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ABSTRACT

This paper presents new evidence on the relationship between competition and innovation by extending previous literature from manufacturing to financial services. We introduce a new measure of overall innovation by estimating and enveloping annual minimum cost frontiers to create a global frontier. The distance to the global frontier constitutes each bank's technology gap, which decreases if the bank manages to innovate. Our innovation measure enables us to derive and estimate the model of [Aghion et al. \(2005b\)](#) at the firm level for the US banking industry. Based on individual bank Call Report data for the period 1984–2004, consistent with theoretical and empirical work by [Aghion et al.](#), we find evidence of an inverted-U relationship between competition and innovation that is robust over several different specifications. Further evidence on major structural changes in the US banking industry indicates that banks moved beyond their optimal innovation level and that interstate banking deregulation resulted in lower bank innovation. Policy implications to financial reform and prudential regulation are discussed also.

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1. Introduction

Seminal work by [Schumpeter \(1942\)](#) posits that product market competition discourages innovation by diminishing monopoly rents. By contrast, [Aghion et al. \(2001\)](#) assert that competition may foster innovation as firms attempt to escape competition.¹ Providing partial support for both conjectures, some empirical studies find an inverted-U pattern between competition and innovation (e.g., [Scherer, 1967](#); [Levin et al., 1985](#)). In an attempt to reconcile theory and evidence, [Aghion and Griffith \(2005\)](#) and [Aghion et al. \(2005b\)](#) propose a theoretical model that is able to explain an inverted-U relationship between competition and innovation, wherein an escape competition effect initially dominates until competition reaches a sufficient level at which the rent dissipation effect thereafter prevails. Their empirical evidence for manufacturing industries in the UK tends to support the hypothesis of an inverted-U pattern. No

previous studies investigate this hypothesis in the financial sector. Also, most previous studies focus on product innovation, whereas process innovation is largely ignored.

The present paper seeks to fill this gap in the literature by examining the relationship between competition and innovation in financial services. While there is no reason to believe that the degree of competition influences innovation differently than other industries, as [Frame and White \(2004\)](#) point out, revolutionary changes in financial institutions and instruments have transpired in the financial industry over the past 20 years. In this regard, banks have innovated to increase the efficiency of the production of financial services as well as the quality and variety of financial products. As a result, innovative banks can more effectively screen loan applicants, offer services at lower costs, and more efficiently intermediate between liquidity demand and supply.

We contribute to the competition/innovation literature in two major ways. First, we introduce a new overall measure of financial innovation. Instead of using traditional innovation outputs (e.g., patents which are mostly relevant to manufacturing), we examine banks' ability to minimize costs through innovations. Following earlier work by [Hayami and Ruttan \(1970\)](#), [Mundlak and Hellinghausen \(1982\)](#), and [Lau and Yotopoulos \(1989\)](#), we estimate and envelope annual minimum cost frontiers to create a global frontier. The distance to the global frontier constitutes each bank's technology gap, which decreases if the bank manages to innovate. The use

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¹ See literature reviews by [Kamien and Schwartz \(1982\)](#) and [Symeonidis \(1996\)](#).

of this innovation measure enables us to examine the innovation behavior of financial firms for which patents and R&D expenditures are unavailable as metrics. Each innovation leads to lower production costs in both the theoretical model and our proposed innovation measure. Because a well-functioning financial sector is crucial to the economy (King and Levine, 1993; Pagano, 1993; Levine, 1997, 2004; Levine and Zervos, 1998; Levine et al., 2000), it is important to understand its innovation dynamics. Recent work by Michalopoulos et al. (2009) demonstrates in a dynamic setting that continuous financial innovation is a requirement for endogenous growth. While numerous studies have been published on bank innovation, they typically focus on specific bank technologies, rather than bank innovation in general. For example, Hannan and McDowell (1984) examine how market concentration affects the adoption of ATMs. Our technology gap measure provides estimates of overall innovation to gain a broader perspective on its potential effects. Also, while most competition/innovation studies employ industry-level data and therefore implicitly assume the same relation across industries despite considerable cross-industry heterogeneity, our new measure affords the opportunity to study competition/innovation behavior at the firm level for a single industry.

Second, we document the impact of historic consolidation in the US banking industry on innovation behavior. Driven by globalization, technological change, deregulation, and other forces, the US banking industry has experienced dramatic changes in its structure and competition (Jones and Critchfield, 2005). In our sample period from 1984 to 2004, the industry consolidated from over 14,000 banks to around 7500 banks (Jones and Critchfield, 2005). In this period, the average size of banks grew as banks with assets totaling more than \$10 billion increased their share of industry assets from 30% to over 70% (Rhoades, 2000). Similar consolidation trends have occurred in the European Union, United Kingdom, Japan, and other countries around the world (Carletti et al., 2007). A major concern is that consolidation has lowered competition. For example, Cetorelli and Strahan (2006) find that, in banking markets that are highly concentrated, nonfinancial firms have significantly less access to credit (see also Stiroh and Strahan, 2003). Also, Fraser et al. (2011) report evidence of market power after large bank mergers that adversely affects the stock prices of borrowing firms. Relevant to our purpose, a number of interesting questions naturally arise. As consolidation has taken place, what are the coincident trends in US bank competition and innovation over time? How has consolidation affected the relationship between competition and innovation? And, what is the role of deregulation in bank innovation dynamics? Our empirical analyses provide detailed evidence on these important questions.

In brief, based on annual data series for all insured US commercial banks spanning two decades, our evidence strongly supports an inverted-U relationship between bank competition and technology gaps. This finding agrees with theory and evidence by Aghion et al. (2005b) and Hashmi (2007) in other industries. We also find that average price cost margins have increased considerably during our sample period, which implies declining competition as consolidation has occurred. Further evidence suggests that: (1) the US banking industry as a whole has consolidated beyond its optimal innovation level and (2) interstate banking deregulation has lowered innovation through its effect on competition. In view of these adverse trends, we discuss potential implications to policy makers making sweeping financial reforms and changes in prudential regulations at the present time.

Section 2 provides a brief overview of studies on financial innovation in the US banking industry. Section 3 describes the theoretical model developed by Aghion et al. (2005b) to explain the inverted-U pattern. Section 4 overviews the data and methodology. Section 5 empirically investigates the existence of an inverted-U relationship, discusses model robustness, considers

whether the consolidation process has gone too far, and examines the impact of interstate banking deregulation. Section 6 concludes.

2. Financial innovation in US banking

Deregulation of prices, products, and geographic restrictions on permissible banking activities over the past 30 years has increased the contribution of market forces to financial innovation in the banking industry. In this regard, Miller (1986) argues that efforts to circumvent regulatory and tax burdens are key drivers of financial innovation. Also, Vives (2001) observes that deregulation and financial innovations, including advances in information technology, management techniques, and risk adjustment (e.g., derivatives, securitization, and off-balance sheet activities), have substantially increased competition in US and European banking markets.

Frame and White (2004) comprehensively survey the small body of financial innovation literature comprised of 39 empirical studies. They define financial innovation as comprising activities that internally reduce bank costs and risks or externally better meet the convenience and needs of customers.² Financial innovations are grouped into new products (e.g., automated teller machines or ATMs, credit and debit cards, adjustable-rate mortgages, etc.), new production processes (e.g., electronic payments and record keeping, automated credit scoring models, securitization of loans, etc.) and new organizational forms (e.g., interstate banking organizations, diversified banks with traditional and nontraditional financial services, etc.). The practical significance of these financial innovations lies in their contribution to enhancing financial intermediation, which allocates savings to investment and thereby contributes to economic growth (see King and Levine (1993), Levine (1997), and others cited above). Frame and White (2004) conclude that the following factors tend to increase innovation in financial services: regulation, institution size, higher education and income, and first-mover, cost, and reputational advantages. Given the important role of financial innovation in the financial system and the economy as a whole, they infer that there is considerable room for future research in this “relatively untilled field.”

A separate branch of the banking literature relevant to this paper examines technical change in the context of cost and profit efficiency analyses of financial institutions.³ In general, the efficiency literature tends to support the institution size effect in financial innovation cited by Frame and White (2004). Elyasiani and Mehdiian (1990) and Hunter and Timme (1991) find that larger banks experienced greater cost efficiency gains compared to small banks in the 1980s. Humphrey (1993) finds that large banks had more technical change than small banks in the late 1970s. Also, Berger and Mester (1997) find that, while large banks had decreasing cost efficiency over time, they exhibited increasing profit efficiency compared to small banks in the 1980s and 1990s. Similarly, Berger and Mester (2003) report decreasing cost productivity but increasing profit productivity among US banks in the period 1991–1997. Consistent with these studies, Wheelock and Wilson (1999) report greater technological gains among large banks in the 1980s and 1990s, which led them to conclude that competitive and regulatory changes in the banking industry have benefited larger over smaller banks. Lastly, Altunbas et al. (1999) find that larger banks in 15 European countries

² Van Horne (1985) more broadly defines financial innovation as making markets more operationally efficient or complete (i.e., the number and types of securities that span all possible return and risk contingencies or states of the world demanded by market participants). Also, Allen and Gale (1994) propose that financial innovation is associated with efficient risk sharing due to the completion of markets.

³ For example, Van Horne (1985) observes that financial innovations are motivated by operational inefficiencies. Less efficient financial institutions are less competitive and, therefore, less likely to survive. Importantly, as Ross (1989) points out, institutions are the major agents of innovation in financial markets.

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