International Journal of Forecasting 28 (2012) 145–160

Contents lists available at SciVerse ScienceDirect

International Journal of Forecasting

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

Forecasting and explaining aggregate consumer credit delinquency behaviour

Jonathan Crook *, John Banasik

Credit Research Centre, The University of Edinburgh Business School, 29 Buccleuch Place, Edinburgh EH8 9JS, United Kingdom

ARTICLE INFO

Keywords:
Finance
Co-integration
ARIMA models
Error correction models
Time series
Unit roots

ABSTRACT

We model aggregate delinquency behaviour for consumer credit (including credit card loans and other consumer loans) and for residential real estate loans using data up until 2008. We test for cointegrating relationships and then estimate short run error correction models. We find evidence to support the portfolio explanations of declines in credit quality for consumer and for real estate loans, but support for the reduced stigma explanation was restricted to real estate loans. Evidence supportive of household-level explanations of irrational borrowing and unexpected net income shocks was found for consumer and real estate loans, but evidence of strategic default was restricted to the volume of consumer loans and real estate loans, and not for credit cards. We also found that the error correction model gave forecasts of the volume of delinquent consumer debt which were of an accuracy comparable to that of an ARIMA model.

1. Introduction

The recent rise in consumer loan defaults and mortgage defaults in the US and Europe has emphasised the significance of accurate credit risk modelling and the interdependence between the banking sector and the real economy. The recent crisis had many causes, but one of them was the increase in default rates of sub-prime mortgage loans in the US. A contributing factor of this was the rapid extension of loans to high risk borrowers whose ability to repay was highly dependent on the state of the macroeconomy. When house price inflation began to fall and interest rates, fuel prices and eventually unemployment increased, many of these borrowers defaulted (Arner, 2009; Crouhy, Jarrow, & Turnbull, 2008). Although this considerable increase in default rates has occurred only since 2006, there are good reasons for believing that the state of the macroeconomy has more long run effects on the proportion of borrowers that default in any one year.

It is important for lenders to be able to explain and predict the aggregate consumer delinquency over time. An increase in the total consumer delinquency, *ceteris paribus*, may increase the need to raise interest rate margins to compensate for the increased risk, and also in order to retain sufficient liquidity. A significant increase in delinquencies may cause lenders with low capital adequacy ratios to become insolvent, causing widespread failures by contagion. The Basel II Accord (BIS, 2006) allows banks to determine their own capital requirements by using their own models to forecast future probabilities of default. These probabilities must be 'through the cycle' (probabilities that do not vary with the business cycle), and a common method of obtaining these is to use a technique that involves modelling default rates in terms of macroeconomic variables (see Heitfield, 2005).

In this paper, we model aggregate consumer default rates in the US over a twenty year period, including the period of their recent escalation. We do this for consumer loans and mortgages separately. We use a cointegration technique to explain the long run relationships between

* Corresponding author. Tel.: +44 131 650 3802; fax: +44 131 650 8337.
E-mail address: j.crook@ed.ac.uk (J. Crook).

0169-2070/$ – see front matter
doi:10.1016/j.ijforecast.2010.12.002

default rates and the macroeconomy, and model changes in the default rates in terms of deviations from the long run relationship and short-run changes in the macroeconomy. We also compare the predictive performances of these models with the performances of ARIMA models, in order to see which methodology gives more accurate forecasts using the especially challenging task of forecasting recent events. We find evidence to support the existence of long run 'equilibrium' relationships between the level of interest rates and the level of debt outstanding on the one hand and aggregate default rates on the other, but, surprisingly, not between the level of house prices and the level of default rates. However, we *do* find that *changes* in house prices have a significant effect on *changes* in default rates, as do changes in disposable income, unemployment, consumer confidence, and interest rates. We also find that the two forecasting methodologies both give highly accurate forecasts of default rates, and are about equally accurate. Had these models been available in mid-2008, the subsequent increases in default rates could have been forecast accurately. We make two contributions. First, we offer a model of aggregate consumer default rates for the US using cointegration techniques, and thus separate long run 'equilibrium' relationships from short run dynamic relationships. Second, we compare the forecasting performances of this econometric technique and ARIMA. To the best of our knowledge, this has not been done before.

The next section of the paper reviews the related literature, and we subsequently explain our model. In view of the especially high interest in mortgage defaults, we present our results for these sectors in separate sections. The final section concludes.

2. Related studies

The literature suggests that there are essentially three reasons why a borrower defaults on a loan. First, a borrower may manage his/her finances poorly, due to hyperbolic discounting, leading to a preference for 'irrational' immediate expenditure (Laibson, Repetto, & Tobacman, 2003). Second, there is an 'ability to pay' hypothesis, namely that a borrower will fail to pay on time when an income or expenditure shock occurs that was not expected at the time when the loan was taken out. The causes of such shocks include unexpected job loss, marital breakdown, family bereavement, health problems, increases in interest payments on loans, and so on. Third, there is the 'strategic default hypothesis', where, when a loan is used to buy a real asset (such as a house), and if the capital market is perfect, with no transaction costs or reputation effects, a borrower would increase his wealth if he defaulted on a loan when the value of it was greater than the value of the asset (Kau, Keenan, & Kim, 1993, 1994).[1] When considering aggregate default rates over time in the United States specifically, several explanations have been advanced. Observing the increase in credit card delinquency rates between 1994 and 1997, Gross and Souleles (2002) propose two explanations. First, that the proportion of borrowers that were high risk has increased, and these are the borrowers who have defaulted. Second, that borrowers 'have become more willing to default', given their risk characteristics, because the social stigma of default and the associated loss of a future credit supply have declined.

Previous empirical studies that have related the delinquency of credit card debt and mortgages to macroeconomic variables have used either duration models or time series models. We start with duration models for credit cards. All three such studies of which we are aware have estimated *account* level duration models using macroeconomic variables as time varying covariates. Gross and Souleles (2002) used a panel of over 200,000 credit card borrowers. Surprisingly, they found that none of the unemployment rate in the county of residence, the per capita income or house prices in the region was significantly related to delinquency, and, together with measures of borrower risk, they could only explain a small proportion of the changes in delinquency rates over time. The residual was tentatively ascribed to the trend of reduced stigma. However, FCIC data suggests that if the period under consideration is extended to between 1992 and 2006, the delinquency rate on credit card debt was trended downwards, if anything, and the same was true of the total consumer debt. Agarwal and Liu (2003) also used panel data for credit card holders for 1995–2001, and found that the probability of a credit card holder missing three consecutive payments in a particular period, given the card holder's predicted level of risk, was increased if the lagged unemployment rate in the county or state of residence was higher, but that the actual change in the unemployment rate had no effect. The account balance three months earlier also had a positive effect on the hazard rate. Bellotti and Crook (2009) estimated a proportional hazards model for a sample of credit cards issued by a UK bank between 1997 and 2001, and found that the base interest rate, real earnings, production and house prices all had a significant effect on the hazard rate.

Turning to account level panel models of duration for mortgage debt delinquency, Lambrecht et al. (1997) used a survival model applied to 5272 borrowers in the UK and found evidence which was more in favour of the ability to pay argument than of the strategic default hypothesis. However, none of the variables which they included varied over time. Deng, Quigley, and Van Order (2000) estimated a competing risks model of prepayment and default, for mortgages granted between 1976 and 1983, to investigate

[1] More realistically, if transaction costs do exist and default does reduce the chance of a borrower gaining future loans, the option to default will not be exercised until the debt is somewhat greater than the asset value, since defaulting removes the option of either defaulting or repaying in the future (Kau et al., 1994). Lambrecht, Perraudin, and Satchell (1997) point out that the costs of default are higher for some than for others. For example, those for whom access to debt is particularly important will experience a higher cost if defaulting reduces the chance of borrowing in the future. According to the permanent income hypothesis, these are individuals who expect their income to rise in the future (Deaton, 1992). Note also that, unlike a Chapter 7 bankruptcy declaration in the United States, a default in some countries, such as the UK, does not prevent creditors from pursuing the debtor for repayment. In such countries, this latter point removes the reason for strategic default.