Journal of Empirical Finance 42 (2017) 66–89

Contents lists available at ScienceDirect

Journal of Empirical Finance

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

Heterogeneous effect of the global financial crisis and the Great East Japan Earthquake on costs of Japanese banks

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ARTICLE INFO

JEL:
G21
C61
C44

Keywords:
Financial crisis
Banking
Economies of scale
Quantile regressions

ABSTRACT

The effect of financial and economic ctarises depends on bank technology, which includes risk attitude and business model. The paper focuses on Japanese banking and examines how technology distinctions determined impact of the 2007–2009 global financial crisis and the economic recession that followed the Great East Japan Earthquake of 2011. Assuming that different types of technology correspond to different cost quantiles, we use panel data quantile regressions to establish a link between efficiency, economies of scale/scope and the effects of the two crises. The analysis reveals technological heterogeneity and shows that the impact of profitability, non-traditional activities and non-performing loans in the two crises differs between high-cost and low-cost banks. Finally, we contrast the business models and risk-taking behavior of Japanese and European banks.

1. Introduction

The way, in which financial and economic crises impact the banking sectors of a country, depends to a large extent on the capital structure, risk-taking behavior and business practices of its banks (Caprio and Honohan, 2014). A choice-theoretic structural approach, which treats a bank as a firm and assigns it a certain optimization problem, interprets these factors as major components of banking technology (Hughes and Mester, 2014). Differences in technology, linked to differences in risk and risk management, have determined how the EU banks respond to financial crises (Bertay et al., 2013; Koutsomanoli-Filippaki and Mamatzakis, 2011). Overall, the assessment of technological heterogeneity is essential for diversified regulation to support viability of the banking sector.

This paper focuses on Japan, where the financial system is mediated to very great extent by banks: banks hold a large share of the country's finances and bank deposits constitute almost half of household assets (Uchida and Udell, 2014). Banks are important intermediaries for enterprise financing and play a decisive role in cushioning economic shocks in Japan (Hoshi and Yasuda, 2015; Yamori et al., 2013). Until now assessment of the sustainability of Japanese banks in crises, the impact of consolidation and bank risk has been carried out using standardized or case-by-case approaches. For instance, government decisions on capital injections to banks during the global financial crisis were based on broadly stated profitability targets and the contents of stock underwriting, with careful examination of each application by the (Endo, 2013). We believe that considerations of technological heterogeneity would offer helpful additional guidance for policy measures.

Such heterogeneity, which has been formally shown for banks in the EU (Koutsomanoli-Filippaki and Mamatzakis, 2011; Behr, 2010), is likely to impact production of banks in Japan. Indeed, mean estimates point to a link between weak balance sheets and loans of Japanese banks (Hosono and Miyakawa, 2014), which indicates that managerial performance (determined by technology) is associated with bank outputs. Risk exposure of Japanese banks is related to growth of deposits, and lending supply is a nonlinear function of bank capital (Nishiyama et al., 2006; Tsuru, 2003). Finally, there are established relations between the total factor

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http://dx.doi.org/10.1016/j.jempfin.2017.02.002
Received 10 July 2016; Received in revised form 7 December 2016; Accepted 25 February 2017
Available online 28 February 2017

productivity or overall financial conditions of banks and investment outcomes in Japan (Miayakawa et al., 2011; Hosono and Masuda, 2005). Despite this, numerous analyses of banking costs in Japan focus on the mean estimates.[1]

We assume that different types of technology correspond to different cost quantiles, i.e bank technology has consequences for the ability to minimize costs (Koutsomanoli-Filippaki and Mamatzakis, 2011). The analysis exploits a conditional quantile regression approach, which does not extrapolate the mean tendency to the tails of the distribution and thereby avoids bias (Hendricks and Koenker, 1992; Koenker and Bassett, 1978). Overall, quantile regressions provide more robust estimates than the classic approaches, which model optimal technology with non-parametric or parametric frontier methods (Bernini et al., 2004).[2] Moreover, linear quantile regressions have a property of equivalence to any monotonically increasing transformation, which is a useful feature for estimating log-linearized functions and inefficiency residuals.[3] Statistically different values of the coefficients for banking variables and annual effects, obtained in regressions for low-cost and high-cost quantiles, would indicate heterogeneous impact of the crises for different levels of banking technologies (Koenker, 2005).

The contribution of this paper is threefold. The paper is an application of a quantile regression approach for measuring longitudinal costs and efficiency in banking and, in particular, in the Japanese banking industry. Secondly, we link the 2007–2009 global financial crisis and the 2011 Great East Japan Earthquake with banking costs, focusing on the significance of bank and macro economic variables, as well as the time period corresponding to each of the crises, across various quantiles of the cost function. Finally, using a second-stage sensitivity analysis, the paper ties bank risk and heterogeneity to the cost function. For this purpose, we examine the association between cost inefficiency, economies of scale/scope for different quantiles and a range of risk variables.

The novelty of our findings is the establishment of technological heterogeneity in Japanese banking: results of the statistical tests show that there is a more efficient production path (low-cost quantiles) and a less efficient production path (high-cost quantiles). The technology distinction is particularly reflected in different relationships between costs, on the one hand, and, on the other hand, bank business model (proxied by number of branches and index of product diversity), risk-taking behavior (for instance, equity capital), and regional environment (loans in gross regional product). Business growth from scale economies has a different relationship to profitability, credit risk (liquidity or loan loss provisions) and business model (e.g. proxied by the securities-to-assets ratio) at banks in each technological group (See a qualitative summary of our findings in Table A1 in the Appendices). Technological heterogeneity may explain the different effects of the global financial crisis and the post-earthquake economic recession, which we find at high-cost and low-cost Japanese banks. For instance, profitability (measured by net interest margin) played a bigger role in supporting business growth during the financial crisis and the post-earthquake recession at high-cost banks than at low-cost banks.

The technological heterogeneity may be linked to managerial opportunities for cost-efficient production and quality of capital (Beccalli et al., 2015; Hosono and Miyakawa, 2014). Technology differences may also be associated with the "skimming hypothesis", when cost efficiency is achieved through less stringent loan monitoring and fewer resources, spent on credit underwriting (Koutsomanoli-Filippaki and Mamatzakis, 2011). The phenomenon was observed during the global financial crisis in Japan, when banks granted loans to small- and medium-sized enterprises.

In contrast with U.S. and European banks, we find that in Japan higher return-on-equity is related to higher cost inefficiencies. Arguably, Japanese banks play a social role in the economy and have a more conservative business model, which is crucial for depositor sentiments. Therefore, the traditional banking model helped to overcome the global financial crisis in Japan (Kamikawa, 2013).

Our study builds upon three streams in the preceding literature. Firstly, we exploit measures of economies of scale and scope under multi-product technology, developed by Panzar and Willig (1977). We use duality conditions of Shephard (1970) and cost functions with risk-taking behavior, proposed by Hughes et al. (1996); Hughes and Mester (1998, 2013) and recently applied by Beccalli et al. (2015). Secondly, we follow the approaches in productivity analysis, given the special features of Japanese banking. Thirdly, there is enormous research on classic parametric and non-parametric efficiency measurement in banking, inspired by Farrell (1957);[4] as well as a gradually developing methodology of quantile regressions, which provides for an ordered set of technological relationships and is increasingly used in banking (Mamatzakis et al., 2012; Koutsomanoli-Filippaki and Mamatzakis, 2011; Behr, 2010; Koenker, 2004).

To the best of our knowledge, applications of quantile regressions in banking are limited to simulation analysis and cross-section estimates (Behr, 2010). Our contribution consists in using the (Canay, 2011) fixed effects panel data model and modifying the (Parente and Santos Silva, 2016) approach for clustered standard errors in the longitudinal data with quantile regressions. It should be noted that some literature incorporates quantile regression approaches into estimation of parametric and nonparametric efficiency (Koutsomanoli-Filippaki and Mamatzakis, 2011; Wheelock and Wilson, 2009; Aragon et al., 2005; Cazals et al., 2002). However, exploiting quantile regressions in such analyses does not eliminate limitations of the parametric/nonparametric methods.

The remainder of the paper is organized as follows. Section 2 outlines the structure of the Japanese banking system and describes how the global financial crises and the post-earthquake economic recession played out in Japan. Section 3 specifies quantile regressions and the cost function. The data and variables are given in Section 4. Section 5 discusses the estimates across quantiles. Conclusions are summarized in the light of international comparison and policy issues in Section 6.

[1] See review of specifications and outline of estimates in Tables C1–C2 the Appendices.

[2] Nonparametric methods rely on linear optimization techniques to construct a hull of observations (Charnes et al., 1978) and, therefore, regard the observations on the constructed frontier as fully efficient, do not account for measurement error, are sensitive to outliers and require large sample size for estimations. An alternative parametric method, that of stochastic frontier analysis, imposes distributional or other assumptions on the error term (Aigner et al., 1977). See the debate in the *Journal of Econometrics* 1980: 13(1).

[3] In this paper we exploit the fact that $Q_\tau(\ln y|x) = \ln(Q_\tau(y|x))$.

[4] See reviews in Paradi and Zhu (2013), Paradi et al. (2011), Thanassoulis et al. (2008) and Greene (2008).