losses are enhanced by an increase in financial fragility (measured by higher aggregate indebtedness) in the face of macroeconomic shocks. In our regression specification, a cross-product term (macroeconomic shock * financial fragility) represents the joint effect of financial fragility and macroeconomic shocks on bank loan losses. The effect of a macroeconomic shock on loan losses is non-linear in a specific

¹ IMF (2009), Statistical Appendix Table 9.
way; the marginal effect of such a shock on bank loan losses depends positively on fragility (indebtedness) so that the impact of an adverse shock is amplified by high fragility. We focus on two obvious and commonly used sources of macroeconomic shocks: stochastic, unpredictable changes in GDP and interest rates.2

Our motivation for using the joint non-linear effects of shocks and fragility is that they together capture the stylized fact of fat tails in the distribution of aggregate number of defaults, and hence loan losses. Moreover, this approach comports with Merton’s (1974) assessment of credit risk dynamics and derived portfolio models of credit risk (e.g., CreditMetrics, 2007). Drawing on such models, we see our macroeconomic shock variables as representative of common factors driving aggregate (portfolio) credit losses and our fragility variable as representative of aggregate (average portfolio) credit quality.

While the theoretical notion that fragility and shocks join affect bank loan losses in a predominantly non-linear way is widely accepted, there is strikingly little empirical research that tests this notion’s statistical or economic significance.

The body of empirical studies can be broken down into three groups. The first group provides stylized numerical examples. Gersbach and Lipponer (2003), for example, apply hypothetical Monte-Carlo simulation to situations where firms differ with respect to initial default probabilities and asset value correlations. They demonstrate that a rise in the interest rate increases not only the likelihood of single defaults but also the correlation of defaults.

Their conclusion is that interest rates have a non-linear effect on defaults. In contrast, Gray et al. (2007) construct a stylized numerical example where non-linearities emerge as the crisis progresses in a system of interlinked industrial sectors. Here, the authors use contingent claims analysis based on option-pricing theory. For example, a firm’s risky debt, linked through a bank loan in combination with the bank’s own borrowing against its assets, makes the bank’s debt a function of the implicit put option on that firm. They conclude that the compound nature of such an implicit put option creates the potential for highly non-linear risk transmission.

A second group of relevant studies consists of empirical estimates that point to the non-linear relationship between the dependent variable (representing outcomes of credit risk) and the explanatory variables. Drehmann (2005), for example, simulates industry-specific default probabilities in a Mertonian framework where firm asset values in various scenarios are determined by selected macroeconomic and market factors such as GDP, interest rates and exchange rates. Estimating an APT-type relationship between assets and explanatory factors, Drehmann finds that systematic factors have a non-linear and non-symmetric impact on credit risk and that highly adverse scenarios have the greatest tendency to raise the probability of default. Pesaran et al. (2006) combine a GVAR model with a corporate loan portfolio in a small sample of public firms. The Monte Carlo-simulations indicate that the non-linearity built into the credit risk model generates asymmetric and non-proportional impacts of shocks on credit risk. This is consistent also with Marcucci and Quagliariello (2009), who estimate an asymmetric effect of business cycle on credit risk by employing a threshold model. This effect is more pronounced during downturns.

Finally, those estimated models that assume a non-linear functional form (often a logit transformation) come closest to our study. Van den End et al. (2006) propose a reduced-form macro model in which a logit-transformed loan-loss provision ratio is a function of GDP and interest rate variables. This modelling feature gives their model its non-linear nature. Other notable examples include Sorge and Virolainen (2006) and Jakubic and Schmieder (2008). Both studies use logistic functional forms to model the dependence of default rates on a few macro variables. The estimated coefficients of the selected macro variables (such as GDP, interest rate and indebtedness) are statistically significant in both studies. Sorge and Virolainen’s simulation results for the Finnish industrial sector clearly display skewed loss distributions due, among other things, to positive default correlations generated by the joint sensitivity to macro factors.

With regard to modelling of macroeconomic shock or surprise variables, our approach departs from earlier studies that identify shocks as deviations from trend or mere (time series) changes. Bikker and Metzemakers (2005) use GDP growth in their loan loss provision studies. Sorge and Virolainen (2006) proxy GDP shocks as deviations from GDP trend in their bankruptcy model. Both approaches, in our view, suffer from a potential weakness concerning construction of the appropriate trend. Drehmann (2005) perhaps comes closest to our chosen approach. He generates innovations in GDP and inflation by regressing each differentiated series on its own two lags, i.e., by fitting separate AR(2) processes to each of the two macro variables. This approach produces expected values as forecasts from the corresponding estimated AR(2) models. He further assumes interest rate surprises are well proxied by changes in interest rates. The underlying motivation is that changes in financial market prices should not be serially correlated and future changes are thus unpredictable.

Loan losses display strong persistency. Indeed, this might indicate a feedback effect from loan losses to macroeconomic activity. For example, De Graeve et al. (2008) and Blank and Dovern (2010) claim to find evidence of feedback or second-round effects when applying a combined micro–macro framework with an integrated multi-equation model.1 In this paper it is nevertheless possible only indirectly to try to deduct evidence of the potential feedback effect.

Data on annual aggregate banking sector loan losses in net terms have been provided for this study by the central banks of Belgium, Denmark, Finland, Germany, Greece, Norway, Spain, Sweden and the United Kingdom. The sample data cover the period from the early 1980s to 2004, and include many banking crises that arose in these countries, notably in the Nordic region.4

A big difference between our dependent variable (realized loan losses or write-offs) and the widely used concepts of both loan-loss provisions and nonperforming loans is that realized loan losses are actual events, while the two alternatives are accounting concepts.5 The timing and amount of loan-loss provisions or nonperforming loans of necessity involve subject judgement. Such subjective features do not weigh heavily in realized net loan losses. This brings us, arguably, closer to the concept of loss-given default (LGD).6

Anticipating our estimation results, we expect that high customer indebtedness, combined with adverse macroeconomic shocks to income and real interest rates, will boost loan losses and distress in the banking sector. The non-linear effects embedded in our estimated model seem to be able to account particularly well for the extremely large loan losses in crisis periods.

Our estimated model with interaction terms outperforms a corresponding purely linear model. Moreover, these results suggest that our macroeconomic shock variable construct (expectations

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1 Ramirez (2009) shows that bank failures can have adverse effects on long-run growth.


3 Bikker and Metzemakers (2005) claim accounting practices and goals influence the provisioning.

4 While a common assumption is a fixed recovery rate, Bastos (2010) finds empirical evidence that recovery rates move cyclically, which further justifies using realized net loan losses as the dependent variable.
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