How Competitive is Croatia's Banking System? A Tale of Two Credit Booms and Two Crises

Evan Kraft and Ivan Huljak

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Abstract

The paper provides an overview of competition in the Croatian banking market for the 1994-2016 period, updating some results from earlier work but also adding new estimates based on methodological improvements in the literature. While the CR(2) indexes of concentration remained fairly stable after 1998, privatization and acquisitions led to rapid growth of the three next largest banks, so that the CR(5) indexes rose. Other competition measures tend to mirror this, with competitive behavior falling somewhat, but not uniformly. We argue that the largest banks did not always take advantage of the market power they possessed for the purpose of increasing prices. Mark-ups estimated with the Lerner index increased, especially after the onset of the 2008 crisis, but increased margins were the result of marginal costs falling even faster than prices. We do find some association between higher mark-ups and greater inefficiency, creating some support for the "quiet life" hypothesis. However, the strong pace of marginal cost decreases and the passing on of lower costs (and better quality) to consumers, as well as the fact that prices already are at low levels, all temper this conclusion substantially.

Keywords:
banking, competition, Croatia, market structure

JEL:
G21, L51, G28, D40, B21

Contents

1 Introduction

Deregulation of banking in many countries in Europe and North America during the 1980s and 1990s was motivated by the desire for increased competition and efficiency, along with a negative evaluation of the role of government ownership in banking. Many of the former communist countries in Eastern Europe followed similar approaches in the 1990s. Chartering requirements were dramatically lowered, allowing substantial entry of new banks. In most countries, however, many of these new entrants did not survive the next banking crisis, and traditional concentration indicators rose again in the late 1990s.

Several studies of deregulation in the US and in EU countries have found evidence of increased competition despite decreasing numbers of banks (Jayaratne and Strahan 1997 and 1998, Angelini and Cetorelli 2001, Stiroh and Strahan 2003, Strahan 2003, Carbo et al 2009, Evanoff and Ors 2008). Claessens and Laeven (2005) provide cross-country evidence suggesting that the correlation between the intensity of competition (measured by the Panzar-Rosse index) and traditional measures of concentration such as the CR4 and Herfindahl-Hirschman index, are low. Additionally, the empirical literature remains highly divided on the association between market power and efficiency (Berger 1995, Berger and Hannan 1998), with both the traditional structure-conduct-performance view and the efficiency view failing to find strong support in many studies. However, there are dissenting voices, such as Koetter, Kolari and Spieldijk 2012, which argue that increased market power led US banks to enjoy a "quiet life" in which they made relatively weak efforts to overcome inefficiencies in their operations. Delis and Tsionas (2009) present similar findings for banks in the EMU. Recent work by Khan et al. (2017) synthesizes two stories: it shows that cost efficiency enables the banks to grow large and increase their market share in an initial period. In the second period, growth leads to higher market power. The authors therefore find evidence that support both the "quiet life" and the "efficient structure" hypothesis at the same time.

Our aim in this paper is to examine these issues in the context of a single transition country case study. Like a number of other transition countries, Croatia allowed relatively free entry into the banking market in the early 1990s. A credit boom ensued, and many of these new banks failed in 1998 and 1999. (Kraft and Galac 2007) In addition to failures, mergers and legislative reform that tightened chartering requirements for savings banks led to a dramatic decrease in the number of banks in Croatia from the mid-1990s to the mid-2000s, raising concerns about the possible negative effects of increased market power. The rapid entry of foreign banks into Croatia's banking market, culminating with the acquisition of several of the largest banks by European banking groups from 1999 to 2000, mainly in privatization deals, altered the banking landscape in ways that merit careful observation and analysis.

While the sheer number of banks fell from 61 banks and 36 savings banks in 1996 to only 34 banks in 2005, interest rates dropped continuously over the period. Other casual indications of competition, including the extent of bank advertising and the range of products and services offered, suggested intensified

competition. The Panzar-Rosse index indicated a competitive banking market in Croatia, at a level similar to that in other European countries (Kraft 2006). The Lerner index, which allows a clearer estimate of the time pattern of competition, presented a mixed picture of the time path of bank margins, with some increases and some decreases, coupled with continuous decreases in bank marginal cost.

Kraft (2006) suggested that these patterns were the result of two kinds of competition-increasing processes that offset the decrease in the number of players on the market: an increase in the number of banks able to compete on the whole Croatian market from only two in 1996 to 10 in 2003, and greatly increased capital in the industry, to a large extent the result of foreign direct investment. Instead of a system characterized by two national players and a set of regional market leaders, the Croatian banking market had become subject to much more extensive and intensive national competition.

Once the privatizations occurred and the bank failures of 1998-99 were dealt with, a new credit boom unfolded. (Kraft and Jankov 2005) Stringent macroprudential measures and increased capital requirements were implemented by the central bank, and the credit boom had slowed down somewhat by 2007. (Kraft and Galac 2011, 2012) When the financial crisis hit Croatia, loan losses rose steeply. NPL ratios increased from 4.9% at the end of 2008 to 11.2% at the end 2010 and to 17.3% by mid-2015, but only a few small banks actually failed. Still, the crisis nearly brought capital inflows to the banking system to a halt. Lending stagnated, and profitability fell. In the aftermath of the acute period of financial crisis, the number of banks continued to decrease. At the end of 2016, only 25 commercial banks remained on the market with clear signs that the consolidation process was likely to continue, leading to higher concentration in the market in the future.

We will present a broader range of tests than in Kraft 2006, taking advantage of the longer time-series now available. Using the Jeon-Miller, Lerner, adjusted Lerner, competition efficiency frontier, Jeon-Miller and Panzar-Rosse indicators, we will provide a more complex picture of the evolution of competition during the booms and busts of Croatia's recent history. Following that, we will also explore the interrelationship between market power and efficiency, in the spirit of Koetter, Kolari and Spieldijk 2012. To study whether large Croatian banks used their market power to lead the quiet life, we run a set of IV regressions between measures of mark ups and measures of cost efficiency.

Our main results are the following:

1) The Lerner index for the banking sector rises slightly after the first crisis in 1998, stabilizes during the credit boom of the 2000s, and rises again after the start of the crisis. However, the trends in the Lerner reflect decreased marginal costs at the large banks along with stable prices. This suggests increasing market power. The findings from the competition efficiency frontier (CEF) analysis suggesting that large banks have less pressure from competition reinforces this impression. However, cross-section regression shows that small banks charge higher prices than large banks, so perhaps a more precise conclusion is that large banks have allowed margins (Lerner indexes) to increase by not decreasing prices any further.

2) Potential to earn revenue in spite of competitive pressure, as estimated by the CEF, has slightly increased over time. However, there are big differences between groups of banks. The five large market leaders are much less constrained by competition than the remaining smaller banks. Therefore, it seems that they used a part of their market power to restrain the trend of falling prices for their products in spite of decreased demand after 2008.

3) The responsiveness of bank revenues to cost changes, measured by the Panzar-Rosse index, is fairly high in Croatia compared to other European banking markets. However, it has generally been decreasing in the period studied. The PRH is negatively correlated with traditional concentration ratios (HHI and CR5), suggesting that increased concentration has actually decreased competition in this sense. This is in contrast to studies such as Claessens and Laeven (2005) that find no significant correlation between competition as measured by PRH and concentration indicators such as CR(5) and HHI.

4) For the consumer, the trend towards decreasing lending interest rates has actually continued. This may be partly due to decreased interest rates in the euro area, especially since 2008. These decreases have certainly decreased the cost of funds for Croatian banks. But the decreases seem also to be due

to increased efficiency, most likely technological progress more than increased x-efficiency, and perhaps increased competitive pressure in Croatia as lenders scramble for the very limited amount of new business available.
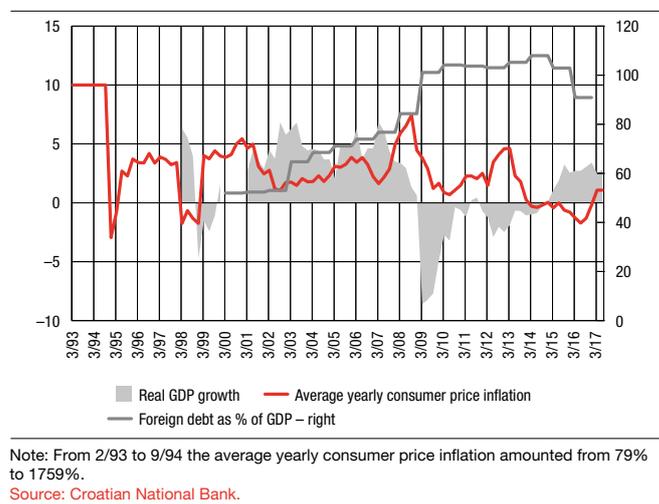
The remainder of this paper is organized as follows: Section 2 provides institutional and economic background. Section 3 presents and discusses results for the Jeon-Miller decomposition, Lerner index, adjusted Lerner index, competition efficiency frontier and Panzar-Rosse revenue elasticity measures. Section 4 tests the relevance of the "quiet-life hypothesis", presenting estimates of the effects of mark-ups on efficiency measures. Section 5 concludes.

2 Background and literature review

2.1 Background – macro and banking system

Croatia experienced fairly strong expansions in 1994-99 and 2001-7, punctuated by the shallow downturn of 1999-2000 and the much sharper decline in 2008-9. GDP growth has barely resumed since then, however, with only a few sporadic quarters of positive GDP growth. Since the stabilization program of October 1993, inflation has generally been in the low single digits. Deflation has actually been recorded in recent years, but most observers do not see it as the main cause of the contraction of GDP.

Figure 1 Real GDP growth, inflation and foreign debt in Croatia, 1993-2016, in %

Legend: Real GDP growth — Average yearly consumer price inflation — Foreign debt as % of GDP – right

Note: From 2/93 to 9/94 the average yearly consumer price inflation amounted from 79% to 1759%.
Source: Croatian National Bank.

Another salient feature of Croatia's macroeconomic landscape has been a high level of foreign debt. Banks have made a significant contribution to the debt run-up as they also relied on foreign debt to finance loan growth, especially in the early 2000s. After the escalation of the crisis and subsequent slow-down of credit growth, banks decreased their foreign debt as domestic deposits provided more than enough financing for current credit growth levels. The debt increase was also strongly driven by Government borrowing during the 2000s, particularly in the years 2002-2005. The foreign debt has been a major concern for Croatian policymakers, and rising country risk has affected the cost of funds for both the sovereign and the private sector.

Before beginning our analysis of competition, a brief survey of conventional bank performance indicators

may be helpful to readers not highly familiar with Croatia's recent banking history. After liberalizing market entry in the initial years of the transition, Croatia began the period covered by this study in 1994 with 61 commercial banks and 36 savings banks. This number fell drastically during the 1998 bank crisis, reaching a plateau at 35 banks during most of the 2000s. Many savings banks failed during the crisis, and legislation introduced in 2001 required the remaining savings banks to re-register as banks or to wind up. The new category of credit union was created in 2006, but the institutions in this sector are so small that we will leave them out of this paper entirely.

Bank profitability was fairly strong in the 1994-2008 period. After losses experienced during the crisis of 1998, bank capitalization was increased through the wave of privatizations and the entry of new foreign players through 2001. Regulations requiring banks to hold extra capital when lending to unhedged borrowers[1] and a general increase in the risk-weighted capital adequacy requirement in the Banking Law of 2008 led to a new wave of increases in the capital ratios of the system after the mid-2000s as well. After 2008, banks maintained an equity to asset ratio of around 14%.

Figure 2 Banking system capitalization and profitability, in %

Note: The profit for 2015 is recalculated to exclude the one-off effect of the conversion of Swiss franc loans. For 2016, bank profits were positively influenced by the Swiss franc loans conversion, as banks were able to reduce the value adjustments for a smaller stock of loans converted from CHF to EUR. However, the effect of the probable increase in repayment rates of the newly converted loans that are more affordable to debtors is not included.[2]
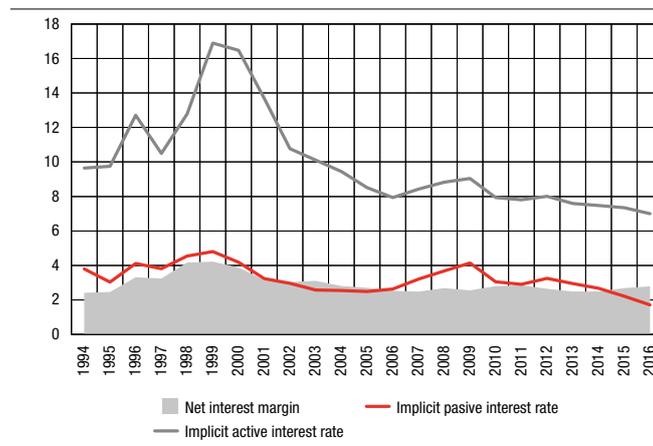Source: Own calculation based on Croatian National Bank data.

Lending interest rates and, more importantly to our story, net interest margins fell fairly steadily throughout the period. The removal of unhealthy banks from the system in the late 1990's, improvements in the legal and regulatory framework, particularly during the Croatia's EU accession process, better non-interest cost performance and lower cost of funds due to easier access to foreign funding sources indisputably contributed to this. We will discuss the possible role of competition below. It is noteworthy that net interest margins have only varied very slightly since 2004, reflecting global developments and recording increases in 2007-2010 and again in 2012.

These trends are also seen in the more detailed information provided in Figure 4 below. While there are episodes such as the substantial increase in interest rates on short-term loans in domestic currency to companies during the 2008 crisis, the overall trends are clearly downward, and seem to continue to a modest degree even in the years since 2011.

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1   Bank lending is mainly done in Croatian kunas, but the debt principal is indexed to the kuna-euro exchange rate in the majority of loans. Croatian borrowers often do not have either income or assets in euros. The Croatian National Bank issued lending standards implementing higher capital requirements for euro-indexed loans to unhedged borrowers in 2004.

2   A detailed description of Swiss franc loans issue in Croatia and some of the potential options for resolving the issue can be found at: http://old.hnb.hr/priopc/2015/eng/ep21012015.pdf. In 2014 and 2015 the government decided to intervene via interest rate and HRK/CHF exchange rate fix to broadly equal the position of Swiss franc borrowers more in line with EUR borrowers. Finally, in September 2015, the Croatian parliament passed amendments to the Consumer Credit Act and the Credit Institutions Act defining the conversion of CHF loans into EUR loans.

Figure 3 Net interest margins, interest revenue and expense, in %

Legend: Net interest margin | Implicit pasive interest rate | Implicit active interest rate

Source: Own calculation based on Croatian National Bank data.

Figure 4 Selected loan interest rates, in %

Legend: Short-term kuna loans to corporates | Long-term indexed loans to corporates | Short-term kuna loans to households | Long-term indexed loans to households
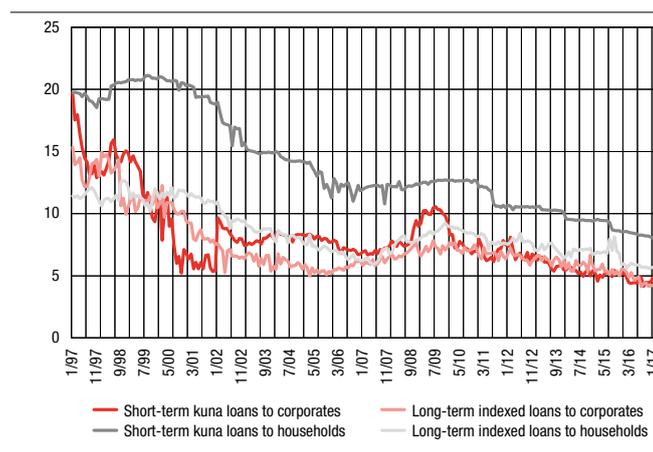
Source: Croatian National Bank.

To conclude this section, we look at indicators of concentration. The two largest banks in Croatia, after a bit of a fall in 1995-96, have maintained a market share of roughly 40-45% of assets, loans and deposits throughout the rest of the analyzed period. This is true despite the sale of both to major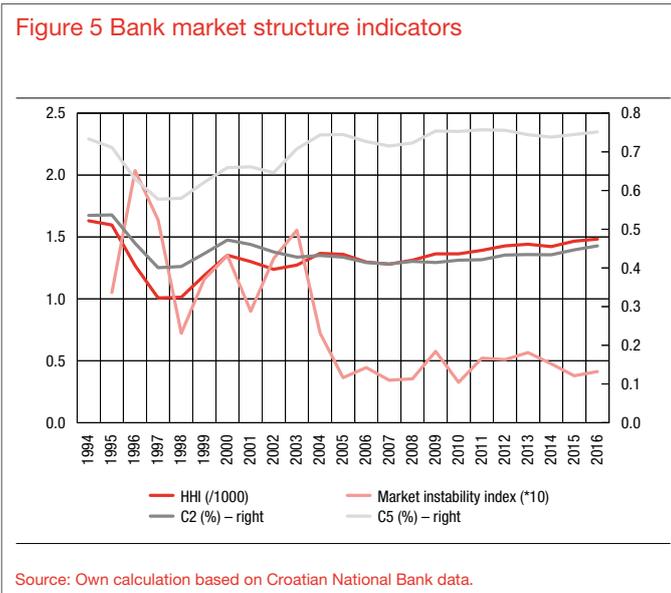ity foreign owners in 1999 and 2000. As the owners of the next 3 largest banks were involved in several acquisitions and rapid organic growth that increased their market shares, the CR5 ratio shows more of an upward trend. The CR5 ratio hit a low of 0.58 in 1998 and rose to 0.76 in 2012.

The Herfindahl-Hirschman index gives a little more information. It falls substantially during the post-liberalization credit boom of the 1990s, reaching a low of 1008 in 1997. It rises to 1351 by 2000, and then settles down. After some ups and downs, the HHI grows slowly but steadily after 2007, reaching the not exceptionally high level of 1483 by the end of 2016.

However, concentration ratios and the HHI can be misleading as concentration can remain unchanged while in fact there is between-bank market repositioning. The market instability (MI) index shows the intensity of market changes by presenting the sum of all absolute value of market share changes in a given year.[3] As

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3   Market instability index is calculated according to Hymer and Pashigan (1962). It is the sum of absolute values of all changes in market shares in a year.

Figure 5 Bank market structure indicators

Source: Own calculation based on Croatian National Bank data.

suggested above, the nineties were a period of significant market instability with liberalization, crisis and entrance of foreign owners. After 2005, the market was rather stable, and the market instability index was quite low.

2.2 Institutional changes – major new laws and regulations

During the period studied, Croatia underwent several changes to its banking laws. New banking laws were introduced in 1999, 2002, 2008 and 2013. The last two reflect Basel II and the 2006 EU Capital Requirements Directive, and Basel III and the 2009 EU Directives respectively. Chartering requirements were somewhat tightened in the 1999 law. The minimum initial capital for a bank was raised to HRK 20 million. However, in 2002 a new law was passed that clearly differentiated banking and financial services. Initial capital requirements depended on the scope of services approved in the bank's license, with license levels requiring HRK 20, 40 and 60 million kuna of equity. Also, corporate governance rules were clearly defined, as were consolidated supervision, internal and external audit.

Additionally, regulation of competition in the banking market was conducted by the central bank until Croatia's accession to the EU in 2013. Since then, the Croatian Competition Agency has taken over national-level regulation, with the EU courts becoming the last instance for appeal.

The legal framework for bank resolution has changed on several occasions. In 1995, the Law on Bank Rehabilitation came into force. This law allowed the Croatian National Bank to determine when a bank would qualify for Government-run and financed rehabilitation procedures. The Deposit Insurance and Bank Rehabilitation Agency implemented the rehabilitation procedure. The procedure was used for four of the largest banks in the 1996-99 period. All of the banks were eventually privatized.

The Law on Bank Rehabilitation was repealed in 2000. The later banking laws provided for forced liquidation, in which a bank whose license was revoked would be liquidated under court supervision. They did not provide for any form of Government seizure of banks as in the Law on Bank on Rehabilitation.

Finally, Croatia's accession to the EU in 2013 meant that EU-chartered banks could provide services directly, or open bank branches in Croatia without prior approval of the Croatian authorities. Both forms of activity are difficult to capture in statistical reporting, and potentially could influence the degree of competition on the market.

2.3 Literature review

In the Croatian banking context, Kraft 2006 examined issues of market competition and efficiency (often in context of specific historic circumstances like privatization, foreign ownership and regulation changes) by employing the Lerner index and the Panzar-Rosse H statistic to study competition. Kraft and Huljak (2011) extended the work by applying the competition efficiency frontier for the first time to a cross-section of banks in one country and showed that larger, mostly foreign banks have more (relative) market power on average, while their revenue is on average less restrained by market competition, as suggested by earlier research for Croatia. However, competition efficiency changed across bank groups during the period studied, with smaller banks serving mostly smaller companies representing the competition efficiency frontier for much of the period.

Researchers have examined issues of bank efficiency in Croatia often in context of specific historic periods marked with privatization, ownership transfer or regulatory changes. Kraft and Tirtoroglu (1998) used a stochastic frontier approach on 1994 and 1995 data to estimate efficiencies for old vs. new and state vs. private banks. They concluded that new banks seem to be more x-inefficient and more scale-inefficient than either old privatized banks or old state banks. However, the authors emphasize that the relationship between profitability and efficiency between banks in Croatia was statistically weak.

Jemrić and Vujčić (2002) used data envelopment analysis to conclude that (between 1995 and 2000) foreign-owned banks are on average more efficient than domestic banks and that new are more efficient than old banks. The authors also find strong equalization in terms of average efficiency in the Croatian banking market, both between peer groups and within peer groups of banks. Using a flexible Fourier cost function, Kraft, Payne and Hofler (2006) showed that new and privatized banks are not necessarily the most efficient in the period from 1994-2000. In addition, according to their results, privatization did not seem to induce greater cost efficiency of banks. However, higher cost efficiency is connected with lower bank default probability.

Finally, Arisis (2010) and Huljak (2015) calculated the cost efficiency of banks in Croatia to test the "quiet-life hypothesis". This hypothesis suggests that banks with greater market power have limited incentive to root out inefficiencies. If true, the hypothesis would imply a negative correlation between measures of market share (proxies for market power) and measures of cost or profit inefficiency. Huljak (2015) suggests that efficiency scores depend on the cost definition used, as domestic and smaller banks are more efficient in managing administrative costs than foreign and larger banks but equally efficient in managing total costs. Also, according to this research, average bank relative efficiency increased on two occasions: first in the late 90s in the period of the banking crisis and subsequent "market cleansing" and second, to a lesser extent, during the Global Financial Crisis.

3 Empirical results

This section first reports results on the sources of improved efficiency, decomposing the overall change into the changes in average profitability, changed shares of more efficient banks, and effects of entry and exit using the Jeon-Miller decomposition. Next, we examine trends in mark-ups, prices and marginal costs by using the Lerner index. We follow this with competition efficiency frontier analysis, and end with revenue elasticity estimation based on the Panzar-Rosse H-statistic.

## 3.1 Sources of improved efficiency: the Jeon-Miller decomposition

The Jeon Miller decomposition provides simple but useful insight into market profitability changes in parallel with changes in market structure. Primarily, it allows us to measure the effects of changes in the structure

of the market on overall system efficiency, measured by profitability. The method decomposes efficiency (profitability) gains into gains in the average level of efficiency (the "within" effect), gains in individual bank efficiency among banks remaining in the industry in each year (the "between" effect), gains from entry of new banks and gains from exits of banks. They call their method the "ideal dynamic decomposition".

Considering the structural changes in the Croatian banking market from 1994 onwards, it makes sense to divide the whole period into two sub-samples for Jeon-Miller analysis. The first sub-sample, 1994-2002, includes the period of dramatic changes in the Croatian banking market. During 1998-99, a banking crisis took place. Subsequently, foreign financial institutions started increasing their ownership of Croatian banks. This period ends with 2002, a year that saw the last significant changes in banking sector ownership structure and increased credit growth.

The Jeon-Miller decomposition for this period suggests that profitability changes largely resulted from the "within" effect. This is in a way expected, as most of the banks did survive these turbulent years. However, their profitability was very volatile. In the year when the banking crisis resulted in the largest drop in profitability, 1998, a positive contribution to profitability came from less profitable banks leaving the market, the exit effect. Also, there was some contribution from the between effect after 1998, which points to divergent profitability between banks. Finally, the entrance of new banks did not substantially affect the profitability of the sector. Most of the new entrants on the market were formed as greenfield investments and grew gradually, so that their profitability was not unusually high in the entry phase.

Figure 6 Jeon-Miller decomposition of Croatian banking sector ROA changes, 1995-2002, in % of total assets

Source: Own calculations based on CNB data.
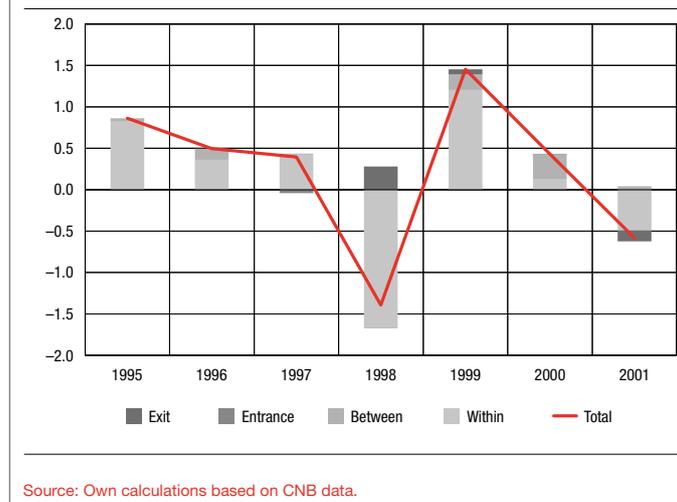
From 2002 onwards, market structure was relatively stable.[4] However, the years from 2003 to 2008 were marked by high credit growth and the years from 2008 to 2016 by financial crisis. Nevertheless, the majority of the change in profitability, as in the previous period, comes from within. Market positions were already taken, the number of banks was stable and profitability scores of the largest banks moved together (high during good years and negative or decreasing in bad years). Therefore, the "within" effect is the result of macroeconomic conditions, as well as of broad changes in the efficiency of the banking system.

However, even though the "within" effect has the strongest impact on the changes of the average profitability over the whole period, the "between" effect is the main driver of ROA increase after the beginning of the crisis. That is, individual banks' improvement relative to the average, while in most years smaller than the change in the average, over time contributes more than any other factor to the increase in system profitability, emphasizing the importance of changes in the structure of the market.

In a market where concentration ratios are stable, the within effect is bound be largest in a given year.

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4   Saving banks and credit unions are not considered in this context. Those institutions made a negligible percentage of the financial sector.

However, the fact that the "within" effect influences the profitability changes the most in individual years can give a misleading impression of long-term developments. Therefore, the cumulative contributions should be calculated, as they offer a clearer picture over several years. Cumulative calculation suggest that in fact the "within" effect is larger than the "between" effect only in the period of market stability (2002-2008). In other periods, the between effect was equal (1995-2001) or significantly larger (2009-2016). Following Jeon and Miller, we suggest that this "between" effect actually reflects the effects of competition in forcing banks to re-structure and improve efficiency. This is especially evident since from 2002 onwards, there was practically no entrance of new players on the market. However, the exit of some less profitable banks (usually through merg-ers) did help average efficiency, especially after the 2008 crisis.

Figure 7 Jeon-Miller decomposition of Croatian banking sector ROA changes, 2002-2016, in % of total assets
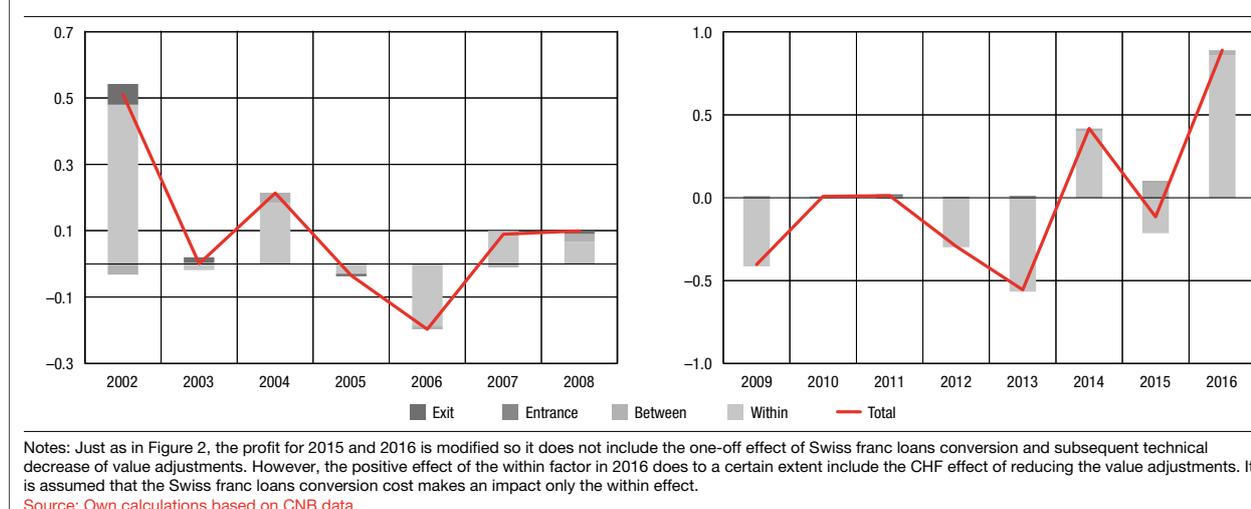
Notes: Just as in Figure 2, the profit for 2015 and 2016 is modified so it does not include the one-off effect of Swiss franc loans conversion and subsequent technical decrease of value adjustments. However, the positive effect of the within factor in 2016 does to a certain extent include the CHF effect of reducing the value adjustments. It is assumed that the Swiss franc loans conversion cost makes an impact only the within effect.
Source: Own calculations based on CNB data.

Table 1 Cumulative contribution of Jeon-Miller factors to bank profitability changes, in percentage points of ROA

Period	Within	Between	Entrance	Exit
1995–2016	1.26	0.89	−0.04	0.31
1995–2001	0.77	0.71	−0.04	0.21
2002–2008	0.59	0.01	0.00	0.08
2009–2016	−0.10	0.17	0.00	0.02

Note: The cumulative contributions of Jeon-Miller factors are not influenced by Swiss franc loans conversion.
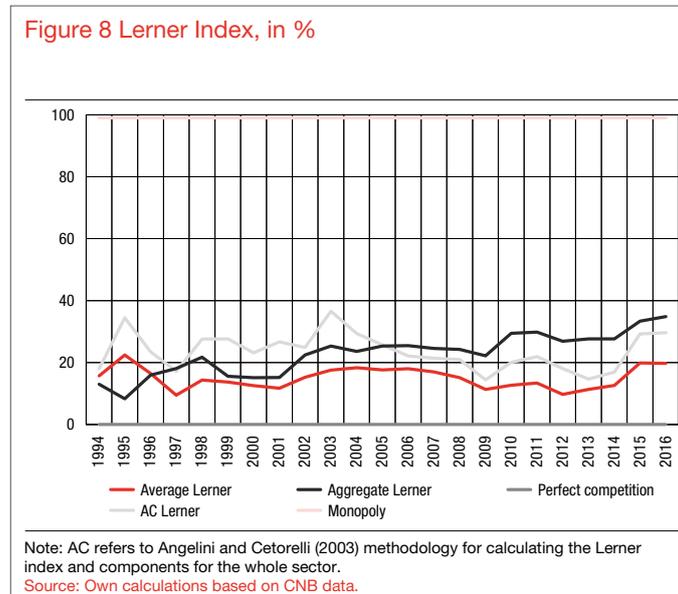Source: Own calculations based on CNB data.

3.2 The Lerner index: mark-ups, marginal costs and prices

There are several advantages to the Lerner index methodology compared to the Panzar-Rosse method, the other main model-based approach. First, it provides mark-ups for each year, making it easier to get a de-tailed time pattern of market power than the Panzer-Rosse method, which only applies to a system in long-term equilibrium. Second, the Lerner index can be used to estimate individual banks' mark-ups and market power. Third, by providing marginal cost estimates, it allows us to say something about productive efficiency at the individual bank level. Fourth, the method requires us to construct average prices per bank, also an illumi-nating piece of information.

We estimate the Lerner index, marginal cost and prices annually for each year, for the system as a whole and for each bank, from 1994 to 2016. We present both the average of the results per banks and weighted av-erages. The latter differ meaningfully from the unweighted averages because the values for the 5 largest banks are in fact considerably different from the average. The Lerner index methodology is based on estimation of a cost-function and a supply equation to obtain an average mark-up. We follow Angelini and Cetorelli (2003) in

estimating the Lerner index mark-up, along with the marginal cost and average price of banking services.

Figure 8 shows both the average and aggregate Lerner indexes based on individual bank mark-up estimates. The average Lerner is relatively stable, and it falls after the 2002-7 period. The aggregate Lerner index, resulting from the imposition of a single mark-up on all banks, actually increased after 2001. However, the aggregate Lerner has a much stronger upward movement, and it stabilizes, rather than falls, in periods after 2002-7. The aggregate Lerner results give an impression of increasing market power, driven by the largest banks.

Figure 8 Lerner Index, in %

Note: AC refers to Angelini and Cetorelli (2003) methodology for calculating the Lerner index and components for the whole sector.
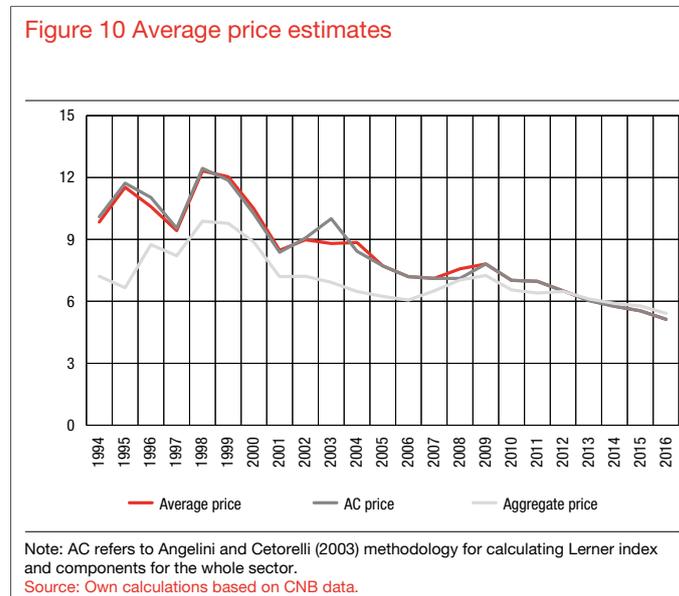Source: Own calculations based on CNB data.

To look under the hood of this analysis, we now turn to the components of the Lerner index: marginal cost and price estimates. Whichever way we aggregate, marginal costs fall fairly steadily. Figure 9 displays the year-by-year results, since it seems unlikely that cyclical effects are important for marginal costs and therefore smoothing is less useful. The steady and significant fall in marginal costs seems to be the result of improved knowledge and technology, acquired both by domestic banks purchasing them on the market (e.g. ATMs) and by the arrival of foreign banks with superior know-how. The fact that aggregate marginal costs are notably lower than average ones tells us that the largest banks held significant cost advantages.[5]

Figure 9 Marginal cost and prices estimates, in %

Note: AC refers to Angelini and Cetorelli (2003) methodology for calculating the Lerner index and components for the whole sector.
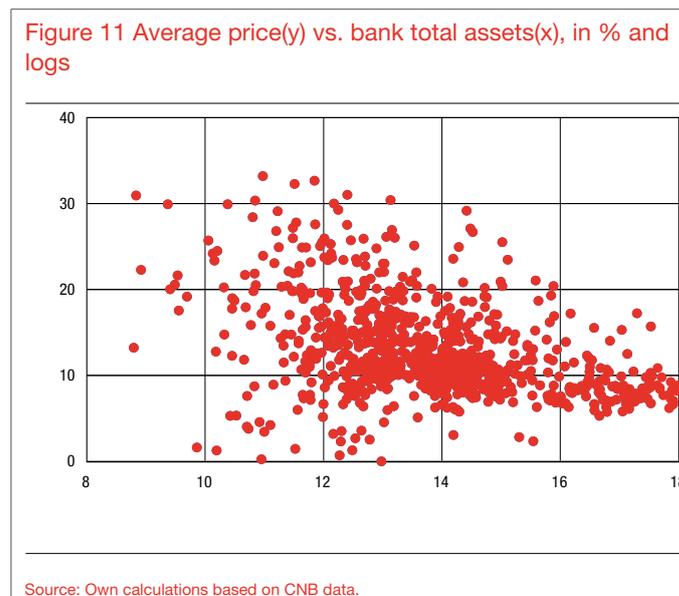Source: Own calculations based on CNB data.

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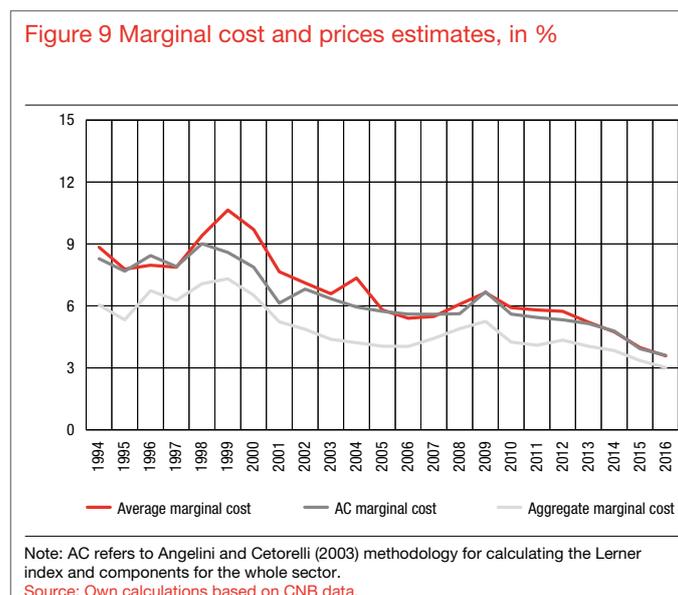
5   Huljak (2015) also suggests that in recent years (2010 onwards) larger banks in Croatia managed to increase their overall cost efficiency.

At the same time, prices also trend downward, but with much greater year-to-year variation. Consumers do appear to have benefited from cheaper banking services over the period. However, one should be aware that in the years after the crisis the share of (cheaper) real estate loans has increased, so that some of the apparent cost decrease is due to a composition effect. Also, credit risk materialization leads to lower effective price as the price calculation is based only on interest received, not accruals.

Figure 10 Average price estimates

Note: AC refers to Angelini and Cetorelli (2003) methodology for calculating Lerner index and components for the whole sector.
Source: Own calculations based on CNB data.

A crucial clue to the overall behavior of the Lerner index can be found by examining the relationship between prices and bank size. The fact that smaller banks charge higher prices reflects the fact that smaller banks are more oriented to working with firms, and in particular with smaller firms. Credit risk is likely to be greater in this market segment. Additionally, cost efficient techniques such as credit scoring are not useful in these areas, implying greater labor costs in screening clients.

Figure 11 Average price(y) vs. bank total assets(x), in % and logs

Source: Own calculations based on CNB data.

Koetter et al (2012) note that Lerner indexes assume that pricing behavior and marginal cost are exogenous to each other. But banks facing less competitive pressure may choose to make less effort to reduce costs. To account for this, we use a simplified version of their argument to calculate an "adjusted" Lerner index. Figure 12 below compares the weighted Lerner with the weighted adjusted Lerner.

$$Adjusted\ Lerner = \frac{Revenue - Marginal\ costs}{Revenue} \tag{1}$$

Figure 12 Adjusted Lerner index vs. weighted individual bank Lerner index, in %

Source: Own calculations based on CNB data.
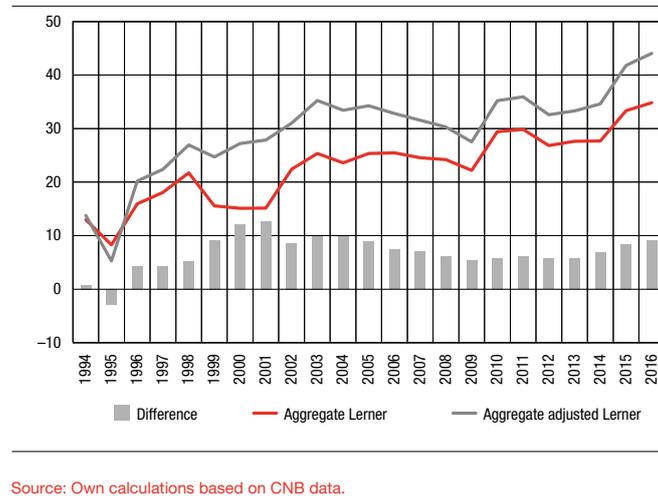
The adjusted Lerner is on average around 7 percentage points greater than the traditional Lerner index. However, the biggest difference between the two is recorded in the period 1999-2005 in the period of the last big market positioning. Finally, after the financial crisis, the difference again increases, suggesting that once we take into account the way that pricing power affects cost decisions, the substantial increase in mark-ups occurred only in two periods: 1999-2005 and after the financial crisis.

Finally, to investigate the link between the behavior of the Lerner index and traditional concentration measures, we ran simple regressions in the spirit of Angellini and Cetorelli (2003). They found that cyclical factors, GDP growth and inflation, had an impact on Lerner indexes for Italy. We specify a model similar to theirs but add a dummy for the macroprudential measures taken by the Croatian National Bank during 2003-7 and a dummy for the financial crisis years, to the regression below.[6] While the significance of the coefficient on the HHI is somewhat below conventional levels for the traditional Lerner index, it is highly significant for the adjusted Lerner index. This regression also lends some support for a link between concentration and increased mark-ups.

To summarize, the Lerner index analysis suggests that mark-ups have increased for the system as a whole over the full sample, driven more by large banks. These banks charge lower prices and have proportionally even lower marginal costs than their smaller competitors. Their mark-ups end up somewhat higher, but they do pass some of their efficiency gains on to their customers. Taking the adjusted Lerner index into account, we can even conjecture that the large banks were somewhat "lazy" on the market power consummation during the credit boom of the 2000s when the fight for market share was apparently more important than profitability concerns. However, once the crisis hit, they reduced costs, partly as a result of their actions but also due to trends in interest costs, which resulted in increased mark-ups. At the same time, the prices of larger and smaller institutions converged to around 5%. We will refine these impressions with further tests in the next subsection.

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6   We use a simple 0-1 dummy here. The Croatian National Bank employed a range of macroprudential measures during 2003-2008. The restrictiveness of the measures increased considerably over time, but we do not attempt to incorporate this here. For more on the measures, see Kraft and Galac 2011 and 2012.

Table 2 Determinants of change in the Lerner index

	Lerner index	Adjusted Lerner index
HHI change	0.642 (–1.41)	1.485* (–2.63)
GDP Gap	0.900*** (–4.23)	0.982*** (–3.76)
Inflation	–0.526** (–2.77)	–0.612* (–2.47)
Credit risk	0.433* (–2.34)	0.563* (–2.41)
Loan to assets	0.533*** (–8.14)	0.285*** (–3.72)
Labour to assets	–53.86 (–0.66)	–105,8 (–1.01)
Macropru. dummy	–0.022 (–1.49)	–0,028 (–1.78)
Crisis dummy	–0.02 (–0.85)	–0,042 (–1.33)
Time trend	0 –0.43	0.001 –0.7
Constant	–0.195** (–3.31)	0.02 –0.28
R-square	0.3	0.165
N	723	727

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

3.3 The competition efficiency frontier

While the Lerner method is a stochastic one, it does not distinguish between actual and potential market power. The competition efficiency frontier (CEF) method, elaborated by Bolt and Humphrey (2010), estimates the revenue-generating potential frontier, and allows the researcher to estimate how close an individual bank is to that frontier. Put differently, the CEF approach tells us the extent to which individual banks' revenues are constrained by competition or how efficient competition is, as a process, in restraining bank revenue.

CEF estimations for Croatia show sharp differences between categories of banks. Huljak and Kraft (2011) find that after 2001, the largest banks' interest-rate spread income is less revenue-constrained than such income for smaller banks. The opposite is true for non-interest income, but this is a much less important category in Croatia. Small banks that mainly serve corporate clients are especially constrained. However, it should be kept in mind that CEF shows the market power available, while the Lerner index shows market power actually exercised through price mark-ups.

The figure below shows our calculations with the whole 1995-2016 sample. The overall picture for the banking system suggests substantially lower constraint of revenues by competition after 1999. There is a big jump after the 1999-2004 window. This strongly contradicts the story that the pro-competitive effects of the increasing number of nationally-active banks after 1999 rein in extra profits. Strong demand for banking services might have been a factor in the years 2001-7, but this would not explain the stability/slight increase in the CEF scores after 2008. Also, one has to keep in mind that unlike the Lerner index, CEF is a relative measure, and the results of the strongest banks on the market are influenced by the results of the weakest banks. Therefore, this indicator is perhaps more useful for its cross-sectional than its time dimension comparisons.[7]

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[7] As with all frontier efficiency measures, the CEF is extremely sensitive to methodology and data changes which is especially obvious in the early part of our sample marked with high volatility.

However, even keeping the limitations of the time-dimension of the CEF in mind, the CEF results suggest similar trends to the Lerner index. For the average bank, market power decreases after the 2001-2006 period. However, looking at the weighted average, it seems that larger banks were not affected. Furthermore, their revenue does not seem to be constrained by market competition. It is however, constrained by low growth rates and issues related to past lending and business decisions.

Figure 13 Average and weighted competition efficiency frontier scores

Source: Own calculations based on CNB data.
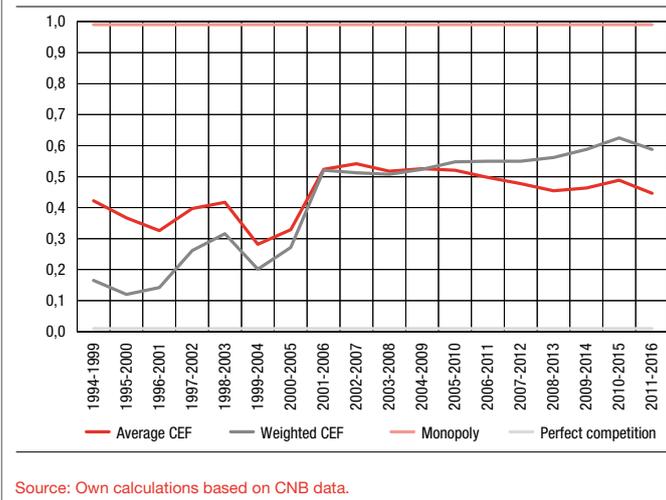
3.4 The elasticity of revenue to costs: the Panzar-Rosse statistic

Our last estimations use the methodologies pioneered by Panzar and Rosse (1987). Their "H-statistic" shows the marginal reaction of bank total revenues to changes in costs. The estimation is only valid if the system is observed in long-run equilibrium. Most empirical estimates return H-statistics between 0 and 1, supporting the characterization of monopolistic competition. Our results for Croatia fit into this range as well.

Estimating the Panzar-Rosse equations for the whole of the 1994-2016 period yields an H-statistic of 0.57. This is relatively high compared to the results for the European banking systems reported in Claessens and Laeven (2005). However, as the figure below shows, rolling-window estimates show a downward trend. Through 2001-2009, the H-statistic rises and falls, reaching at one point approximately the 1994 level. Thus,

Figure 14 Panzar-Rosse statistic

Source: Own calculations based on CNB data.
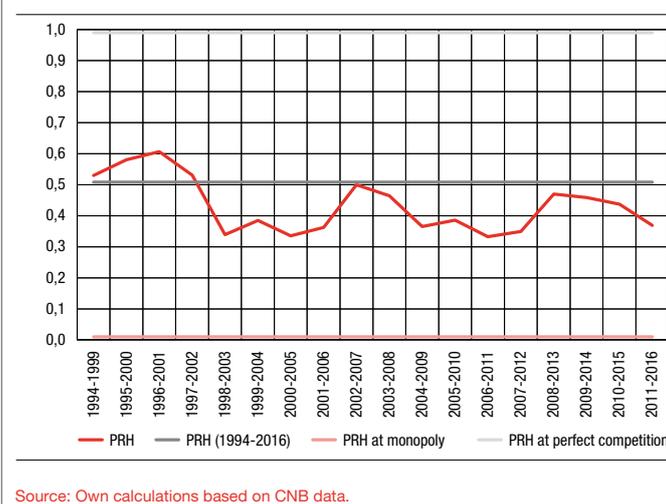
1998-99 consolidation and the period after-2008 crisis were marked with slight decrease in competition according to this indicator.

Based on all of the evidence presented so far, it seems that the largest banks, facing substantial loan losses, had enough pricing power to keep prices steady in the face of decreased demand. Another possible factor affecting the decrease in the H-statistic in recent years could be Croatia's accession to the EU in July 2013. Potentially, EU accession could have increased competition from EU banks located outside of Croatia, since after the accession, EU banks were allowed to provide services directly to the Croatian market without setting up subsidiaries. This factor might explain the flattening of the figure above after the 2008-13 window, but would not explain the renewed downturn in the last two windows observed.

4 Market power and efficiency: the quiet life hypothesis

To this point, we have only considered possible endogeneity between efficiency and market power in our calculation of the adjusted Lerner index. In this section, we pursue this question further, using a framework similar to that of Koetter, Kolari and Spierdijk (2012). Having in mind that banks do not have to use their market power for increasing mark-ups, we focus on the question of whether higher market power results in lower efficiency, a form of the "quiet-life hypothesis". We approach this issue by measuring efficiency using the stochastic-frontiers approach and examining the relationship between efficiency and monopolistic mark-ups represented via Lerner index and the adjusted Lerner index discussed above.

In the first step, we specify the following fixed effects panel model:

$$Efficiency = \alpha_i + \beta_{ij} * Mark-up + \gamma_{ij} + Control\ variables + \varepsilon_{ij} \qquad (2)$$

Table 3 provides summary statistics of the variables used in the model.

Table 3 Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
SFA efficiency	886	0.91	0.08	0.39	0.98
Lerner	761	0.20	0.14	0.00	0.83
Adjusted Lerner	766	0.27	0.14	0.00	0.92
GDP GAP	929	0.11	0.03	0.01	0.15
HHI	962	0.13	0.03	0.00	0.16
Market share	928	0.02	0.05	0.00	0.29
Loans to assets	928	0.59	0.14	0.00	1.62
Deposits to assets	926	0.63	0.18	0.00	1.08
Credit risk	908	0.02	0.04	−0.12	0.59
Equity to assets	928	0.19	0.16	−0.16	1.00

Source: Own calculations based on CNB data.

Table 4 provides the results of our efficiency model. First of all it is important to mention that the tests indicate a potential issue with endogeneity, which confirms our choice of a panel two-stage regression with fixed effects as suggested by the Hausman test. The endogeneity issue can be sourced to the fact that efficiency enhances profitability and profitability is implicitly included in the Lerner index.

Our results also suggest that market power in fact does lead to somewhat lower efficiency. This is valid for all the sub-periods except 2001-2008, the period of stability and strong growth. Depending on the specification of the model, the impact of market power on efficiency ranges between −6.5 and −14.6 percent of total

costs translating into 0.5% to 1.0% of total assets. It is also worth mentioning that the strongest (negative) connection between market power and efficiency is recorded in the period of turbulence 1994-2000.

Table 4 Quiet life hypothesis test for Croatian banking market

	Dependent: SFA efficiency score Market power: Lerner index				Dependent: SFA efficiency score Market power: Adjusted Lerner			
	1994–2016	1994–2000	2001–2008	2009–2016	1994–2016	1994–2000	2001–2008	2009–2016
Market power	−0.146*** (−4.11)	−0.326** (−3.25)	0.0258 −0.55	−0.0990** (−2.82)	−0.0647* (−1.96)	−0.308* (−2.07)	0.0195 −0.48	−0.0866** (−3.00)
GDP GAP	−0.0489 (−0.85)	0.199 −0.81	−0.058 (−0.43)	0.146*** −3.51	−0.109 (−1.93)	0.145 −0.57	−0.055 (−0.41)	0.152*** −3.5
HHI	0.0879 −0.64	0.133 −0.42	0.394 −1.38	−0.147 (−0.34)	−0.0629 (−0.47)	0.014 −0.04	0.352 −1.24	−0.219 (−0.48)
Market share	−0.156 (−1.06)	−0.22 (−0.49)	−0.264* (−1.98)	0.309** −2.84	−0.0995 (−0.68)	−0.185 (−0.37)	−0.255 (−1.86)	0.335** −2.9
Loans to assets	0.0318 −1.14	0.239* −2.48	0.00331 −0.13	0.0432** −2.75	−0.0409 (−1.93)	0.108 −1.22	0.00748 −0.41	0.0155 −1.33
Deposits to assets	−0.0836*** (−4.09)	−0.228*** (−3.43)	−0.104*** (−5.65)	−0.0244* (−2.04)	−0.0881*** (−4.37)	−0.248*** (−3.62)	−0.105*** (−5.57)	−0.0283* (−2.49)
Credit risk	0.063 −1.09	0.12 −1.22	−0.0802 (−0.43)	−0.0107 (−0.20)	0.0106 −0.18	0.125 −1.01	−0.0753 (−0.37)	0.0126 −0.23
Equity to assets	−0.0248 (−0.88)	0.0281 −0.46	−0.0271 (−0.85)	0.0258 −0.96	−0.0512 (−1.81)	0.0128 −0.21	−0.0288 (−0.81)	0.0461 −1.48
Time trend	0.00425*** −13.57	−0.00112 (−0.56)	0.00299*** −10.77	0.00439*** −4.27	0.00429*** −13.91	−0.00188 (−0.92)	0.00301*** −10.92	0.00453*** −4.18
Constant	0.943*** −28.47	0.889*** −9.46	0.934*** −16.08	0.879*** −18.21	1.006*** −34.47	1.017*** −12.22	0.936*** −17.49	0.905*** −18.34
Davidson-Mackinnon test	21.1	10.66	0.17	16.59	9.89	5.154	0.758	19.968
F	1.59	1.16	1.194	1.141	1.592	1.162	1.198	1.141
P-value	0	0.001	0.679	0	0.002	0.025	0.385	0
N. of obs.	661	229	250	182	667	231	254	182

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Considering that the main driver of the efficiency and market power relationship comes from one rather specific historic period, these findings do not, in our judgment, provide robust support for the quiet-life hypothesis in Croatia. It is not utterly implausible to think that the large banks did not really face enough competition in the 1994-2001 period to work diligently to improve efficiency. In the first two years of the period, 1994-95, interbank interest rates were extremely high, and there was an expectation of a Government bailout of large banks. Kraft and Tirtiroglu (1998) find evidence that bank profitability and cost efficiency were not correlated in this period. Banks that had ample liquidity were able to earn extremely high interest rates on interbank loans, generating excellent profits without the hard work of cutting costs.

However, after the Government seized and rehabilitated four of the five largest banks in 1995-96, this situation ended. The rehabilitated banks, after a year or two of restructuring, became stronger competitors. It would seem plausible that the 1998-99 banking crisis only reinforced the push towards greater cost efficiency, as banks used all means possible to ensure their survival. A quiet-life view also clashes with the significant organizational and technological advances such as greatly improved risk management, the introduction of ATMs, improvement of IT systems and the like, of this period (Kraft et al 1998 and 2000). Overall, the evidence does not seem highly compelling.

In fact, the decomposition of the Lerner index clearly shows that it is actually the decrease of marginal costs that drives the increase of the Lerner index. However, marginal cost is on the decrease due to the cheaper funding as well as increased efficiency. Also, before the major privatizations of 1999-2000, Croatian banks acquired technology – both actual equipment such as ATM's and know-how such as credit risk models and

processes – on the market. After privatization, the larger banks were part of foreign bank groups that diffused standard practices throughout their network of subsidiaries. There would therefore seem to be a case to be made that increased efficiency was not only related to competitive pressures on the domestic market, but also to processes within international banking groups and competitive pressures in the home markets of those bank groups.

Looking at bank prices, it seems that, besides pricing strategy, a convergence to 5% is being driven by different external factors for larger and smaller institutions. With larger institutions, price is decreasing also due to the relative increase of (cheaper) residential loans, while for the smaller institutions price is affected more by their higher credit risk and subsequent lower collection of interest income.

These external processes may suffice to explain why Croatian banks did not entirely succumb to the quiet-life temptations of increased market power. Additionally, the imperatives of survival after each of the two banking crises in the period may have ruled out a truly quiet life.

5 Conclusions

The sweeping liberalization of entry onto the banking market with Croatia's independence and the beginning of transition greatly increased the number of banks in Croatia. But the Croatian banking market became substantially more concentrated after 1998. However, this increase in national competition included the formation of a larger number of banks competing across the whole country, rather than competing mainly in regional markets. And the consolidation of 1998-2000 was in part the result of privatization and foreign bank entry, processes that led to increased investment in the banking industry.

Still, our findings suggest some degree of increased exercise of market power over the period. While banks did seem to have substantially larger potential market power, they did not always exercise that potential to the fullest. In the scramble for market share during the credit boom of the 2000s, larger banks generally did not use their pricing power according to our analysis. It seems that they were more eager to increase their presence and market share. After the 2008 crisis, banks used their pricing power to stabilize margins, but prices decreased.

Summing up the information from the competition measures together, everything suggests that during the initial period of our sample from 1995 to 2000, marked by two banking crises, the entrance of foreign banks and subsequently high volatility of the market, competition was high. In the tranquil period marked by strong credit growth, high profitability and risk build-up from 2001 to 2008, competition decreased and positions on the market were taken that are still in place today. Even though competition decreased further after the start of the crisis in late 2008, our analyses do not point to the same reasons. According to the Lerner index, it was due to faster decrease of marginal cost than prices and according to the CEF, due to the fact that larger institutions were able to resist competitive pressure.

Overall indicators of bank margins, most of all the Lerner index, do indicate some correlation between increased concentration and increased exercise of pricing power, but the increases do not seem to be nearly as large as the increases in concentration would lead one to expect. Similarly, results from Panzar-Rosse estimates of the elasticity of revenue to costs do suggest some decrease in competitive pricing behavior through Croatia's entry into the EU in 2013. These decreases, while noteworthy, still leave Croatia with a moderately high level of competitive behavior by the standards of EU banking markets.

At the same time, the trend towards decreasing marginal costs continued fairly steadily throughout the period. In addition, the interest rates paid by Croatian borrowers also trended downward fairly consistently and the implicit price for all sectors currently stands just above 5% for all banks. Having in mind the country risk premium as well as credit risk in Croatia, the space for price decrease is probably getting smaller. Increasing concentration and decreasing competitive behavior, it seems, were not enough to offset the trends to lowering costs and to passing on at least some of these cost-savings to customers. Therefore, the regression analyses in

section 4 above suggesting that increased market power leads to lower efficiency have to be taken with caution as prices are affected by the structure of the loan portfolio of each bank and credit risk at the same time.

Looking ahead, the effects of increased competition resulting from Croatia's accession to the EU in July 2013 could be important determinants of the future evolution of the market. Panzar-Rosse estimates do show stabilizing revenue elasticity immediately after 2013, although this effect seems short lived. At this point, the evidence does not seem consistent with the hypothesis that direct provision of banking services by EU financial institutions in other countries has had pro-competitive effects, but this potential clearly exists.

There certainly are other factors to consider in any discussion of the future trajectory of competition in the Croatian banking system. Major changes of regulation embodying the Basel III process were adopted in 2013. Policy actions in Croatia and the EU in general certainly deserve scrutiny. Further research into the intensity of competition, its impact on efficiency, and also its impact on financial stability, is most definitely called-for. In this light, one should consider the competition banks are facing from shadow banks as well as among themselves. In addition, cross border financing seems to be generating competition that local supervisors can hardly monitor, let alone regulate.

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Appendix

1 Jeon-Miller decomposition

Jeon and Miller (2005) proposed a very interesting decomposition that allows the measurement of the effects on banking system performance efficiency. The method allows us to decompose efficiency gains into gains in the average level of efficiency (the "within" effect), gains in individual bank efficiency among banks remaining in the industry in a given year (the "between" effect), gains from entry of new banks and gains from exits of banks.

Mathematically, the decomposition looks like this:

$$\Delta R_t = within + between + entry - exit$$

$$within = \sum stay \ r_{i,\Delta t} \overline{\theta}_i$$

$$between = \sum stay \ (r_i - \overline{R}) \theta_{i,\Delta t}$$

$$entry = \sum enter \ (r_{i,t} - \overline{R}) \theta_{i,t}$$

$$exit = \sum exit \ (r_{i,t-i} - \overline{R}) \theta_{i,t-1}$$

Where:

R_t = Return on equity for banking system as a whole at time t.

$r_{i,t}$ = Return on equity for individual bank i at time t.

$\theta_{i,t}$ = Share of bank i in total banking system capital at time t.

$\overline{R} = (R_t + R_{t-1})/2$

$\overline{\theta} = (\theta_t + \theta_{t-1})/2$

$\theta_{i,t} = \theta_{i,t} - \theta_{i,t-1}$

$r_{i,\Delta t} = r_{i,t} + r_{i,t-1}$

2 Lerner index calculation

Lerner index is calculated as the relative mark-up:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}},$$

where P_{it} and MC_{it} are the price charged and the marginal cost of bank i at time t respectively. The average price charged is calculated as the ratio of interest revenue to interest earning assets while the marginal cost is estimated from trans-log cost function:

$$lntc = lnyi + lnwi + \sum\sum yiyi + \sum\sum wiwi + \sum\sum yiwi + \varepsilon,$$

where:

tc = total cost (operating and interest),

yi= three bank products (loans, other earning assets, net fees and commission),

wi= the prices of three bank inputs (labor, physical assets and financial capital).

Angelini and Cetorelli (2003) show that a very common behavioral model can be used to measure the degree of competition in the industry. The model supposes that individual banks set prices to maximize profits, with prices including two components: marginal cost and a mark-up based on market power. The price equation is then:

$$pj = C'j(qj, wj) + \lambda$$

C' represents the derivative of the cost function C, which is to say it represents marginal cost. Cost C is a function of the quantity of output, q, and input prices, represented by the vector w turns out to be an indicator of the industry's overall degree of market power. When divided by the average output price of the industry, this indicator allows us to compute the Lerner index, L= λ /p, which measures the relative mark-up of price over marginal cost. This method provides more precise estimates than simply running regressions for the price function alone. The three-stage least squares (3SLS) method is used to provide the most consistent estimates possible.

3 Competition efficiency frontier

The competition efficiency concept is derived from standard efficiency methodology by reversing the rationale and searching for the bank most affected by competition. Therefore, the further a bank (or a group of banks) is from the frontier the greater its market power. This means that while we still maintain that bank revenue reflects productivity, cost and competition, we actually reverse the story and claim that revenues of banks are restrained by productivity, cost and competition.

For estimation of spread revenue, we use the standard trans-log function with two inputs (labor and physical capital):

$$\ln(Y_i) = \theta_0 + \sum \theta_i \ln X_i + 0.5$$
$$* \sum \sum \theta_{ij} \ln X_i \ln x_j$$
$$+ \sum \sum \delta_k \ln X_i \ln P_k + \sum \pi_k P_k + 0.5 * \sum \sum \pi_{km} \ln P_k \ln P_m$$

Where: Y – spread revenue to operating costs, Pk – productivity ratios: labor deposit ratio and tangible assets to deposit ratio, X – input costs: price of labor, price of physical capital, Pm – unit costs: processing cost, tangible assets unit cost and output gap. The subscript i is for the bank.

Under the DFA approach, the total residual is composed of a random component and a competition component. Over a long enough time period random component will average to close to zero, while competition component will average to the competition effect. After running the regression, the series of residuals is averaged across banks for six years. Finally, the CE frontier is calculated using the following formula:

$$CEF_i = \exp(ln\,\overline{u}_i - ln\overline{u}_{min})$$

Where:
CEF – competition efficiency for a bank i, u – averaged residuals across time for a bank and min u – the minimum residual for all banks.

4 Panzar-Rosse statistic

The Panzar-Rosse H-test (Panzar and Rosse 1987) is a theoretically-grounded and widely used method to measure the degree of competition in actual markets. This method takes advantage of the fact that the response to input price changes will vary according to the degree and nature of competition. In a perfectly

competitive market, price equals marginal cost, so that any change in marginal cost will be exactly reflected in price changes. However, in a situation of monopolistic competition, prices are already above marginal cost. Thus, adjustment of output prices to input prices will only be partial, depending on the degree of competition. In the extreme case of a monopoly, output prices will not change when input prices change, because output prices are optimized to maximize revenues and continue to be set above marginal costs. The test is carried out by estimating the following equation:

$$\ln(p_{it}) = \alpha + b1 \ln(w1_{it})$$
$$+ b2 \ln(w2_{it}) + b3 \ln(w3_{it}) + c1 \ln(y1_{it}) + c2 \ln(y2_{it}) + c3 \ln(y3_{it}) + e_{it}$$

where p – ratio of income to assets (usually gross interest revenues to total assets), the w's are factor costs (labor, funds and physical capital), and the y's are exogenous variables affecting income.

The Panzar-Rosse H-test is then formed as: b1+b2+b3. If 0<H<1, the market is characterized by monopolistic competition. And if H<0, the market is a monopoly.

However, before testing the model, it is necessary to test to see whether the banking system under analysis was in long-term equilibrium over the period studied. The reason for this is that the characterizations of the market as perfectly competitive, monopolistically competitive or monopoly are based on the assumption that the system is observed in equilibrium.

Testing for long-term equilibrium involves an additional test, in which the dependent variable is return on assets rather than income to assets. In long-term equilibrium, the return on assets should not vary if factor prices vary. That is, in the equation:

$$\ln(ROA_{it}) = \alpha + d1 \ln(w1_{it})$$
$$+ d2 \ln(w2_{it}) + d3 \ln(w3_{it}) + f1 \ln(y1_{it}) + f2 \ln(y2_{it}) + f3 \ln(y3_{it}) + e_{it}$$

the sum of the coefficients d1+d2+d3 it should equal zero.

The input costs were: labor costs, interest costs, and administrative and operational costs. The exogenous variables, following Claessens and Laeven (2003), were total bank assets, loans to assets, and the capital asset ratios.

5 Efficiency scores

We calculate the efficiency scores by using a stochastic frontier analysis (SFA) that enables us to calculate a bank and year specific efficiency scores. In the first step, we compose a trans-log function for banks using three inputs and three outputs.

$$lntc = lnyi + lnwi + \sum\sum yiyi + \sum\sum wiwi + \sum\sum yiwi + \varepsilon,$$

Where:
tc = total cost (operating and interest),
yi= three bank products (loans, other earning assets, net fees and commission),
wi= the prices of three bank inputs (labor, physical assets and financial capital).

In the second step, we use SFA and assume that the error term consists of random and inefficiency components. To disentangle the two, we use the **sfmodel** command provided by Kumbhakar (2015).

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