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How Banking Competition Changed over Time

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Abstract

This paper is the first detailed and world-wide investigation of the developments in banking competition during the past fiffteen years. Using the Panzar-Rosse approach, we establish significant changes over time in the competitiveness of the banking industry. The changes in competition over time are small on average, but substantial for several countries and regions. Various Western economies faced a significant decline in banking competition during recent years. In particular, the competitive climate in the euro area was subject to a major break around 2001 - 2002, initiating a period of less competition. Also for the United States and Japan we establish a break during this period. The part of Eastern Europe that now belongs to the European Union experienced a significant but modest decrease in competition during the past ten years. Furthermore, the banking industry in emerging markets became more competitive during the last decade. We attribute the predominantly downward trend in competition to increased bank size and the shift from traditional intermediation to off-balance sheet activities.

Keywords: competition, banking industry, Panzar-Rosse model, structural breaks

JEL classification: C52, G21, L11, L13

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1 Introduction

Over the past decades, both new developments in information technology and further progress in liberalization and harmonization of the financial markets have strongly affected the financial environment in which banks operate. Developments in ICT have changed banks' production technology, products, distribution strategy and the size of financial markets. The Second Banking Coordination Directive, as part of the single European market project in 1992, and the establishment of Economic and Monetary Union (EMU) in 1999 have removed important obstacles to cross-border competition. The creation of large and transparent euro capital markets has promoted competition within the European banking world. Comparative advantages in the management of equity, debt issues, and investment management and mediation have been sharply reduced since the euro replaced the national currencies. Similarly, several changes have drastically altered the banking landscape in the United States. For instance the Reigle-Neal Act of 1994, allowing national banks to operate branches across state lines as of 1997. Another important change was the 1999 Gramm-Leach-Bliley Act, which eliminated the Glass-Steagall Act restrictions against affiliations between commercial and investment banks (stemming from 1933) and allowed banks to engage in underwriting and other dealing activities. These contributions to international integration, together with the entry of new types of competitors using the Internet, are likely to have contributed to banks' competitiveness, particularly in the EMU area. The transition from centrally planned economies to markets economies in Eastern and Central Europe also had a major impact on bank competition in that area. Increased competition may, on pain of being pushed out of the market, force banks to improve their efficiency.

On the other hand, efficiency has also been among the many drivers of the consolidation wave in the banking industry observed during the past decades. This prominent development is reflected by a sharp fall in the number of banks, by the increased banking concentration, and by the rise in the market share of the largest banks both in absolute terms and relative to the smaller banks. The consolidation process may have impaired competition, reducing the improvements in competitiveness mentioned above. For instance, Bikker et al. (2006b) show that larger banks have more market power. Informational technology may have added to higher fixed costs in the banking industry, resulting in increased (unused) scale economies, particularly for smaller banks. Such increased scale economies would contribute further to market power and, hence, to reduction of competition.

Also some other important developments in the banking industry are likely to have affected the competitive developments over time. The continuous shift over time from traditional intermediation to new, more sophisticated and complex products may have reduced competition. Price and quality of modern bank services are more opaque and wholesale banking is often also more tailor-made. Consequently, price competition in these markets is presumably more limited than in traditional intermediation. Hence, competition may be expected to be less strong on the growing non-interest markets.

Given this multitude of major developments with respect to competition, this paper investigates whether and how banking competition has changed over time. We apply the Panzar-Rosse (P-R) approach to measure banks' market power over time. This method uses the H-statistic as a measure of banking competition in a country and is based on the seminal article of Panzar and Rosse (1987). We assess changes in the H statistic over time in three different ways. First, we provide explorative yearly and rolling-window estimates of the H statistic for eleven major industrial economies and two regions to assess how the competitive climate changed during the period $1989-2004$. Second, we focus on 101 countries and analyze the general trend in banking competition during the period $1986-2004$. For the aforementioned countries and regions we have enough data to estimate several parametric models that offer various degrees of flexibility to capture possibly nonlinear changes in the competitive climate. Finally, we detect structural breaks in competition over time using econometric tests for structural stability. These tests do not impose a priori fixed break dates, but are able to detect breaks endogenously. As a robustness check, we additionally correct for a wide range of macro-economic factors to ensure that the changes we assess and the breaks we detect are genuine and not merely due to e.g. movements of the business cycle.

We establish significant changes in banking competition over time. The changes in competition over time in the 101 countries under consideration are small on average, but substantial for several countries and regions. Various major Western economies experienced a significant decline in banking competition in recent years. In particular, the competitive climate in the euro area was subject to a major break around $2001-2002$, initiating a period with less competition. Also for the United States and Japan we establish a break during this period. The countries of Eastern Europe that have been part of the EU since May 2004, experienced a significant but modest decrease in competition during the period $1994-2004$. Moreover, the banking industry in emerging markets has become more competitive during the past few years.

The setup of this paper is as follows. Section 2 provides a brief overview of the literature dealing with changes in banking competition over time. This leads us to Section 3, where we describe the data used. Next, Section 4 introduces the Panzar-Rosse model to measure banking competition. Section 5 presents four approaches to assess changes in competition over time, including tests to detect structural breaks, and provides corresponding estimation outcomes and test results. Finally, Section 6 summarizes and concludes.

2 Literature review

Several studies analyze competition in the banking industry over time, either assuming that competition changes gradually over time or by providing yearly estimates of competition. Some of these studies analyze a relatively short sample period of three to five years using the P-R approach, such as Nathan and Neave (1989), Molyneux et al. (1994), Hydroyiannis et al. (1999), De Bandt and Davis (2000), and Mkrtchyan (2005). Generally, yearly estimates yield erratic results, without clear trends.

Van Leuvensteijn et al. (2007) apply a new approach, the Boone indicator of competition, to the loan markets of eight major countries during the 1994-2004 period. They document an increasing level of competition in Japan, but a decline in France, Italy, and the United States.

Yeyati and Micco (2003) and Wong et al. (2006) apply the P-R model, but investigate a longer period of ten to eleven years. They establish a fairly stable level of competition, slightly increasing over time, even when concentration increases. Angelini and Cetorelli (2003) also analyze a longer time span, focusing on the Italian banking industry during the years 1987−1997. They estimate yearly Lerner indices of competition for a cross-section of Italian banks. Subsequently, they explain these indices from a range of determinants, such as market structure, bank-specific characteristics, macro-economic correction variables and a time dummy distinguishing the period before and after the Second Banking Directive. They document a significant increase in banking competition after 1992, which they contribute to the deregulation process which culminated in the implementation, in 1993, of the Second Banking Directive. Bikker and Haaf (2002) apply the P-R approach in analyzing banking competition in 23 European and non-European countries during the period 1988 − 1998. They allow for gradual changes in the competitive climate and establish a significant increase in competition in 40% of the countries under consideration (i.e. 9 out of 23) and a significant decrease in one country only. A similar approach is adopted by De Bandt and Davis (2000), but for a short period of five years. They find significant changes over time for France only, but without clear trend.

3 Bank data sample

This section describes the data used for the empirical assessment of the changes in banking competition over time.

3.1 Bankscope data

This paper uses a detailed data set obtained from Bankscope. The data set covers 25,000 private and public banks all over the world with standardized reporting data that facilitate comparison across different accounting systems. The panel data set, prior to outlier reduction, is fairly extensive covering banks in 120 countries and spanning the years 1986−2004.

The data set is unbalanced as (for various reasons) not all banks are included throughout the entire period, with strong underrepresentation in the earlier years.

We focus on consolidated data (if available) from commercial, cooperative and savings banks and remove all observations pertaining to other types of financial institutions, such as securities houses, medium and long term credit banks, specialized governmental credit institutions and mortgage banks. The latter types of institutions are presumably less dependent on the traditional intermediation function and may have a different financing structure compared to our focus group. In any case, we favor a more homogeneous sample. We apply a number of selection rules to the most important variables and eliminate data of banks under special circumstances (e.g. holding companies, banks in start-up or discontinuity phases), erroneous data and abnormally high or low ratios between key variables. To compensate for structural differences across countries, we adjust the bounds as necessary. This allows for some flexibility regarding the inclusion of countries that have experienced (extremely) high inflation rates and hence (extremely) high interest rates, or which are more labor-intensive. This operation reduces the number of observations by 6%. For the complete set of selection rules and the exclusion rates, we refer to Bikker et al. (2006a). Finally, we exclude all countries for which the number of bank-year observations over the sample period is less than 50, a minimum number needed to obtain a sufficiently accurate estimate of the country's H statistic. This reduces our sample from 120 to 101 countries (see Table 1).

Our final sample consists of 112,343 bank-year observations from 17,476 different banks, with observations from later years dominating the sample. The United States provided by far the largest number of bank-year observations at 54,466 followed by Germany (19,137), Italy (6,149), France (3,641), and Japan (3,028).

3.2 Macro data

Later we also need some macro data on market capitalization, real annual GDP growth, and long and short rates. These figures have been obtained from the WorldBank (WDI online), the IMF, De Nederlandsche Bank, other central banks and national statistical offices. To proxy the long rate we take the yield on a government bond. For the short rate we use either the money market rate, the call money rate, the interbank deposit rate, the overnight interbank minimum rate, or the average cost of central bank debt, depending on availability.

4 The Panzar-Rosse model

This section provides a short introduction to the Panzar-Rosse (P-R) with constant competition and and extended version of this model that allows banking competition to change gradually over time.

4.1 The approach

Following Bikker and Haaf (2002), the empirical translation of the P-R approach assumes a log-linear marginal cost (MC) function of the form

$$\ln \mathrm{MC} = \alpha_0 + \alpha_1 \ln \mathrm{OUT} + \sum_{i=1}^{m} \beta_i \ln \mathrm{FIP}_i + \sum_{j=1}^{p} \gamma_j \ln \mathrm{EX}_{\mathrm{COST}_j}, \tag{1}$$

where OUT is the output of the bank, FIP the factor input prices and $\mathrm{EX}_{\mathrm{COST}}$ other variables exogenous to the cost function. For the sake of simplicity, we omit the subscripts indicating bank number and bank year. Also the marginal revenue (MR) function is assumed to have a log-linear form, i.e.

$$\ln \mathrm{MR} = \delta_0 + \delta_1 \ln \mathrm{OUT} + \sum_{k=1}^{q} \xi_k \ln \mathrm{EX}_{\mathrm{REV}_k}, \tag{2}$$

where $\mathrm{EX}_{\mathrm{REV}}$ represents variables related to the bank-specific demand function. For a profit-maximizing bank, marginal costs equal marginal revenues in equilibrium. This results in the equilibrium value

$$\begin{aligned} \ln \mathrm{OUT}^* \quad = \quad & (\alpha_0 - \delta_0 + \sum_{i=1}^{m} \beta_i \ln \mathrm{FIP}_i + \sum_{j=1}^{p} \gamma_j \ln \mathrm{EX}_{\mathrm{COST}_j} \\ & - \sum_{k=1}^{q} \xi_k \ln \mathrm{EX}_{\mathrm{REV}_k})/(\delta_1 - \delta_0). \end{aligned} \tag{3}$$

The reduced-form revenue equation is obtained as the product of equilibrium output and the common price level. The latter is determined by the inverse-demand equation, which in logarithmic form looks like

$$\ln p^* = \xi + \ln(\sum_i \mathrm{OUT}_i^*), \tag{4}$$

where the asterisk refers to the equilibrium value. Based on this framework, Bikker and Haaf (2002) arrive at the following empirical reduced-form equation

$$\begin{aligned} \ln \mathrm{II} &= \alpha + \beta \ln \mathrm{AFR} + \gamma \ln \mathrm{PPE} + \delta \ln \mathrm{PCE} \\ &\quad + \sum_j \xi_j \ln \mathrm{BSF}_j + \eta \ln \mathrm{OI} + \mathrm{error}, \end{aligned} \tag{5}$$

where II denotes interest income, AFR the annual funding rate, PPE the price of personnel expenses, PCE the price of capital expenditure and other expenses, BSF bank-specific exogenous factors and OI the ratio of other income to total assets. Although the choice of dependent and explanatory variables often varies, Equation (5) is similar to what is commonly used in the literature.

Rosse and Panzar (1977) and Panzar and Rosse (1987) use Equation (5) to construct the 'H statistic' that allows for a quantitative assessment of the competitive nature of banking markets and the market power of banks. The H statistic is calculated as the sum of the elasticities of a bank's total revenue with respect to that bank's input prices. Hence, based on Equation (5), this statistic equals $H = \beta + \gamma + \delta$. The banking industry is characterized by monopoly or perfect cartel for $H \leq 0$. This is a very general result, requiring little beyond the profit maximization hypothesis itself. Under certain assumptions, it holds that $H \leq 1$ under monopolistic competition, whereas $H = 1$ under perfect competition. Vesala (1995, page 55) proves that H is an increasing function of the demand elasticity e. Hence, in the case of monopolistic competition H serves as a measure of market power over the range $(0, 1)$.

4.2 Empirical implementation

In order to apply the P-R approach to our data, we use the following empirical reduced form equation of bank revenues, in line with Equation (5):

$$\begin{aligned} \ln \mathrm{II} &= \alpha + \beta \ln \mathrm{AFR} + \gamma \ln \mathrm{PPE} + \delta \ln \mathrm{PCE} + \eta_1 \ln \mathrm{LNS\_TA} \\ &\quad + \eta_2 \ln \mathrm{ONEA\_TA} + \eta_3 \ln \mathrm{DPS\_F} + \eta_4 \ln \mathrm{EQ\_TA} \\ &\quad + \eta_5 \mathrm{OI\_II} + \xi_1 \mathrm{COM\_dum} + \xi_2 \mathrm{COO\_dum} + \mathrm{error}. \end{aligned} \tag{6}$$

We cannot observe the three input factor prices (AFR, PPE, PCE) directly. Therefore, we use the ratio of interest expense to total funds as a proxy for the average funding rate, the ratio of annual personnel expenses to total assets as an approximation to the price of personnel expenses, and the ratio of other non-interest expenses to (modeled[1]) fixed assets as a proxy for the price of capital expenditure. Of course, using the ratio of annual personnel expenses to the number of fulltime employees would be a better measure of the unit price of labor. However, due to the limited availability of employee numbers, we use the total assets configuration instead.[2] Additionally, we include a number of bank-specific factors as control variables, mainly balance-sheet ratios that reflect bank behavior and risk profile, which may affect revenues. The ratio of customer loans to total assets (LNS_TA) represents credit risk. Generally, banks compensate for this risk by imposing a surcharge on the prime lending rate, which affects interest income. ONEA_TA equals the ratio of other non-earning assets to total assets, which mirrors characteristics of the asset composition. The ratio of customer deposits to the sum of customer deposits and short term funding (DPS_F) captures features of the funding mix. The ratio of equity to total assets (EQ_TA) is used to account for the leverage reflecting differences in risk preferences across banks. Furthermore, to take into account the increasing role of banking activities

[1] To deal with possible inaccuracies in the measurement of fixed assets, we make an adjustment to this variable. Following Resti (1997) and Bikker and Haaf (2002), we regress the natural logarithm of fixed assets on the logarithm of total assets and loans, including quadratic and cross terms of these variables. Subsequently, we use the regression forecasts of fixed assets to calculate the price of capital expenditure.

[2] Furthermore, closer investigation of the number of employees reported in Bankscope reveals that these data are rather unreliable.

other than financial intermediation, which draw on the same inputs, we complement the analysis including the ratio of other income to interest income (OI_II). The specification of this explanatory variable hinges on the fact that all inputs are used to generate total income (TI), so that $\ln(\text{TI}) = \ln(\text{II} + \text{OI}) \approx \ln(\text{II}) + \text{OI}/\text{II}$. Using OI_II as an additional explanatory variable with coefficient η_5, this equation by approximation encompasses the models explaining only II ($\eta_5 = 0$) and merely TI ($\eta_5 = 1$). Finally, COM_dum and COO_dum are dummy variables for, respectively, commercial and cooperative banks. They accommodate differences in asset types and sizes and revenue structures across banking types, not accounted for by the other covariates.

As demonstrated by Bikker et al. (2006a), the P-R model generally employed in the literature is misspecified. They show that taking interest income as share of total assets (the 'price'), instead of the absolute interest income (the 'revenue') as the dependent variable in the P-R model leads to serious overestimation of the degree of competition in the banking industry. Generally, a correctly specified P-R model provides significantly lower estimates of competition. Throughout this paper, we estimate the degree of competition in the banking industry from the correctly specified P-R model.

4.3 Modeling issues

The common approach in the literature is to estimate the P-R model of Equation (6) separately for each country, resulting in country-specific H statistics. In this case the level of a country's competition is the average level of competition on the markets where its banks operate. In this paper we first follow the existing literature and estimate P-R models at the country level. Additionally, we also estimate a panel P-R model (with time-dependent H statistic) for the entire EU-15 and a group of Eastern-European countries to see how competition in these regions has changed over time. To estimate one single P-R model for multiple countries the standard P-R model in Equation (6) needs some adjustments to take into account differences across countries with respect to e.g. market structure and macro-economic situation. Therefore, we include various control variables in the P-R model, resulting in a new reduced-form revenue equation given below. Since we now study banks in different countries, we add subscripts to the revenue equation's variables. Subscript i denotes banks, subscript j countries, and t years. This yields, for $i = 1, \ldots, N$, $j = 1, \ldots, M$ and $t = 1, \ldots, T$:

$$\begin{aligned} \ln \mathrm{II}_{ijt} &= \alpha + \beta \ln \mathrm{AFR}_{ijt} + \gamma \ln \mathrm{PPE}_{ijt} + \delta \ln \mathrm{PCE}_{ijt} + \eta_1 \ln \mathrm{LNS\_TA}_{ijt} \\ &\quad + \eta_2 \ln \mathrm{ONEA\_TA}_{ijt} + \eta_3 \ln \mathrm{DPS\_F}_{ijt} + \eta_4 \ln \mathrm{EQ\_TA}_{ijt} \\ &\quad + \eta_5 \mathrm{OI\_II}_{ijt} + \xi_1 \mathrm{COM\_dum}_{ijt} + \xi_2 \mathrm{COO\_dum}_{ijt} + \epsilon_1 \mathrm{marketcap\_gdp}_{jt} \\ &\quad + \epsilon_2 \mathrm{real\_growth\_gdp}_{jt} + \epsilon_3 \mathrm{diff\_long\_short}_{jt} + \mathrm{error}_{ijt}. \end{aligned} \quad (7)$$

To account for macro-economic differences between countries, we include the ratio of market capitalization to GDP, real annual GDP growth, and the difference between the long and the short rate (or yield curve) as explanatory variables to the revenue equation. The H statistic resulting from Equation (7) equals (as usual) $H = \alpha + \beta + \gamma$ and reflects the average level of competition in the EU-15 during the period $1989 - 2004$.

Based on a Hausman test, we include country-specific fixed-effects in the specification of Equation (7) using the least-squares dummy variable approach. We add dummy variables to the model for France, Luxembourg, Germany, Austria, Spain, and Italy.[3] We estimate a similar fixed-effects panel P-R model for nine Eastern European countries that are now part of the EU, being Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia, Estonia, Latvia, and Lithuania.[4]

5 Empirical results

We apply the P-R model in four different ways to assess changes in the competitive climate in the banking industry, using unbalanced data.

[3]For the other countries, we have relatively few observations. Therefore, we group them together into one category that we use as the reference category.

[4]In the panel P-R model for the nine Eastern-European countries we do not include dummies for commercial and cooperative banks, since virtually all banks are commercial ones.

5.1 Yearly estimates of competition

The first approach is based on a yearly estimation of the P-R model in Equation (6). This method is used to explore country specific changes in competition over time and is also applied in e.g. Molyneux et al. (1994), De Bandt and Davis (2000), and Angelini and Cetorelli (2003). We can only apply this method to countries and years for which the sample covers a sufficiently large amount of banks. We can plot the resulting annual values of the H statistic over time to get a first impression of the changes in H over the years. A disadvantage of this approach is that the H values may show rather erratic patterns over time; see Molyneux et al. (1994).

For each country for which we have at least 50 observations a year (including the EU-15 and Eastern Europe), we estimate the P-R model of Equation (6) separately for each year. The resulting H statistics are displayed in Figure 1 as a function of time and and cover the countries France, Germany, Italy, United Kingdom, Austria, Denmark, Luxembourg, Spain, Switzerland, United States, Japan, the EU-15, and Eastern Europe. The starting year of the sample period varies per country, and years with less than 50 bank-year observations a year have been excluded. As expected, the confidence intervals for the yearly estimates are large (although they are generally smaller for later years when there are more observations). Nevertheless, the pictures give a rough indication of the changes in competition over time. Countries with large fluctuations in the degree of competition are Italy, Switzerland, United Kingdom, United States, and Eastern Europe. For France, Germany, and the EU-15 the changes over time are relatively small.

5.2 Recursive least squares

The second method is based on recursive least squares applied to the P-R model. We estimate the model of Equation (6) repeatedly, starting with a sample of a few years and using ever larger subsets of the data. In other words, we estimate the P-R model over an expanding window by increasing the sample by one year at a time. When the samples would cover enough years, the corresponding recursive residuals could be used to apply certain tests for structural stability (e.g. a CUSUM test, see Brown, Durbin, and Evans, 1975). However, our samples are too short to obtain reliable test outcomes so that we omit these formal tests. We only present the recursive estimates for the H statistic to get a visual impression of the changes in the H statistic when more years of data are added to the sample.

For the countries and regions studied in Section 5.1, we also estimate the P-R model of Equation (6) by means of recursive least squares and display the corresponding H statistic as a function of time in Figure 2. Although the confidence bounds are wide − particularly for early years when the sample period is still small − the estimates are less erratic than the yearly ones and several countries feature a clear trend in H. Whereas in France, Germany, Italy, Luxembourg, Switzerland, United States, and the EU-15 competition seem to have declined over time, the remaining nations (being United Kingdom, Austria, Denmark, Spain, Japan, and Eastern-Europe) show a more stable H statistic with often a slight increase over time. Figure 2 also shows an increase over time in the level of competition in Eastern Europe.

5.3 Parametric approach

Although the recursive least squares estimates give a good visual impression of the changes in the competitive climate over time, we are also interested in a more formal assessment of the change in banking competition over the years. Therefore, we propose a third, more formal approach based on Bikker and Haaf (2002). We include time-dependent coefficients in Equation (6), assuming that the long-term equilibrium market structure changes only gradually over time. The new reduced form revenue equation is written as

$$\begin{aligned}\ln \mathrm{II} \;=\;& \alpha + (\beta \ln \mathrm{AFR} + \gamma \ln \mathrm{PPE} + \delta \ln \mathrm{PCE}) \times \exp(\zeta \cdot \mathrm{TIME}) + \eta_1 \ln \mathrm{LNS\_TA} \\ & + \eta_2 \ln \mathrm{ONEA\_TA} + \eta_3 \ln \mathrm{DPS\_F} + \eta_4 \ln \mathrm{EQ\_TA} + \eta_5 \mathrm{OI\_II} \\ & + \xi_1 \mathrm{COM\_dum} + \xi_2 \mathrm{COO\_dum} + \mathrm{error}. \qquad (8)\end{aligned}$$

Here the case $\zeta = 0$ refers to the situation that the competitive structure is constant over time, while $\zeta > 0$ (respectively $\zeta < 0$) indicates an increase (decrease) in competitiveness over time. When competition is allowed to change over time as in Equation (8), the H statistic in the size-independent model equals $H(\text{TIME}) = (\beta+\gamma+\delta)\exp(\zeta \cdot \text{TIME})$. This specification helps to avoid erratic changes in the countries' competitive conditions. The model in Equation (8) is by estimated by means of nonlinear least squares.[5]

For all 101 countries in our sample, we estimate the P-R model of Equation (8). The estimation results are given in Table 2, which also includes the estimation results for the EU-15 and Eastern Europe based on Equation (7). A one-sided t-test points out that the time coefficient ζ is significantly negative for 39 countries, while it is significantly positive for 22 countries. A two-sided t-test show that ζ is significantly different from zero for 49 countries. For the remaining 52 countries, ζ is not significantly different from zero. For the emerging markets among the 101 countries in our sample, the average value of ζ equals 0.0067 (i.e. an annual rise in H of 0.67%), reflecting that emerging economies are generally in a transition process of becoming more competitive.[6] The remaining nations have a negative average value of ζ equal to -0.0181 (i.e. an annual decline in H of 1.8%). For both the EU-15 and the group of nine Eastern European countries the coefficient ζ is significantly negative.

On average, the changes in competition over time are small. The average value of the H statistic ranges from 0.55 (0.19) at the end of the eighties up to 0.50 (0.13) in 2004. The standard P-R model, ignoring changes in H over time, yields an average H statistic of 0.52 (0.14). For the EU-15, the H statistics drops from 0.87 (0.02) in 1989 to 0.55 (0.01) in 2004. In Eastern Europe the H statistic has been decreasing over time as well, from 0.61 (0.06) in 1994 to 0.55 (0.03) in 2004. Apparently, the average levels of competition

[5]Throughout, we do not include bank-specific random or fixed effects in the P-R model. However, we notice that inclusion of these effects does hardly affect the resulting values of the H-statistic. For more details, see Bikker et al. (2006a).

[6]We classify a country as an emerging market when it is part of the Morgan Stanley Emerging Markets Index (as of July 2006). Since this index does not contain some smaller emerging economies, we add Estonia, Latvia, Lithuania, Slovakia, Costa Rica, Panama, Uruguay, Venezuela, Kazakhstan, Vietnam, and Nigeria to the list of emerging economies.

in the EU-15 and Eastern Europe came closer over the years and at the end of the period attained the same level.

As a robustness check, we estimate Equation (5) again and allow time to have a quadratic or cubic impact on competition. With the quadratic and cubic specifications, we have $H(\text{TIME}) = (\beta + \gamma + \delta)\exp(\zeta_1 \cdot \text{TIME} + \zeta_2 \cdot \text{TIME}^2)$ and $H(\text{TIME}) = (\beta + \gamma + \delta)\exp(\zeta_1 \cdot \text{TIME} + \zeta_2 \cdot \text{TIME}^2 + \zeta_3 \cdot \text{TIME}^3)$, respectively. Table 3 display the estimation results. The quadratic and cubic models generally need more observations than the simple linear model to get sufficiently accurate estimates. Therefore, we only report the results for eleven major industrial economies, the EU-15 and a group of Eastern-European countries. For ten out of thirteen cases, the quadratic term is significant. For eleven out of thirteen cases, the H statistic is a concave function of time, meaning that competition increases to reach a maximum and decreases thereafter. For Eastern-Europe the individual coefficients in the quadratic specification are insignificant. Table 4 also reports the year in which the maximum or minimum value of the H statistic was attained and the corresponding minimum or maximum value of H. An F test makes clear that for all countries the time-related coefficients are jointly significant. The cubic model includes relatively many insignificant time coefficients, although for eight out of thirteen cases the third order-term is significant. Also, a joint F test points out that for only one single country (Denmark) the time-related coefficients are jointly insignificant. For Eastern-European, the third-order term is significant, but the remaining coefficients are not. Also, the three time coefficients are jointly significant. Furthermore, according to Table 4 the value of the H statistic at the beginning and the end of the sample period often depends substantially on the order of the time polynomial in the chosen model.

The outcomes suggest that the linear model is able to pick up the general trend of the changes in the competitive climate, but that banking competition may develop in a more complex way than the linear model suggests.

5.4 Tests for structural stability

The fourth method is based on formal statistical tests for structural stability. This approach differs substantially from what we did before. In Section 5.3 we imposed a parametric structure on the evolution of the H statistic over time. Here, we adopt a more agnostic approach. We only identify the points in time where the H statistic changed substantially, without imposing a particular form on the behavior of H over time.

The general setup of the test for structural stability is as follows. We allow the input price elasticities β, γ and δ in Equation (6) to depend on time. Consequently, the H statistic, defined as $H = \beta + \gamma + \delta$, may also vary over time. Hence, we write $\beta = \beta_t$, $\gamma = \gamma_t$ and $\delta = \delta_t$. The null hypothesis of a constant level of banking competition over time reduces to the null hypothesis of structural stability of input prices and is formulated as

$$H_0 : \beta_t = \beta_0; \gamma_t = \gamma_0; \delta_t = \delta_0 \qquad [t = 1, \ldots, T], \tag{9}$$

for certain unknown values of β_0, γ_0 and δ_0. As alternative hypothesis we consider a one-time structural change with year of change t^*, which, for $\theta = (\alpha, \beta, \gamma)$, is given by

$$H_1(t^*) : \theta_t(t^*) = \begin{cases} \theta_1 & \text{for } t = 1, \ldots, t^*; \\ \theta_2 & \text{for } t = t^* + 1, \ldots, T. \end{cases}$$

for two constants θ_1 and θ_2. We focus on the situation that the single year of change t^* is unknown. In this case the 'sup-Wald' test discussed in Andrews (1993) is a natural candidate. This is an extension of the traditional Chow test (Chow (1960)) and is also referred to as a Quandt-type test (Quandt (1960)). Where the Chow test is a test for structural change at a given (exogenously determined) point in time, Andrew (1993)'s break point is determined endogenously by the sup-Wald test.

The idea behind the panel sup-Wald test is straightforward.[7] For each possible break year t^*, Equation (6) is estimated over the periods before and after this year. The vector of

[7]Since the traditional sup-Wald test, like most other tests for structural stability, is not directly suitable for our type of panel data consisting of multiple bank observations per year, we adjust this test according to Baltagi (1981).

input price elasticities $\theta = (\beta, \gamma, \delta)$ is allowed to differ before and after the break, but the remaining coefficients are assumed to be stable over time. Next, a Wald test is conducted to test for parameter stability in terms of the vector of input price elasticities, according to the aforementioned H_0 and $H_1(t^*)$. The sup-Wald test is obtained as the largest Wald statistic over break points $\pi = 2, \ldots, T-1$. Furthermore, the date at which it's maximum occurs is the potential break point. In a second version of this test, not only the input price elasticities are allowed to vary over time, but instead all coefficients are allowed to fluctuate. The test statistics are calculated in a similar fashion.

Since the critical values for the supremum tests as tabulated by Andrews (1993) are not necessarily valid in a panel data framework, we follow Dieboldt and Chen (1996) and use a parametric bootstrap under the null hypothesis of structural stability to obtain correct p-values and critical values. As a robustness check, we also perform the avg-Wald and exp-Wald tests proposed by Andrews (1993). Although these tests, unlike the sup-Wald test, do not locate the point of structural change, they do assess whether or not a significant structural change has taken place in the sample period.

There are also tests to locate multiple structural breaks; see Bai and Perron (1998, 2003). However, since our samples are not sufficiently long, we confine our analysis to single break point tests.

Table 5 displays the outcomes of the tests for structural stability. For the eleven major industrial economies, the EU-15 and Eastern Europe we have sufficient data at hand to perform three tests of structural stability with a single endogenous break year (being the sup-Wald, avg-Wald, and the exp-Wald test). For each country we report the value of the tests statistics, the corresponding p-value (obtained from a parametric bootstrap with 500 bootstrap replications), and the break year based on the sup-Wald test.

With exception of Italy, all countries considered that have joined the EMU feature a significant structural break in either 2001 or 2002. This is some years after the formal establishment of the EMU in 1999 and the introduction of the 'virtual' euro. For the non-EMU countries Denmark and the United Kingdom two out of three tests suggest that there is no significant break, whereas in Switzerland a significant break emerges in 1995. For Italy we establish an early break in 1991. The tests for structural stability applied to the EU-15 suggest that there is a significant break on the aggregate level of the EU in 2002. For Eastern Europe there is no significant break according to two out of three tests. For Japan we find a break in 2003, which is the start of a period of increased competition, marking the reform process after a decade of banking crises. For the United States we detect a break in 2001, which initiates a period of lower competition.

The last four columns of Table 5 provide the value of the H statistic in the periods before and after the break and corresponding standard errors. Zooming in on the countries with a significant structural break, we see that only in Japan competition is lower during the years preceding the break. For all other countries with a significant change in the competitive climate, competition decreased over time.

5.5 Interpretation of empirical results

It seems unlikely that the breaks in $2001 - 2002$ and the subsequent decline in banking competition in the EMU countries were caused by a lagged response to the establishment of the EMU and the introduction of the 'virtual' euro in 1999. Above all, the euro is expected to have increased competition among banks. However, indirectly the euro might have played a role anyhow. First, banks may behaved more competitively around the introduction of the euro (expecting stronger competition), but only temporarily as the expected rise in competition did not take place. Hence, the underlying downward trend in competition (see Section 5.3) created a break a few years after the euro was established. Since we correct for several macro-economic variables in the panel P-R model in Equation (7), the structural break identified is not caused by the business cycle but a pure break. Second, the newly created euro capital market has changed the nature of banking services, as it boosted corporate capital market financing at the cost of direct bank lending.[8] In the euro

[8]The capital market financing of non-financial companies increased by 400% in the euro area during the period 1999-2007. As percentage of total lending (including bank lending) capital market debt increased from 17% to 40%. In the non-euro countries in Europe the change in capital market financing varied between -23% (Switzerland) and 150% (Sweden). In the United States, Japan, and Canada the growth was

area it has reduced traditional intermediation of banks, whereas it has favored the service of banks in debt issues. We expect that competition in this debt issue service, where prices and quality are less dominant than reputation, is significantly lower than in the lending market. Although the introduction of the euro in this respect has enforced the efficiency of corporate funding, it may have impaired the average competitive pressure of the euro-area banks.

Similarly, it would not be plausible to interpret the 2002 break in the United States as a lagged response to the repeal in 1999 of the Glass-Steagall Act or to the Riegle-Neal Act. These laws are expected to have improved competition.

We attribute the predominantly downward trend in competition to the process of consolidation, which generally creates larger banks with higher market power (see Bikker et al. (2006b)). Another explanation for the decline in competition is the continuous shift over time from traditional intermediation to more sophisticated and complex banking products. Price and quality of modern banks' services are more opaque and these services are more tailor-made than those based on traditional intermediation markets. Therefore, modern services are likely to give banks an advantage in exploiting their market power. In order to find evidence for our hypothesis, we extend the time-dependent P-R model in Equation (8) and also allow H to depend on the ratio of other income to total income. A significantly negative sign for the coefficient of the share of other income relative to total income would be a first indication that more sophisticated and complex products indeed reduce competition. Table 7 provides some first evidence that a relative increase in the share of other income reduces banking competition in the EU-15. We find a significantly negative effect for five individual European countries. However, our hypothesis is not accepted world-wide, as we do not find evidence for a number of countries outside the EU-15, such as the United States, Eastern Europe, Japan, Switzerland and the United Kingdom.

between -10% (Japan) and 70% (Canada).

5.6 Robustness checks

Throughout this paper, we have been working with unbalanced data samples. Our primary motivation to rely on unbalanced samples is that balanced ones are much smaller, thereby limiting also the number of countries in our analysis. However, measures of competition could potentially be contaminated by changes in the coverage of the Bankscope database, which varies from year to year. Coverage is more limited in the earlier years of the sample period. Consequently, estimates of H based on unbalanced data samples may show temporal fluctuations that are merely due to changing bank coverage. Also, the unbalanced nature of the data could possible bias the estimates of the H statistic. If smaller banks generally operate in a less (more) competitive environment but enter the sample relatively late, this may cause a downward (upward) bias in the estimated degree of competition.

To assess the relevance of these potential problems, we do a robustness check by analyzing several balanced samples. For eight major Western economies we consider balanced samples covering the period $1994-2004$. These countries are the United States, Germany, France, Italy, Denmark, Spain, Luxembourg and Switzerland; see Table 6. The individual samples cover a relatively short period, since a longer time horizon would result in samples with too few banks. The reason that we do not have balanced samples for other countries stems from the lack of balanced samples containing a sufficient amount of banks. We also construct a balanced sample for the EU-15, with exception of the Netherlands, Sweden, and Ireland (for which we do not have enough data). The latter sample covers the period $1989-2004$ and is balanced in the sense that it contains the same banks in each year. Hence, we have balanced samples for eight individual countries covering a short period but a relatively large number of banks, and a balanced sample for the EU-15 stretching out over a longer period but with fewer banks per country. The number of banks and bank-years for the balanced samples are displayed in the second and third columns of Table 6. Although the balanced samples are substantially smaller than the unbalanced ones and contain relatively few banks, we can still use them to get an idea of the differences between balanced and unbalanced data samples. We repeat the analyses of Sections 5.1, 5.2, 5.3, and 5.4 for the balanced data. Throughout, the results for the balanced data are quite similar to the outcomes based on the unbalanced samples. In particular, based on the balanced samples we also detect a strong structural break around $2001 - 2002$ with less competition afterwards. To save space, we do not report full estimation results.[9]

One key assumption underlying the P-R model is that the banks analyzed are in a state of long-run competitive equilibrium (see Panzar and Rosse (1987) and Nathan and Neave (1989)). The observed breaks in some countries may raise the question whether the banks in these countries are in equilibrium or not. That is, a break suggests that the market is in transition from one regime to the next around the break date. However, the disequilibrium relates to an input price shock only, which is generally unrelated to a regime shift of the kind we investigate. As demonstrated in Bikker et al. (2006a), the countries Denmark (no break), France (break in 2001), and United States (break in 2002) are not always in equilibrium during their sample period, emphasizing the possibly transitional phase of the banks in these countries.

6 Conclusions

This paper is the first to investigate in detail the developments in banking competition during the past fifteen years in 101 countries. Using the Panzar-Rosse approach, we establish significant changes in the competitiveness of the banking industry over time.

On average, the changes in competition over time in the 101 countries under consideration are small, but substantial for several countries and regions. Various major Western economies faced a significant decline in banking competition during the past years. For instance, competition decreased by almost 60% in the EU-15. The part of Eastern Europe that is now part of the EU also experienced a significant decrease in competition during the period $1994 - 2004$, although the actual change in the competitive climate in this area is relatively modest (approximately 10%). By contrast, the banking industry in emerging markets became more competitive during the past few years.

[9] These results are available from the authors upon request.

We attribute the predominantly downward trend in competition to the process of consolidation, which generally creates larger banks with higher market power. Furthermore, the continuous shift over time from traditional intermediation to more sophisticated and complex products may also have reduced competition. Price and quality of modern banks' services are more opaque and these services more tailor-made than those based on traditional intermediation markets. Therefore, modern services are likely to give banks an advantage in exploiting their market power. For Europe we find some empirical evidence for this view, but more research is needed to relate the developments in banking competition to the growth in non-interest markets.

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Table 1: Sample information for the 101 countries under consideration

country	ID	start	# obs.	# banks	country	ID	start	# obs.	# banks
Algeria	DZ	1987	51	10	Lithuania	LT	1993	67	13
Andorra	AD	1988	75	8	Luxembourg	LU	1988	1,340	137
Argentina	AR	1990	448	109	Macau	MO	1992	60	8
Armenia	AM	1996	59	12	Macedonia	MK	1992	63	12
Australia	AU	1987	240	32	Malaysia	MY	1992	337	43
Austria	AT	1987	1,339	194	Malta	MT	1989	62	8
Azerbaijan	AZ	1996	50	12	Mauritius	MU	1991	50	12
Bahamas	BS	1991	68	11	Mexico	MX	1989	112	31
Bahrain	BH	1988	117	10	Moldova	MD	1993	61	12
Bangladesh	BD	1992	270	33	Monaco	MC	1992	135	14
Belgium	BE	1987	596	77	Morocco	MA	1987	72	13
Bermuda	BM	1989	53	4	Mozambique	MZ	1992	51	11
Bolivia	BO	1991	136	16	Nepal	NP	1992	90	13
Botswana	BW	1990	50	6	Netherlands	NL	1987	375	51
Brazil	BR	1990	900	167	New Zealand	NZ	1987	89	9
Canada	CA	1987	536	66	Nigeria	NG	1989	319	63
Cayman Islands	KY	1992	58	11	Norway	NO	1987	417	64
Chile	CL	1988	232	35	Oman	OM	1988	78	9
China PR	CN	1988	52	12	Pakistan	PK	1988	207	24
Colombia	CO	1989	293	40	Panama	PA	1989	131	44
Costa Rica	CR	1991	174	38	Paraguay	PY	1990	189	26
Croatia	HR	1991	280	47	Peru	PE	1991	186	26
Cyprus	CY	1989	113	19	Philippines	PH	1988	369	49
Czech Republic	CZ	1989	210	34	Poland	PL	1992	261	50
Denmark	DK	1988	976	99	Portugal	PT	1988	290	32
Dominican Republic	DO	1991	170	27	Romania	RO	1993	135	29
Ecuador	EC	1987	120	29	Russian Federation	RU	1992	632	205
El Salvador	SV	1993	72	14	Saudi Arabia	SA	1987	142	10
Estonia	EE	1993	58	12	Senegal	SN	1993	50	9
Finland	FI	1988	110	14	Singapore	SG	1987	93	20
France	FR	1986	3,641	417	Slovakia	SK	1990	102	21
Germany	DE	1987	19,137	2,299	Slovenia	SI	1993	109	20
Ghana	GH	1991	87	15	South Africa	ZA	1987	189	32
Greece	GR	1988	162	28	Spain	ES	1988	1,513	168
Hong Kong	HK	1988	329	38	Sri Lanka	LK	1992	72	12
Hungary	HU	1989	136	26	Sweden	SE	1987	417	90
Iceland	IS	1990	100	25	Switzerland	CH	1987	2,818	408
India	IN	1989	648	75	Taiwan	TW	1988	69	25
Indonesia	ID	1987	696	105	Thailand	TH	1988	153	18
Ireland	IE	1988	219	34	Trinidad and Tobago	TT	1992	74	11
Israel	IL	1988	145	17	Turkey	TR	1987	210	51
Italy	IT	1987	6,149	817	Ukraine	UA	1993	181	41
Ivory Coast	CI	1992	56	11	United Arab Emirates	AE	1989	120	17
Japan	JP	1987	3,028	562	United Kingdom	GB	1987	1,007	133
Jordan	JO	1989	115	11	United States	US	1989	54,466	9,395
Kazakhstan	KZ	1993	114	23	Uruguay	UY	1990	154	38
Kenya	KE	1989	188	38	Venezuela	VE	1987	280	54
Korea	KR	1991	108	19	Vietnam	VN	1991	135	23
Kuwait	KW	1988	77	6	Zambia	ZM	1990	57	8
Latvia	LV	1992	141	29					
Lebanon	LB	1990	492	59	EU-15		1989	36,304	4,772
Liechtenstein	LI	1989	80	12	Eastern Europe		1994	1,177	234
					total			112,343	17,476

Table 2: **Estimation results for the time-dependent P-R model**

country	**ID**	ζ	p**-value**	H(start)	**std.dev.**	H(ols)	**std.dev.**	H(end)	**std.dev.**
Algeria	DZ	-0.0080	0.59	0.39	0.56	0.25	0.51	0.34	0.47
Andorra	AD	0.0068	0.03	0.79	0.07	0.89	0.03	0.88	0.05
Argentina	AR	0.0716	0.03	0.20	0.08	0.40	0.09	0.55	0.09
Armenia	AM	0.0312	0.28	0.33	0.15	0.50	0.10	0.43	0.12
Australia	AU	0.0130	0.18	0.23	0.20	0.57	0.16	0.29	0.21
Austria	AT	-0.0133	0.00	-0.06	0.11	0.07	0.09	-0.05	0.08
Azerbaijan	AZ	-0.3572	0.07	-0.02	0.46	0.11	0.18	0.00	0.03
Bahamas	BS	-0.0130	0.13	0.71	0.20	0.53	0.19	0.60	0.14
Bahrain	BH	-0.0765	0.00	1.39	0.32	0.52	0.16	0.41	0.11
Bangladesh	BD	-0.0083	0.00	0.96	0.04	0.95	0.07	0.87	0.05
Belgium	BE	-0.0175	0.00	0.98	0.15	0.54	0.12	0.73	0.11
Bermuda	BM	-0.0077	0.00	0.98	0.05	0.76	0.05	0.87	0.04
Bolivia	BO	-0.0007	0.86	1.00	0.09	0.99	0.06	0.99	0.07
Botswana	BW	0.1298	0.03	0.04	0.04	0.08	0.22	0.23	0.16
Brazil	BR	0.0965	0.00	0.14	0.05	0.31	0.07	0.55	0.10
Canada	CA	-0.0720	0.00	0.67	0.29	0.08	0.15	0.20	0.08
Cayman Islands	KY	0.0834	0.28	0.35	0.23	0.59	0.22	0.96	0.42
Chile	CL	0.0247	0.01	0.63	0.11	0.94	0.06	0.93	0.06
China PR	CN	-0.0004	0.94	1.58	0.36	1.56	0.34	1.57	0.26
Colombia	CO	0.0818	0.01	0.23	0.08	0.56	0.13	0.78	0.11
Costa Rica	CR	-0.0290	0.34	1.13	0.34	0.77	0.20	0.78	0.21
Croatia	HR	-0.0895	0.03	0.14	0.17	0.41	0.10	0.04	0.04
Cyprus	CY	-0.0215	0.37	-0.13	0.16	-0.11	0.27	-0.09	0.11
Czech Republic	CZ	-0.0085	0.06	0.93	0.16	0.76	0.15	0.82	0.13
Denmark	DK	0.0081	0.08	0.23	0.05	0.30	0.05	0.27	0.04
Dominican Republic	DO	-0.1057	0.01	0.92	0.35	0.60	0.32	0.23	0.12
Ecuador	EC	-0.0088	0.52	0.77	0.28	0.65	0.23	0.67	0.16
El Salvador	SV	-0.0294	0.04	0.62	0.15	0.41	0.09	0.45	0.10
Estonia	EE	-0.0428	0.47	0.17	0.25	0.41	0.15	0.11	0.13
Finland	FI	0.0084	0.16	-0.06	0.16	-0.24	0.23	-0.07	0.18
France	FR	-0.0447	0.00	1.83	0.07	0.58	0.07	0.82	0.04
Germany	DE	-0.0132	0.00	1.00	0.03	0.65	0.03	0.80	0.02
Ghana	GH	-0.0187	0.43	0.78	0.24	0.64	0.27	0.61	0.18
Greece	GR	0.0207	0.27	0.34	0.15	0.55	0.08	0.47	0.09
Hong Kong	HK	-0.0046	0.36	-0.04	0.13	0.00	0.13	-0.04	0.12
Hungary	HU	0.4082	0.00	0.00	0.00	0.17	0.13	0.79	0.22
Iceland	IS	0.0166	0.01	0.44	0.23	-0.15	0.29	0.55	0.32
India	IN	0.0030	0.37	0.47	0.07	0.49	0.08	0.49	0.06
Indonesia	ID	-0.0355	0.00	-0.11	0.07	0.04	0.05	-0.06	0.04
Ireland	IE	-0.0227	0.06	1.61	0.29	1.11	0.21	1.12	0.20
Israel	IL	0.0091	0.01	0.13	0.07	0.12	0.08	0.15	0.08
Italy	IT	-0.0017	0.54	0.08	0.02	0.08	0.05	0.08	0.03
Ivory Coast	CI	-0.0888	0.17	-0.12	0.50	0.39	0.46	-0.04	0.19
Japan	JP	0.0070	0.00	0.39	0.03	0.45	0.07	0.44	0.02
Jordan	JO	-0.0218	0.00	0.45	0.06	0.27	0.07	0.33	0.06
Kazakhstan	KZ	-0.1365	0.11	1.26	0.60	0.50	0.11	0.28	0.16
Kenya	KE	0.1400	0.01	0.08	0.07	0.76	0.11	0.62	0.11
Korea	KR	-0.0347	0.00	1.62	0.62	0.28	0.32	1.03	0.41
Kuwait	KW	-0.0485	0.03	0.79	0.11	0.70	0.13	0.36	0.12
Latvia	LV	0.0116	0.38	0.46	0.15	0.57	0.11	0.52	0.11
Lebanon	LB	0.0297	0.00	0.27	0.05	0.44	0.06	0.41	0.05
Liechtenstein	LI	-0.0048	0.01	0.87	0.11	0.71	0.08	0.81	0.09
Lithuania	LT	0.0303	0.47	0.29	0.20	0.45	0.13	0.40	0.19
Luxembourg	LU	0.0051	0.07	0.34	0.04	0.33	0.05	0.37	0.06
Macau	MO	-0.1435	0.00	1.29	0.40	0.36	0.14	0.23	0.05
Macedonia	MK	-0.0988	0.27	-0.05	0.45	1.08	0.33	-0.01	0.15
Malaysia	MY	-0.0090	0.07	0.79	0.07	0.74	0.10	0.70	0.07
Malta	MT	0.1633	0.01	0.03	0.02	0.72	0.09	0.30	0.11

Table 2 – continued from previous page

country	**ID**	ζ	p**-value**	H(start)	**std.dev.**	H(ols)	**std.dev.**	H(end)	**std.dev.**
Mauritius	MU	-0.0222	0.44	0.78	0.32	0.58	0.13	0.58	0.12
Mexico	MX	-0.1260	0.23	2.45	2.06	0.85	0.20	0.37	0.29
Moldova	MD	0.0400	0.09	0.37	0.18	0.64	0.21	0.58	0.17
Monaco	MC	-0.0205	0.16	0.53	0.18	0.38	0.13	0.41	0.13
Morocco	MA	-0.0176	0.10	0.43	0.26	0.20	0.25	0.32	0.23
Mozambique	MZ	0.0137	0.41	0.52	0.11	0.50	0.11	0.61	0.18
Nepal	NP	0.0015	0.56	0.88	0.10	0.92	0.11	0.90	0.09
Netherlands	NL	-0.0055	0.14	1.01	0.13	0.90	0.09	0.92	0.10
New Zealand	NZ	-0.0379	0.00	-0.47	0.19	0.35	0.07	-0.25	0.10
Nigeria	NG	0.0126	0.05	0.61	0.06	0.68	0.06	0.74	0.07
Norway	NO	-0.0019	0.35	0.52	0.06	0.48	0.06	0.50	0.05
Oman	OM	0.0053	0.58	0.32	0.14	0.39	0.08	0.35	0.11
Pakistan	PK	-0.0021	0.51	0.56	0.13	0.52	0.11	0.54	0.12
Panama	PA	-0.0007	0.93	0.57	0.09	0.56	0.07	0.56	0.06
Paraguay	PY	0.0178	0.02	0.59	0.07	0.61	0.07	0.75	0.09
Peru	PE	0.1851	0.00	0.12	0.04	0.61	0.08	1.37	0.13
Philippines	PH	-0.0747	0.00	0.93	0.17	0.65	0.06	0.28	0.04
Poland	PL	-0.2405	0.00	0.45	0.49	0.09	0.11	0.03	0.03
Portugal	PT	0.0171	0.24	-0.02	0.09	-0.14	0.13	-0.02	0.11
Romania	RO	-0.0099	0.36	0.66	0.10	0.59	0.07	0.59	0.07
Russian Federation	RU	-0.0019	0.83	0.42	0.06	0.41	0.04	0.41	0.04
Saudi Arabia	SA	-0.0108	0.00	0.62	0.08	0.47	0.06	0.51	0.07
Senegal	SN	-0.2322	0.01	2.27	0.93	1.06	0.14	0.18	0.11
Singapore	SG	0.2355	0.33	0.01	0.04	0.33	0.47	0.51	0.69
Slovakia	SK	-0.0897	0.00	0.56	0.17	0.39	0.11	0.16	0.03
Slovenia	SI	-0.1227	0.00	1.12	0.28	0.39	0.11	0.29	0.09
South Africa	ZA	0.0673	0.14	0.65	0.34	0.84	0.54	2.03	0.78
Spain	ES	-0.0098	0.00	0.61	0.14	0.90	0.08	0.52	0.13
Sri Lanka	LK	-0.0172	0.03	0.82	0.17	0.58	0.24	0.67	0.15
Sweden	SE	-0.2211	0.00	-3.60	0.39	0.48	0.13	-0.08	0.03
Switzerland	CH	-0.0151	0.00	0.96	0.05	0.81	0.05	0.74	0.04
Taiwan	TW	0.0126	0.02	0.76	0.13	0.97	0.12	0.94	0.10
Thailand	TH	-0.0057	0.06	0.69	0.09	0.60	0.09	0.63	0.07
Trinidad & Tobago	TT	-0.0204	0.07	0.27	0.14	0.08	0.14	0.21	0.12
Turkey	TR	0.1234	0.09	0.05	0.07	0.38	0.18	0.43	0.24
Ukraine	UA	0.0223	0.25	0.34	0.10	0.45	0.06	0.44	0.06
United Arab Emirates	AE	-0.0194	0.02	0.61	0.11	0.42	0.07	0.46	0.09
United Kingdom	GB	-0.0167	0.01	1.03	0.11	0.76	0.06	0.76	0.07
United States	US	0.0057	0.00	0.43	0.01	0.48	0.01	0.46	0.00
Uruguay	UY	-0.0096	0.32	0.61	0.06	0.56	0.09	0.53	0.05
Venezuela	VE	-0.0326	0.04	1.29	0.26	0.87	0.06	0.74	0.09
Vietnam	VN	-0.0067	0.13	0.81	0.09	0.74	0.09	0.74	0.08
Zambia	ZM	-0.0176	0.06	0.68	0.15	0.50	0.09	0.53	0.09
average		-0.0089		0.55	0.19	0.52	0.14	0.50	0.13
regions									
EU-15		-0.0306	0.00	0.87	0.02	0.51	0.02	0.55	0.01
Eastern Europe		-0.0103	0.01	0.61	0.06	0.52	0.05	0.55	0.05

Table 3: Estimation results for P-R model with linear, quadratic and cubic impact of time on the H statistic

linear

country	ζ	p**-value**
Austria	-0.0133	0.00
Germany	-0.0132	0.00
France	-0.0447	0.00
Italy	-0.0017	0.54
Japan	0.0070	0.00
United States	0.0057	0.00
United Kingdom	-0.0167	0.01
Spain	-0.0098	0.00
Denmark	0.0081	0.08
Luxembourg	0.0051	0.07
Switzerland	-0.0151	0.00
EU-15	-0.0306	0.00
Eastern Europe	-0.0103	0.01

quadratic

country	ζ_1	p**-value**	ζ_2	p**-value**	F **test**
Austria	-0.0273	0.06	0.0007	0.31	0.00
Germany	0.0301	0.00	-0.0019	0.00	0.00
France	-0.0542	0.00	0.0030	0.00	0.00
Italy	0.0483	0.00	-0.0028	0.00	0.00
Japan	0.1769	0.00	-0.0060	0.00	0.00
United States	0.0287	0.00	-0.0011	0.00	0.00
United Kingdom	-0.0212	0.58	0.0002	0.90	0.02
Spain	-0.0248	0.00	0.0009	0.01	0.00
Denmark	0.0635	0.01	-0.0025	0.02	0.05
Luxembourg	-0.0438	0.00	0.0029	0.00	0.00
Switzerland	0.0322	0.01	-0.0020	0.01	0.00
EU-15	0.0130	0.01	-0.0024	0.00	0.00
Eastern Europe	0.0134	0.36	-0.0022	0.10	0.01

cubic

country	ζ_1	p**-value**	ζ_2	p**-value**	ζ_3	p**-value**	F **test**
Austria	0.0995	0.02	-0.0147	0.00	0.0005	0.00	0.00
Germany	-0.0928	0.00	0.0109	0.00	-0.0004	0.00	0.00
France	0.0126	0.69	-0.0044	0.18	0.0002	0.03	0.00
Italy	0.3366	0.00	-0.0386	0.00	0.0013	0.00	0.00
Japan	0.2036	0.00	-0.0080	0.10	0.0001	0.66	0.00
United States	-0.1598	0.00	0.0185	0.00	-0.0006	0.00	0.00
United Kingdom	-0.1143	0.35	0.0095	0.42	-0.0003	0.43	0.03
Spain	0.0377	0.01	-0.0082	0.00	0.0004	0.00	0.00
Denmark	0.2994	0.13	-0.0251	0.15	0.0007	0.18	0.29
Luxembourg	-0.0322	0.15	0.0012	0.69	0.0001	0.58	0.00
Switzerland	-0.0169	0.56	0.0036	0.26	-0.0002	0.08	0.00
EU-15	-0.1008	0.00	0.0135	0.00	-0.0006	0.00	0.00
Eastern Europe	-0.0064	0.09	0.0146	0.07	-0.0009	0.03	0.00

For 11 major industrial economies and two regions, this table reports the value of the time-coefficients in the linear, quadratic, and cubic time-dependent P-R model. Corresponding p-values (reflecting the significance of the coefficients) are also supplied. Moreover, the table also provides p-values corresponding to a joint F test for the null hypothesis that the time coefficients are jointly zero.

Table 4: Development of the H statistic over time for linear, quadratic, and cubic time-dependent P-R model

linear

country	**H(start)**	**std.dev.**	**H(start)**	**std.dev.**
Austria	-0.06	0.11	-0.05	0.08
Germany	1.00	0.03	0.80	0.02
France	1.83	0.07	0.82	0.04
Italy	0.08	0.02	0.08	0.03
Japan	0.39	0.03	0.44	0.02
United States	0.43	0.01	0.46	0.00
United Kingdom	1.03	0.11	0.76	0.07
Spain	0.61	0.14	0.52	0.13
Denmark	0.23	0.05	0.27	0.04
Luxembourg	0.34	0.04	0.37	0.06
Switzerland	0.96	0.05	0.74	0.04
EU-15	0.87	0.02	0.55	0.01
Eastern Europe	0.61	0.06	0.55	0.05

quadratic

country	**H(begin)**	**std.dev.**	**H(end)**	**std.dev.**	**opt. year**	**H opt.**
Austria	-0.09	0.11	-0.07	0.09	*	
Germany	0.80	0.04	0.76	0.03	1994	0.90
France	0.48	0.06	0.49	0.06	1994	0.38
Italy	0.04	0.03	0.04	0.03	1995	0.05
Japan	0.11	0.02	0.40	0.02	2001	0.42
United States	0.39	0.01	0.47	0.00	2002	0.47
United Kingdom	1.05	0.22	0.77	0.07	*	
Spain	0.69	0.15	0.59	0.14	2001	0.59
Denmark	0.16	0.05	0.24	0.04	2000	0.25
Luxembourg	0.35	0.05	0.37	0.06	1995	0.30
Switzerland	0.83	0.07	0.79	0.04	1994	0.94
EU-15	0.75	0.02	0.53	0.01	1991	0.77
Eastern Europe	0.60	0.06	0.54	0.05	1997	0.61

cubic

country	**H(begin)**	**std.dev.**	**H(end)**	**std.dev.**
Austria	-0.11	0.08	-0.12	0.08
Germany	1.11	0.05	0.71	0.03
France	0.39	0.05	0.49	0.06
Italy	0.00	0.01	0.00	0.03
Japan	0.10	0.04	0.40	0.02
United States	0.67	0.03	0.46	0.01
United Kingdom	1.41	0.56	0.74	0.09
Spain	0.47	0.14	0.45	0.15
Denmark	0.06	0.05	0.20	0.04
Luxembourg	0.35	0.05	0.37	0.06
Switzerland	0.93	0.09	0.78	0.04
EU-15	0.92	0.03	0.51	0.01
Eastern Europe	0.65	0.06	0.54	0.05

For 11 major industrial economies and two regions, this table reports the values of the H statistic at the beginning and the end of the sample period, according to the linear, quadratic, and cubic time-dependent P-R model. Corresponding standard errors are also supplied. When in the quadratic model the optimal value of H is attained after the year 2004, this is indicated by a (*). In this case, we neither report the year in which the minimum or maximum is reached or the corresponding value of H.

Table 5: Tests of structural stability

country	**start sample**	**break year**	***p*-value sup Wald**	***p*-value avg Wald**	***p*-value exp Wald**	***H* before**	**std.dev.**	***H* after**	**std.dev.**
Austria	1997	2002	0.03	0.03	0.02	0.14	0.15	0.02	0.15
Germany	1989	2002	0.00	0.00	0.00	0.83	0.03	0.66	0.07
France	1989	2001	0.00	0.00	0.00	0.90	0.07	0.33	0.09
Italy	1989	1991	0.00	0.00	0.00	0.67	0.16	0.14	0.05
Japan	1998	2003	0.00	0.00	0.00	0.45	0.07	0.60	0.08
United States	1993	2002	0.00	0.00	0.00	0.53	0.02	0.44	0.02
United Kingdom	1992	1995	0.09	0.02	0.07	0.83	0.07	0.61	0.10
Spain	1996	2002	0.00	0.00	0.00	0.41	0.10	0.25	0.16
Denmark	1995	1996	0.10	0.03	0.06	0.14	0.09	0.19	0.06
Luxembourg	1993	2001	0.00	0.00	0.00	0.48	0.07	0.35	0.09
Switzerland	1992	1995	0.00	0.00	0.00	1.10	0.11	0.56	0.06
EU-15	1989	2002	0.00	0.00	0.00	0.63	0.02	0.44	0.03
Eastern Europe	1994	2002	0.09	0.03	0.08	0.59	0.06	0.58	0.08

This table reports the outcomes of three different tests for structural stability for some major industrial economies, the EU-15, and Eastern Europe. For each country the sample period runs until 2004. The reported p-values have been obtained by means of a parametric bootstrap (with $R = 500$ bootstrap replications) under the null hypothesis of structural stability. The last four columns provide the value of the H statistic in the periods before ('H before') and after the break date ('H after'), as well as corresponding standard errors.

Table 6: Sample properties of balanced data sets

country	**# obs.**	**# banks**
France	1,089	99
Germany	7,007	637
Italy	1,287	117
United States	3,553	323
Denmark	517	47
Luxembourg	473	43
Spain	363	33
Switzerland	792	72
EU-12	3,456	216

Remark: 'EU-12' stands for the EU-15, excluding Ireland, the Netherlands, and Sweden.

Table 7: **Impact of time and ratio of other income to interest income on H statistic**

This table reports the coefficients of TIME and log(OI_II) on the H statistic, according to an extended version of Equation (8).

country	**coeff. of TIME**		**coeff. of log(OI_II)**	
Japan	0.005	**	0.037	***
UK	−0.041	***	0.120	**
USA	0.006	***	0.000	
EU15	−2.784	***	−0.055	***
Eastern Europe	0.171		0.154	***
Spain	−0.002		−0.096	***
Denmark	0.030	**	−0.084	**
Luxembourg	0.014	***	−0.018	**
Italy	−0.013	***	−0.265	***
France	−0.044	***	−0.048	***
Germany	−0.013	***	−0.010	*
Switzerland	−0.0158	***	0.064	***

Explanation: (*) significant at 90% level, (**) significant at 95% level, (***) significant at 99% level.

Figure 1: Yearly estimates of the H statistic

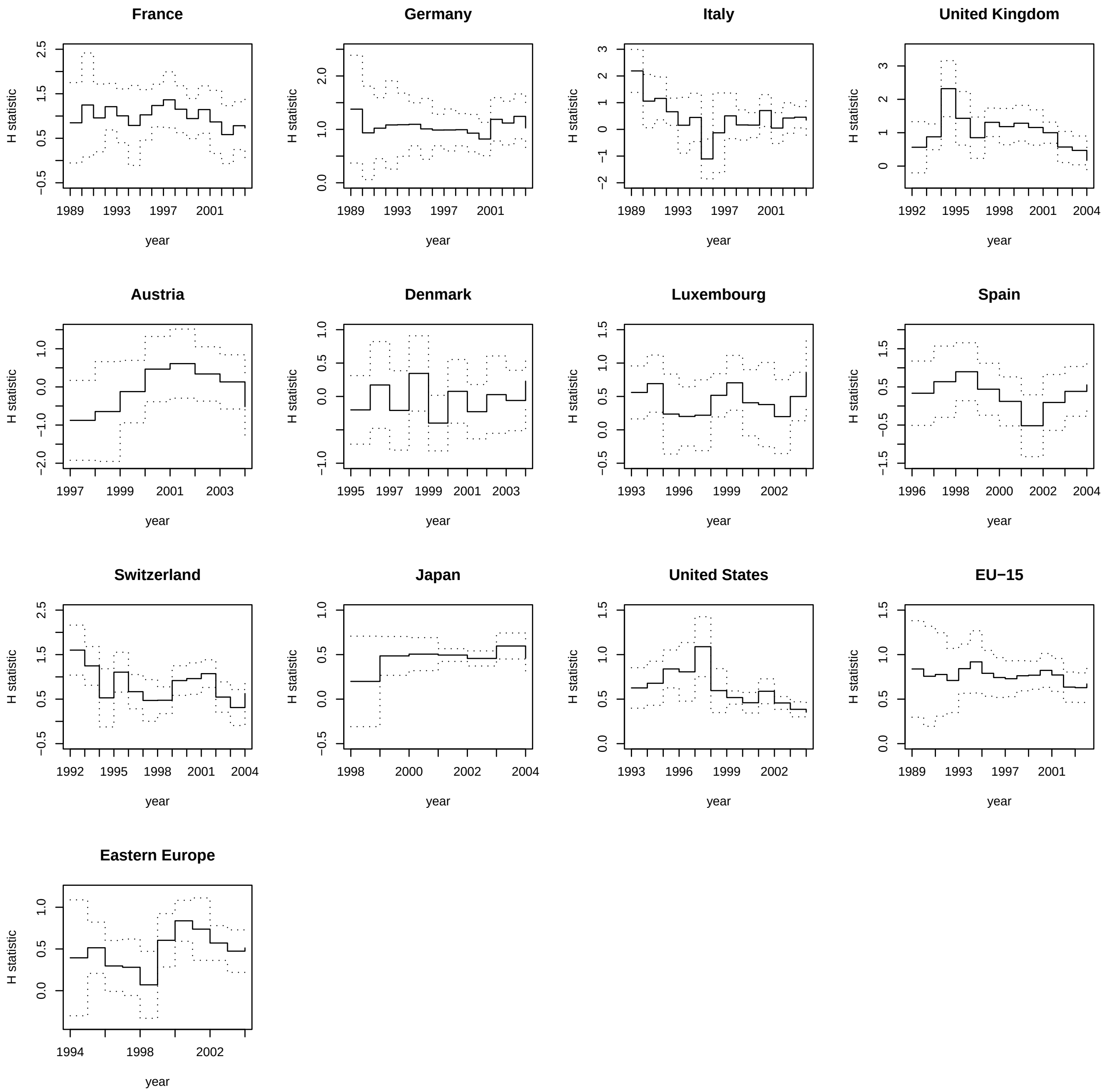

Figure 2: Recursive least squares estimates of the H statistic