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Real estate market and financial stability in US metropolitan areas: A dynamic model with spatial effects[☆]

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This paper investigates spatio-temporal variations in ex-post credit risk in the United States, as a function of real estate prices, loan purchases made by government sponsored enterprises, and a set of local characteristics during the recent housing boom and bust.

We model bank's non-performing loans as a first-order dynamic panel data regression model with group-specific effects and spatial autoregressive errors. To estimate this model, we develop an ad-hoc generalized method of moments procedure which consists of augmenting moments proposed by the panel literature to estimate short *T*, pure dynamic panels, with a set of quadratic conditions in the disturbances. Results on estimation of the empirical model point at the negative impact of real estate prices on non-performing loans. Further, our results show that a rise in the number of real estate mortgages backed by government-sponsored enterprises increases non-performing loans, thus deteriorating the quality of banks' loan portfolio.

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1. Introduction

Since the second half of 2007, the United States experienced a severe financial crisis that spread to the financial sector of European and Asian economies and triggered a deep, worldwide, recession. The US housing market and its interaction with the financial system have been pointed as the main cause of such crisis, through the build-up of a bubble in real estate markets that eventually collapsed.

Housing booms and busts are often associated with systemic financial stress (Herring and Wachter, 1999; Reinhart and Rogoff, 2008). Among others, Reinhart and Rogoff (2008) show that six major historical episodes of banking crises in advanced economies, since mid-1970, were associated with housing-bust. The authors also report that this pattern was found in many emerging countries including the devastating Asian financial crisis of 1997–1998. A number of studies on the recent housing boom in the United States emphasise the link between a decrease in lending standards and a sharp expansion in loan delinquency in the prime and subprime mortgage market (see, for example Dell'Ariccia and Marquez, 2006; Mayer et al., 2009). The rapid boom in house prices experienced over the period 1997–2005, accompanied by a reduction in lending standards, led to the point that many people were able to purchase properties they couldn't afford otherwise. Over these years, an important component of the mortgage credit was in the form of subprime lending targeted to borrowers providing little or no down payment, with questionable and troubled credit histories, and minimal income requirement for loan origination. Mortgages with balloon payments, variable interest rates, and/or interest-only periods, were often sold on the presumption that individuals could refinance their mortgages at later stages. Further, individual mortgages were put into pools of assets out of which the so-called mortgage backed securities were created and sold both within the US and abroad. When house prices began to fall below the nominal value of loans, both speculative buyers and owner-occupiers that were unable to repay their mortgages could not roll them or sell their properties and, as a consequence, started to default. Public opinion has also pointed at the involvement of government-sponsored enterprises (GSEs) Fannie Mae and Freddie Mac[1] in the subprime mortgage market as bearing

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[1] In the United States, the most common securitization trusts are Fannie Mae and Freddie Mac, US government-sponsored enterprises. Ginnie Mae, a US government-sponsored enterprise backed by the full faith and credit of the US government, guarantees its investors receive timely payments, but buys limited numbers of mortgage notes. Other private institutions also securitize mortgages. These are known as "private-label" mortgage securities.

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responsibility for the financial crisis. These agencies set affordable housing goals in order to support mortgages to low-income borrowers and other high-risk groups, in specific neighbourhoods and geographic areas, by purchasing and securitising mortgages in the form of mortgage-backed securities. For several years, these GSEs have provided safe and stable means of lending to buyers who did not have access to prime credit. However, in the more recent years, with the growth of private-label securitization, we assist to a deterioration in mortgage underwriting standards of GSEs and excessive risk taking, to compete with private-label securitization for market share. This has resulted in the oversupply of underpriced housing finance that led, in 2006, to an increasing number of borrowers, often with poor credit, who were unable to pay their mortgages, ultimately causing a rapid increase in home foreclosures (Bolotnyy, 2012).

In this paper we investigate spatio-temporal variations in ex-post credit risk as a function of real estate prices, GSE loan purchases, and a set of local, socio-economic characteristics in the United States. We take non-performing loans (NPLs) as proxy for ex-post credit risk. As a proxy for real estate prices we focus on house prices of residential properties, using data from the Federal Housing Finance Agency on loan purchases made by the GSEs Fannie Mae and Freddie Mac. We explore the impact of house prices on NPLs across US metropolitan areas, both in the period of housing boom, in the years 2000 to 2005, and during the house-price bubble bursting, over the years 2006 to 2011. Dividing the sample period into two subsets is also justified by the structural break in house prices observed towards the end of the first sub-period.

Economic theory has formulated a number of hypotheses to explain the relationship between financial stability and real estate prices. Some authors suggest that increases in house prices reduce the risk of real estate financing perceived by banks, thus inducing excessive lending to risky real estate borrowers (Dell'Ariccia and Marquez, 2006). In addition, rising house prices may encourage the riskiest investors to bet on further price increases, leading to a rise in the demand of credit. These factors work in the same direction and tend to increase the bank exposure to risky assets, thus suggesting a positive relationship between NPLs and real estate prices, as increasing bank loans also increase ex-post credit risk. Other theories instead predict a negative relation. For example, the collateral value hypothesis asserts that, in a period of rising house prices, the value of the collateral increases thus improving borrowers' financial position, which in turn reduces the associated risk of default (Koetter and Poghosyan, 2010). During the bursting of the bubble, theoretical models also suggest that, when house prices start to fall below the nominal value of loans, both speculative buyers and owner-occupiers that are unwilling or unable to repay their mortgages, find it difficult to roll over their loans or sell their properties. As a consequence, default rates increase and we expect a negative relationship between NPLs and real estate prices.

In our empirical application, we also wish to investigate how loan purchases made by the GSEs Fannie Mae and Freddie Mac affect NPLs, both before and during the house-price bubble bursting. These agencies had more than 40% of total US mortgage debt outstanding on their balance sheets at the height of the housing bubble, and experienced a financial collapse along with the rest of the market. Understanding the size of impact of GSEs' loan purchases on NPLs is of great interest for institutional investors, and policy makers wishing to regulate the housing market.

Previous studies on the determinants of NPLs use data either at country- or at bank-level. However, data at country-level do not allow to capture the heterogeneity within an economy. For example, there is a wide range of variation in the structure and performance of the housing market across the US territory in terms of housing values exposure to subprime loans, foreclosure rates as well as demographic and economic factors. It is likely that these variations in housing market are reflected in the quality of bank loan portfolios. Hence, differently from previous works, in this paper we consider as statistical unit the Metropolitan Statistical Area (MSA). A MSA is a geographical region in the US with a relatively high population density at its core, and close economic ties throughout the area. Given that this unit of aggregation is the target of many policy interventions, exploring the impact of real estate prices and other local characteristics on credit risk at MSA level is of great interest.

Following existing literature, we adopt a dynamic specification for NPLs and focus on a first-order dynamic panel data regression model. We condition on a set of macroeconomic indicators, such as personal income and unemployment, that are well known to influence borrowers' balance sheet and their debt servicing capacity. However, we observe that other socio-economic factors may also affect NPLs, such as the degree of urbanization, deprivation and crime, which are notoriously difficult to quantify and are well known to be geographically concentrated. Accordingly, in our empirical model we allow errors to be spatially correlated and assume that they follow a spatial autoregressive process. Ignoring spatial dependence, when this is present in the data, leads to inefficient estimates, which may cause wrong inferences. The availability of reliable models is very important for all market participants, including institutional investors, those who regulate housing, GSEs, mortgage lenders, and related financial institutions. In our regression specification, we also incorporate MSA-specific effects, and control for MSA-specific heteroskedasticity, to allow for heterogeneity in the characteristics of borrowers across different MSAs.

To estimate this model, we develop an ad-hoc generalized method of moments (GMM) procedure which consists of augmenting moments proposed by the panel literature to estimate pure dynamic panels, with a set of quadratic conditions in the disturbances. Recent years have witnessed an emerging interest towards the use of GMM for estimating regression models with spatially correlated disturbances. The proposed model is in line with the framework advanced by Mutl (2006). However, the work in Mutl (2006) relays on the restrictive assumption of homoskedastic group-specific effects and idiosyncratic errors, which does not apply to our empirical study. For example, it is likely that the conditional variance of ex-post credit risk varies with characteristics such as house prices, or income. From a computational point of view, our proposed approach is also simpler and more parsimonious as it requires a smaller set of parameters to be estimated. This method is a general procedure that can be used in many other areas of economics such as labour economics, health economics or macroeconomics to name few, where the variable of interest is characterised by both spatial and temporal patterns. We test the small sample properties of our GMM estimator by the means of a small Monte Carlo exercise, presented in Appendix A.

In the following, Section 2 briefly reviews the literature on the determinants of NPLs. Section 3 sets out the framework of a regression model with spatially correlated disturbances, while Section 4 introduces the GMM estimator. Sections 5 and 6 describe the data and empirical results, respectively. Finally, Section 7 concludes.

2. Review of related literature

A number of studies examine the relationship between the real estate market and bank exposures. Hilbers et al. (2001) use probit and logit models to estimate the likelihood of a financial crisis conditional on country characteristics and the real residential property price index, for 11 countries. The authors find that a downturn in residential property prices increases the probability of financial sector distress. Koetter and Poghosyan (2010) test two competing views of the relation between nominal estate prices and bank distress: the *collateral value* and the *deviation* hypotheses. The former suggests a negative relation because increasing house prices rises the market value of collateral on outstanding real estate loans, thus enhancing the financial positions of bank customers (Kiyotaki and Moore, 1997). The deviation theory conjectures that soaring house prices can lead to the accumulation of risks by banks due to moral hazard and adverse selection problems, inducing

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