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By *Dimitris K. Chronopoulos, Hong Liu, Fiona J. McMillan and John O.S. Wilson*

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Abstract

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1. Introduction

The intensity of competition in the banking industry has implications for the level of entrepreneurial activity, access to finance, the allocation of capital funds, the competitiveness and development of manufacturing and service sectors, the level of economic growth and the extent of financial stability. In cases where competition is limited or absent, interventionist policies are often required to increase rivalry and ensure imperfections in the competitive process are reduced.

Structural and conduct deregulation and prudential regulation along with technological and financial innovation as well as changes in the economic environment have transformed the banking industry. In the US, geographic and product market regulations historically constrained the activity of commercial banks. Over the past two decades, however, financial deregulation (which aimed to increase competition) eased several previous constraints. For example, the McFadden Act of 1927, which prohibited interstate branch banking, was repealed by the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994; while the Glass-Steagall Act of 1933, which prohibited commercial banks from transacting other financial services including investment banking and insurance, was repealed by the Gramm-Leach-Bliley Financial Services Modernization Act of 1999. This series of deregulatory steps reduced or eliminated barriers to entry in many markets. New strategic opportunities for enhanced profitability were created for established banks, which many realized by geographic and product diversification. The net effect of such changes on competition and the profitability of incumbent banks remains unclear.

This paper seeks to examine the evolution of US bank profitability pre- and post- the introduction of the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA Act) and the Gramm-Leach-Bliley Financial Services Modernization Act (GLB Act) . We utilize econometric models to assess the extent to which entry and exit are sufficiently free to

eliminate any abnormal profit quickly so that all bank profit rates tend to converge towards a long-run average value. The alternative is that some incumbent banks have the capability to prevent imitation, or retard or block entry. If so, abnormal profit tends to persist from year to year, and differences in bank-level long-run average profit rates may be sustained indefinitely. The degree of first-order serial correlation in profit data provides an indication of the speed at which competition causes above- or below-average profits in one year to converge subsequently towards long-run equilibrium values.

The present study augments the literature on the determinants of bank profitability (most of which is static in nature) by using a system Generalised Methods of Moments (GMM) estimator with Windmeijer-corrected standard errors (to address endogeneity issues that arise when modelling profit in a dynamic setting). Furthermore, and in contrast to previous studies, we allow for time-varying persistence of profit.

We utilise a sample of over 17,500 commercial banks over the period 1984-2010 to assess the determinants of bank profits using a model which includes a profit persistence parameter (which captures competitive pressure) and various other bank and industry-specific covariates. Indicator variables that capture the enactment of key regulatory events and the recent financial crisis are also included. This allows comparisons of profit persistence to be drawn between the period before the changes in regulation (which took place in the 1990s) and after, and the impact of the recent financial crisis.

The principal findings are as follows. The competitive process reduces positions of abnormal profitability, albeit this is not immediate. In other words there is evidence of short run profit persistence in US banking. Changes in regulation enacted during the 1990s affect both the level and persistence of bank profitability. Specifically, the passage of the Riegle-Neal Interstate Banking and Branching Efficiency Act (which eliminated federal restrictions on interstate banking) resulted in reduced profits persistence and bank profit levels, while the

Gramm-Leach-Bliley Financial Services Modernization Act (which allowed banks to diversify across business segments) increased profits persistence and profit levels. The financial crisis of 2007 to 2010 appears to also have resulted in an increase in the persistence of bank profitability, which could be the result of a number of ad-hoc policy interventions (such as taxpayer funded bailouts of large failing banks) that appeared to prioritize stability over competition during the crisis period.

Bank size is found to have a non-linear relationship with profitability, while banks with higher level of asset growth, lower equity, more relaxed lending standards, higher liquidity, and less diversified income streams and asset portfolios tend to have higher profitability. Finally we find strong evidence that profits are pro-cyclical and tend to increase during phases of economic growth and deteriorate during periods of slow growth.

The rest of the paper is organized as follows. Section 2 describes recent changes in the US banking industry. In Section 3 we review relevant literature on the determinants and persistence of bank profitability. Section 4 describes the empirical model. Section 5 presents the data and reports the empirical findings**.** Finally, Section 6 concludes.

2. Developments in US banking

The US banking industry experienced an enormous transformation over the course of the last few decades, as extensive regulations implemented during the Great Depression era (in the 1930s) were subsequently removed. Both the Reigle-Neal Act and the Gramm-Leach-Bliley Financial Services Modernization Act of 1999 were instrumental in ratifying deregulation that began in the 1970s and spanned several decades. Both Acts also helped accelerate the adoption of new financial processes and information technologies by US banks (Barth et al., 2010). Following deregulation, the number of commercial banks halved as a result of thousands of mergers and acquisitions (M&A), while the largest banks experienced a

ten-fold increase in size, which ultimately resulted in an increase in industry concentration.[1] Evidence as to the extent to which this increased concentration impacted on competition paints a rather mixed picture. Jayaratne and Strahan (1998) argue that geographic deregulation created a more competitive environment by allowing banks to enter new markets and compete with incumbent banks. Dick (2006) documents a decline in bank spreads subsequent to geographic deregulation, suggestive of increased competition. More recently, Yildirim and Mohanty (2010) (relying on the assumption that the US banking market is in long-run equilibrium) find that geographic deregulation has very limited effect on the competitive conduct of banks at the state level. Evidence relating to the impact of the Gramm-Leach-Bliley Financial Services Modernization Act on US banks suggests that productivity and profitability were largely unchanged. Furthermore, diversified banks appear to have underperformed their more focused counterparts (Yeager et al, 2007).[2] Barth et al (2000), however, argue that the passage of the Gramm-Leach-Bliley Financial Services Modernization Act favours larger banks, which affords them increased market power, and reduces the level of bank competition.

Deregulation and technological change created new opportunities for growth. The banks that grew quickly became less like traditional banks, as they adopted high output, low cost business models that relied on scale economies, and used automated production and distribution processes to deliver standardized products and services. Smaller banks have also grown but continue to operate under traditional high unit cost and high value added business models that rely on soft information to deliver differentiated products to customers (DeYoung et al., 2004; DeYoung, 2010).

[1] Berger et al. (1995) document significant changes in the US industry from 1979 (prior to major deregulation of the early 1980s) to 1994 (prior to the effects of the Interstate Banking and Branching Efficiency Act of 1994, which permitted almost nationwide branch banking). DeYoung (2010) describes the recent evolution of the US banking industry.

[2] Market based studies suggest that banks did not benefit from the introduction of the GLB Act (Carow and Heron (2002) and Hendershott et al, (2002).

Consolidation during the 1980s and 1990s has also been accompanied by an increase in the portion of industry income generated from fees rather than interest (as larger banks generate a greater portion of their income from non-interest activities than smaller banks). DeYoung and Roland (2001) argue that the increase in non-interest income at US banks has fundamentally altered risk-return profiles.[3] Clark et al. (2007) emphasize how the increasingly fee-focused strategies of large US banking companies expose these banks to economic and business cycle volatility. Nevertheless, until mid-2007 there was a general consensus that the US banking system was sound and performing well, particularly because banks appeared to be holding historically high levels of capital and posting record levels of profitability. Costs of production were static (if not declining) and the increase in total revenues from traditional and non-traditional sources meant that by the mid-2000s, US bank profitability was buoyant (Carlson and Weinbach, 2007).

From 2007, problems in the US residential mortgage market led to increased number of foreclosures and defaults leading to the decline in the value of the securities backed by such assets and problems within the US banking industry (Gerardi et al., 2008). This culminated in a liquidity freeze in interbank markets and the subsequent credit crunch led to the financial crisis. The financial crisis led to large losses and failure and closure of many banks, and forced government agencies to intervene with measures designed to stabilize the financial system (Bech and Rice, 2009; Lee and Rose, 2010; Fleming, 2012). Such interventions prioritized stability over competition (Beck et al., 2010). All in all, poor monetary policies, misaligned incentives for investors, bank executives and credit rating agencies, poor disclosure, accounting rules, lax lending standards, loopholes in regulation and supervision, and fraud have all been cited as contributory factors to the financial crisis, and its subsequent negative impact on bank profitability (Brunnermeier, 2009; Keys et al., 2010).

[3] DeYoung and Rice (2004) find that marginal increases in non-interest income are associated with a worsening of banks' risk-return trade-off. Stiroh (2004a, 2004b) and Goddard et al. (2008) find no evidence of diversification gains at banks and credit unions that combine interest and non-interest earning activities.

3. Literature review

Competition encourages efficiency by allowing the most efficient firms to survive and prosper at the expense of their inefficient counterparts. Furthermore, competition is often seen as a spur to economic efficiency as firms pursue and adopt innovations in order to gain a competitive advantage. To this end, some economists have argued that competitive market structures will increase consumer choice and welfare, while monopoly tends to lead to the opposite. In banking, the level of competition has implications for access to finance, the allocation of capital funds, the competitiveness and development of manufacturing and service sectors, the level of economic growth and the extent of financial stability.

Early research on competition adopts a static approach to focus on market structure-performance linkages starting from the Structure-Conduct-Performance (SCP) paradigm and the Chicago Revisionist School (Gilbert 1984; Hannan, 1991; Berger and Hannan, 1998).[4] The former contested that a small number of banks may be able to collude either implicitly or explicitly, or use independent market power, to charge higher prices (lower rates paid on deposits, higher rates charged on loans) so as to earn abnormal profits. The latter contested that finding evidence of a positive relationship between concentration and profitability does not necessarily infer collusive behaviour as it may simply reflect the relationship between size and efficiency (larger banks gain from scale and other efficiency advantages so more concentrated markets are inherently more profitable). The extent to which banks are able to earn high profits through the exercise of individual or collective market power, or as a

[4] At a theoretical level the traditional Structure Conduct Performance (SCP) view of industrial organisation considers the industry as a single unit consisting of firms which are assumed to be alike in all respects except size. As an industry becomes more concentrated, firms find it easier to collude and erect barriers to entry to earn excess profits. All firms are expected to earn similar profits if market power is shared. This view of industrial organisation has provided the basis for numerous studies that have found a weak positive correlation between concentration and profits (Bain, 1951, 1956). Revisionists argue that efficient firms earn higher profits, so average profits are positively correlated with concentration levels, even though there is no collusion (Demsetz, 1973, 1974). A detailed review of these issues in mainstream industrial organisation can be found in Schmalensee (1988, 1989).

consequence of superior efficiency, has never been satisfactorily resolved (Goddard et al., 2007; Casu and Girardone, 2006; Dick and Hannan, 2010).[5]

Later research draws on contestable markets theory and its new empirical industrial organisation (NEIO) counterpart to emphasise the influence of potential as well as actual competition, and consequently focus on competitive conduct of firms in response to changes in demand and supply conditions.[6] Empirical banking research in this tradition has found differences in competitive conditions across banking sectors from the 1980s until the present day (Claessens and Laeven, 2004; Goddard and Wilson, 2009).

More recently, researchers have adopted an approach to assess the extent of competition via the dynamics of bank performance. This is motivated by Brozen's (1971) observation that while the relevant micro theory identifies equilibrium relationships between variables such as concentration and profitability, there is no certainty that any observed profit figure represents an equilibrium value. Following the work of Mueller (1977, 1986), this persistence of profit (POP) approach attempts to assess the extent to which entry, exit and governance mechanisms are efficient enough to drive banks' profit rates to converge toward a long-run average equilibrium value. In other words, the degree of serial correlation in profit data provides an indication of the intensity of competition in a contestable market as determined by (actual and potential) entry and exit conditions (Baumol 1982; Baumol et al., 1982). The alternative hypothesis is that barriers to competition exist which retard or block the entry of new banks. If so, abnormal profit tends to persist from year to year, and differences in bank-level long-run average profit rates may be sustained indefinitely.

The persistence of profits approach offers the benefits of a dynamic framework for assessing both the level and persistence of bank performance. Levonian (1993) utilises stock

[5] Studies that assess the determinants of bank profits at individual or cross–country level include Molyneux and Thorton (1992), Berger (1995a), Dermiguc-Kunt and Huizinga (1999), Mamatzakis and Remoundos (2003) Staikouras and Wood (2004), Athanasoglou et al. (2006), Micco et al. (2007), Pasiouras and Kosmidou (2007), Athanasoglou et al. (2008), Tregenna (2009) and Dietrich and Wanzenried (2011).
[6] Bresnahan (1989) provides a detailed discussion of these issues.

market and financial accounting data from a sample of large US banks over the period 1986-1991 to show that excess profits dissipate at a slow rate. Roland (1997) uses financial statements of US Bank Holding Companies (BHC) for the period 1986 to 1992 to assess the extent of profits persistence. Entry barriers result in a significant number of BHCs exhibiting negative abnormal profits. Berger et al. (2000) employ a non-parametric methodology in order to examine exogenous propagation mechanisms of profit persistence. Propagation mechanisms are identified as local market power, informational opacity and regional macroeconomic shocks. Results indicate that both local market power and informational opacity are correlated with profit persistence. Furthermore, bank performance is affected by macroeconomic shocks.

Cross country studies also find evidence of profits persistence in banking.[7] A recent example is Goddard et al. (2011) who report that the persistence of profit is weaker for banks in developing countries than for those in developed countries. In particular, they note that banks located in North America and Western Europe display a relatively high degree of persistence relative to counterparts located in East Asia. Furthermore, persistence is stronger when entry barriers are high and competition is low. Drawing on the insghts provided by previous literature, the remainder of this paper presents an analysis of the effects of regulatory change on both the level and persistence of bank profitability.

4. Methods

This section presents the estimable model used in this study, and provides a rationale for the covariates included. Our estimable model controls for the effects of bank-specific, industry-specific and macroeconomic factors on bank profitability.

The model is specified as:

[7] Other examples using datasets comprising banks located in various countries include Goddard et al. (2004a) and Flamini et al (2009).

$$\pi_{i,t} = \alpha_0 + \alpha_1 \cdot \pi_{i,t-1} + b \cdot IND_t + d \cdot \pi_{i,t-1} \cdot IND_t + q \cdot M_{t-1} + z \cdot X_{i,t-1} + \gamma_i + u_{i,t} \quad (1)$$
$$i = 1,...,N; t = 1,...,T.$$

Where $\pi_{i,t}$ is the profitability of bank *i* at time *t* measured by the return on assets (ROA), and expressed as deviation from the sample mean at time *t*. $\pi_{i,t-1}$ is the one-period lagged profitability. The vector of variables capturing the regulatory changes as well as the recent financial crisis is denoted by IND_t, M_t is a vector of industry- and economy-wide variables and $X_{i,t}$ is a vector of bank-specific regressors. γ_i captures the individual bank-specific effects and $u_{i,t}$ denotes the random error.

Equation (1) takes the form of a linear dynamic panel regression model. Such model includes the first lag of the dependent variable as the covariate and contains unobserved individual effects (either fixed or random). By construction, the individual effects are correlated with the lagged dependent variable, rendering the standard fixed effects or random effects estimators inconsistent. To address the endogeneity between the dependent variable and the lagged dependent variable, we fit model (1) to the data using the two-step system GMM estimator with Windmeijer-corrected standard errors. The system GMM estimator reduces potential biases in finite samples, and asymptotic imprecision associated with the difference estimator (Blundell and Bond, 1998).We also use one-year lags of all independent variables to mitigate any other potential endogeneity concerns between bank profitability and its determinant factors. Year dummies are included to capture the technology changes.[8]

[8] In order to conserve space, these year dummies are not reported in Tables 3, 4 and 5.

4.1. Regulatory and crisis covariates

Regulatory changes (discussed in Section 2) may have affected the competitive environment leading to changes in bank profitability. These changes are introduced into the model using indicator variables. We create a dummy variable, *IBBEA***,** equal to one for the period after the enactment of the Riegle-Neal Interstate Banking and Branching Efficiency Act in 1994, and zero otherwise. For the Gramm-Leach-Bliley Financial Services Modernization Act of 1999 we create *GLB*, a dummy variable which is equal to one after 1999 and zero otherwise.

We also investigate how the recent financial crisis and its aftermath affected bank profitability. To this end, *CC*, an indicator variable that takes a value of one for the years 2007 to 2010 and zero otherwise, is included in the estimable model.

The speed at which short-run excess profits are eliminated is also likely to be affected by changes in regulation and the recent financial crisis.[9] We introduce multiplicative interaction terms between the lagged profitability measure (ROA) and *IBBEA*, *GLB*, and *CC* in order to capture the impact of regulatory change and recent financial crisis on profit persistence.

4.2. Bank-specific covariates

We consider several bank-specific covariates that are likely to affect bank profitability. The log of total assets (*ln(Total Assets*)) is included to capture the effect of bank size on profitability. We might expect a positive or negative relationship between bank size and profitability. On the one hand, small banks charge a higher risk premium for extending credit to more risky customers. This is reflected by a higher interest-rate margin, which feeds through to higher revenues and profits. In contrast, Martinez-Peria and Mody (2004) argue

[9] In a related contribution, De Haan and Poghosyan (2012) using quarterly data for a large sample of US banks covering the period 2004 to 2009 find that larger banks have lower earnings volatility than their smaller counterparts, especially during the recent financial crisis.

that banks with higher market shares can charge higher rates on loans, thus boosting revenues and profitability. Large banks may also reap economies of scale and reduce costs, leading to higher profits. Consequently, we have no clear prior expectation as to the relationship between bank size and profitability. We also include a quadratic term of bank size to capture any non-linearity in this relation.

Following Short (1979), Bourke (1989), among others, we also control for bank growth in our model via the growth in total assets (*Asset growth*). The relation between bank growth and profitability is difficult to anticipate a priori. One might expect that a faster growing bank would be able to generate greater profits. However, if the growth in assets is realized through a lower loan quality, the relationship between growth and profitability is likely to be negative.[10] High growth rates may also attract new entrants and depress the profitability of incumbents.

The ratio of net charge offs to total loans (*Net charge off/Loans*) is included to capture the effects of credit risk on bank profitability. Periods of increased lending may result in an increase in net charge offs due to the relaxation of lending standards by bank managers responding to competitive and external governance pressures that arise as a result of short-term profit targets set by bank owners (Berger and Udell, 2004; Ruckes, 2004). While conventional wisdom suggests a positive relationship between *Net charge off/Loans* and profitability (higher charge offs reflects recognition of bad loans), a cleaned up better performing loan book in one year may lead to greater profits in the following year. Hence, we do not have a clear expectation of the relationship between *Net charge off/Loans* and profitability.

Non-interest earning activities have accounted for an increasingly larger proportion of banks' income in recent years (Stiroh, 2004a,b). *Income diversification* (defined as non-

[10] Evidence for banks located outside the US suggests there is a trade-off between growth and profitability (Goddard et al., 2004b).

interest income divided by total operating income), is included to capture any relationship between diversification and profitability. Previous evidence suggests that this shift towards non-interest income has not improved the risk-adjusted returns of banks because higher volatility in non-interest earning activities tend to offset the relatively stable returns to retail banking (DeYoung and Rice, 2004; Stiroh and Rumble, 2006; Laeven and Levine, 2007).

We introduce the ratio of loans to total asset (*Loans/Assets*) as a measure of liquidity and lending specialization. In the case of liquidity, we would expect banks with relatively high *Loans/Assets* to be more likely to incur losses if a 'fire-sale' of assets is required to meet liquidity needs.[11] While in the case of lending specialization, evidence suggests that a high loan to assets ratio can be interpreted as providing informational advantages, which may lower intermediation costs and improve profitability (Freixas, 2005). A priori we do not have clear expectation on the relationship between *Loans/Assets* and profitability.

Bank capital is measured by the equity-to-total assets ratio (*Equity/Assets*). The conventional view of risk-return trade-off implies a negative relationship between *Equity/Assets* and bank performance. On the other hand, banks with low capital ratios may endure high costs of insurance against bankruptcy. Berger (1995a) suggests there is a positive relation between the capital-assets ratio and bank performance. Overall, there is no clear relation between *Equity/Assets* and profitability.

In order to capture the mix of assets in bank portfolios we include a measure of loan portfolio concentration (*Loan HHI*). This is computed as the sum of the squared market shares of all loan categories in a bank's asset portfolio (Casu et al, 2013).

[11] Until very recently, little attention has been paid to the importance of bank liquidity and its implication for value. However, recent evidence suggests that the extent to which banks create liquidity differs by bank size, ownership structure and the extent to which they are focused on retail banking activities (Berger et al., 2005).

4.3. Industry structure and macro-economic variables

In view of the importance of concentration in empirical studies of competition, we use the Herfindahl–Hirschman index (HHI), computed at the national level, as a summary measure of industry structure. Evidence regarding the relationship between concentration and profitability is rather mixed and inconclusive (Gilbert, 1984; Berger, 1995b; Berger et al, 2004).

Finally, the growth of the economy (*GDP growth*) is also included in the regression to control for fluctuations in macroeconomic conditions. We expect a positive relationship between *GDP growth* and bank profitability as banks are likely to have more business opportunities during buoyant economic conditions (Albertazzi and Gambacorta, 2009).

5. Data and results

5.1. Data

The data comprises annual balance sheet and income statement data for all US banks over the period 1984 to 2010 collected from the Reports of Condition and Income (Call Reports).[12] Banks with total assets of less than $100,000 are excluded from the sample. These small banks are omitted from our analysis because they tend to be short-lived and exhibit very different business behaviour relative to other banks (DeYoung, 2003). In order to minimize the potential impact of outliers, banks with equity less than 1% of their total assets are excluded from the sample, and the dependent variable (ROA) is truncated at the 0.5^{th} and 99.5^{th} percentile. Following previous studies (for example, Graeve et al., 2007), we treat banks as separate entities prior to any merger event and as one bank thereafter.

Table 1 presents information on the number of banks included in the sample and summary statistics for the ROA by year. We observe that the number of commercial banks

[12] The starting year of 1984 is used as this is when there was a major overhaul to the Call Report format, which required banks to provide more detailed information. Starting in 1984 also provides us with the necessary data for the estimation of the Boone indicator (which we use as an alternative measure of competition in Section 5.3).

declines steadily over the last three decades, from 14,352 banks in 1984 to 6,458 in 2010 (owing primarily to M&A activity). Average profitability (ROA) increases gradually from 0.68% in 1984 to slightly above 1% in the mid-1990s. After the mid-1990s the value of the ROA largely plateaus. Finally ROA becomes negative in 2009 as the effects of the recent financial crisis impacts on bank balance sheets.

Table 2 provides descriptive statistics for all the variables included in our estimable model. The overall average ROE over the last three decades is 8.33%. US banks on average have a 9.76% equity to assets ratio, well above the required regulatory minima, while the loan quality is relatively high (net charge offs-to-total loans ratio is 0.73%). 9.34% of total operating income is from non-interest income business activities (Income diversification). On average asset growth was 9.51% per annum.

5.2. Results

This sub-section presents the results of our empirical analysis. We regress profitability on one-period lagged values of profit, a set of instruments (that capture the effects of regulatory change and the financial crisis) and a set of bank, industry and macroeconomic covariates.

Table 3 presents various specifications of Equation (1) using normalised ROA as the dependent variable. Specification 1 investigates the effects of the enactment of the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994 and the Gramm-Leach-Bliley Financial Services Modernization Act of 1999 on the level and persistence of profitability. In this specification, $\pi_{i,t-1}$ refers to profits persistence in the period prior to 1994. The sum of the $\pi_{i,t-1}$ parameter and its interaction with the *IBBEA* dummy refer to the persistence of profit in the period 1994 to 1998. Finally, the sum of the $\pi_{i,t-1}$ parameter and its interaction

with *IBBEA* and *GLB* dummies, respectively, represents profit persistence in the period post-1999.

The coefficient on $\pi_{i,t-1}$ is 0.619 and is found to be statistically significant at the 1% level. This is in line with the finding reported by Goddard et al. (2011) for US banking over the period 1997 to 2007. This level of persistence implies that until 1994 banks' abnormal profits were not instantaneously eliminated by the competitive process. As a consequence, banks were able to retain a significant portion of their profit from year to year. Profits persistence then declined following the passage of the 1994 Act, evidenced by the negative sign on the coefficient of the interaction between *IBBEA* and $\pi_{i,t-1}$. This indicates that the decision to remove the interstate banking restrictions led to greater competition in the US banking system. Finally, following 1999 and the repeal of the Glass-Steagall Act, profit persistence increased pointing to a decline in the degree of competition in the market. This is documented by the positive and statistically significant coefficient on the multiplicative interaction term between *GLB* and $\pi_{i,t-1}$.This finding is in line with the market power view of diversification. According to this view diversification increases opportunities for predatory pricing and may reduce intra-industry rivalry if several large diversified financial institutions face each other in different markets (Edwards, 1955). Such practices could lead to reduced competition and higher industry concentration (Montgomery, 1994).

In Specification 2, we include *CC*, a dummy variable to capture the effect of the financial crisis that began in 2007. *CC* is included both by itself and as an interaction term with $\pi_{i,t-1}$. The results for this specification follow the same pattern found in Specification 1. The results also point to a further increase in profit persistence in the period post-2007. This increase coincides with the financial crisis, which began in 2007 as a result of a liquidity shortfall in the US banking system, triggered by a collapse in the housing market. This

liquidity shortfall necessitated a number of ad-hoc policy interventions that appeared to prioritize stability over competition in response to the financial crisis.

Besides investigating the impact of the regulatory change on competition, it is also important to illustrate its impact on the level of bank profitability. While such information is typically conveyed by the coefficient of the regulatory change variable, the inclusion of a multiplicative interaction term (of the regulatory change variable with past profitability) renders its interpretation a conditional marginal effect.[13] In such a multiplicative interaction model the coefficient of the interaction term should also be taken into consideration for assessing the marginal effect of the regulatory change on bank profitability. Therefore, the positive coefficient of the IBBEA Act dummy and the negative coefficient of the interaction between IBBEA Act dummy and past profitability suggest that the marginal impact of IBBEA Act on bank profitability is decreasing with the level of past profitability, whereas the opposite is true for the marginal effect of the GLB Act on profitability. [14]

In specifications 3 to 5, we split the sample into three periods. The first period spans 1984-1993, the time before the enactment of the Riegle-Neal Interstate Banking and Branching Efficiency Act. The second period covers the years from the passage of the Riegle-Neal Act in 1994 until 1998, the year before the passage of the Gramm-Leach-Bliley Financial Services Modernization Act. Finally, we also consider the period from 1999 to 2010. The results are consistent to those reported in specification 1. The profit persistence coefficient in the second period (0.492) is considerably lower than that of the first period (0.586), which is consistent with the previous finding for the full sample period that the passage of the Riegle-Neal Act in 1994 intensified the competition. Profit persistence in the last period 1999-2010 (0.537) is higher than that of the second period (0.492), which is also

[13] It is important to reiterate that in our regressions we use the standardised ROA as a measure of profitability.
[14] The marginal effect is equal to the coefficient on regulatory change dummy (IBBEA or GLB), plus the coefficient on the interaction term times the level of past profitability $\pi_{i,t-1}$.

consistent with our previous finding that the repeal of the Glass-Steagall Act leads to reduced competition.

With respect to the control variables in the fully specified model (Specification 2), the positive coefficient on *ln(Total Assets)* together with the negative coefficient on *ln(Total Assets)_squared* suggests a non-linear (concave) relationship between bank size and profitability. This finding implies that banks of sizes up to $470 million in total assets benefit from economies of scale that feed through to higher reported profits. However, this benefit diminishes as banks grow beyond that size. This is also consistent with recent evidence that suggests that banks face increasing returns to scale up to at least $500 million of total assets (DeYoung, 2013). Faster growing banks appear more profitable than their slower growing counterparts as the coefficient on *Asset growth* is positive and statistically significant at the 1% level. The bank capital ratio (*Equity/Assets*) enters the regression significantly and negatively. This finding is in line with Tregenna (2009) who also reports a negative relation between capital and profitability for US banks. We also find a positive coefficient on *Net charge off/Loans*. This may indicate that a cleaned up better performing loan book in the previous year leads to greater profits in the following year. The *Loans/Assets* variable enters the regression significantly and negatively, indicating a positive relation between bank liquidity and profitability, which is also consistent with prior studies (Berger and Bouwman, 2009). Sufficient liquidity may imply less liquidity risk and consequently have a positive impact on bank profitability. The negative sign on *Income diversification* indicates that an increased reliance on non-interest income is associated with a decline in the profitability of US banks. *Loan HHI* also enters the regression significantly and negatively, indicating that banks with more diversified loan portfolios have lower profitability. *HHI* enters the regression negatively, indicating that higher concentration leads to decreased profitability. Finally, we find a positive coefficient on *GDP growth*, which suggests that bank profitability

is closely tied to the fortunes of the US economy, increasing during boom periods, only to decline when macroeconomic conditions deteriorate.

In Table 4 we classify banks into small, medium and large groups based on the breakpoints of the bottom 33.3 percent and the top 33.3 percent of their total assets in our sample and report the regression results in specifications 1 to 3, respectively. We find that the profit persistence coefficient for the group of medium sized banks (0.695) is slightly higher than smaller and larger sized banks (0.632 and 0.620, respectively). According to DeYoung and Rice (2004), banks of different size adopt different business models. Medium sized banks operate in the local area and enjoy more market power than smaller local counterparts, but are not exposed to nationwide or international competitive pressures of larger banks.

5.3 Sensitivity analysis

Table 5 presents the results of a comprehensive sensitivity analysis, which tests the robustness of our findings. Specification 1 uses the loan loss provisions to total assets ratio (*Loan loss provisions/Assets*) as a credit risk measure instead of the *Net charge off/Loans*. In specification 2, we follow Leuvensteijn et al (2011) and Delis (2012) to introduce the Boone indicator of market competition (Boone, 2008).[15] In specifications 3 and 4 we replace the equity to total assets ratio with the Tier 1 and total capital ratio, respectively. In specifications 3 and 4, the interaction terms are omitted since the data for Tier 1 and Tier 2 capital ratios are not available before 1999. In specification 5, we replace the loan to assets ratio with an alternative liquidity measure, defined as the sum of cash, securities for sale and Fed funds

[15] The Boone indicator can be estimated from the following equation: $\ln \pi_i = \alpha + \beta \ln mc_i + \varepsilon_i$ where π_i is the profit of each bank i, mc_i is marginal cost of bank i, and β denotes the Boone indicator of market power. This is based on the idea that the more efficient a bank becomes (lower marginal cost) the greater the profit should be, ceteris paribus. As competition intensifies, the slope of the regression should become even more negative, since inefficient banks are punished more harshly by fiercer competition. Following Liu et al (2013) we use a linear cost function to estimate the marginal cost.

sold divided by total assets. Finally, in specification 6, we use return on equity (ROE) as the dependent variable to check whether our results are sensitive to our choice of profit measure.

Our main results hold, and we continue to find that the persistence of profit decreases considerably after the passage of the Riegle-Neal Act followed by a moderate increase after the enactment of the Gramm-Leach-Bliley Financial Services Modernization Act of 1999, and the recent financial crisis. The impact of the other covariates on profitability is also similar to the results of the full model reported in Table 3.

6. Final Remarks

This paper examines the dynamics of profitability for US commercial banks during the period 1984 to 2010. We assess the impact of deregulation enacted in the 1990s, and the recent financial crisis on the level and persistence of bank profits.

Size, diversification, liquidity, credit risk and asset growth significantly influence bank profitability. Profits are pro-cyclical, tending to increase during phases of economic growth and deteriorate during periods of slow growth.

Bank profits exhibit persistence, which varies over the sample period with changes in regulation and the financial crisis. Profit persistence diminishes following the Riegle-Neal Interstate Banking and Branching Efficiency Act in 1994, only to partially increase following the Gramm-Leach-Bliley Financial Services Modernization Act of 1999 and the financial crisis.

Overall, policy actions including the enactment of the Riegle Neal 1994 and the Gramm-Leach-Bliley Acts appear to affect the intensity of competition (as measured by the speed at which convergence towards long-run average profitability is achieved) in US banking. The results of our analysis suggest that competition has diminished since 2007 as government agencies introduced ad-hoc policy measures (prioritized stability over

competition) to deal with the financial crisis.

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Table 1. Descriptive Statistics for ROA from 1984 to 2010.

Year	No. of Banks	Mean	Median	Minimum	Maximum
1984	14,352	0.68	0.92	-3.43	2.17
1985	14,214	0.59	0.90	-4.06	2.14
1986	13,930	0.43	0.79	-4.25	2.05
1987	13,404	0.49	0.81	-4.08	1.97
1988	12,807	0.65	0.89	-3.26	2.02
1989	12,433	0.74	0.94	-2.90	2.11
1990	12,123	0.67	0.88	-2.91	1.95
1991	11,746	0.73	0.91	-2.56	1.99
1992	11,326	0.99	1.09	-1.72	2.27
1993	10,870	1.10	1.15	-1.15	2.45
1994	10,372	1.08	1.11	-0.75	2.27
1995	9,866	1.10	1.12	-0.67	2.23
1996	9,460	1.09	1.15	-0.98	2.25
1997	9,074	1.09	1.14	-1.41	2.51
1998	8,710	1.01	1.08	-2.00	2.65
1999	8,516	0.97	1.06	-2.36	2.69
2000	8,249	0.97	1.06	-2.38	2.79
2001	8,019	0.89	0.98	-2.33	2.58
2002	7,833	1.00	1.05	-1.81	2.63
2003	7,710	0.99	1.02	-1.83	2.66
2004	7,567	1.00	1.03	-1.73	2.62
2005	7,458	1.01	1.05	-2.12	2.68
2006	7,329	0.96	1.02	-2.69	2.82
2007	7,220	0.79	0.93	-3.26	2.66
2008	7,011	0.29	0.68	-5.26	2.29
2009	6,761	-0.01	0.50	-6.17	2.12
2010	6,458	0.36	0.64	-4.32	2.23

Notes: Banks with total assets of less than $100,000 or with equity less than 1% of their total assets are excluded from the sample.

Table 2. Summary statistics.

	Mean	Median	Std. Dev.	Number of Obs.
ROA	0.79	0.98	0.99	241,259
ROE	8.33	10.47	12.72	241,259
ln(Total assets)	11.19	11.04	1.35	241,259
Asset growth	9.51	5.85	16.34	241,259
Net charge offs/Loans	0.73	0.32	1.08	241,259
Loan/Assets	56.93	58.52	15.63	241,259
Income diversification	9.34	7.88	6.15	241,259
Equity/Assets	9.76	8.88	3.55	241,259
Loan HHI	0.45	0.43	0.19	241,259
Boone indicator	-0.85	-0.52	0.86	241,259
HHI	167.39	82.54	145.13	241,259
GDP growth	5.73	5.80	2.22	241,259
Loan loss provisions/Assets	0.40	0.20	0.61	241,913
Tier 1 capital ratio	16.37	13.54	8.80	86,375
Total capital ratio	17.52	14.68	8.75	86,375

Notes: This table reports the summary statistics of the variables. The detailed definition of the variables can be found in Appendix I.

Table 3. Determinants of profitability (ROA).

	(1)	(2)	(3)	(4)	(5)
	1984-2010	1984-2010	1984-1993	1994-1998	1999-2010
Constant	-1.168***	-1.123***	-0.991***	-1.442***	-0.760***
$\pi_{i,t-1}$	0.619***	0.648***	0.586***	0.492***	0.537***
$\pi_{i,t-1} \times$ IBBEA	-0.234***	-0.258***			
$\pi_{i,t-1} \times$ GLB	0.099***	0.071***			
$\pi_{i,t-1} \times$ CC		0.065***			
ln(Total Assets)	0.217***	0.209***	0.203***	0.215***	0.237***
ln(Total Assets) squared	-0.008***	-0.008***	-0.008***	-0.008***	-0.009***
Asset growth	0.001***	0.001***	0.002***	0.001***	0.001***
Equity/Assets	-0.007***	-0.008***	-0.014*	0.002	-0.005***
Net charge off/Loans	0.097***	0.104***	0.102***	0.067***	0.081***
Loans/Assets	-0.003***	-0.003***	-0.006***	-0.000	-0.002***
Income diversification	-0.006***	-0.006***	-0.011***	-0.006***	-0.002***
Loan HHI	-0.060***	-0.055***	-0.099***	0.032*	-0.126***
GDP growth	0.014***	0.014***	-0.001	0.002	0.011***
HHI	-0.001**	-0.001**	0.004*	0.000	-0.001**
IBBEA	0.186***	0.191***			
GLB	0.345**	0.285**			
CC		0.071*			
Observations	241,259	241,259	108,890	45,994	86,375
No. of banks	17,588	17,588	15,280	10,617	9,724
Hansen	4.24	3.75	3.75	6.29	2.34

Notes: The table presents the results of the effect of regulatory changes and control variables on bank profitability measured by ROA. Profitability π_t is measured by ROA and expressed as deviation from the sample mean at time *t*. All explanatory variables enter the regressions with a year period lag to address any potential endogeneity problems. System GMM estimator with Windmeijer correction is used for all regressions. 'Hansen' is the Hansen test statistic of over-identifying restrictions. Column (1) and (2) report the results for the overall sample, while column (3) to (5) report the results for three sub-sample periods. Year dummies are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively. For detailed variable definitions, please see Appendix I.

Table 4. Determinants of profitability (ROA) by size category.

	(1)	(2)	(3)
	Small sized banks	Medium sized banks	Large sized banks
Constant	-0.924	0.293	0.216
$\pi_{i,t-1}$	0.632***	0.695***	0.620***
ln(Total Assets)	0.231*	0.317**	0.081**
ln(Total Assets) squared	-0.012*	-0.017***	-0.004**
Asset growth	0.002***	0.003***	0.002***
Equity/Assets	-0.014***	-0.016***	-0.006**
Net charge off/Loans	0.132***	0.140***	0.081***
Loans/Assets	-0.004***	-0.004***	-0.002***
Income diversification	-0.012***	-0.010***	-0.003***
Loan HHI	0.057***	-0.074***	-0.104***
GDP growth	0.036***	0.011**	-0.003
HHI	0.000	-0.002***	-0.001
Obs.	78,875	79,907	82,477
No. of Banks	6,329	5,651	5,608
Hansen	3.21	3.31	1.04

Notes: The table presents the results of the determinants of bank profitability measured by ROA. We classify banks into small, medium and large groups based on the breakpoints of the bottom 33.3 percent and the top 33.3 percent of their total assets in the sample. Columns (1) to (3) report the results for the three groups, respectively. Profitability π_t is measured by ROA and expressed as deviation from the sample mean at time *t*. All explanatory variables enter the regressions with a year period lag to address any potential endogeneity problems. System GMM estimator with Windmeijer correction is used for all regressions. 'Hansen' is the Hansen test statistic of over-identifying restrictions. Year dummies are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively. For more detailed variable definitions, please see Appendix I.

Table 5. Sensitivity analysis.

	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	ROA	ROA	ROA	ROA	ROE
Constant	-1.087***	-1.186***	-0.792***	-0.783***	-1.096***	-8.959***
$\pi_{i,t-1}$	0.601***	0.648***	0.540***	0.540***	0.634***	0.649***
$\pi_{i,t-1} \times$ IBBEA	-0.198***	-0.258***			-0.249***	-0.276***
$\pi_{i,t-1} \times$ GLB	0.089***	0.071***			0.073***	0.080***
$\pi_{i,t-1} \times$ CC	0.086***	0.065***			0.071***	0.055***
ln(Total Assets)	0.221***	0.209***	0.242***	0.241***	0.181***	1.903***
ln(Total Assets) squared	-0.008***	-0.008***	-0.009***	-0.009***	-0.007***	-0.070***
Asset growth	0.001***	0.001***	0.001***	0.001***	0.001***	0.012***
Equity/Total assets	-0.006***	-0.008***			-0.005***	-0.285***
Net charge off/Loans		0.104***	0.082***	0.082***		1.087***
Loans/Total assets	-0.006***	-0.003***	-0.002***	-0.002***		-0.021***
Income Diversification	-0.005***	-0.006***	-0.002***	-0.002***	-0.006***	-0.045***
Loan HHI	-0.037***	-0.055***	-0.121***	-0.122***	-0.079***	-0.751***
GDP growth	0.019***	0.017***	0.011***	0.011***	0.011***	0.143***
HHI	-0.002***		-0.001**	-0.001**	-0.001***	-0.012***
IBBEA	0.241***	0.088***			0.174***	2.221***
GLB	0.422***	0.062***			0.318***	3.170***
CC	0.116***	-0.006			0.067*	1.002***
Loan loss provisions/Assets	0.229***				0.104***	
Boone		0.035**				
Tier 1 capital ratio			-0.002***			
Total capital ratio				-0.002***		
Alternative liquidity ratio					0.0001	
Obs.	241,913	241,259	86,375	86,375	241,343	241,259
Banks	17,637	17,588	9,724	9,724	17,591	17,588
Hansen	0.44	3.75	2.73	2.74	0.3	3.73

Notes: The table presents the results of the robustness tests. $\pi_{i,t}$ denotes normalised profitability of bank *i* at time *t*. Specification (1) uses Loan loss provisions/Assets as an alternative credit risk indicator instead of Net charge off/Loans; Specification (2) includes the Boone indicator to control for the degree of competition in the market; Specifications (3) and (4) use Tier 1 capital ratio and Total capital ratio instead of risk-unadjusted Equity/Total assets ratio, respectively; Specification (5) uses normalised ROE as the dependent variable

instead of ROA. All explanatory variables enter the regressions with a year period lag to address any potential endogeneity problem. System GMM estimator with Windmeijer correction is used for all regressions. 'Hansen' is the Hansen test statistic of over-identifying restrictions. Specifications (1), (2), and (5) are estimated over the full sample spanning 1984-2010. Specifications (4) and (5) are estimated over the years 1999-2010 due to data for Tier 1 and Tier 2 ratios being available from 1999 onwards. Year dummies are included in the model but not reported in the table. *, **, and *** represent 10, 5 and 1 percent significance level, respectively. For more detailed variable definitions, please see Appendix I.

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