# IMF Working Paper

# Recent Developments in European Bank Competition

*Yu Sun*

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**Prepared by Yu Sun[1]**

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**Abstract**

This paper investigates the degree of bank competition in the euro area, the U.S. and U.K. before and after the recent financial crisis, and revisits the issue whether the introduction of EMU and the euro have had any impact on bank competition. The results suggest that the level of bank competition converged across euro area countries in the wake of the EMU. The recent global financial crisis led to a fall in competition in several countries and especially where large credit and housing booms had preceded the crisis..

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## I. INTRODUCTION

The European banking sector has been hit hard by the recent financial crisis. Many banks incurred large losses and only managed to stay in business with exceptional support from national governments and central banks. Fixing the banking sector and weaning off weak banks from public support will require significant restructuring. This process has started in several euro-area countries and is supported by EU rules that require restructuring of corporations including banks if certain state aid has been provided. Bank restructuring and consolidation would also be supported by a healthy competition in the banking sector. This paper revisits the issue whether the introduction of the European Economic and Monetary Union (EMU) and the euro has had any impact on bank competition in the euro area, the U.S. and U.K., including by breaking up national banking sectors by size, domestic and foreign ownership and commercial versus savings and loans banks. In addition, the degree of bank competition before and after the financial crisis is also a main topic of this paper.

Bank competition has been studied extensively over the past years. Theories suggest that increased competition in the financial sector could lower costs, improve efficiency of financial intermediation and quality of financial services, promote innovation and, more importantly, greater access to finance by nonfinancial sectors and households. However fierce competition may undermine financial stability if banks take excessive risk and invest too little in information collection and establishing long-term relationship with their customers (Claessens, 2009). Decressin and Kudela (2007) compare the efficiency and competition between EU and U.S. banks and find that small European banks tend to be less efficient and competitive than their U.S. counterparts. Shaffer (2001) compares banking sectors across a number of industrialized countries and shows that markets for banking services are either contestable or resemble a Cournot oligopoly in most countries. Bikker and Spierdijk (2008) study development in bank competition worldwide over time and find that the euro area faced a significant decline in bank competition in recent years, while emerging market became more competitive. They attribute the decline in competition to the increase in concentration and bank size and off-balance sheet activities. Claessens and Laeven (henceforth CL, 2004, 2005,) further investigate the factors that drive bank competition and its impacts on economic growth. Their findings suggest that bank competition is strongly correlated with foreign entry and fewer entry and activity restrictions and that a competitive financial sector especially benefits sectors or industries that are highly dependent on external financing (see, Rajan and Zingales, 1998).

There are several approaches to measure bank competition: financial market concentration, the number of banks per million people, the size of banks' net interest margins, etc. This paper uses the H-statistic, developed by Panzar and Rosse (1987, henceforth PR) which has been widely used to measure competition in the banking system by investigating the

relationship between a bank's costs and its revenues. H-statistics are estimated for euro area countries, a euro area aggregate, the U.K. and U.S. over the period 1995–2009. For countries where sufficient data are available, this paper analyzes the evolution of the competition environment over time and compare the differences between groups of banks separated by size, business model and ownership.

Estimation results suggest that the euro area experienced a decline in the bank competition after EMU; however competition levels in euro countries seem to have converged in the wake of EMU. Following the global financial crisis, bank competition declined further in several euro-area countries, especially where large credit and housing booms took place, including the U.S. and Spain. In other countries, however, statistically significant changes could not yet be detected also because only a few years of data are available since the crisis hit.

Across countries, there is no strong pattern suggesting that large or small banks compete harder. In most countries, commercial banks and foreign banks compete somewhat harder than savings banks and domestic banks before EMU. However, the differences in the competition levels of different bank types and ownership are not significant after EMU.

This paper is organized in the following manner. Section I provides a review of measures of competition, the factors that drive competition and its effects. Section II discusses the empirical model and methodology to estimate the competition indicator. Section III presents data and empirical results. Section IV concludes.

## A.  Bank Competition: Measurement

Traditional performance measures and market structure indicators of the financial sector, for example, the net interest margin to total assets ratio, the Lerner index, net income to total assets ratio, the concentration index and the number of institutions per million people, do not necessarily measure competition accurately  and often send conflicting signals. Carbo and others (2009) compare the rankings of existing competition indicators for a number of European countries, and find that these indicators give conflicting results because they measure different aspects of bank activities. The net interest margin is better for analyzing traditional banking loan and deposit services; while the return on assets and the Lerner index measure both traditional financial services and off-balance sheet activities. Moreover, these indicators are also influenced by the country-specific macroeconomic environment, rule of law, taxation system and bank specific characteristics, such as leverage and risk preferences (Claessens, 2009).

Another approach to measuring the degree of competition is to study the actual behavior of banks based on empirical industrial organization models. Based on this approach, the PR methodology provides a reduced form revenue model to measure the change of marginal revenue in response to change in factor prices and has been widely adopted in various empirical studies. CL and Bikker and Spierdijk (2008) applied this method to a large sample of countries, finding evidence of monopolistic bank competition with varying degree across countries.

## B.  Determinants of Competition

One popular indicator used in empirical research is the market structure, mainly defined as the concentration in the market. Many banks and low concentration tend to promote competition. However, the structure could be endogenous since firms' behavior affects market structure. CL find that the degree of contestability determines effective competition by removing bank entry and exit barriers. Under the assumption of no entry and exit barriers, the increase of output price and the corresponding abnormal profits will attract new entrants until firms lower prices back to normal profits.  So a concentrated market may still be very competitive if banks can easily enter in case of excessive profits. To evaluate the degree of contestability, one needs to look into the entry requirement, the entry barriers for foreign banks and other factors (Claessens, 2009). CL find that greater foreign entry and fewer activity restrictions are important determinants for more competition. Nathan and Neave (1989) assess competition in the Canandian banking system and conclude that potential entry of competitors forces banks to price competitively.

Besides contestability, other factors, such as the development of technology, networks and economy of scales, moral hazard problems incurred by asymmetric information, and preferences of risks are also important in determining the degree of competition (Bikker and Spierdijk, 2008).

## C.  Effects of Competition

Similar to other industries, increased competition in the financial sector could result in lower costs, higher efficiency, better quality of financial services and therefore greater access to finance by nonfinancial firms and households.  Better access to finance and lower cost of capital promote growth of other industries, especially those dependent on external finance (Besanko and Thakor (1992), Samaniego (2010)). Some research investigates the linkage between bank competition and growth of industries, and shows that financially dependent industries grow faster in countries with strong bank competition (CL, 2005).

However, theory shows that the effects of competition are complex. Advances in technology and information process can promote financial system consolidation, which in turn leads to

greater distance and less lending to SMEs, i.e. small and median enterprises (Bekaert, Harvey, and Lundblad, 2005). Intensive competition can also undermine the incentives of banks to invest in information collection and long-term relationship lending to avoid costs. Increased competition may encourage banks to engage in more risky activities and therefore undermine the stability in the financial sector. However, competition is not a necessary condition of fragility. A bank run could happen to a monopolist too and one needs to take into account the macroeconomic environment and the quality of supervision and regulation and legal institutions when evaluating a possible trade-off between stability and competition. Boyd, De Nicolo, and Jalal, (2009)and De Nicolo and Turk Ariss (2010) do not find much evidence for a trade-off between competition and stability.

## II. THE EMPIRICAL MODEL

### A. The Panzar-Rosse Methodology

PR[2] developed a general test for market structure using a reduced form revenue equation, which is regarded as a key method of measuring the degree of competition in the new empirical industrial organization literature. Based on the profit-maximization equilibrium condition, the PR methodology evaluates the relation between costs and revenues to determine different market structures: monopoly, monopolistic competition and perfect competition. The sum of the factor price elasticities in PR model is:

$$\psi \equiv \sum w_i (\frac{\partial R}{\partial w_i}) / R \tag{1}$$

where $R(.)$ is the revenue function, $w_i$ is the input factor i, so $\psi$ is the sum of the factor price elasticities.

PR show that in a monopoly market, $\psi \leq 0$. Since the increase in costs leads to a cut in output, and marginal revenue (which is equal to marginal cost) is always positive, the increase in input prices results in a fall in total revenue.[3] With monopolistic competition, $0 < \psi \leq 1$, because firms raise output prices in response to increase in factor prices, but the rise in output price and input price is not one to one, depending on the demand elasticity. The higher demand elasticity, the lower market power and higher competition. With perfect competition, $\psi = 1$, because in the long run, entry and exit will force firms to set output prices at the minimum average cost, so the output prices change in the same direction and the extent as the factor prices, and the relation of the rise in cost and revenue is one to one.

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[2] For more details on the PR model, please refer to the appendix.
[3] PR assume demand elasticity is larger than 1.

## B.  The Model and H-statistic

PR's empirical model for testing market structure has been widely used for the banking system. This paper uses the following reduced-form bank revenue equation to test the competition environment in the banking system for each country independently:

$$
\begin{aligned}
\ln(P_{it}) = {} & \alpha_0 + \beta_1 \ln(W_{1,it}) + \beta_2 \ln(W_{2,it}) + \beta_3 \ln(W_{3,it}) + \gamma_1 \ln(Y_{1,it}) + \gamma_2 \ln(Y_{2,it}) \\
& + \gamma_3 \ln(Y_{3,it}) \\
& + T_1 * [\alpha_1 + \beta_4 \ln(W_{1,it}) + \beta_5 \ln(W_{2,it}) + \beta_6 \ln(W_{3,it}) + \gamma_4 \ln(Y_{1,it}) \\
& + \gamma_5 \ln(Y_{2,it}) + \gamma_6 \ln(Y_{3,it}) \,] \\
& + T_2 * [\alpha_2 + \beta_7 \ln(W_{1,it}) + \beta_8 \ln(W_{2,it}) + \beta_9 \ln(W_{3,it}) \ln(W_{3,it}) + \gamma_7 \ln(Y_{1,it}) \\
& + \gamma_8 \ln(Y_{2,it}) + \gamma_9 \ln(Y_{3,it}) \,] \\
& + \varepsilon_{it} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (2)
\end{aligned}
$$

where i is bank i, and t is year t. In order to compare the competition levels before and after the EMU and the recent financial crisis, this equation introduces two time dummies: $T_1$=1 for period after EMU (2001-07), $T_1$=0 otherwise; $T_2$=1 for period of the financial crisis (2008-09), $T_2$=0 otherwise. [4] For sample splits by size, business model and ownership and comparisons pre and post EMU, only time dummy $T_1$ is included in the equation. Following CL (2004), $P_{it}$ is the ratio of gross interest income over total assets as the proxy for output price of loans. For robustness check, this paper also uses the ratio of gross interest income and other operating income over total assets as the dependent variable $P_{it}$ to cover noninterest income. $W_{1,it}$ is calculated as the ratio of total interest expenses to total deposits and money market funding, as the proxy for input price of deposits; $W_{2,it}$ is the ratio of personnel expense over total assets, as the proxy for labor cost; $W_{3,it}$ is the ratio of other operating expenses over total assets, as the proxy for input prices of equipment and other fixed capital. $Y_{1,it}$, $Y_{2,it}$, and $Y_{3,it}$ are the ratio of equity over total assets, the ratio of net loans to total assets and the total assets respectively, which are used as the control variables for bank specific effects. Bikker, et al (2008) point out that the scaled revenue function (including total assets as a control variable) can lead to overestimation of the degree of competition in the banking industry. Estimation with an un-scaled revenue function did not change the results qualitatively but significance levels were low. To facilitate comparison with previous studies, only scaled results are reported in this paper.

The H-statistic, defined in PR's model as the sum of factor price elasticities, is :

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[4] Bikker and Groeneveld (2000), De Bandt and Davis (2000) and Bikker (2004) estimate H-statistics recursively over time. A possible complication of such an approach is that H-Statistics are only valid under the assumption that markets are in long-run equilibrium which could be at odds with frequent variations in the level of competition.

$H = \beta_1 + \beta_2 + \beta_3 \ for \ pre \ EMU(1995 - 2000);$

$H = \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 \ for \ post \ EMU \ (2001 - 07);$

$H = \beta_1 + \beta_2 + \beta_3 + \beta_7 + \beta_8 + \beta_9 \ for \ the \ financial \ crisis \ (2008 - 09).$

The interpretation of the H-statistic is the following: under perfect competition, the total revenue and total cost rise by the same amount when the input prices increase, while under monopoly, the total revenue falls and the marginal cost increases. Therefore, the H-statistic should be: $H < 0$ under monopoly, $H = 1$ under perfect competition, and $0 < H < 1$ under monopolistic competition.

This paper estimates the H-statistic based on the reduced-form bank revenue equation (2) using pooled OLS[5] for two models: one is estimated with the dependent variable of gross interest revenue ratio, and the other one is estimated using gross interest revenue and other revenue ratio as the dependent variable. These two models generate close estimates of H-statistics. The H-statistics used as the indicator of competition of banking system are the average of the H-statistics estimated using these two models.

## C. Equilibrium Test

Since PR's model for perfect competition and monopolistic competition is based on the assumption of long-run equilibrium, which is tested, following CL by estimating the equation:

$$\ln(ROA_{it})$$
$$= \alpha_0 + \beta_1 \ln(W_{1,it}) + \beta_2 \ln(W_{2,it}) + \beta_3 \ln(W_{3,it}) + \gamma_1 \ln(Y_{1,it}) + \gamma_2 \ln(Y_{2,it}) + \gamma_3 \ln(Y_{3,it})$$
$$+ T_1 * [\alpha_1 + \beta_4 \ln(W_{1,it}) + \beta_5 \ln(W_{2,it}) + \beta_6 \ln(W_{3,it}) + \gamma_4 \ln(Y_{1,it}) + \gamma_5 \ln(Y_{2,it})$$
$$+ \gamma_6 \ln(Y_{3,it}) \ ]$$
$$+ T_2 * [\alpha_2 + \beta_7 \ln(W_{1,it}) + \beta_8 \ln(W_{2,it}) + \beta_9 \ln(W_{3,it}) \ln(W_{3,it}) + \gamma_7 \ln(Y_{1,it}) + \gamma_8 \ln(Y_{2,it})$$
$$+ \gamma_9 \ln(Y_{3,it}) \ ]$$
$$+ \varepsilon_{it} \qquad\qquad\qquad (3)$$

where ROA is the ratio of pre-tax profits to total assets, as the proxy for returns on bank assets. To avoid negative values of returns on assets, the independent variable is calculated as $\ln(1 + ROA_{it})$. In equilibrium, input prices should not affect returns on total assets. Thus this paper tests whether the E-statistics=0 using F-test:

$E = \beta_1 + \beta_2 + \beta_3 \ for \ pre \ EMU(1995 - 2000);$

$E = \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 \ for \ post \ EMU \ (2001 - 07);$

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[5] Due to the limited observations for some countries, the fixed effect panel estimation could be inefficient (the average number of observations for each bank is very low, e.g. in some cases less than 2, especially when the full sample is split into sub-samples. And the Hausman test rejects fixed effects in these cases.). To be consistent in the full sample and sub-sample analysis, OLS is preferred.

$$E = \beta_1 + \beta_2 + \beta_3 + \beta_7 + \beta_8 + \beta_9 \ for \ after \ the \ financial \ crisis \ (2008 - 09).$$

If the F-test can not reject the null $E = 0$, then the market is in long run equilibrium. The tests suggest that for most countries this condition is not violated[6].

## III. DATA AND EMPIRICAL RESULTS

### A. Data

The sample includes ten euro area countries, the United Kingdom and the United States included as a benchmark.[7] Figure 1 shows some traditional measures of financial development for the sample countries. Domestic credit provided by the banking sector as percentage of GDP and domestic credit to the private sector over GDP measure a key function of financial intermediaries: the channeling of savings to investors. Market capitalization over GDP measures the size of stock market. The interest rate spread is an indicator of market efficiency. All variables are the average of 2001–07. From the figure we can see that domestic credit provided by the banking sector, domestic credit to the private sector and market capitalization are positively related with GDP per capita, while the interest rate spread is negatively related with it, reflecting that more advanced financial development is generally associated with higher efficiency.

For the variables in the competition and equilibrium tests, this paper uses bank-level annual data from BANKSCOPE for the years 1995–2009 and focuses on commercial banks, savings banks, and cooperative banks. Other types of financial institutions, including investment banks, real estate &mortgage banks, other nonbanking credit institutions, government banks, securities firms, bank holding companies and so on, are not included in the sample, because their structures and functions are usually different from the traditional financial intermediation. Data from consolidated accounts are used if available, otherwise unconsolidated accounts are used.

As discussed in the previous section, the dependent variable is the ratio of gross interest revenue to total assets or gross interest revenue and other revenue to total assets. The independent variables are: the ratio of interest expenses to total deposits and money market funding, personnel expense to total assets, other operating expense to total assets, equity to total assets, net loans to total assets and total assets. All variables[8] are taken natural

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[6] Equilibrium test results are not reported, but are available upon request.

[7] The euro area countries in the sample include members since the start in 1999: Austria, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain, and Greece which joined in 2001.

[8] We need to be aware that accounting differences across countries (especially with the U.S.) and over time may affect the comparability of the accounting data. For example, the Continental model focuses on debt holders, while the Anglo-Saxon model favors share holders, which may leads to different emphases on losses/costs or

(continued…)

logarithms in the estimation models. Banks for which all major variables are available are kept in the sample. Certain outlier rules are applied: the 1st and 99th percentiles of the distributions of main variables are eliminated. To obtain an accurate estimation of H-statistic, this paper only report results for countries with more than 50 bank-year observations. This rule applies particularly to estimations breaking up national banking sectors by size, domestic and foreign ownership and commercial versus savings banks. In the full sample regression, the largest number of observations is available for the United States, followed by Germany, Italy and France with over 2000 bank-year observations (see column (1) and (2) in Table 3 for the number of observations and banks for each country). Table 1 and 2 show the median statistics for each country, and the correlation matrix of major variables for all observations in all countries for the period of 1995–2009.

## B. Results

The following sub-sections present estimation results for bank competition over time, comparisons across banks of different sizes, types and ownership.

**Before and after EMU**

The effect of EMU is studied by dividing the whole period into two sub-periods: 1995–2000, and 2001–07.[9] Table 3 displays the estimated average H-statistic for each country and a euro area aggregate[10] for the period of pre EMU (1995–2000), post EMU (2001–07) and post crisis (2008-09). Column (3) and (4) report the H-statistic and standard error before EMU for each country or region, column (5) and (6) after EMU. Column (9) displays the changes in the H-statistics from pre to post EMU period.

The overall competition level in euro area dropped slightly after EMU, from 0.699 to 0.518 while competition levels across member countries converged[11]. The finding that large and financially integrated countries or regions tend to exhibit less competitive behavior than smaller sectors is in line with others studies, including Bikker and Spierdijk (2008), who also

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gains in their statements and therefore possible distortions of the comparisons of H-statistics which are based on factor cost elasticities. Although variables are normalized with total assets, and the effects of accounting differences on H-statistics are not specifically estimated in this paper, conclusions should be drawn with caution.

[9] EMU started in 1999 but the euro entered circulation only in 2002. Estimation results are robust if the sample is split in 1999, or 2000.

[10] This paper delete branches of euro banks in other euro countries in the estimations for euro area aggregate to avoid double counting. For example, Deutsche is treated as one German bank, notwithstanding it having major business abroad. Since consolidated accounts are used if available, this recollection method is reasonable and less complicated given the data.

[11] The standard deviation of H-statistics of euro member countries drops from 0.17 before EMU to 0.12 after EMU.

find some deterioration in competitive behavior over time for Europe's banks. They argue that banks in large and integrated financial markets are pushed by rising capital market competition and tend to shift from traditional intermediation to more sophisticated and complex products associated with less price competition. While the small decline in the level of bank competition for the euro area is statistically significant, it is somewhat smaller than the estimates reported by Bikker et al. (2008) using an un-scaled revenue function. For Austria and Germany, a slight increase in the competition level of their banking systems is estimated; however, the increase is not statistically significant. The H-statistics in Finland, France, Greece, Italy and Netherlands dropped after EMU. At the same time, Spain, the U.K. and the U.S. experienced some small but statistically significant improvement in the competition level of their banking systems.

**Before and after the recent financial crisis**

The recent financial crisis and possibly corresponding policies seem to have left a strong mark on bank competition in many countries, as indicated by the competition indicators before and after the crisis for the sample. Using the reduced revenue equation (2), this section estimates the H-statistic for each country. The post-crisis period covers year 2008 to 2009. Though most countries show equilibrium market structure in the equilibrium test in both periods, the results should be treated cautiously as exit and entry of banks in some countries signals that the long-run equilibrium characterized by zero profits which is a necessary condition for the validity of the H-Statistics could be distorted.

Column (7) and (8) of Table 3 show the H-statistics after the financial crisis. In the U.S., Italy, Germany, Spain and the euro area, bank competition seems to have declined following the financial crisis; however the declines in Germany, Italy and euro area are trivial. Estimates suggest that in the U.S. and Spain, where large credit and housing booms had preceded the crisis, a significant fall in competition following the recent global financial crisis may have occurred. While competition in Netherlands shows some increase, other euro countries remained broadly unchanged. Finally, these post-crisis estimates only provide preliminary evidence in view of the limited number of observations and the fact the structural changes in the aftermath of the crisis may distort the long-run market equilibrium necessary for validity of the H-Statistic.

In the following sub-sections, results for bank competition comparisons across banks of different sizes, types and ownership are presented. Due to the limited observations in the post crisis period in some countries, the over time comparisons of the sample separations are made between pre and post EMU periods.

**Bank competition among large and small banks**

There is no strong pattern suggesting whether large (top 50) or small banks (bottom 50) compete harder (see Table 4 for the comparison among banks of different sizes). For some countries, like U.S. and U.K., small banks compete more intensively, while larger banks in Austria, France, Italy, Portugal and Spain are more competitive before EMU. In other countries, the competition indicators of larger banks are not statistically different from those of smaller banks before EMU (panel A of table 4). Panel B of table 4 compares competition among large and small banks after EMU. Interestingly, small banks show more competitive behavior in most countries, except in France and Spain. Panel C compares the changes of competition within small and large banks. The euro area, France, Greece, Italy and Netherlands have experienced a significant drop in competition in both small and large banks, while both banks in the U.S. and U.K. showed a noticeable increase.

**Comparison across bank types**

The sample countries vary in the composition of their banking systems. For some countries, including U.S, U.K., Finland, Greece and etc, commercial banks dominate, while in Germany and Italy, there are more savings banks and cooperative banks. The sample is divided into two groups: savings and cooperative banks, and commercial banks. This section investigates selected countries: U.S., France, Germany, Italy, Spain and Austria because other countries have a predominant number of one group of banks while lack the other group (see column (17)-(20) in table 5 for the number of observations and banks in the sample).

Before EMU, in Germany, Italy and USA, commercial banks are more competitive than savings/corporative banks. After EMU, the differences between commercial banks and savings/corporative banks are small and not significant, in most euro countries (except Spain), which indicates competition levels of different types of banks after EMU seem to converge. For the euro area, commercial banks display higher competition level after EMU. In contrast, commercial banks are consistently more competitive in the U.S. over time. Panel C in table 5 displays the evolution of H-statistics for two groups of banks. Most euro-area countries and the euro area as a whole have seen drops in competition for both types of banks, in contrast with improvements in the U.S.

However, there is no sign suggesting that whole banking systems with more diversified bank types compete harder. After comparing the H-statistics of U.S, France, Germany, Italy, Spain and Austria with those of other countries in both sub-sample periods for all types of banks (see table 3), the average H-statistic of the former group, which has more diversified banking system, is lower than that of the later one, and the difference is statistically significant at 5% level[12].

**Foreign vs. Domestic banks**

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[12] The t-test is not reported, but can be easily computed.

Some research indicates that the competition from foreign banks promotes the competition in local market. This paper finds mixed patterns: some domestic markets become more competitive over time, while some do not. Foreign banks here are defined to have over 51% of foreign ownership. Due to the limited information from the database, not all banks report their global ultimate ownership. In this section, the sample only includes banks which report their global ultimate owners and countries with more than 50 bank-year observations in each (foreign/domestic) group (see panel C in table 6 for the number of observations and banks). Therefore, countries in this section are reduced to: U.S., U.K., France, Italy and Portugal.

Panels A and B in Table 6 display the results for both foreign and domestic banks before and after EMU. In France and U.S., foreign banks compete harder before EMU, but the differences between foreign and domestic banks are smaller and not significant after EMU. For Italy and Portugal, the competition among foreign banks and domestic banks is not significantly different in both periods. From results in panel B, we could see that after EMU, the difference in the competition levels between foreign and domestic banks tend be less obvious in both Europe and U.S. Panel C of table 6 shows the evolution of H-statistics among foreign and domestic banks. In Franc and Italy, both foreign and domestic banks regressed (although the fall in domestic banks in Italy is not significant), while foreign banks in U.K. and domestic banks in U.S. banking systems improved over time.

## IV. CONCLUSION

Estimates of bank competition for the euro-area countries, a euro area aggregate and the U.K., U.S. suggest that neither the introduction of the euro nor the recent financial crisis has had a common impact across countries. The euro area experienced a significant but small decline in bank competition after EMU and the financial crisis. Some studies with similar findings have attributed the decline in competition to the process of consolidation, and the movement of bank activities from traditional financial business to off-balance sheet activities. More importantly, competition levels in euro countries seem to have converged after EMU, not just at the average national market level, but also between different bank types and ownership. Finally, following the financial crisis, competition fell in many countries, and especially in some countries where large credit and housing booms took place.

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## APPENDIX: SIMPLIFIED PANZAR-ROSSE MODEL

**Monopoly**

For monopoly market, the firm profits can be written as:

$$\pi = R(y, z) - C(y, z, w, t) \qquad (1)$$

Where $R(y, z)$ is the revenue function, and $C(y, z, w, t)$ is the firm's cost function. Here, z is a vector of exogenous variables and y is a vector of decision variables in the revenue function. In the cost function, w is a vector of input prices, and t is a vector of exogenous variables. Let $y^0 = argmax_y\{\pi(y, z, w, t)\}$ and $y^1 = argmax_y\{\pi(y, z, (1 + h)w, t)\}$, with $h > 0$. Define $R^0 = R(y^0, z) \equiv R^*(z, w, t)$ and $R^1 = R(y^1, z) \equiv R^*(z, (1 + h)w, t)$. Then we can get the following inequality by definition:

$$R^1 - C(y^1, (1 + h)w, t) \geq R^0 - C(y^0, (1 + h)w, t) \qquad (2)$$

Assuming the cost function is linearly homogeneous, after a few simple algebra transitions we could easily obtain

$$\frac{R^1 - R^0}{h} = \frac{[R^*(z, (1 + h)w, t) - R^*(z, w, t)]}{h} \leq 0 \qquad (3)$$

Also assuming the reduced form revenue function is differentiable, (3) yields

$$\psi^* \equiv \sum w_i \left(\frac{\partial R^*}{\partial w_i}\right) / R^* \leq 0 \qquad (4)$$

as $h \to 0$.

$\psi^*$ is the sum of the factor price elasticities, which is non-positive for a profit-maximizing monopolist, since the increase in cost leads to cut in output and thus fall in the revenue.

**Monopolistic Competition**

In Monopolistic competition, PR assumes that the firms are in long-run equilibrium and earn zero economic profit. So the firm profits can be written as:

$$\pi = R(y, \hat{n}, z, ) - C(\hat{y}, z, w, t) = 0 \qquad (5)$$

where $\hat{n}$ and $\hat{y}$ are the long run equilibrium number of rivals and output, which are defined as functions of $z, w$ and $t$.

Different from monopoly, the demand curve facing a monopolistic competitive firm is dependent on the number of rivals, the prices and quantities of the substitute goods in the market. The inverse demand function $P(y, n, z)$ is a function of output (y), the number of rivals (n) and other exogenous variables (z). They also assume that $\frac{\partial P}{\partial y} \equiv P_y < 0$ and $\frac{\partial P}{\partial n} \equiv P_n < 0$, i.e. the demand is decreasing function of its own output and the number of rivals in the market. The demand elasticity facing individual firm, $(y, n, z) \equiv -P/[\frac{y\partial P}{\partial y}]$, is assumed to be non-decreasing function of the number of rivals, i.e. $\frac{\partial e}{\partial n} = (PP_{yn} - P_y P_n)/[y(P_y)^2] \geq 0$.

Letting $R(y, n, z) = yP(y, n, z)$, the first order condition for the profit function with respect to y is:

$$R_y - C_y = 0 \qquad (6)$$

Totally differentiating (5) and (6) using Cramer's Rule, and summing over all inputs, PR transforms (4) into:

$$\hat{\psi} = \sum w_i \left(\frac{\partial \hat{R}}{\partial w_i}\right) / \hat{R} = 1 + \frac{R_y(R_n R_y - R_{yn}R)}{[\hat{R}(R_{yy} - R_{yy})R_n]} \qquad (7)$$

where $\hat{R} = R(\hat{y}, \hat{n}, z)$.

(7) can be rewritten into (8) using $R(y, n, z) = yP(y, n, z)$:

$$\hat{\psi} = \sum w_i \left(\frac{\partial \hat{R}}{\partial w_i}\right) / \hat{R} = 1 + \frac{R_y[y^2(P_n P_y - P_{yn}P)}{[\hat{R}(R_{yy} - R_{yy})R_n]} \le 1 \qquad (8)$$

By assumption that $\frac{\partial e}{\partial n} \ge 0$, then $\hat{\psi} \le 1$, i.e. the sum of elasticities of factor prices for a monopolistic competitive firm is less than or equal to unity.

**Competitive Market**
In the competitive market, changes input prices will lead to entry and exit in the long run and thus affect the output and output price. (5) and (6) can be written into:

$$p^c y^c - C(y^c, w, t) = 0 \qquad (9)$$

and $\qquad p^c - C_y(y^c, w, t) = 0 \qquad (10)$

where $p^c$ and $y^c$ are defined as the equilibrium price and output in perfect competitive market.

Totally differentiating (9) and (10) and using Cramer's Rule, PR obtains the sum of factor price elasticities for the perfect competition:

$$\psi^c = \sum \left(\frac{w_i}{R^c}\right)(\partial R^c / \partial w_i) = [(\frac{C_y}{yC_{yy}})(C - yC_y) + C ]/R^c \qquad (11)$$

where $R^c \equiv p^c(w, t)y^c(w, t)$. Further substituting (9) and (10) into (11), we could get

$$\psi^c = \sum \left(\frac{w_i}{R^c}\right)(\partial R^c / \partial w_i) = 1 \qquad (12)$$

In the competitive equilibrium, the sum of factor price elasticities is equal to unity.

## Table 1. Summary Statistics

| Country | Gross interest income over total assets | Total income over total assets | Total interest expenses to total deposits and money market funding | Personnel expense over total assets | Other operating expenses over total assets | Equity over total assets | Net loans to total assets | Total assets ('000,000 USD) |
|---|---|---|---|---|---|---|---|---|
| Austria | 0.045 | 0.077 | 0.029 | 0.012 | 0.008 | 6.15 | 57.70 | 471.09 |
| Finland | 0.042 | 0.072 | 0.032 | 0.008 | 0.010 | 5.52 | 56.96 | 22900.00 |
| France | 0.054 | 0.092 | 0.037 | 0.014 | 0.011 | 6.39 | 63.74 | 3942.03 |
| Germany | 0.052 | 0.088 | 0.031 | 0.015 | 0.010 | 5.10 | 62.59 | 567.64 |
| Greece | 0.056 | 0.100 | 0.036 | 0.014 | 0.012 | 7.47 | 59.53 | 5039.09 |
| Ireland | 0.040 | 0.056 | 0.042 | 0.001 | 0.002 | 4.86 | 53.83 | 15600.00 |
| Italy | 0.051 | 0.092 | 0.035 | 0.015 | 0.013 | 10.34 | 63.21 | 564.45 |
| Netherlands | 0.050 | 0.075 | 0.049 | 0.008 | 0.007 | 5.28 | 59.92 | 16200.00 |
| Portugal | 0.059 | 0.091 | 0.049 | 0.010 | 0.010 | 5.80 | 55.54 | 5915.19 |
| Spain | 0.048 | 0.081 | 0.029 | 0.011 | 0.008 | 6.97 | 67.73 | 6200.13 |
| U.K. | 0.056 | 0.086 | 0.047 | 0.009 | 0.009 | 7.42 | 48.43 | 4854.15 |
| U.S. | 0.059 | 0.103 | 0.027 | 0.015 | 0.013 | 9.58 | 65.85 | 113.53 |

Note: This table reports the median of major variables for each country. The sample covers the years 1995-2009. Data source: BankScope

## Table 2. Correlation Matrix Between Major Variables

| | Gross interest income over total assets | Total income over total assets | Total interest expenses to total deposits and money market funding | Personnel expense over total assets | Other operating expenses over total assets | Equity over total assets | Net loans to total assets | Total assets ('000,000 USD) |
|---|---|---|---|---|---|---|---|---|
| Gross interest income over total assets | 1 | | | | | | | |
| Total income over total assets | 0.8605* | 1 | | | | | | |
| Total interest expenses to total deposits and money market funding | 0.5692* | 0.2216* | 1 | | | | | |
| Personnel expense over total assets | 0.1871* | 0.4637* | -0.2253* | 1 | | | | |
| Other operating expenses over total assets | 0.1905* | 0.4407* | -0.1652* | 0.5734* | 1 | | | |
| Equity over total assets | -0.0273* | 0.0489* | -0.1176* | 0.0772* | 0.0229* | 1 | | |
| Net loans to total assets | 0.2113* | 0.2147* | 0.0495* | 0.0814* | 0.0862* | -0.1219* | 1 | |
| Total assets ('000,000 USD) | -0.0816* | -0.1182* | 0.0975* | -0.1125* | -0.0898* | -0.1022* | -0.0529* | 1 |

Note: This table reports the correlation matrix between major variables for all observations including all countries in the sample for 1995-2009. * significant at 5% level

# Table 3. H-Statistics Over Time

| | # obs. | # banks | Before EMU | | After EMU | | After Crisis | | compare pre and post EMU | | compare pre and post Crisis | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | H-Statistic | S.E | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E | ΔH | S.E |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9)=(5)-(3) | (10) | (11)=(7)-(5) | (12) |
| Austria | 751 | 114 | 0.583*** | 0.0355 | 0.604*** | 0.0273 | 0.707*** | 0.104 | 0.0209 | 0.0437 | 0.103 | 0.107 |
| Finland | 94 | 15 | 0.797*** | 0.0966 | 0.550*** | 0.0628 | 0.647*** | 0.0528 | -0.247** | 0.116 | 0.0964 | 0.0793 |
| France | 2,921 | 359 | 0.638*** | 0.0139 | 0.584*** | 0.0162 | 0.625*** | 0.0504 | -0.0544*** | 0.0212 | 0.0414 | 0.0529 |
| Germany | 6,625 | 1558 | 0.432*** | 0.0141 | 0.449*** | 0.00956 | 0.364*** | 0.0211 | 0.0171 | 0.0166 | -0.0849*** | 0.0229 |
| Greece | 199 | 28 | 0.816*** | 0.0780 | 0.518*** | 0.0599 | 0.385*** | 0.0992 | -0.298*** | 0.0966 | -0.133 | 0.113 |
| Ireland | 144 | 28 | 1.020*** | 0.161 | 0.754*** | 0.0705 | 0.589*** | 0.125 | -0.266 | 0.172 | -0.165 | 0.144 |
| Italy | 4,776 | 689 | 0.878*** | 0.0144 | 0.588*** | 0.0130 | 0.496*** | 0.0310 | -0.290*** | 0.0194 | -0.0917*** | 0.0334 |
| Netherlands | 169 | 29 | 0.896*** | 0.155 | 0.407*** | 0.0611 | 0.611*** | 0.0833 | -0.488*** | 0.162 | 0.204** | 0.0976 |
| Portugal | 255 | 37 | 0.705*** | 0.0401 | 0.679*** | 0.0525 | 0.849*** | 0.170 | -0.0254 | 0.0660 | 0.170 | 0.178 |
| Spain | 1,120 | 164 | 0.704*** | 0.0261 | 0.795*** | 0.0282 | 0.505*** | 0.0509 | 0.0908** | 0.0380 | -0.290*** | 0.0579 |
| U.K. | 813 | 137 | 0.506*** | 0.0371 | 0.647*** | 0.0270 | 0.618*** | 0.0467 | 0.141*** | 0.0443 | -0.0289 | 0.0531 |
| U.S. | 82,566 | 9338 | 0.309*** | 0.00691 | 0.425*** | 0.00258 | 0.270*** | 0.00529 | 0.116*** | 0.00725 | -0.155*** | 0.00578 |
| euro area | 16,706 | 2969 | 0.699*** | 0.00645 | 0.518*** | 0.00609 | 0.444*** | 0.0123 | -0.182*** | 0.00879 | -0.0737*** | 0.0136 |

Note: The table displays the estimated average H-statistics of two reduced-form bank revenue equations using pooled OLS for each country and euro area aggregate independently: $\ln P = \alpha_0 + \beta_1 \ln W_1 + \beta_2 \ln W_2 + \beta_3 \ln W_3 + \gamma_1 \ln Y_1 + \gamma_2 \ln Y_2 + \gamma_3 \ln Y_3 + T_1*(\alpha_1 + \beta_4 \ln W_1 + \beta_5 \ln W_2 + \beta_6 \ln W_3 + \gamma_4 \ln Y_1 + \gamma_5 \ln Y_2 + \gamma_6 \ln Y_3) + T_2*(\alpha_2 + \beta_7 \ln W_1 + \beta_8 \ln W_2 + \beta_9 \ln W_3 + \gamma_7 \ln Y_1 + \gamma_8 \ln Y_2 + \gamma_9 \ln Y_3) + \varepsilon$. One is estimated using gross interest revenue over total assets as dependent variable, the other one using gross revenue (interest and other revenue) over total assets. The sample covers years 1995-2009. The pre EMU period is from 1995-2000, post EMU from 2001-07, and post financial crisis from 2008-09. $T_1, T_2$ are the time dummies for EMU and financial crisis respectively: $T_1=1$ for for 2001-2007, $T_1=0$, otherwise; $T_2=1$ for 2008-09, $T_2=0$, otherwise. $H= \beta_1+\beta_2+\beta_3$ for pre EMU period, $H= \beta_1+\beta_2+\beta_3+\beta_4+\beta_5+\beta_6$ for post EMU, $H= \beta_1+\beta_2+\beta_3+\beta_7+\beta_8+\beta_9$ for post financial crisis period. Column (9) and (11) display the difference in the H-statistic pre and post EMU, i.e. (9)=(5)-(3), and the H-statistic pre and post financial crisis, i.e. (11)=(7)-(5) . All variables in the estimations are annual data from BankScope. *** p<0.01, ** p<0.05, * p<0.1.

**Table 4. H-Statistics of Banking System by Size**

Panel A: Before EMU

| | SMALL | | LARGE | | Diff | |
|---|---|---|---|---|---|---|
| | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E |
| | (1) | (2) | (3) | (4) | (5)=(3)-(1) | (6) |
| Austria | 0.459*** | 0.0523 | 0.714*** | 0.0471 | 0.255*** | 0.0698 |
| Finland | 0.840*** | 0.0919 | 0.783*** | 0.175 | -0.0572 | 0.196 |
| France | 0.616*** | 0.0184 | 0.675*** | 0.0202 | 0.0582** | 0.0271 |
| Germany | 0.447*** | 0.0204 | 0.415*** | 0.0210 | -0.0319 | 0.0290 |
| Greece | 0.789*** | 0.0960 | 0.829*** | 0.169 | 0.0399 | 0.194 |
| Italy | 0.803*** | 0.0232 | 0.929*** | 0.0182 | 0.126*** | 0.0295 |
| Netherlands | 1.153*** | 0.176 | 0.837*** | 0.287 | -0.316 | 0.337 |
| Portugal | 0.677*** | 0.0437 | 0.858*** | 0.0839 | 0.182* | 0.0936 |
| Spain | 0.659*** | 0.0319 | 0.804*** | 0.0503 | 0.145** | 0.0593 |
| U.K. | 0.534*** | 0.0419 | 0.406*** | 0.0612 | -0.128* | 0.0730 |
| U.S. | 0.375*** | 0.00935 | 0.245*** | 0.00989 | -0.130*** | 0.0135 |
| euro area | 0.667*** | 0.0109 | 0.706*** | 0.00817 | 0.0394*** | 0.0134 |

Panel B: After EMU

| | SMALL | | LARGE | | Diff | |
|---|---|---|---|---|---|---|
| | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E |
| | (7) | (8) | (9) | (10) | (11)=(9)-(7) | (12) |
| Austria | 0.665*** | 0.0345 | 0.543*** | 0.0422 | -0.122** | 0.0535 |
| Finland | 0.709*** | 0.134 | 0.735*** | 0.0747 | 0.0265 | 0.160 |
| France | 0.534*** | 0.0258 | 0.612*** | 0.0207 | 0.0783** | 0.0332 |
| Germany | 0.455*** | 0.0151 | 0.441*** | 0.0133 | -0.0145 | 0.0199 |
| Greece | 0.483*** | 0.104 | 0.481*** | 0.0811 | -0.00129 | 0.135 |
| Italy | 0.601*** | 0.0178 | 0.587*** | 0.0185 | -0.0149 | 0.0256 |
| Netherlands | 0.579*** | 0.0766 | 0.333*** | 0.0724 | -0.246** | 0.100 |
| Portugal | 0.810*** | 0.0671 | 0.455*** | 0.0760 | -0.354*** | 0.102 |
| Spain | 0.739*** | 0.0417 | 0.852*** | 0.0405 | 0.113* | 0.0580 |
| U.K. | 0.645*** | 0.0364 | 0.601*** | 0.0382 | -0.0440 | 0.0517 |
| U.S. | 0.432*** | 0.00367 | 0.423*** | 0.00349 | -0.00905* | 0.00497 |
| euro area | 0.495*** | 0.0110 | 0.553*** | 0.00760 | 0.0579*** | 0.0133 |

| Panel C: Compare pre and post EMU | | | | |
| --- | --- | --- | --- | --- |
| | SMALL | | LARGE | |
| | ΔH | S.E | ΔH | S.E |
| | (13)=(7)-(1) | (14) | (15)=(9)-(3) | (16) |
| Austria | 0.206*** | 0.0616 | -0.170*** | 0.0626 |
| Finland | -0.131 | 0.158 | -0.0473 | 0.190 |
| France | -0.0826*** | 0.0317 | -0.0625** | 0.0283 |
| Germany | 0.00799 | 0.0251 | 0.0253 | 0.0244 |
| Greece | -0.306** | 0.144 | -0.348* | 0.190 |
| Italy | -0.202*** | 0.0292 | -0.342*** | 0.0259 |
| Netherlands | -0.574*** | 0.188 | -0.504* | 0.296 |
| Portugal | 0.133* | 0.0806 | -0.403*** | 0.113 |
| Spain | 0.0803 | 0.0524 | 0.0481 | 0.0642 |
| U.K. | 0.112** | 0.0546 | 0.195*** | 0.0698 |
| U.S. | 0.0567*** | 0.00992 | 0.178*** | 0.0104 |
| euro area | -0.172*** | 0.0155 | -0.154*** | 0.0112 |

Note: The table displays the estimated average H-statistics of two reduced-form bank revenue equations using pooled OLS for each country and euro area independently: $lnP=\alpha0+\beta1lnW1+\beta2lnW2+\beta3lnW3+\gamma1lnY1+\gamma2lnY2+\gamma3lnY3+T1*(\alpha1+\beta4lnW1+\beta5lnW2+\beta6lnW3+\gamma4lnY1+\gamma5lnY2+\gamma6lnY3)+\varepsilon$. One is estimated using gross interest revenue over total assets as dependent variable, the other one using gross revenue (interest and other revenue) over total assets. T1 is the time dummy for EMU, T1=0 for 1995-2000, T1=1 for 2001-2007. Column (5) and (11) display the difference in the H-statistic between small and large banks before and after EMU respectively, i.e. (5)=(3)-(1), (11)=(9)-(7). Column (13) and (15) reports the change in H-statistic before and after EMU for small and large banks respectively, i.e. (13)=(7)-(1), (15)=(9)-(3). All variables in the estimations are annual data from BankScope. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

## Table 5. H-Statistics of Banking System by Bank Types

**Panel A: Before EMU**

| | Commercial | | Savings/Corporative | | Diff | |
|---|---|---|---|---|---|---|
| | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E |
| | (1) | (2) | (3) | (4) | (5)=(1)-(3) | (6) |
| Austria | 0.594*** | 0.0400 | 0.741*** | 0.0966 | -0.147 | 0.105 |
| France | 0.632*** | 0.0158 | 0.693*** | 0.0288 | -0.0610* | 0.0324 |
| Germany | 0.609*** | 0.0475 | 0.419*** | 0.0148 | 0.190*** | 0.0495 |
| Italy | 0.922*** | 0.0248 | 0.865*** | 0.0172 | 0.0571* | 0.0302 |
| Spain | 0.640*** | 0.0443 | 0.859*** | 0.0334 | -0.219*** | 0.0550 |
| U.S. | 0.359*** | 0.00722 | 0.239*** | 0.0192 | 0.120*** | 0.0204 |
| euro area | 0.682*** | 0.00974 | 0.721*** | 0.00904 | -0.0388*** | 0.0132 |

**Panel B: After EMU**

| | Commercial | | Savings/Corporative | | Diff | |
|---|---|---|---|---|---|---|
| | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E |
| | (7) | (8) | (9) | (10) | (11)=(7)-(9) | (12) |
| Austria | 0.608*** | 0.0379 | 0.642*** | 0.0456 | -0.0342 | 0.0592 |
| France | 0.572*** | 0.0189 | 0.616*** | 0.0336 | -0.0436 | 0.0385 |
| Germany | 0.454*** | 0.0325 | 0.452*** | 0.0101 | 0.00212 | 0.0340 |
| Italy | 0.587*** | 0.0262 | 0.606*** | 0.0149 | -0.0195 | 0.0301 |
| Spain | 0.678*** | 0.0400 | 0.956*** | 0.0383 | -0.277*** | 0.0555 |
| U.S. | 0.437*** | 0.00260 | 0.395*** | 0.00799 | 0.0422*** | 0.00833 |
| euro area | 0.584*** | 0.0112 | 0.533*** | 0.00833 | 0.0510*** | 0.0139 |

**Panel C: Compare pre and post EMU**

| | Commercial | | Savings/Corporative | | Commercial | | Savings/Corporative | |
|---|---|---|---|---|---|---|---|---|
| | ΔH | S.E | ΔH | S.E | # obs. | # banks | # obs. | # banks |
| | (13)=(7)-(1) | (14) | (15)=(9)-(3) | (16) | (17) | (18) | (19) | (20) |
| Austria | 0.0142 | 0.0538 | -0.0987 | 0.107 | 359 | 52 | 392 | 62 |
| France | -0.0594** | 0.0245 | -0.0769* | 0.0436 | 1396 | 200 | 1525 | 159 |
| Germany | -0.155*** | 0.0574 | 0.0326* | 0.0174 | 177 | 67 | 6448 | 1491 |
| Italy | -0.335*** | 0.0360 | -0.259*** | 0.0228 | 969 | 149 | 3807 | 540 |
| Spain | 0.0386 | 0.0596 | 0.0968** | 0.0493 | 291 | 59 | 829 | 105 |
| U.S. | 0.0780*** | 0.00754 | 0.156*** | 0.0207 | 75217 | 8411 | 7349 | 927 |
| euro area | -0.0987*** | 0.0148 | -0.189*** | 0.0121 | 3002 | 498 | 12987 | 2356 |

Note: The table displays the estimated average H-statistics of two reduced-form bank revenue equations using pooled OLS for each country and euro area independently:
$\ln P = \alpha_0 + \beta_1 \ln W_1 + \beta_2 \ln W_2 + \beta_3 \ln W_3 + \gamma_1 \ln Y_1 + \gamma_2 \ln Y_2 + \gamma_3 \ln Y_3 + T_1 * (\alpha_1 + \beta_4 \ln W_1 + \beta_5 \ln W_2 + \beta_6 \ln W_3 + \gamma_4 \ln Y_1 + \gamma_5 \ln Y_2 + \gamma_6 \ln Y_3) + \varepsilon$.
One is estimated using gross interest revenue over total assets as dependent variable, the other one using gross revenue (interest and other revenue) over total assets. $T_1$ is the time dummy for EMU, $T_1 = 0$ for 1995-2000, $T_1 = 1$ for 2001-2007. Column (5) and (11) display the difference in the H-statistic between commercial and savings banks before and after EMU respectively, i.e. (5)=(3)-(1), (11)=(9)-(7). Column (13) and (15) reports the change in H-statistic before and after EMU for commercial and savings banks respectively, i.e. (13)=(7)-(1), (15)=(9)-(3). All variables in the estimations are annual data from BankScope. *** p<0.01, ** p<0.05, * p<0.1.

**Table 6. H-Statistics of Banking System by Foreign/Domestic Ownership**

Panel A: Before EMU

| | Foreign | | Domestic | | Diff | |
|---|---|---|---|---|---|---|
| | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E |
| | (1) | (2) | (3) | (4) | (5)=(1)-(3) | (6) |
| France | 0.765*** | 0.0589 | 0.626*** | 0.0399 | 0.138* | 0.0707 |
| Italy | 0.712*** | 0.165 | 0.924*** | 0.0305 | -0.212 | 0.167 |
| Portugal | 0.740*** | 0.0921 | 0.581*** | 0.0785 | 0.159 | 0.123 |
| U.K. | 0.421*** | 0.0439 | 0.792*** | 0.0729 | -0.372*** | 0.0852 |
| U.S. | 0.431*** | 0.0632 | 0.242*** | 0.0279 | 0.189*** | 0.0681 |

Panel B: After EMU

| | Foreign | | Domestic | | Diff | |
|---|---|---|---|---|---|---|
| | H-Statistic | S.E | H-Statistic | S.E | ΔH | S.E |
| | (7) | (8) | (9) | (10) | (11)=(7)-(9) | (12) |
| France | 0.550*** | 0.0519 | 0.487*** | 0.0501 | 0.0637 | 0.0723 |
| Italy | 0.638*** | 0.109 | 0.496*** | 0.0295 | 0.142 | 0.113 |
| Portugal | 0.807*** | 0.148 | 0.712*** | 0.0687 | 0.0945 | 0.164 |
| U.K. | 0.700*** | 0.0351 | 0.556*** | 0.0417 | 0.144*** | 0.0540 |
| U.S. | 0.358*** | 0.0358 | 0.397*** | 0.0109 | -0.0385 | 0.0373 |

Panel C: compare pre and post EMU

| | Foreign | | Domestic | | Foreign | | Domestic | |
|---|---|---|---|---|---|---|---|---|
| | ΔH | S.E | ΔH | S.E | # obs. | # banks | # obs. | # banks |
| | (13)=(7)-(1) | (14) | (15)=(9)-(3) | (16) | (17) | (18) | (19) | (20) |
| France | -0.214*** | 0.0782 | -0.140** | 0.0630 | 157 | 24 | 491 | 53 |
| Italy | -0.0741 | 0.197 | -0.428*** | 0.0417 | 61 | 7 | 889 | 100 |
| Portugal | 0.0666 | 0.173 | 0.131 | 0.106 | 50 | 6 | 80 | 11 |
| U.K. | 0.280*** | 0.0548 | -0.236*** | 0.0816 | 334 | 59 | 336 | 47 |
| U.S. | -0.0725 | 0.0720 | 0.155*** | 0.0298 | 406 | 45 | 4811 | 515 |

Note: The table displays the estimated average H-statistics of two reduced-form bank revenue equations using pooled OLS for each country independently:
$lnP = \alpha_0 + \beta_1 lnW_1 + \beta_2 lnW_2 + \beta_3 lnW_3 + \gamma_1 lnY_1 + \gamma_2 lnY_2 + \gamma_3 lnY_3 + T_1*(\alpha_1 + \beta_4 lnW_1 + \beta_5 lnW_2 + \beta_6 lnW_3 + \gamma_4 lnY_1 + \gamma_5 lnY_2 + \gamma_6 lnY_3) + \varepsilon$.
One is estimated using gross interest revenue over total assets as dependent variable, the other one using gross revenue (interest and other revenue) over total assets. T1 is the time dummy for EMU, T1=0 for 1995-2000, T1=1 for 2001-2007. Column (5) and (11) display the difference in the H-statistic between foreign and domestic banks before and after EMU respectively, i.e. (5)=(3)-(1), (11)=(9)-(7). Column (13) and (15) reports the change in H-statistic before and after EMU for foreign and domestic banks respectively, i.e. (13)=(7)-(1), (15)=(9)-(3). All variables in the estimations are annual data from BankScope. *** p<0.01, ** p<0.05, * p<0.1.

**Figure 1. Traditional Measures of Financial Development across Countries**
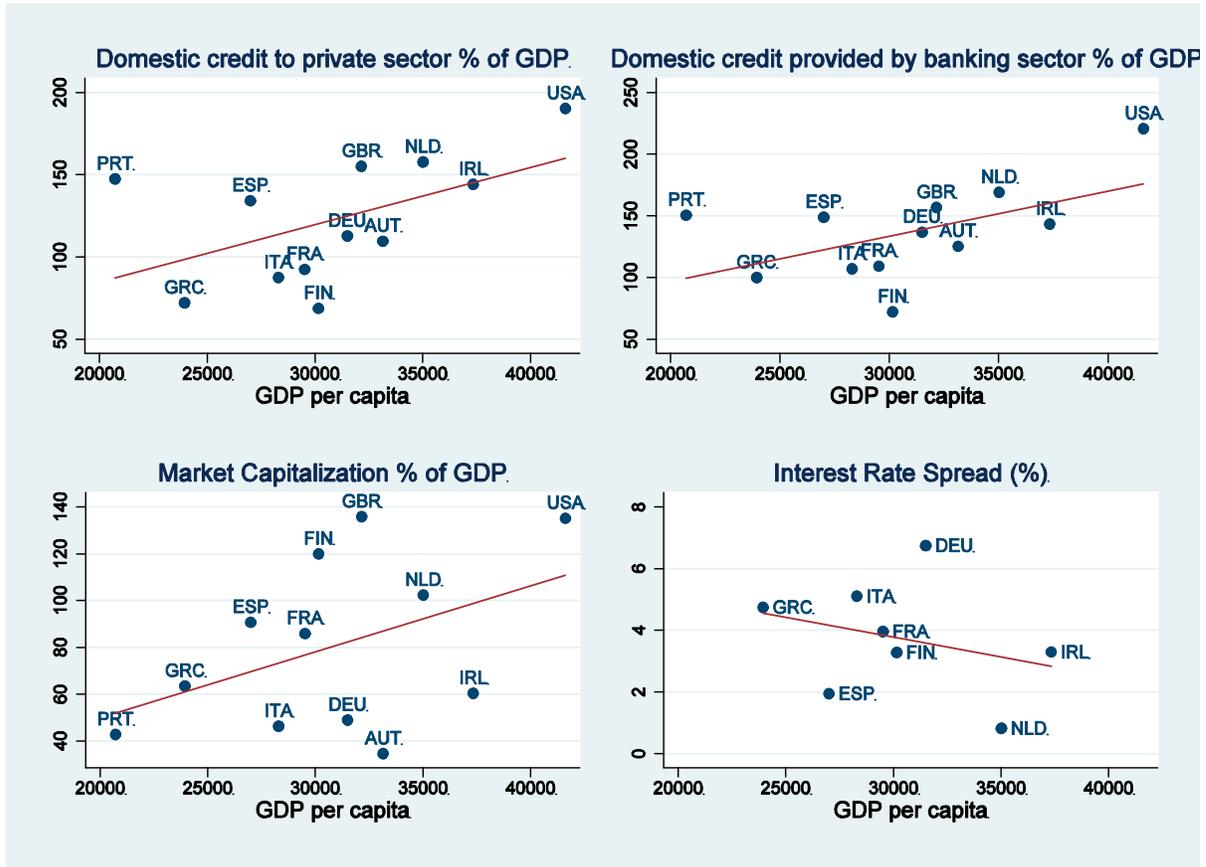


Note: All variables are the average of 2001-07. Countries in the interest rate spread graph are not inclusive due to the lack of data. Data source: International Financial Statistics.