The ECB Single Supervisory Mechanism: Effects on Bank Competition

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Abstract

Under the Single Supervisory Mechanism (SSM) introduced in 2014, supervision of significant euro area banks moved from national authorities to the European Central Bank. We find that the SSM reduced competition for SSM banks in countries that were at the center of the sovereign debt crisis by increasing Lerner indices and profit persistence. In other euro area countries, the SSM had little effect on competition or increased competition for SSM banks. Profit persistence also indicates that banking sectors are not in long-run equilibrium, which does not hamper identification but inflates standard errors of estimated SSM effects on the Lerner Index.

Keywords: ECB Single Supervisory Mechanism; Banking supervision; Competition; Lerner index; Persistence of profits

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1. Introduction

In response to deficiencies in bank regulation and supervision that became apparent in the global financial crisis of 2007–2008 and the subsequent sovereign debt crisis, the European Union introduced the Single Supervisory Mechanism (SSM) in November 2014. Prior to the SSM, all banks were supervised by national authorities. Under the SSM, the European Central Bank (ECB) directly supervises "significant" euro area banks.[2] Currently, the ECB directly supervises 111 significant banks, holding about 82% of all banking assets. For simplicity, we refer to these banks as SSM banks.[3]

In addition to the SSM, there have been other regulatory reforms (e.g. Basel III) and the macroeconomic environment has also changed (e.g. the negative interest rate environment). All these changes apply to all banks in the euro area. The shift from national supervision to direct ECB supervision under the SSM is the only fundamental regulatory change that applies exclusively to SSM banks. In this paper, we examine whether the SSM affects the competitive position of SSM banks.

Examining the impact of the SSM on competition is important for at least three reasons. First, very little is known about the impact of supervisory changes on competition. The ECB states that direct ECB supervision under the SSM should establish a common approach to day-to-day supervision, harmonized supervisory actions and corrective measures, and ensure the consistent application of regulations and supervisory policies.[4] However, the ECB does not comment on the possible impact of the SSM on competition. The question therefore arises whether the direct and uniform supervision by the ECB changes competition for SSM banks?

Second, there is a well-known tension between banking competition and financial stability due to asymmetric information issues, implicit "too big to fail" insurance and institutional and regulatory design

[2] A bank is considered significant if it meats at least one of the following criteria: its assets exceed 30 billion euro, the bank is important for the country or the euro area as a whole, it has important cross-border activities, it has requested or received funding from the European Stability Mechanism or the European Financial Stability Facility. Significant banks are often the largest banks in a country, but "less significant" banks in large euro area countries can be larger than significant banks in small euro area countries.

[3] The SSM applies to all banks in the euro area. However, for the sake of simplicity, we refer to banks under direct ECB supervision as SSM banks and banks that continue to be supervised by national authorities as non-SSM banks.

[4] https://www.bankingsupervision.europa.eu/about/thessm/html/index.en.html

(Beck et al., 2013; Berger et al., 2017). In this context, the competition-fragility view argues that banks facing competitive pressure may take too much risk in the search for yield (Keeley, 1990; Achen, 2000; Matutes and Vives, 2000; Vives, 2019), thereby increasing financial fragility (Jiménez et al., 2013). In contrast, the competition-stability view emphasizes the positive effects of competition. More competition would lead to lower lending rates, thereby promoting firm profitability and reducing default risk (Boyd and De Nicolo, 2005). For example, Anginer et al. (2014) find that more competition reduces systemic risk, Goetz (2018) finds for the US that increasing competition reduces the probability of bank failure and increases bank profitability, and Martinez-Miera and Repullo (2010) find an U-shaped relationship between competition and bank failure. Therefore, it is important to know whether the SSM leads to more or less competition for SSM banks.

Third, it is sometimes argued that regulatory capture leads to lax supervision by national authorities (Barth et al., 2012; Boyer and Ponce, 2012). Under the SSM, the ECB directly supervises SSM banks in cooperation with national supervisors, but national supervisors act independently as part of the SSM, and decisions are taken by the ECB's Supervisory Board and approved by the Governing Council. Supervision in the SSM is therefore likely to be stricter and more consistent than supervision by national authorities. As a result, ECB supervision may enhance confidence in SSM banks and give SSM banks a competitive advantage over non-SSM banks. More consistent supervision may, however, also increase competition.

The above points make it clear that the SSM can have pro-competitive and anti-competitive effects and that the overall impact of the SSM on competition is difficult to predict on the basis of theoretical considerations alone. An empirical investigation of this question is therefore essential.

In this paper we examine the impact of the SSM on competition from a static and a dynamic perspective. Examining competition from both angles is important for at least two reasons. First, we can measure the impact of the SSM more broadly and get a more complete picture about banking competition in the euro area. Second, as we shall see, the dynamic properties of competition affect the precision and the interpretation of estimates of static measures of competition.

In the conventional static view, prices and output are the main choice variables, and the focus is on equilibrium outcomes. Equilibrium outcomes with prices above marginal costs are viewed as an indication of market power or collusive behavior that leads to welfare losses for society. In contrast, the dynamic view of competition, which gave rise to the persistence of profits literature (Mueller, 1977, 1986; Geroski and Jacquemin, 1988; Mueller, 1990), adopts a more Schumpeterian perspective where equilibria are less important. Competition is seen as a process in which many forms of non-price competition also exist. Firms with new successful products achieve a competitive advantage and earn temporary monopoly rents, but competition erodes those rents over time.

Consistent with the static view, we examine whether the SSM affects the market power of SSM banks. We measure market power using the Lerner index (Lerner, 1934), which measures the difference between a firm's output price and its marginal cost at the profit-maximizing output rate. Although other measures of competition such as the Panzar and Rosse H-statistic (Panzar and Rosse, 1987) and the Boone indicator (Boone, 2008) are also used in the literature, the Lerner index is by far the most popular measure (Blair and Sokol, 2015). For example, Shaffer and Spierdijk (2020) cite more than 45 recent studies that use the Lerner index to measure competition in the banking sector.[5]

Like any measure of market power, the Lerner Index has certain weaknesses. The index may be biased if some assets are incorrectly treated as output (Shaffer and Spierdijk, 2020). Non-maximizing behavior (Berger and Humphrey, 1991) and economies of scale (Spierdijka and Zaourasa, 2018) can also lead to bias. With this in mind, we estimate the Lerner index with the standard inputs and total assets as output using a translog cost function, as is common in the literature. In this way, we obtain results that can be compared with previous studies. However, to improve the stability of the estimates, we use a panel data framework with simultaneous equations and bank-specific effects.

In the dynamic analysis, we examine whether the intensity of bank competition has changed since the introduction of the SSM using the persistence of profits framework developed in Mueller (1986) and Mueller (1990). Goddard et al. (2011) and Gugler and Peev (2018) recently applied this framework

[5]Measures of market structure that attempt to indirectly measure competition include n-firm concentration ratios and the Herfindahl-Hirschman index.

to study the persistence of bank profit rates. In this framework, profit rates are modeled as a reduced form autoregressive process in which the speed of convergence of profit rates reflects the intensity of competition. Competition is intense when profit rates converge quickly to the long run profit rate, and less intense when profit rates converge slowly.

Systematic deviations of bank profit rates from long-run equilibrium rates are inconsistent with the static view of competition. We therefore examine how disequilibrium affects estimates of SSM effects on the Lerner index. As we will see, the estimates correctly capture the SSM effects, but the effects should be interpreted as disequilibrium effects or a as combination of equilibrium and disequilibrium effects. We also point out that disequilibrium inflates the standard errors of the estimated SSM effects on the Lerner index.

There is an extensive literature on banking competition and its implications for regulation and financial stability. Vives (2016) offers a comprehensive overview. Recent work on competition in the EU banking sector includes Apergis et al. (2016), Coccorese et al. (2021), Cruz-Garcia et al. (2017), Maudos and Vives (2019), and Weill (2013), among others. Most of these studies conclude that competition in the EU banking sector increased until the financial crisis of 2007-2008 and decreased somewhat thereafter, likely due to government bailouts and financial assistance.

The literature on the impact of the SSM on bank behavior is rather sparse. With respect to bank lending, Fiordelisi et al. (2017) notes that the introduction of the SSM had the unintended effect of SSM banks reducing lending in order to shrink their balance sheets and increase capitalization. Ampudia et al. (2021) find that firms borrowing from SSM banks shift investments from knowledge-based intangible investment to capital-based physical assets. In terms of profitability, Avgeri et al. (2021) and Raunig and Sigmund (2022) find that the SSM has a positive impact on the profitability of SSM banks. Okolelova and Bikker (2022) is the only work we know that looks at the impact of the SSM on bank competition. Their study covers Austrian, French, German, Italian and Spanish banks over the period 2013–2016. Using the Lerner index and the Boone indicator, the authors find that the market power of SSM banks in these five countries decreased after the introduction of the SSM.

In this paper, we contribute to the literature by examining the impact of the SSM on the Lerner index and the dynamics of SSM banks' profit rates using a large panel data set of euro area banks from sixteen countries reporting to the SNL Financial database. Our data set covers the period 2004-2019 and includes annual balance sheet and income statement data for more than 2600 banks from Austria, Belgium, Cyprus, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovenia, and Slovakia.

For the banking sectors of the countries in our sample, we estimate average country-specific Lerner indices of about 0.01 to 0.30 for the entire sample period. During the financial crisis of 2007–2008, the average Lerner index fell slightly in most countries. Otherwise, the country-specific Lerner indices often do not show a clear trend. The impact of the SSM on the individual Lerner indices of SSM banks turns out to be heterogeneous. We find clearly positive SSM effects on the Lerner indices of SSM banks from Ireland, Italy and Portugal. For the SSM banks in other countries, the SSM effects on the Lerner index are mostly zero or negative. Furthermore, the standard errors of the estimated SSM effects are often rather large.

With respect to bank profit rates, we find that profit rates converge rather slowly in all countries of our sample. This helps explain why our estimated SSM effects on the Lerner index are often imprecise. Since the introduction of the SSM, the persistence of profit rates of SSM banks has fallen significantly in the small banking sectors of Luxembourg, Malta and Slovenia and has risen sharply in Cyprus, Greece, Netherlands, Portugal, and Slovakia. In the other countries, the persistence of the profit rates of SSM banks has not changed or has increased only slightly.

We continue as follows. In the next section, we explain in detail how we estimate the Lerner index and how we measure the persistence of bank profit rates. In Section 3, we describe our strategy for identifying SSM effects on the Lerner index and discuss how to interpret such estimates. In Section 4, we outline how we measure changes in the persistence of SSM banks' profit rates. In Section 5 we describe our data and in Section 6 we present and discuss our empirical results. In the last section, we draw some conclusions.

2. Measuring Competition

We now describe how we measure competition from the static and the dynamic perspective. Following the static view, we measure banks' market power with the Lerner index. According to the dynamic view, we model the dynamics of bank profit rates to examine how fast profit rates converge to their long run level.

2.1. Lerner Index

The theoretical approach to estimate the Lerner index was developed by Iwata (1974) and Appelbaum (1982) and first applied to the banking sector by Angelini and Cetorelli (2003). Since then, the Lerner index has been used in many empirical banking studies either as an endogenous or exogenous variable (Maudos and de Guevara, 2004; Maudos and Solis, 2009; Maudos and Vives, 2019; Yildirim and Kasman, 2021).

Using standard static Cournot optimization (for details, see Appendix B) and a translog cost function (see, Angelini and Cetorelli, 2003; Agoraki et al., 2011; Efthyvoulou and Yildirim, 2014, among many others), we obtain the following cost function,

$$\begin{aligned} ln(C_{it}) \quad = \quad & \alpha_{1i} + s_0 ln(q_{it}) + \tfrac{s_1}{2}(ln(q_{it}))^2 + ln(q_{it}) \textstyle\sum_{j=1}^{3} s_{j+1} ln(w_{jit}) + \\ & \textstyle\sum_{j=1}^{3} c_j ln((w_{jit}) + c_4 ln(w_{1it}) * ln((w_{j3}) + \\ & c_5 ln(w_{1it}) * ln(w_{2it}) + c_6 ln(w_{2it}) * ln(w_{3it}) + \\ & \textstyle\sum_{i=1}^{3} c_{i+6} ln((w_{ji})^2 + \epsilon_{1it} \ , \end{aligned} \tag{1}$$

where α_{1i} is a bank-specific fixed effect, q_{it} denotes total assets, and ϵ_{1it} is an error term. Following the literature, we use interest rate expenses (w_{1it}), staff expenses (w_{2it}) and other operating expenses (w_{3it}) as input factors. As suggested in Mester (1996), we use the equity ratio as an additional input factor in an extended version of Eq. (1) to account for the possibility that capital is used as a funding source for loans.

The main advantage of the translog cost function is its flexibility. Many other popular cost functions (e.g. Cobb-Douglas) are special cases of the translog cost function. Furthermore, even if the true cost function is different, the translog specification still provides a 2nd order Taylor approximation to the true cost function.

The first derivative (i.e. the marginal cost function) of Eq. (1) and a mark-up are then set to be equal to the marginal revenue which leads to

$$p_{it} = \frac{C_{it}}{q_{it}} \left(s_0 + s_1 ln(q_{it}) + \sum_{j=1}^{3} s_{j+1} ln(w_{jit}) \right) + \eta_i + \mu \cdot SSM_{it} + \epsilon_{2it} \ , \tag{2}$$

where ϵ_{2it} is an error term and p_{it} is the price of the aggregate bank output, which is defined as the sum of interest income, fee and commission service income, income from investment and other income divided by total assets. The term η_i captures the average ability of bank i to set the price over its marginal costs.

Raunig and Sigmund (2022) found positive SSM effects on the return on assets of SSM banks, which are likely caused by increased confidence in the soundness of SSM banks and by better risk management in SSM banks. Such effects could also influence the mark-up in the marginal revenue equation for SSM banks. Therefore, Eq. (2) also contains the dummy variable SSM_{it} for SSM banks, which is zero before 2014 and one afterwards, and μ captures a possibly additional mark-up for SSM banks since 2014. The mark-up for bank i at time t is then defined as $\zeta_{it} = \eta_i + \mu \cdot SSM_{it} + \epsilon_{2it}$.

In order to calculate ζ_{it} for each bank in each time period, we proceed as follows. We estimate Eq. (1) and Eq. (2) as a system of simultaneous equations with bank-specific fixed effects to obtain stable coefficient estimates. We also restrict the parameters $s_0, s_1, s_2, s_3, s_4, s_5$ and s_6 to be identical to increase the precision of the estimated coefficients (Bresnahan, 1989). Since all right hand side variables in Eq. (2) depend on the endogenous variable C_{it} in Eq. (1), we instrument these variables with all exogenous variables from Eq. (1). As a result, we obtain consistently estimated coefficients $\hat{s}_0, \hat{s}_1, \hat{s}_2, \hat{s}_3, \hat{s}_4$ and $\hat{s}_5$. Finally, we obtain the Lerner index for each bank i at time t as

$$L_{it} = \frac{p_{it} - \frac{C_{it}}{q_{it}}\left(\hat{s}_0 + \hat{s}_1 ln(q_{it}) + \sum_{j=1}^{3} \hat{s}_{j+1} ln(w_{jit})\right)}{p_{it}} . \tag{3}$$

2.2. Persistence of Profits

The static view of competition implicitly assumes that a country's banking sector is in long-run equilibrium. This implies that deviations of bank profit rates from long-run profit rates are purely random. In contrast, the dynamic view of competition accounts for the possibility that competition does not always eliminate excess profits immediately. Profit rates may therefore deviate systematically from long run profit rates. In addition, due to entry barriers and market power, banks may earn permanent rents.

We model the dynamics of bank profit rates along the lines of Mueller (1990) and decompose a bank's profit rate in year t,

$$\Pi_{it} = C_t + R_i + S_{it} , \tag{4}$$

into a possibly time-varying competitive rate of return C_t common to all banks, a permanent bank-specific rent R_i, and a short-run bank-specific rent S_{it}. As bank profit rates may vary with the business cycle, we follow the persistence of profits literature and subtract the average rate of return $\bar{\Pi}_t$ calculated across all banks in a country in year t from Π_{it} to eliminate business cycle effects. The resulting normalized profit rate is

$$\pi_{it} = r_i + s_{it} , \tag{5}$$

where $s_{it} = S_{it} - \bar{S}_t$ and $r_i = R_i - \bar{R}$.[6] It is assumed that competitive forces (e.g. price competition, the thread of entry and actual entry, etc.) erode short-run rents over time. Therefore, S_{it} should converge to zero by assumption as time tends to infinity, which implies that $\bar{S}_t$ and s_{it} also converge to zero.

[6] $\bar{S}_t = \frac{1}{N}\sum_{i=1}^{N} S_{it}$ and $\bar{R} = \frac{1}{N}\sum_{i=1}^{N} R_i$.

The standard way in the literature to model short-run rents is to specify a first-order autoregressive process,

$$s_{it} = \lambda_i s_{it-1} + u_{it} \,, \tag{6}$$

where $|\lambda_i| < 1$ for stationarity and u_{it} is an error term with zero mean and constant variance. Since Eq. (4) holds in every period, it can be used to eliminate s_{it} and s_{it-1} from Eq. (6) yielding

$$\pi_{it} = \pi_{ip}(1 - \lambda_i) + \lambda_i \pi_{it-1} + u_{it} \,, \tag{7}$$

where $\pi_{ip} = r_i$ is the long-run normalized profit rate for bank i as t goes to infinity. The parameter λ_i measures the persistence of short-run rents. Eq. (7) is the workhorse equation for modeling the dynamics of firm profit rates in the persistence of profits literature.[7]

In measuring the intensity of competition, we focus on the parameter λ_i. The competition intensity is high when λ_i is small and the intensity is low when λ_i is high. If $\lambda_i = 0$ for all banks in a country, then the country's banking sector is in a long-run equilibrium state.[8]

3. Estimating SSM Effects on the Lerner Index

Since we have repeated observations on the same banks over time, we use panel data models to estimate SSM effects on the Lerner index. In these models, we need to control for confounders of the effects of

[7] The assumption in Eq. (6) could be extended to higher order AR-processes such as $s_{it} = \sum_{j=1}^{p} \lambda_{ij} s_{it-j} + u_{it}$, which results in $\pi_{it} = \pi_{ip}(1 - \sum_{j=1}^{p} \lambda_{ij}) + \sum_{j=1}^{p} \lambda_{ij} \pi_{it-j} + u_{it}$.

[8] In long-run equilibrium the Lerner index and profit rates are positively correlated. In Eq. (2) $\zeta_{it} = \eta_i + \epsilon_{2,it}$ (ignoring the SSM dummy) defines the mark-up for bank i at time t as a permanent mark-up η_i plus some random noise. In long-run equilibrium, Eq. (7) simplifies to $\pi_{it} = \pi_{ip} + u_{it}$. Then the only difference between π_{it} and ζ_{it} is that ζ_{it} measures profitability as a mark-up over marginal costs, while π_{it} measures profitability as a deviation from the cross sectional mean profit rate. The Lerner index, $L_{it} = \zeta_{it}/p_{it}$, is just the mark-up divided by the price p_{it}. In long-run equilibrium we should therefore find a positive correlation between a bank's Lerner index and its profit rate.

the SSM on the Lerner Index to obtain estimates that have a causal interpretation. As we will explain shortly, we achieve unconfoundedness by using bank size and bank-specific fixed effects to control for selection into the SSM.

3.1. Econometric Models

We estimate the effects of the SSM on the Lerner index using four models of increasing flexibility. Our simplest model assumes a constant SSM effect. The next model also assumes a constant SSM effect, but allows for different time effects for SSM and non-SSM banks. In the third model, the SSM effects can vary over time. In the fourth model, the SSM effects can vary over time and the time effects for SSM and non-SSM banks can be different.

The first model is given by the following regression,

$$L_{it} = \delta \cdot SSM_{it} + \beta \cdot BS_{it} + a_i + b_t + \epsilon_{it} , \tag{8}$$

where L_{it} is the Lerner index for bank i at time t, BS_{it} is bank size measured by the log of total assets, a_i is a time-constant bank specific effect, b_t is an aggregate time effect, and ϵ_{it} is an error term. $SSM_{it} = (G_i \cdot I_t)$ is an indicator variable, where $G_i = 1$ when bank i belongs to the group of SSM banks and $G_i = 0$ otherwise and $I_t = 1$ when the SSM is active and zero otherwise. Hence, $SSM_{it} = 1$ when bank i is an SSM bank and the SSM is active. The coefficient δ measures the effect of the SSM on the Lerner index for SSM banks. The model can be estimated using a standard fixed effects estimator. Robust standard errors can be obtained using a cluster robust variance matrix estimator.

The second model,

$$L_{it} = \delta \cdot SSM_{it} + \beta \cdot BS_{it} + \theta g_t + a_i + b_t + \epsilon_{it} , \tag{9}$$

contains the additional term $g_t = (G_i \cdot t)$ to allow for different time effects for SSM and non-SSM banks.

As a result, SSM_{it} can also be correlated with unobserved variables that are responsible for a specific trend for SSM banks.

The third model relaxes the assumption of a constant SSM effect and allows for time-varying SSM effects. The model becomes

$$L_{it} = \sum_{\tau=1}^{q} \delta_{+\tau} \cdot SSM_{i,t+\tau} + \sum_{\tau=0}^{m} \delta_{-\tau} \cdot SSM_{i,t-\tau} + \beta \cdot BS_{it} + a_i + b_t + \epsilon_{it} , \quad (10)$$

where the q leads ($\delta_{+1}, ..., \delta_{+q}$) capture possible anticipatory effects and the m lags ($\delta_0, ..., \delta_{-m}$) capture the possibly time-varying SSM effects. The SSM was first announced in September 2012 and Fiordelisi et al. (2017) argue that in 2013 banks could already see whether they would become an SSM bank. Therefore, these banks may have already changed their business strategy before the launch of the SSM in 2014. To account for this possibility, we allow for an anticipatory SSM effect in 2013.

The fourth and most flexible model is

$$L_{it} = \sum_{\tau=1}^{q} \delta_{+\tau} \cdot SSM_{i,t+\tau} + \sum_{\tau=0}^{m} \delta_{-\tau} \cdot SSM_{i,t-\tau} + \beta \cdot BS_{it} + \theta g_t + a_i + b_t + \epsilon_{it} . \quad (11)$$

This model allows for time-varying SSM effects and different time-effects for SSM and non-SSM banks.

The estimated SSM effects in these models have a causal interpretation if the key identifying assumption of strict exogeneity holds. Strict exogeneity means that the relationship between the explanatory variables of interest and the outcome variable is unconfounded. In our case, the treatments, $SSM_i = (SSM_{i1}, ..., SSM_{iT})$, must be uncorrelated with the error term ϵ_{it} conditional on the control variables, the fixed effect a_i, and time t. This implies that past treatments must not directly affect current outcomes, and past outcomes must not directly affect current treatment (Cunningham, 2021). In our case, both requirements are arguably fulfilled. First, SSM membership in earlier years does not directly affect Lerner indices in later years, since SSM measures from year $t-1$ can only be enforced in year t if a bank is also in the SSM in year t. Second, SSM membership does not depend on the Lerner index. Therefore, there is also no reverse causality between SSM effects and the outcome.

To ensure unconfoundedness, all four models include bank size BS_{it} as a control variable, since selection into the SSM almost always depends on bank size. For example, 112 out of 116 banks were in the SSM in 2014 because of their size or their size relative to GDP. Thus, by including bank size and bank fixed effects, we control directly for selection into the SSM. The other selection criteria (the amount of cross-border activities and direct public financial assistance requested or received from the European Stability Mechanism or the European Financial Stability Facility) play almost no role. Nonetheless, in these few remaining cases, the bank fixed effect should also absorb these potentially confounding effects. Finally, the selection into the SSM is a non-random assignment.

Our goal is to measure the total (or overall) effect of the SSM on the Lerner index of SSM banks. This total effect subsumes all direct and indirect effects of the SSM. For example, a direct effect of the SSM could result from increased confidence in the soundness of SSM banks, which could SSM banks give a competitive advantage over non-SSM banks. Indirect SSM effects could arise as SSM banks adjust key business variables in response to SSM regulation. Banks could, for example, adjust their capital ratio or change their business strategy in response to SSM regulation.

To identify the total effect of the SSM on the Lerner index, we must control for selection into the SSM to avoid confounding, but allow direct and indirect SSM effects to operate. Therefore, the models (8) - (11) do not contain any other firm-specific explanatory variables apart from bank size. If we were to include additional control variables, we would risk "controlling away" indirect SSM effects. For example, if the SSM would affect market power indirectly via adjustments of the capital ratio, our estimated SSM effect would not capture this indirect effect if we included the capital ratio as a control variable, since holding the capital ratio constant blocks this indirect SSM effect. The models also do not include any macroeconomic variables, as these variables are not required to identify SSM effects.

3.2. SSM Effects, Lerner Index and Persistence of Profits

The static theory on which the Lerner index is based assumes that a country's banking sector is in long-run equilibrium (Geroski, 1990; Elzinga and Mills, 2011). However, Berger et al. (2000), Goddard et al.

(2011) and Gugler and Peev (2018) find that short-run rents in the banking sector decline slowly. Thus, a banking sector may not be in long-run equilibrium at all points in time when the data used to estimate the Lerner index are observed. This raises the question of how disequilibrium affects estimates of SSM effects. We now show that Eq. (8) – Eq. (11) identify the SSM effects in equilibrium and in disequilibrium.

In equilibrium, an estimated Lerner index, $L_{it} = L_i^* + \epsilon_{it}$, should differ from the true index L_i^* only by some random noise ϵ_{it}. In contrast, in disequilibrium a Lerner index may be estimated with disequilibrium data and therefore contain an additional systematic measurement error $\epsilon_{it}^d = (L_{it} - L_i^*)$. Following Geroski (1990), we now take our simplest model in Eq. (8) and work out the SSM effect that the model estimates in different situations. What follows also applies analogously to the models in Eq. (9) – Eq. (11).

In equilibrium, $L_i^* = \delta \cdot SSM_{it} + \beta \cdot BS_{it} + a_i + b_t$ is the systematic part in Eq. (8). Disequilibrium adds a measurement error ϵ_{it}^d and the model becomes

$$L_{it} = \delta \cdot SSM_{it} + \beta \cdot BS_{it} + a_i + b_t + \epsilon_{it} + \epsilon_{it}^d \,. \tag{12}$$

We now consider three cases. In the first case, the SSM causes a shift in the equilibrium Lerner index L_i^*. In the second case, the SSM causes disequilibrium and helps to explain the measurement error ϵ_{it}^d. In the third case, the SSM causes disequilibrium and a shift in the equilibrium Lerner index. In all three cases we allow for the possibility that bank size BS_{it} may also help to explain deviations from equilibrium.

If the SSM shifts the equilibrium Lerner index, then the coefficient δ in Eq. (12) captures this effect correctly as SSM_{it} is unrelated with $\epsilon_{i,t}^d$. Since BS_{it} may help to explain the measurement error,

$$(L_{it} - L_i^*) = \epsilon_{it}^d = \alpha \cdot BS_{it} + \epsilon_{it}^l \,. \tag{13}$$

Substituting of Eq. (13) into Eq. (12) shows that the slope coefficient on BS_{it} becomes $(\alpha + \beta)$. However, this is unproblematic as we want to identify the effect of the SSM and not the effect of bank size.

If the SSM causes only disequilibrium, then $\delta = 0$ in Eq. (12) and the SSM effect enters via the measurement error. In this case Eq. (13) becomes

$$\epsilon_{it}^{d} = \alpha \cdot BS_{it} + \gamma \cdot SSM_{it} + \epsilon_{it}^{l} \, . \tag{14}$$

Plugging Eq. (14) into Eq. (12) shows that the estimated coefficient on SSM_{it} in Eq. (12) yields γ, which is just the disequilibrium effect of the SSM on the Lerner index.

If the SSM causes disequilibrium and a permanent shift in the Lerner index, then $\delta \neq 0$ in Eq. (12) and the SSM effect also enters via the measurement error ϵ_{it}^{d}. Plugging Eq. (14) into Eq. (12) shows that the estimated coefficient for the variable SSM_{it} in Eq. (12) is now $(\delta + \gamma)$, which is the overall effect of the SSM on the Lerner index that results from the equilibrium and disequilibrium effects of the SSM.

As we have just seen, disequilibrium does not impede the estimation of SSM effects, but the estimates may capture disequilibrium effects or a combination of equilibrium and disequilibrium effects. Disequilibrium does, however, affect the standard errors and hence the t-statistics of the estimated SSM effects. In Eq. (13) and Eq. (14) the disequilibrium measurement error contains the additional noise term ϵ_{it}^{l}. This additional noise inflates standard errors. As a result, the SSM effects will be less precisely estimated.

4. SSM and the Persistence of Profits

In Section 2.2 we said that the parameter λ in Eq. (7) measures how quickly competition erodes short-run rents. We now describe how we examine whether the persistence of profits of SSM banks has changed since the launch of the SSM.

In the persistence of profits literature, profits are usually measured by the return on assets because return on assets captures the performance of all assets under the management of a firm (Berger et al., 2000; Chronopoulos et al., 2015; Gugler and Peev, 2018). We follow this literature and compute the normalized profit rate $\pi_{it} = \Pi_{it} - \bar{\Pi}_t$ for bank i in year t as the deviation of the bank's return on assets Π_{it} from the average return on assets $\bar{\Pi}_t$ of the country's banking industry in year t.

Given that we have fifteen years of data, we do not estimate λ separately for each bank. Instead, we estimate a λ for the euro area and separate λ coefficients for the sixteen countries in our sample. To measure changes in the persistence of profits of SSM banks, we estimate the autoregressive panel data model

$$\pi_{it} = \mu_i + \delta_0 SSM_{it} + \delta_1 \pi_{it-1} SSM_{it} + \lambda \pi_{it-1} + u_{it} \,, \tag{15}$$

where $\mu_i = \pi_{ip}(1 - \lambda)$ is a bank-specific fixed effect and u_{it} is an error term. The dummy variable $SSM_{it} = 1$ if bank i is an SSM bank and the SSM is effective, otherwise $SSM_{it} = 0$. The coefficient δ_1 in Eq. (15) captures the change in the persistence of profits of SSM banks since the launch of the SSM. The parameter δ_0 captures a shift in the fixed effects of SSM banks. This parameter must be interpreted with caution, as δ_0 is only identified if $\delta_1 = 0$. In this case, λ remains unchanged and δ_0 captures a change in long-run projected profit rates.

When we estimate Eq. (15) for the euro area, we assume that λ is the same for all banks. The estimated λ then provides information about the average persistence of profits in the euro area before the introduction of the SSM, and the estimated δ_1 provides information about a change in the average persistence of profits of SSM banks since the introduction of the SSM. As the intensity of banking competition can vary from country to country, we also estimate Eq. (15) separately for each country. In this case, λ is assumed to be the same for all banks in a country.

5. Data

Our unbalanced panel data set consists of annual balance sheet data of euro area banks over the time period 2004–2019 from the SNL Financial's database. We include every bank at the unconsolidated level that reports to SNL in our initial sample, which comprises 2,666 banks. Of these banks, 116 are SSM banks. To ensure that outliers and reporting errors do not influence our estimation results, we clean the data in five steps.

First, since the minimum regulatory Tier 1 ratio under Basel II was 4%, we remove all banks that report a Tier 1 ratio under 4%. Legally, a Tier 1 ratio under 4% is possible, but in these cases regulatory authorities step in and take strict measures such as removing the bank's management, revoking the bank license and (or) forcing the bank into resolution. This ratio was gradually increased to 6% as part of Basel III from 2014 onward.

Second, we remove a few banks that seem to report twice with slightly different bank identifiers.[9] Third, for variables that are ratios, we calculate the interquartile range. To eliminate reporting errors, we discard values outside the four-fold interquartile range. In the fourth step, we drop banks that report data for less than three years in our sample period.

In the final cleaning step, we drop all banks that report total assets of less than one million euros. Most of these banks hardly report any other balance sheet and income statement variables and including them would not change our estimation results.

5.1. Explanatory Variables

Our bank-specific explanatory variables are bank size, measured by the log of total assets, and the variables we need to estimate the Lerner index. To estimate the translog cost function given by Eq. (1), we include total assets, interest rate expenses, staff expenses, other operating expenses, the equity ratio and total costs. Total costs are the sum of interest expenses, labor costs and provisions and other expenses. In the marginal revenue equation given by Eq. (2), we include total income divided by total assets. Total income includes interest income, dividends from equity, fee and commission income and other non-interest income.

[9] These banks have the following SNL IDs/names: 4255652, 4242082, Citibank Europe Plc, JSC Bankas Finasta AB, Lietuvos bankas, Luminor Bank AS, RCB Bank Ltd., Rigensis Bank AS, Swedbank AS, 4242265, TCS Group Holding Plc, UAB Medicinos Bankas, 4580293, 4569819, 4574631, 4782274 and 4257268.

Table 1: Summary statistics

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max	Data.Cov
Input variables							
Total Assets	1,000	282,021	1,097,68	26,445,228	5,199,353	2,601,695,000	61.11
Interest expenses	0	1,602	8,196	499,668	52,233	101,786,000	59.89
Labor Costs	1	3,180	11,093	168,542	44,202	17,553,000	59.45
Labor Costs over TA	0	0.01	0.01	0.01	0.01	0.03	58.39
Provision and other expenses	10	2,403	8,802	157,041	38,522	29,752,000	59.49
Provision and other expenses over TA	0	0.01	0.01	0.01	0.01	0.02	57.21
Total costs	10	8,088	32,073	821,014	151,087	105,905,000	59.73
Total costs over TA	0	0.02	0.03	0.03	0.04	0.09	58.45
Interest income	1	7,118	29,515	796,098	143,360	107,859,000	59.92
Dividends from equity	1	1,399	8,541	52,460	29,032	1,808,000	7.18
Fee and commission income	100	66,259	163,149	737,965	398,975	16,412,000	11.53
Fee and commission expenses	0	9,361	27,776	195,156	104,526	6,500,000	11.56
Net fee and commission income	-576,000	1,464	6,089	124,462	27,893	12,765,000	60.02
Other non-interest income	2	6,102	20,626	101,710	62,048	8,389,000	8.92
Total income	-60,410	9,666	38,572	936,603	185,166	109,461,000	60.28
Total income over TA	-0.01	0.03	0.04	0.04	0.04	0.10	59.25
Tier 1 capital ratio	0.04	0.12	0.15	0.16	0.19	0.44	48.40
Lerner indices							
2 SLS Lerner Index (no equity)	-0.36	0.17	0.25	0.24	0.32	0.85	56.41
3 SLS Lerner Index (no equity)	-0.41	0.12	0.20	0.19	0.27	0.80	56.28
2 SLS Lerner Index (equity ratio)	-0.34	0.17	0.25	0.24	0.32	0.81	47.05
3 SLS Lerner Index (equity ratio)	-0.39	0.12	0.19	0.18	0.26	0.75	46.93
Persistence of profits							
ROA before Tax and Risk	-1.56	0.58	0.85	0.88	1.15	3.27	58.13
Dev ROA	-2.81	-0.27	-0.01	0	0.24	2.57	58.13

Data sources: SNL, all Lerner indices are estimated as described in Section 2.1.
The table shows the minimum (Min.), first quantile (1st Qu.), median (Median), mean (Mean), third quantile (3rd Qu.), maximum (Max) and the data coverage (Data Cov.) for the variables used in this paper. Data Cov. refers to the percentage of available observations if the data was a balanced panel. The data set contains yearly data for 2,668 banks over the period 2004–2019 for the following countries: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI) and Slovakia (SK).
All variables except ratios are in thousands of euros.
Provision and other expenses is defined as operating expenses minus compensation benefits.
Total costs are the sum of interest rate expenses and operating expenses, which are the sum of operating DD&A, compensation and benefits, occupancy and equipment, tech and communications expense, marketing and promotion expense, other provisions and other expense.
Total income is defined as the sum of interest income, dividends from equity, other non-interest income and net fee and commission income. We use net fee and commission income instead of the split fee and commission income and fee and commission expenses as it has a much higher data coverage. Consequently, we do not include fee and commission expenses in the total costs to avoid double counting.
The 2 SLS Lerner Index (no equity) and the 3 SLS Lerner Index (no equity) are estimated with two-stage least squares and three-stage least squares in a seemingly unrelated regression framework based on Eq. (1) and Eq. (2). The 2 SLS Lerner Index (equity ratio) and the 3 SLS Lerner Index (equity ratio) are estimated in the same way but with the Tier 1 capital ratio as an additional input factor in Eq. (1).
ROA before Tax and Risk refers to the standard return on assets definition. The sum of net interest income, dividends income from equity, net fee and commission income and net other non-interest income is divided by total assets.
Dev ROA refers to the deviation of the ROA of bank i in year t in country j from the average ROA of all banks in country j in year t.

5.2. Dependent Variables

The dependent variable in the static analysis is the Lerner index given by Eq. (3) based on the estimated coefficients in Eq. (1) and Eq. (2). We estimate the Lerner index in four different ways. The "2 SLS

Lerner Index (no equity ratio)" and the "3 SLS Lerner Index (no equity ratio)" are estimated with two and three stage least squares without including the equity ratio as a fourth input factor. The "2 SLS Lerner Index (equity ratio)" and the "3 SLS Lerner Index (equity ratio)" are estimated with the equity ratio (approximated by the Tier 1 capital ratio) as a fourth input factor.[10]

The dependent variable in the dynamic analysis is the normalized profit rate, defined as the deviation of the return on assets (Dev ROA) of bank i in year t in country j from the average return on assets of all banks in country j in year t. For completeness, we also show the return on assets before tax and risk in Table 1.

6. Empirical Results

We now present our empirical results about the impact of the SSM on the competitive position of SSM banks. We first describe how the average learner indices for the countries in our sample have evolved over time. Then we present our results for the euro area and county-specific SSM effects on the Lerner index and the persistence of profits of SSM banks. In the last subsection we put our results together and discuss some implications.

6.1. Results for the Lerner Index

We begin with the evolution of the Lerner index over the period 2005–2019 for the countries in our sample. As mentioned in Section 5, we estimate a bank's annual Lerner index in four different ways. Since we get very similar results (Table 1), we only report the results for our most efficient estimate – the 3SLS Lerner index (equity ratio).

We calculate a country-specific Lerner index in year t as the average over the estimated individual Lerner indices for the banks in a country in year t. Table 2 shows how these country-specific Lerner indices evolved over time. Most indices range from 0.01 to 0.3, suggesting low to medium levels of bank market

[10] Appendix B and Appendix C provide further details on the estimation of the Lerner indices.

power in most countries. The Lerner indices do not show a strong overall trend, but in many countries the Lerner index falls slightly during the financial crisis and rises somewhat afterwards.

To check whether our country-specific Lerner indices are in plausible range, we compare them with Lerner indices from other studies. For a sample of Austrian banks with subsidiaries in Slovakia and Slovenia, Feldkircher and Sigmund (2017) obtain similar Lerner indices for these countries with quarterly regulatory reporting data ranging from 2008–2016. Our results are also similar to Yildirim and Kasman (2021) based on BankFocus data covering the period 2013–2018. Maudos and Vives (2019) also obtain similar results for selected euro area countries in most cases.

Table 2: Average country-specific Lerner index developments over time

Year	AT	BE	CY	DE	ES	FI	FR	GR	IE	IT	LU	MT	NL	PT	SI	SK
2005	0.17	0.16	0.22	0.06	0.23	0.15	0.01	0.26	0.17	0.24	0.07		0.09	0.11		
2006	0.12	0.14	0.24	0.06	0.19	0.11	0.02	0.18	0.11	0.25	0.08	0.05	0.04	0.13	0.21	
2007	0.11	0.09	0.23	0.06	0.17	0.14	0.07	0.15	0.07	0.21	0.09	0.24	-0.01	0.14	0.16	
2008	0.12	0.11	0.15	0.08	0.14	0.11	0.09	0.13	0.07	0.19	0.09	0.23	0.02	0.13	0.18	0.27
2009	0.16	0.12	0.13	0.11	0.23	0.10	0.14	0.14	0.13	0.23	0.16	0.24	-0.01	0.14	0.22	0.24
2010	0.20	0.14	0.12	0.18	0.17	0.06	0.17	0.16	0.24	0.15	0.15	0.32	0.09	0.21	0.24	0.25
2011	0.20	0.12	0.20	0.18	0.15	0.12	0.16	0.13	0.20	0.17	0.18	0.25	0.10	0.21	0.20	0.29
2012	0.15	0.12	0.18	0.17	0.20	0.08	0.13	0.01	0.15	0.17	0.20	0.23	0.06	0.19	0.18	0.24
2013	0.17	0.17	0.21	0.19	0.19	0.06	0.16	0.11	0.14	0.14	0.21	0.25	0.15	0.17	0.15	0.30
2014	0.20	0.21	0.27	0.20	0.25	0.13	0.17	0.20	0.14	0.13	0.24	0.23	0.17	0.20	0.20	0.35
2015	0.19	0.24	0.27	0.21	0.26	0.14	0.19	0.24	0.17	0.11	0.23	0.30	0.18	0.21	0.25	0.35
2016	0.19	0.22	0.23	0.22	0.20	0.11	0.17	0.25	0.20	0.10	0.20	0.29	0.15	0.25	0.25	0.30
2017	0.20	0.21	0.18	0.23	0.26	0.10	0.19	0.22	0.19	0.13	0.18	0.25	0.19	0.26	0.23	0.35
2018	0.22	0.21	0.16	0.23	0.28	0.14	0.19	0.22	0.15	0.16	0.15	0.29	0.18	0.24	0.28	0.34
2019	0.24	0.21	0.11	0.22	0.26	0.15	0.18	0.21	0.13	0.15	0.21	0.25	0.17	0.24	0.28	0.29

Source: SNL, authors' calculations.
This table reports the average Lerner index of banks in Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI) and Slovakia (SK) over the period 2005–2019.

We now turn to the impact of the SSM on the market power of SSM banks. We focus again on the 3SLS (equity ratio) based Lerner index, which is the dependent variable in the four econometric specifications outlined in Section 3.1. As explained, we account for the selection into the SSM by controlling for bank size measured by the logarithm of total assets and by including bank fixed effects. This identification strategy yields the total effect (i.e. the sum of the direct and all indirect effects) of the SSM on market power.

Table 3 shows the SSM effects estimated with the full sample of 2,230 banks. In all four models, the

SSM effects are often positive but small and rather imprecisely estimated. The coefficient on the SSM dummy for 2013 in Eq. (10) and Eq. (11) is also small, indicating that there are no announcement effects. In the most flexible specification Eq. (11), the SSM effects increase over time from about 0.019 in 2016 to 0.043 in 2019. These effects are again rather imprecisely estimated. As explained in Section 3.2, the low precision may be partly due to disequilibrium measurement errors.

Table 4 and Table 5 report the estimated country-specific SSM effects obtained with the most flexible specification given by Eq. (11). For comparison, the first column in Table 4 again shows the estimates using the entire sample. The SSM effects are again often imprecisely estimated, but in some countries the SSM effects are quite large and also statistically significant. In particular, we find sizable positive SSM effects for Ireland, Italy, and Portugal, suggesting that the SSM has increased the market power of the SSM banks in these countries. It is noteworthy that these countries were at the center of the sovereign debt crisis. In most other countries, the SSM effects are often slightly negative, indicating that the market power of SSM banks has declined. The negative SSM effects are strongest for Austria, Malta, the Netherlands and Slovakia.

Table 3: SSM effects on Lerner Index

	Lerner Index 1	Lerner Index 2	Lerner Index 3	Lerner Index 4
log(TA)	0.0326***	0.0325***	0.0327***	0.0329***
	(0.0107)	(0.0107)	(0.0107)	(0.0107)
SSM dummy	0.0101	0.0159		
	(0.0106)	(0.0124)		
SSM 2013			−0.0042	0.0060
			(0.0102)	(0.0108)
SSM 2014			0.0053	0.0186
			(0.0110)	(0.0144)
SSM 2015			0.0123	0.0286
			(0.0135)	(0.0189)
SSM 2016			0.0001	0.0195
			(0.0145)	(0.0218)
SSM 2017			0.0109	0.0333
			(0.0138)	(0.0247)
SSM 2018			0.0149	0.0403
			(0.0139)	(0.0273)
SSM 2019			0.0141	0.0426
			(0.0149)	(0.0302)
$G_i \times t$		−0.0010		−0.0030
		(0.0016)		(0.0026)
Year 2006	−0.0113*	−0.0106*	−0.0113*	−0.0092
Year 2007	−0.0258***	−0.0246***	−0.0258***	−0.0222***
Year 2008	−0.0416***	−0.0400***	−0.0415***	−0.0369***
Year 2009	−0.0087	−0.0068	−0.0087	−0.0031
Year 2010	0.0058	0.0082	0.0061	0.0128
Year 2011	0.0113	0.0138	0.0116	0.0185
Year 2012	−0.0057	−0.0031	−0.0054	0.0017
Year 2013	−0.0010	0.0015	−0.0005	0.0061
Year 2014	0.0112	0.0135	0.0117	0.0184
Year 2015	0.0110	0.0134	0.0112	0.0178
Year 2016	0.0068	0.0092	0.0077	0.0143
Year 2017	0.0213**	0.0237**	0.0215**	0.0281**
Year 2018	0.0268**	0.0293**	0.0268**	0.0334***
Year 2019	0.0173	0.0199	0.0173	0.0238*
R-squared	0.72	0.72	0.72	0.72
Adj. R-squared	0.68	0.68	0.68	0.68
Number of obs.	18,588	18,588	18,588	18,588
Number of groups	2,230	2,230	2,230	2,230
Average. Obs. group	8.34	8.34	8.34	8.34
Min. Obs. group	3	3	3	3
Max. Obs. Group	15	15	15	15

Source: Own calculations. SNL.
The dependent variable is 3SLS Lerner Index (equity ratio).
log(TA) refers to the logarithm of total assets.
SSM is a dummy variable that is 1 when a bank is an SSM bank and the SSM is active and 0 otherwise. The SSM 2013-SSM 2019 dummies are 1 for SSM banks when the SSM is active or anticipated in the corresponding year and 0 otherwise. G_i is a dummy variable which is one when a bank belongs to the group of SSM banks and is zero otherwise. The variable t denotes time.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. We use cluster robust standard errors with clustering at the bank level.

Table 4: SSM on Lerner Index: Euro Area and AT to GR

	EA	AT	BE	CY	DE	ES	FI	FR	GR
log(TA)	0.0329***	0.0164	−0.0669	0.0968**	0.0559***	−0.0370	0.0673***	−0.0038	0.0502
	(0.0107)	(0.0206)	(0.0507)	(0.0483)	(0.0170)	(0.0399)	(0.0241)	(0.0261)	(0.0718)
SSM 2013	0.0060	−0.0253	−0.0297	−0.0240	0.0022	−0.0258	0.1188	−0.0352	−0.0557
	(0.0108)	(0.0446)	(0.0387)	(0.0500)	(0.0113)	(0.0512)	(0.1206)	(0.0277)	(0.0565)
SSM 2014	0.0186	−0.0885	−0.0161	0.0302	−0.0132	−0.0196	0.0864	−0.0233	−0.0694
	(0.0144)	(0.0717)	(0.0460)	(0.1012)	(0.0203)	(0.0535)	(0.0968)	(0.0356)	(0.0711)
SSM 2015	0.0286	−0.1699	−0.0092	−0.0449	−0.0002	−0.0108	0.1498	−0.0341	−0.1341*
	(0.0189)	(0.1045)	(0.0663)	(0.1212)	(0.0220)	(0.0649)	(0.1168)	(0.0421)	(0.0790)
SSM 2016	0.0195	−0.1475	−0.0263	−0.0032	−0.0449	0.0403	0.0913	−0.0378	0.0165
	(0.0218)	(0.1220)	(0.0827)	(0.1062)	(0.0297)	(0.0711)	(0.0853)	(0.0401)	(0.0750)
SSM 2017	0.0333	−0.1665	−0.0200	−0.0359	−0.0180	0.0310	0.0766	−0.0275	0.0716
	(0.0247)	(0.1255)	(0.1038)	(0.1238)	(0.0330)	(0.0816)	(0.0877)	(0.0509)	(0.0720)
SSM 2018	0.0403	−0.1972	−0.0497	−0.0713	−0.0040	0.0341	−0.0577	−0.0561	0.0086
	(0.0273)	(0.1489)	(0.0980)	(0.1124)	(0.0392)	(0.0941)	(0.0813)	(0.0623)	(0.0791)
SSM 2019	0.0426	−0.2208	−0.0819	−0.0298	−0.0175	0.0861	−0.1733	−0.0472	0.0629
	(0.0302)	(0.1565)	(0.1157)	(0.1236)	(0.0416)	(0.1046)	(0.1112)	(0.0648)	(0.0967)
$G_i \times t$	−0.0030	0.0094	0.0021	0.0051	0.0041	−0.0058	−0.0109	0.0021	0.0243***
	(0.0026)	(0.0125)	(0.0075)	(0.0117)	(0.0042)	(0.0100)	(0.0122)	(0.0048)	(0.0076)
Year 2006	−0.0092	−0.0101	−0.0035	0.0197	−0.0063	−0.0191	−0.0119	−0.0078	−0.0592**
Year 2007	−0.0222***	−0.0307**	−0.0139	0.0113	−0.0176	−0.0043	−0.0690**	0.0000	−0.1047***
Year 2008	−0.0369***	−0.0104	−0.0364**	−0.0629	−0.0258	−0.0321	−0.1102***	0.0166	−0.1587***
Year 2009	−0.0031	0.0107	0.0101	−0.0945*	−0.0094	0.0597**	−0.0718	0.0755***	−0.1620***
Year 2010	0.0128	0.0500**	0.0460	−0.0677	0.0118	−0.0169	−0.0954*	0.1077***	−0.1552**
Year 2011	0.0185	0.0537**	0.0320	0.0264	0.0112	−0.0150	−0.0383	0.0967***	−0.2146***
Year 2012	0.0017	0.0076	0.0341	−0.0305	0.0005	0.0377	−0.0799	0.0732**	−0.3405***
Year 2013	0.0061	0.0222	0.0730*	0.0304	0.0124	0.0412	−0.1174**	0.1090***	−0.2692***
Year 2014	0.0184	0.0529**	0.0782***	0.0748	0.0153	0.0932	−0.0473	0.1111***	−0.2199***
Year 2015	0.0178	0.0464**	0.1024***	0.0943	0.0204	0.1014	−0.0431	0.1264***	−0.1537**
Year 2016	0.0143	0.0315	0.0965***	0.0240	0.0295	0.0404	−0.0667	0.1213***	−0.2217***
Year 2017	0.0281**	0.0407*	0.0929*	−0.0275	0.0407*	0.1067	−0.0696	0.1257***	−0.2604***
Year 2018	0.0334***	0.0584**	0.0940***	−0.0485	0.0341	0.1383**	−0.0370	0.1210***	−0.2639***
Year 2019	0.0238*	0.0757***	0.1085***	−0.1582	0.0200	0.1155	−0.0507	0.1117***	−0.3367***
R-squared	0.72	0.76	0.80	0.73	0.81	0.60	0.60	0.86	0.77
Adj. R-squared	0.68	0.72	0.75	0.62	0.79	0.52	0.54	0.84	0.70
N. of obs.	18,588	3,445	229	134	7,335	641	672	853	161
N. of groups	2,230	422	26	16	876	88	73	93	18
Avg. Obs. group	8.34	8.16	8.81	8.38	8.37	7.28	9.21	9.17	8.94
Min. Obs. group	3	3	3	5	3	3	5	3	3
Max. Obs. Group	15	15	15	14	15	15	15	15	15

Source: Own calculations. SNL.
The dependent variable is 3SLS Lerner Index (equity ratio).
Countries/Area: Euro area (EA), Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR).
log(TA) refers to the logarithm of total assets.
SSM is a dummy variable that is 1 when a bank is an SSM bank and the SSM is active and 0 otherwise. The SSM 2013-SSM 2019 dummies are 1 for SSM banks when the SSM is active or anticipated in the corresponding year and 0 otherwise. G_i is a dummy variable which is one when a bank belongs to the group of SSM banks and is zero otherwise. The variable t denotes time.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. We use cluster robust standard errors with clustering at the bank level.

Table 5: SSM on Lerner Index: IE to SK

	IE	IT	LU	MT	NL	PT	SI	SK
Intercept	0.3596	−0.6719***	0.1104	2.4599***	1.4152**	0.1088	0.1578	−2.0478
	(0.3999)	(0.1767)	(0.8865)	(0.6420)	(0.7008)	(1.6068)	(0.6909)	(1.5301)
log(TA)	−0.0003	0.0845***	−0.0070	−0.1615***	−0.0703*	−0.0034	0.0029	0.1390
	(0.0208)	(0.0166)	(0.0482)	(0.0411)	(0.0357)	(0.0878)	(0.0419)	(0.0987)
SSM 2013	0.0912	0.0288	−0.0302	−0.1441*	−0.0135	−0.0270	−0.1305**	−0.0536
	(0.0721)	(0.0238)	(0.0610)	(0.0770)	(0.0324)	(0.0281)	(0.0647)	(0.0684)
SSM 2014	0.1597*	0.0678***	−0.0749	−0.2075***	−0.0710*	0.0922	0.0383	−0.1273
	(0.0937)	(0.0254)	(0.0884)	(0.0777)	(0.0385)	(0.0739)	(0.1248)	(0.0993)
SSM 2015	0.2409*	0.0742*	−0.0721	−0.2742***	−0.1327*	0.0521	0.1885***	−0.1313
	(0.1311)	(0.0423)	(0.1233)	(0.0877)	(0.0702)	(0.0555)	(0.0490)	(0.1319)
SSM 2016	0.2505	0.0759*	−0.1009	−0.2794**	−0.1201	0.0790	0.0937**	−0.1517
	(0.2441)	(0.0440)	(0.1355)	(0.1245)	(0.0790)	(0.0688)	(0.0421)	(0.1671)
SSM 2017	0.3612	0.1123***	−0.0848	−0.2442**	−0.1331	0.1004	0.0670	−0.2051
	(0.2597)	(0.0427)	(0.1481)	(0.1191)	(0.1076)	(0.0833)	(0.0573)	(0.2137)
SSM 2018	0.5043**	0.1371***	−0.1197	−0.3406**	−0.1264	0.1920**	0.0781	−0.1750
	(0.2305)	(0.0413)	(0.1543)	(0.1410)	(0.1141)	(0.0832)	(0.0571)	(0.2372)
SSM 2019	0.5064**	0.1557***	−0.1879	−0.4533***	−0.1349	0.2599***	0.0838	−0.1482
	(0.2259)	(0.0460)	(0.1870)	(0.1392)	(0.1159)	(0.0751)	(0.0579)	(0.2866)
$G_i \times t$	−0.0389**	−0.0166***	0.0154	0.0338**	0.0222**	−0.0024	0.0035	0.0205
	(0.0166)	(0.0041)	(0.0231)	(0.0151)	(0.0091)	(0.0071)	(0.0068)	(0.0340)
Year 2006	0.0001	0.0079	0.0328		−0.0233	0.0104		
Year 2007	−0.0195	−0.0195	0.0811	0.1906**	−0.0395	0.0133	−0.0198	
Year 2008	−0.0401	−0.0457**	0.0783**	0.1827***	−0.0324	0.0025	−0.0067	
Year 2009	0.0463	−0.0078	0.1550***	0.1867***	−0.0595	0.0094	−0.0094	0.0159
Year 2010	0.0975	0.0077	0.1636***	0.2610***	−0.0388	0.0067	−0.0202	0.0506
Year 2011	0.0922	0.0288	0.1418***	0.1990***	−0.0370	0.0165	−0.0587	0.0854
Year 2012	0.0659	0.0246	0.1598***	0.1792***	−0.0742*	−0.0043	−0.0836*	0.0233
Year 2013	0.0735	−0.0107	0.1826***	0.2109***	−0.0212	−0.0170	−0.0997**	0.0772
Year 2014	0.0843	−0.0222	0.1986***	0.2401***	0.0213	0.0043	−0.0702	0.1372
Year 2015	0.0896	−0.0464**	0.1807***	0.3165***	0.0178	0.0183	−0.0585	0.1190
Year 2016	0.0750	−0.0588**	0.1272**	0.2859***	−0.0126	0.0674	−0.0458	0.0754
Year 2017	0.0442	−0.0327	0.1373***	0.2575***	−0.0058	0.0735	−0.0607	0.0965
Year 2018	−0.0279	−0.0035	0.1004*	0.3205***	−0.0112	0.0466	−0.0137	0.0610
Year 2019	−0.0347	−0.0239	0.1230**	0.3226***	−0.0230	0.0416	−0.0127	−0.0069
R-squared	0.71	0.69	0.74	0.75	0.73	0.63	0.67	0.72
Adj. R-squared	0.61	0.64	0.67	0.65	0.67	0.56	0.57	0.60
N. of obs.	182	3,206	260	119	299	569	179	107
N. of groups	22	384	36	13	34	64	20	12
Avg. Obs. group	8.27	8.35	7.22	9.15	8.79	8.89	8.95	8.92
Min. Obs. group	3	3	3	3	3	3	3	4
Max. Obs. Group	15	15	15	13	15	15	14	12

Source: Own calculations. SNL.
The dependent variable is 3SLS Lerner Index (equity ratio).
Countries: Ireland IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI), Slovakia (SK).
log(TA) refers to the logarithm of total assets.
SSM is a dummy variable that is 1 when a bank is an SSM bank and the SSM is active and 0 otherwise. The SSM 2013-SSM 2019 dummies are 1 for SSM banks when the SSM is active or anticipated in the corresponding year and 0 otherwise. G_i is a dummy variable which is one when a bank belongs to the group of SSM banks and is zero otherwise. The variable t denotes time.
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$. We use cluster robust standard errors with clustering at the bank level.

6.2. *Results for the Persistence of Profits*

We now turn to the results for Eq. (15), which we use to examine whether the persistence of profits of SSM banks has changed since the introduction of the SSM. Eq. (15) is a dynamic fixed effects model, and it is well known that the standard panel fixed effects estimator yields inconsistent estimates for λ even when the number of cross-sectional units goes to infinity (Nickell, 1981). In addition, estimates of λ can be severely biased when the time dimension is small. Therefore, we use the system GMM estimator of Blundell and Bond (1998) as implemented by Sigmund and Ferstl (2021) to get consistent estimates for λ. As outlined in Section 4, we estimate Eq. (15) for the euro area and for the individual countries. Table 6 and Table 7 show the results.

The first column (EA) in Table 6 shows the estimates for the euro area. The estimated persistence parameter λ for the euro area before the introduction of the SSM is 0.40 and highly statistically significant, implying that banks' short-run rents are not eroding quickly. The estimate for the δ_1, the change in the persistence of short-run rents of SSM banks, is about 0.29 and also highly statistically significant. This suggests that the persistence of short-run rents of SSM banks has increased since the introduction of the SSM.

The country-specific estimates for Eq. (15), reported in the other columns of Table 6 and Table 7 provide a more diverse picture. The country-specific pre-SSM estimates for λ are all positive and range from 0.20 to 0.75. Almost all of these estimates are also statistically significant. Our pre-SSM estimates for λ are also very similar to the estimates reported in Goddard et al. (2011). Long-run equilibrium implies that $\lambda = 0$, but our estimates are clearly positive. This suggest that the banking sectors in the countries are not in long-run equilibrium.

The estimates for δ_1 – the change in λ since the introduction of the SSM – are around zero or positive for eleven out of sixteen countries. However, the estimates are often not very precise. For Belgium, Spain, France, and Ireland δ_1 is close to zero. For Austria, Finland, and Italy δ_1 is about 0.20, which implies some increase in the persistence of short-run rents. For Luxembourg, Malta, and Slovenia δ_1 is clearly negative, implying that competitive pressure has increased and short-run rents erode more quickly.

For Cyprus, Greece, Netherlands, Portugal, and Slovakia the estimated δ_1 is well above 0.30. Thus, the persistence of profits has increased markedly in these countries since the launch of the SSM. Another similarity is that all five countries struggled during the European debt crisis. In particular, Cyprus, Greece, and Portugal were unable to pay or refinance their debt without help from the ECB or the International Monetary Fund.

To see whether the rather large average increase in the persistence of short-term rents in the euro area mainly originate from the observations from Cyprus, Greece, the Netherlands, Portugal and Slovakia we re-estimate Eq. (15) without these countries. The λ estimated with the smaller sample is still 0.27 and again highly statistically significant.[11] This suggests that the increase in the persistence of short-run rents of SSM banks is a more general phenomenon.

In Section 4 we briefly noted that δ_0 in Eq. (15) identifies a change in long-run projected profit rates if λ does not change (i.e. $\delta_1 = 0$). We find statistically significant positive estimates for δ_0 for Austria, Spain, and Slovenia, and a statistically significant negative estimate for Finland. But only for Spain δ_1 is close to zero. Hence, long-run projected profit rates might have changed in Spain, but not in any of the other countries.

[11] The estimation results are available from the authors upon request.

Table 6: Country level SSM effects on persistence of profits: EA and AT to GR

	EA	AT	BE	CY	DE	ES	FI	FR	GR
Dev ROA (-1)	0.4008***	0.2628***	0.6125***	0.4856	0.4273***	0.3676***	0.2657***	0.5004***	0.3912***
	(0.0256)	(0.0535)	(0.1782)	(0.3940)	(0.0466)	(0.0637)	(0.0500)	(0.1029)	(0.1205)
Dev ROA (-1) x SSM	0.3096***	0.2022	0.0253	0.4331	0.1193	−0.0218	0.2112	0.0692	0.5870**
	(0.0557)	(0.1762)	(0.1776)	(0.5973)	(0.1455)	(0.2051)	(0.2519)	(0.2037)	(0.2911)
SSM dummy	0.0015	0.1213***	0.0162	−0.0735	−0.0784	0.1451*	−0.1774***	−0.0065	0.0609
	(0.0149)	(0.0469)	(0.0487)	(0.0469)	(0.0574)	(0.0782)	(0.0486)	(0.0435)	(0.0540)
constant	−0.0042	−0.0078	−0.0010	−0.0428	−0.0000	−0.0117	0.0099	−0.0182	−0.1640***
	(0.0051)	(0.0112)	(0.0414)	(0.0494)	(0.0072)	(0.0315)	(0.0226)	(0.0221)	(0.0607)
Number of Obs.	17,569	2,970	305	148	6937	664	553	1583	164
Number of Groups	2,483	440	38	21	914	118	77	187	23
Obs per group: min	3	3	3	3	3	3	3	3	3
avg	7.10	6.80	8.00	7.00	7.60	5.60	7.20	8.50	7.10
max	13	13	13	13	13	13	13	13	13
Hansen statistics:	95.55	9.32	11.25	3.86	50.18	15.44	19.07	26.22	4.24
nof para:	11	10	10	10	10	10	10	10	10
p-value:	0.00	0.50	0.34	0.95	0.00	0.12	0.04	0.00	0.94

Source: Own calculations. SNL.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.
We apply the two-step system GMM estimator by Blundell and Bond (1998) with Windmeijer corrected standard errors (Windmeijer, 2005).
The dependent variable is Dev ROA (the deviation of the return on assets of bank i at time t from the country average at time t).
Countries/Area: Euro area (EA), Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR).

Table 7: Country level SSM effects on persistence of profits: IE to SK

	IE	IT	LU	MT	NL	PT	SI	SK
Dev ROA (-1)	0.7472***	0.4252***	0.4232***	0.5420*	0.4027	0.1927**	0.3041***	0.3308*
	(0.2259)	(0.0390)	(0.1595)	(0.2938)	(0.2679)	(0.0841)	(0.0789)	(0.1861)
Dev ROA (-1) x SSM	0.0215	0.3932***	−0.1870	−0.4042	0.4916	0.3605**	−0.3681	0.4845
	(0.3079)	(0.0984)	(0.2640)	(1.3987)	(0.3083)	(0.1427)	(0.2742)	(0.3374)
SSM dummy	0.0095	0.0049	−0.0225	−0.2054	0.0245	0.0177	0.4878***	−0.2910
	(0.1038)	(0.0463)	(0.1013)	(0.2596)	(0.0678)	(0.1850)	(0.1072)	(0.2322)
constant	−0.0506	0.0177	−0.0008	0.0450	−0.0377	−0.0186	−0.0554	0.0595
	(0.0431)	(0.0120)	(0.0575)	(0.0892)	(0.0638)	(0.0410)	(0.0698)	(0.1343)
Number of Observations	228	2,469	451	114	277	454	144	108
Number of Groups	29	393	77	16	45	68	21	16
Obs per group: min	3	3	3	3	3	3	3	3
avg	7.90	6.30	5.90	7.10	6.20	6.70	6.90	6.80
max	13	13	13	13	13	13	13	11
Hansen statistics:	11.29	9.66	16.92	9.25	15.67	7.18	5.12	7.70
nof para:	10	10.	10	10	10	10.	10	10
p-value:	0.34	0.47	0.08	0.51	0.11	0.71	0.88	0.66

Source: Own calculations. SNL.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.
We apply the two-step system GMM estimator by Blundell and Bond (1998) with Windmeijer corrected standard errors (Windmeijer, 2005).
The dependent variable is Dev ROA (the deviation of the return on assets of bank i at time t from the country average at time t).
Countries: Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI), Slovakia (SK).

6.3. The Results Put Together

In this section we combine the results from the static and the dynamic analysis to provide a broader picture of the competitive effects of the SSM on SSM banks. Table 8 summarizes the main results for the sixteen euro area countries.

We start with the Lerner index. We find positive trends in the Lerner index for SSM banks in Greece, Malta, and the Netherlands, and a negative trends for Ireland and Italy (column "Trend" in Table 8). For the other countries, we find no separate trend in the Lerner index for SSM banks. In countries with no trend, the SSM effects on the Lerner index are almost always around zero or negative, indicating more competition from the static point of view.

The SSM has also increased competition in Greece, Malta, and the Netherlands because the SSM has reduced the positive trend in the Lerner index of the SSM banks. In Ireland and Italy, the SSM effects are positive and dampen the negative trend in the Lerner index and therefore reduce competition. However, in both countries the return on assets of SSM banks is consistently below the yearly average return on assets computed for all banks in a country. The SSM therefore helps to improve the return on assets of SSM banks in these countries (see, Table 9 and Table 10). Portugal is the only country with no trend in the Lerner index of SSM banks where the SSM significantly increases the Lerner index. As the average return on assets for SSM banks in Portugal is also below the average return on assets for all Portuguese banks, the SSM again helps to improve the profitability of SSM banks in this case.

The persistence of profits did not increase or increased only moderately since the introduction of the SSM in eight countries, and the persistence decreased in three countries. In nine of these eleven countries, the SSM effects on the Lerner index are also around zero or negative. The two countries with positive SSM effects on the Lerner index but little or no increase in the persistence of profits are Ireland and Italy – countries that ran into serious trouble in the wake of the sovereign debt crisis.

As already mentioned, in Cyprus, Greece, Netherlands, Portugal, and Slovakia the persistence of profits increased rather sharply. However, in these countries the degree of the persistence was only average or below average. Most importantly, these are again all countries that were in trouble during the sovereign debt crisis. Interestingly, with the exception of Portugal, the SSM effects on the Lerner index are zero or negative in these countries.

Taken together, this gives the following picture. In countries that were not severely affected by the sovereign debt crisis, the SSM generally did not lead to an increase in the market power of SSM banks. In countries that were at the heart of the sovereign debt crisis, the SSM helped to stabilize SSM banks. Either SSM banks with low profitability could stay in the market, which translates in increased profit persistence (i.e. banks can sustain low profitability longer), or SSM banks became more profitable, which translates into higher Lerner indices.

Table 8: Overview of competitive effects of SSM on SSM banks

	Lerner		Persistence	
Country	Trend	SSM effects	Pre-SSM	SSM effects
AT	no	negative	below average	increase small
BE	no	zero	above average	unchanged
CY	no	zero	average	increase large
DE	no	zero	average	increse small
ES	no	zero	average	unchanged
FI	no	positive/negative	below average	increase small
FR	no	zero	above average	unchanged
GR	positive	negative/zero	average	increase large
IE	negative	positive	above average	unchanged
IT	negative	positive	average	increase small
LU	no	zero/negative	average	decrese small
MT	positive	negative	above average	decrease large
NL	positive	negative	average	increase large
PT	no	positive	below average	increase large
SL	no	positive/zero	below average	decrease large
SK	no	negative	below average	increase large

Countries: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI), Slovakia (SK).

Table 9: Mean deviations of return on assets of SSM banks from the country averages

	AT	BE	CY	DE	ES	FI	FR	GR	IE	IT	LU	MT	NL	PT	SI	SK
2005	-0.00	-0.09	0.12	-0.22	0.22	0.05	-0.41	0.57	0.21	-0.05			-0.36	-0.04	0.00	
2006	0.26	-0.09	0.12	-0.22	0.37	0.14	-0.42	0.67	0.24	-0.05	-0.63		-0.37	-0.04	-0.01	
2007	0.51	-0.17	-0.05	-0.20	0.44	0.12	-0.44	0.82	0.24	-0.19	-0.33	-0.05	-0.23	-0.15	-0.14	
2008	0.10	-0.16	0.30	-0.38	0.43	0.11	-0.35	0.76	0.23	-0.18	0.06	-0.04	-0.02	0.08	0.12	0.28
2009	0.37	-0.34	-0.06	-0.23	0.59	0.06	-0.40	0.83	-0.04	-0.10	-0.07	-0.17	-0.02	-0.16	0.00	0.78
2010	0.68	-0.24	0.17	-0.54	0.65	0.02	-0.48	0.35	-0.04	0.13	0.06	0.14	-0.28	0.13	0.00	1.15
2011	0.37	-0.22	0.18	-0.58	0.24	-0.11	-0.27	0.61	-0.02	0.04	0.30	0.22	-0.17	-0.11	-0.03	1.07
2012	0.28	-0.33	0.05	-0.49	-0.02	0.06	-0.26	0.55	-0.54	-0.20	-0.20	0.28	-0.10	0.02	0.25	0.77
2013	0.45	-0.36	0.26	-0.41	0.22	0.14	-0.37	0.23	-0.25	-0.18	0.18	0.30	-0.17	-0.16	-0.41	1.19
2014	0.17	-0.17	0.67	-0.42	0.23	-0.49	-0.21	-0.23	-0.04	-0.32	0.08	-0.14	-0.22	-0.24	-0.37	0.90
2015	0.26	-0.16	0.27	-0.33	0.23	-0.33	-0.24	-0.29	-0.10	-0.24	0.06	-0.05	-0.14	-0.19	0.81	0.77
2016	0.43	-0.16	0.18	-0.43	0.29	-0.03	-0.17	0.16	-0.20	-0.06	-0.07	-0.10	-0.09	-0.19	0.17	0.55
2017	0.33	-0.15	-0.07	-0.34	0.34	0.02	-0.07	0.53	-0.21	-0.05	-0.00	0.16	-0.10	-0.03	0.25	0.43
2018	0.33	-0.16	-0.23	-0.36	0.23	0.07	-0.12	0.44	-0.09	0.04	0.03	-0.07	-0.05	0.03	0.47	0.17
2019	0.35	-0.20	-0.23	-0.33	0.19	-0.09	-0.07	0.22	-0.29	0.09	-0.10	-0.19	-0.18	-0.00	0.35	0.12

Countries: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI), Slovakia (SK).

Table 10: Mean deviations of return on assets of non-SSM banks from the country averages

	AT	BE	CY	DE	ES	FI	FR	GR	IE	IT	LU	MT	NL	PT	SI	SK
2005	0.00	0.05	-0.06	0.11	-0.08	-0.03	0.07	-0.33	-0.11	0.04	-0.00	0.00	0.09	0.04		0.00
2006	-0.09	0.05	-0.08	0.10	-0.10	-0.09	0.05	-0.38	-0.12	0.03	0.13	0.00	0.08	0.03	0.03	
2007	-0.14	0.12	0.03	0.07	-0.09	-0.06	0.04	-0.47	-0.10	0.07	0.03	0.05	0.05	0.08	0.42	0.00
2008	-0.03	0.11	-0.30	0.13	-0.08	-0.06	0.03	-0.51	-0.09	0.07	-0.01	0.04	0.01	-0.04	-0.36	-0.42
2009	-0.10	0.24	0.04	0.08	-0.11	-0.03	0.04	-0.48	0.02	0.03	0.01	0.11	0.00	0.08		-0.78
2010	-0.01	0.06	-0.06	0.01	-0.05	-0.00	0.03	-0.07	0.01	-0.01	-0.00	-0.03	0.05	-0.01	-0.00	-0.31
2011	-0.01	0.05	-0.05	0.01	-0.03	0.01	0.02	-0.08	0.00	-0.00	-0.02	-0.04	0.03	0.01	0.01	-0.27
2012	-0.00	0.08	-0.01	0.01	0.00	-0.00	0.02	-0.15	0.11	0.01	0.02	-0.05	0.02	-0.00	-0.04	-0.19
2013	-0.01	0.09	-0.05	0.01	-0.03	-0.01	0.03	-0.07	0.05	0.01	-0.01	-0.08	0.02	0.01	0.03	-0.30
2014	-0.00	0.05	-0.11	0.01	-0.04	0.03	0.02	0.08	0.01	0.01	-0.01	0.04	0.03	0.02	0.07	-0.27
2015	-0.00	0.04	-0.05	0.01	-0.04	0.02	0.02	0.10	0.02	0.01	-0.01	0.01	0.03	0.01	-0.16	-0.26
2016	-0.01	0.04	-0.03	0.01	-0.05	0.00	0.01	-0.06	0.05	0.00	0.01	0.03	0.02	0.01	-0.04	-0.17
2017	-0.01	0.04	0.01	0.01	-0.05	-0.00	0.01	-0.19	0.05	0.00	0.00	-0.04	0.03	0.00	-0.06	-0.14
2018	-0.01	0.04	0.03	0.01	-0.04	-0.00	0.01	-0.17	0.02	-0.00	-0.00	0.02	0.01	-0.00	-0.11	-0.06
2019	-0.01	0.07	0.03	0.01	-0.04	0.00	0.01	-0.10	0.08	-0.00	0.01	0.05	0.05	0.00	-0.09	-0.04

Countries: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI), Slovakia (SK).

7. Conclusion

Before the launch of the SSM in 2014, all euro area banks were supervised by national authorities. Within the framework of the SSM, significant euro area banks are directly supervised by the ECB. In this paper, we empirically examined whether this fundamental regulatory change has had an impact on the competitive position of SSM banks. Consistent with the static view of competition, we measured market power using the Lerner index, which implicitly assumes that the banking sector in a country is in long-run equilibrium. For all countries we find that the profit rates of banks deviate systematically from their long-run projected profit rates, which is inconsistent with long-run equilibrium. Therefore, we worked out how deviations from long-run equilibrium affect estimates of SSM effects on the Lerner index. From the dynamic perspective, we examined whether the persistence of profit rates of SSM banks changed after the introduction of the SSM.

Our results on the persistence of bank profit rates indicate that competition does not immediately erode short-run rents. Therefore, banks with above-average profit rates make above-average profits for some time, and banks with below-average profit rates may face lower profit rates for a period of time. Our results also imply that the countries' banking sectors are not in long run-equilibrium. We show that this inflates the standard errors of estimated SSM effects on the Lerner index and therefore helps to explain why the SSM effects are often imprecisely estimated. We also show that the estimates still correctly identify the SSM effects on the Lerner index, but the estimates capture disequilibrium effects or a combination of disequilibrium and equilibrium effects.

From a policy perspective, our results suggest that the impact of the SSM is different for counties that were at the center of the sovereign debt crisis than for countries that were not heavily affected by the crisis. In the "crisis" countries, the SSM stabilized SSM banks by helping them to stay in the market, which significantly increased profit persistence (Cyprus, Greece, Netherlands, Portugal, and Slovakia), or by increasing return on assets, which increased the Lerner index (Ireland, Italy, and again Portugal). In the other countries, the persistence of profits of SSM banks increased only moderately, did not change, or even fell. In these countries, the SSM either has no significant impact on the Lerner index of the SSM banks or the impact on the Lerner index is often negative. This indicates that the introduction of the SSM had no impact on competition or increased competition for the SSM banks in these countries.

With hindsight, it is probably undisputed that the introduction of the SSM helped to increase the stability of the banking sector in countries that were at the heart of the sovereign debt crisis (Angeloni, 2018). Our results suggest that this contribution was accompanied by a reduction in competitive pressure and an increase in the market power of SSM banks in these countries. Our dynamic analysis indicates that these anti-competitive effects may last for some time but are unlikely to be permanent.

References

Achen, C. (2000). Why lagged dependent variables can suppress the explanatory power of other independent variables. Conference presentation, Annual Meeting of the Political Methodology, Los Angeles.

Agoraki, M.-E. K., Delis, M. D., and Pasiouras, F. (2011). Regulations, competition and bank risk-taking in transition countries. *Journal of Financial Stability*, 7:38–48.

Ampudia, M., Beck, T., and Popov, A. (2021). Out with the new, in with the old? Bank supervision and the composition of firm investment. *CEPR Discussion Paper*, 16225.

Angelini, P. and Cetorelli, N. (2003). The effects of regulatory reform on competition in the banking industry. *Journal of Money, Credit and Banking*, 35:663–684.

Angeloni, I. (2018). The single supervisory mechanism: were expectations fulfilled? *European Central Bank*.

Anginer, D., Demirguc-Kunt, A., and Zhu, M. (2014). How does competition affect bank systemic risk? *Journal of Financial Intermediation*, 23(1):1–26.

Apergis, N., Fafaliou, I., and Polemis, M. L. (2016). New evidence on assessing the level of competition in the european union banking sector: A panel data approach. *International Business Review*, 25(1):395–407.

Appelbaum, E. (1982). The estimation of the degree of oligopoly power. *Journal of Econometrics*, 19(2–3):287–299.

Avgeri, I., Dendramis, Y., and Louri, H. (2021). The single supervisory mechanism and its implications for the profitability of european banks. *Journal of International Financial Markets, Institutions and Money*, 74:101382.

Barth, J. R., Caprio Jr, G., and Levine, R. (2012). *Guardians of finance: Making regulators work for us*. Mit Press.

Beck, T., De Jonghe, O., and Schepens, G. (2013). Bank competition and stability: Cross-country heterogeneity. *Journal of financial Intermediation*, 22(2):218–244.

Berger, A. N., Bonime, S. D., Covitz, D. M., and Hancock, D. (2000). Why are bank profits so persistent? the roles of product market competition, informational opacity, and regional/macroeconomic shocks. *Journal of Banking & Finance*, 24(7):1203–1235.

Berger, A. N. and Humphrey, D. B. (1991). The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics*, 28(1):117–148.

Berger, A. N., Klapper, L. F., and Turk-Ariss, R. (2017). Bank competition and financial stability. In *Handbook of Competition in Banking and Finance*. Edward Elgar Publishing.

Blair, R. D. and Sokol, D. D. (2015). *The Oxford handbook of international antitrust economics*, volume 2. Oxford Handbooks.

Blundell, R. and Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1):115–143.

Boone, J. (2008). A new way to measure competition. *The Economic Journal*, 118(531):1245–1261.

Boyd, J. H. and De Nicolo, G. (2005). The theory of bank risk taking and competition revisited. *The Journal of Finance*, 60(3):1329–1343.

Boyer, P. C. and Ponce, J. (2012). Regulatory capture and banking supervision reform. *Journal of Financial Stability*, 8(3):206–217.

Bresnahan, T. (1989). Empirical studies of industries with market power. In Schmalensee, R. and Willig, R., editors, *Handbook of Industrial Organization*, volume 2, chapter 17, pages 1011–1057. North Holland.

Chronopoulos, D. K., Liu, H., McMillan, F. J., and Wilson, J. O. (2015). The dynamics of us bank profitability. *The European Journal of Finance*, 21(5):426–443.

Clark, J. A. and Speaker, P. J. (1994). Economies of scale and scope in banking: evidence from a generalized translog cost function. *Quarterly Journal of Business and Economics*, pages 3–25.

Coccorese, P., Girardone, C., and Shaffer, S. (2021). What affects bank market power in the euro area? a country-level structural model approach. *Journal of International Money and Finance*, 117:102443.

Cruz-Garcia, P., de Guevara, J. F., and Maudos, J. (2017). The evolution of market power in european banking. *Finance Research Letters*, 23:257–262.

Cunningham, S. (2021). *Causal inference*. Yale University Press.

Efthyvoulou, G. and Yildirim, C. (2014). Market power in CEE banking sectors and the impact of the global financial crisis. *Journal of Banking and Finance*, 40:11–27.

Elzinga, K. G. and Mills, D. E. (2011). The lerner index of monopoly power: origins and uses. *American Economic Review*, 101(3):558–64.

Feldkircher, M. and Sigmund, M. (2017). Comparing market power at home and abroad: Evidence from austrian banks and their subsidiaries in cesee. *Focus on European Economic Integration*, Q3/2017:59–77.

Fiordelisi, F., Ricci, O., and Stentella Lopes, F. S. (2017). The unintended consequences of the launch of the single supervisory mechanism in europe. *Journal of Financial and Quantitative Analysis*, 52(6):2809–2836.

Geroski, P. A. (1990). Modeling persistent profitability. In Mueller, D. C., editor, *The Dynamics of Company Profits*. Cambridge University Press.

Geroski, P. A. and Jacquemin, A. (1988). The persistence of profits: a european comparison. *The economic journal*, 98(391):375–389.

Goddard, J., Liu, H., Molyneux, P., and Wilson, J. O. (2011). The persistence of bank profit. *Journal of Banking & Finance*, 35(11):2881–2890.

Goetz, M. R. (2018). Competition and bank stability. *Journal of Financial Intermediation*, 35:57–69.

Gugler, K. and Peev, E. (2018). The persistence of profits in banking: an international comparison. *Applied Economics*, 50(55):5996–6009.

Iwata, G. (1974). Measurement of conjectural variations in oligopoly. *Econometrica*, 42(5):947–966.

Jiménez, G., Lopez, J. A., and Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial stability*, 9(2):185–195.

Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking. *The American Economic Review*, pages 1183–1200.

Lerner, A. (1934). The concept of monopoly and the measurement of monopoly power. *The Review of Economic Studies*, 1(3):157–175.

Martinez-Miera, D. and Repullo, R. (2010). Does competition reduce the risk of bank failure? *The Review of Financial Studies*, 23(10):3638–3664.

Matutes, C. and Vives, X. (2000). Imperfect competition, risk taking, and regulation in banking. *European Economic Review*, 44(1):1–34.

Maudos, J. and de Guevara, J. (2004). Factors explaining the interest margin in the banking sectors of the European Union. *Journal of Banking and Finance*, 28(9):2259–2281.

Maudos, J. and Solis, L. (2009). The determinants of net interest income in the Mexican banking system: An integrated model. *Journal of Banking and Finance*, 33:1920–1931.

Maudos, J. and Vives, X. (2019). Competition policy in banking in the european union. *Review of Industrial Organization*, 55(1):27–46.

Mester, L. J. (1996). A study of bank efficiency taking into account risk-preferences. *Journal of banking & finance*, 20(6):1025–1045.

Mueller, D. C. (1977). The persistence of profits above the norm. *Economica*, 44(176):369–380.

Mueller, D. C. (1986). *Profits in the long run*. Cambridge University Press.

Mueller, D. C. (1990). The persistence of profits in the united states. In Mueller, D. C., editor, *The Dynamics of Company Profits*, pages 35–58. Cambridge University Press.

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica*, 47:1417–1426.

Okolelova, I. and Bikker, J. A. (2022). The single supervisory mechanism: Competitive implications for the banking sectors in the euro area. *International Journal of Finance & Economics*, 27(2):1818–1835.

Panzar, J. C. and Rosse, J. N. (1987). Testing for" monopoly" equilibrium. *The Journal of Industrial Economics*, pages 443–456.

Raunig, B. and Sigmund, M. (2022). The ECB single supervisory mechanism: Effects on bank performance and capital requirements. Working Paper 244, Oesterreichische Nationalbank.

Shaffer, S. and Spierdijk, L. (2020). Measuring multi-product banks' market power using the lerner index. *Journal of Banking and Finance*, 117:105859.

Sigmund, M. and Ferstl, R. (2021). Panel vector autoregression in r with the package panelvar. *The Quarterly Review of Economics and Finance*, 80:693–720.

Spierdijka, L. and Zaourasa, M. (2018). Measuring banks' market power in the presence of economies of scale: A scale-corrected lerner index. *Journal of Banking and Finance*, 87:40–48.

Vives, X. (2016). *Competition and stability in banking*. Princeton University Press.

Vives, X. (2019). Competition and stability in modern banking: A post-crisis perspective. *International Journal of Industrial Organization*, 64:55–69.

Weill, L. (2013). Bank competition in the eu: How has it evolved? *Journal of international financial markets, institutions and money*, 26:100–112.

Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics*, 126:25–51.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.

Yildirim, C. and Kasman, A. (2021). Market power evolution and convergence in european banking: An empirical note. *Bulletin of Economic Research*, 73(4):535–544.

Appendix A. Summary Statistics: SSM and Non-SSM Banks

In Table A.11 and Table A.12, we provide separate summary statistics for SSM and non-SSM banks. For comparability, the summary statistics for the SSM banks and non-SSM banks are computed over the entire sample period and not only since 2014, when the SSM was introduced.

Table A.11: Summary statistics: SSM Banks

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max	Data.Cov
Input Variables							
Total Assets	75,133	31,722,729	62,101,107	206,762,271	181,820,904	2,202,423,000	82.86
Interest expenses	69	303,964	1,061,000	4,216,997	3,648,000	101786000	81.94
Labor Costs	1,167	132,000	381,000	1,360,410	941,913	17,553,000	82.29
Labor Costs over TA	0.00	0.00	0.01	0.01	0.01	0.02	82.34
Provision and other expenses	1,009	138,140	343,064	1,250,505	928,032	19,124,000	82.11
Provision and other expenses over TA	0.00	0.00	0.01	0.01	0.01	0.02	81.82
Total costs	3120.00	836396.50	1,850,000	6,835,051	5,829,750	105,905,000	81.71
Total costs over TA	0.00	0.02	0.03	0.03	0.04	0.08	80.27
Interest income	2,536	754,409	1,906,556	6,548,441	5,862,660	107,859,000	82.34
Dividends from equity	1	3,213	13,556	101,517	74,450	1,808,000	46.62
Fee and commission income	100	170,267	412,494	1,675,215	1,518,047	16,412,000	68.09
Fee and commission expenses	0	34,802	92,263	467,786	293,974	6,500,000	68.09
Net fee and commission income	-134,000	80,212	260,653	1,033,490	741,000	12,765,000	82.46
Other non-interest income	146	18,957	61,715	213,721	213,875	3,871,000	49.57
Total income	2,536	1,020,914	2,278,230	7,742,384	6,682,250	109,461,000	82.63
Total income over TA	0.00	0.03	0.04	0.04	0.05	0.10	81.30
Tier 1 capital ratio	0.04	0.10	0.13	0.14	0.16	0.44	78.07
Lerner Indices							
2 SLS Lerner Index (no equity)	-0.36	0.05	0.18	0.17	0.29	0.74	78.59
3 SLS Lerner Index (no equity)	-0.39	0.05	0.16	0.16	0.26	0.75	78.88
2 SLS Lerner Index (equity ratio)	-0.33	0.06	0.19	0.18	0.29	0.75	76.63
3 SLS Lerner Index (equity ratio)	-0.39	0.05	0.16	0.16	0.25	0.75	76.80
Persistence of Profits							
ROA before Tax and Risk	-1.30	0.44	0.78	0.89	1.29	3.25	81.88
Dev ROA	-2.48	-0.42	-0.12	-0.05	0.24	2.09	81.88

Data sources: SNL, all Lerner indices are estimated as described in Section 2.1.
The table shows the minimum (Min.), first quantile (1st Qu.), median (Median), mean (Mean), third quantile (3rd Qu.), maximum (Max) and the data coverage (Data Cov.) for the variables used in this paper. Data Cov. refers to the percentage of available observations if the data was a balanced panel. The data set contains yearly data for 2,668 banks over the period 2004–2019 for the following countries: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI) and Slovakia (SK).
All variables except ratios are in thousands of euros.
Provision and other expenses is defined as operating expenses minus compensation benefits.
Total costs are the sum of interest rate expenses and operating expenses, which are the sum of operating DD&A, compensation and benefits, occupancy and equipment, tech and communications expense, marketing and promotion expense, other provisions and other expense.
Total income is defined as the sum of interest income, dividends from equity, other non-interest income and net fee and commission income. We use net fee and commission income instead of the split fee and commission income and fee and commission expenses as it has a much higher data coverage. Consequently, we do not include fee and commission expenses in the total costs to avoid double counting.
The 2 SLS Lerner Index (no equity) and the 3 SLS Lerner Index (no equity) are estimated with two-stage least squares and three-stage least squares in a seemingly unrelated regression framework based on Eq. (1) and Eq. (2). The 2 SLS Lerner Index (equity ratio) and the 3 SLS Lerner Index (equity ratio) are estimated in the same way but with the Tier 1 capital ratio as an additional input factor in Eq. (1).
ROA before Tax and Risk refers to the standard return on assets definition. The sum of net interest income, dividends income from equity, net fee and commission income and net other non-interest income is divided by total assets.
Dev ROA refers to the deviation of the ROA of bank i in year t in country j from the average ROA of all banks in country j in year t.

Table A.12: Summary statistics: Non-SSM Banks

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max	Data.Cov
Input Variables							
Total Assets	1,000	259,300	916,193	15,170,997	3,671,496	2,601,695,000	60.12
Interest expenses	0	1,437	6,917	265,043	34,288	93,021,000	58.89
Labor Costs	1	2,942	9,539	92,381	33,761	16,772,000	58.41
Labor Costs over TA	0	0.01	0.01	0.01	0.01	0.03	57.30
Provision and other expenses	10	2,245	7,571	87,375	27,621	29,752,000	58.46
Provision and other expenses over TA	0	0.01	0.01	0.01	0.01	0.02	56.10
Total costs	10	7,455	27,296	441,467	101,260	97,738,000	58.73
Total costs over TA	0.00	0.02	0.03	0.03	0.04	0.09	57.46
Interest income	1	6,517	25,262	431,304	99,700	97,578,000	58.90
Dividends from equity	1	1,000	6,764	33,199	24,383	1,763,000	5.39
Fee and commission income	141	54,337	132,759	415,152	271,786	14,883,000	8.97
Fee and commission expenses	0	6,892	20,614	101,528	59,830	4,162,000	8.99
Net fee and commission income	-576,000	1,369	5,305	66,834	20,287	10,796,000	59
Other non-interest income	2	4,887	15,107	66,127	42,000	8,389,000	7.08
Total income	-60,410	8,854	32,578	506,132	127,627	101,763,000	59.26
Total income over TA	-0.01	0.03	0.04	0.04	0.04	0.10	58.25
Tier 1 capital ratio	0.04	0.12	0.15	0.16	0.19	0.44	47.05
Lerner Indices							
2 SLS Lerner Index (no equity)	-0.36	0.17	0.25	0.24	0.32	0.85	55.40
3 SLS Lerner Index (no equity)	-0.41	0.13	0.20	0.19	0.27	0.80	55.25
2 SLS Lerner Index (equity ratio)	-0.34	0.18	0.25	0.24	0.32	0.81	45.71
3 SLS Lerner Index (equity ratio)	-0.39	0.12	0.20	0.18	0.26	0.75	45.58
Persistence of Profits							
ROA before Tax and Risk	-1.56	0.59	0.85	0.88	1.15	3.27	57.05
Dev ROA	-2.81	-0.26	-0.01	0.00	0.24	2.57	57.05

Data sources: SNL, all Lerner indices are estimated as described in Section 2.1.
The table shows the minimum (Min.), first quantile (1^{st} Qu.), median (Median), mean (Mean), third quantile (3^{rd} Qu.), maximum (Max) and the data coverage (Data Cov.) for the variables used in this paper. Data Cov. refers to the percentage of available observations if the data was a balanced panel. The data set contains yearly data for 2,668 banks over the period 2004–2019 for the following countries: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Malta (MT), Netherlands (NL), Portugal (PT), Slovenia (SI) and Slovakia (SK).
All variables except ratios are in thousands of euros.
Provision and other expenses is defined as operating expenses minus compensation benefits.
Total costs are the sum of interest rate expenses and operating expenses, which are the sum of operating DD&A, compensation and benefits, occupancy and equipment, tech and communications expense, marketing and promotion expense, other provisions and other expense.
Total income is defined as the sum of interest income, dividends from equity, other non-interest income and net fee and commission income. We use net fee and commission income instead of the split fee and commission income and fee and commission expenses as it has a much higher data coverage. Consequently, we do not include fee and commission expenses in the total costs to avoid double counting.
The 2 SLS Lerner Index (no equity) and the 3 SLS Lerner Index (no equity) are estimated with two-stage least squares and three-stage least squares in a seemingly unrelated regression framework based on Eq. (1) and Eq. (2). The 2 SLS Lerner Index (equity ratio) and the 3 SLS Lerner Index (equity ratio) are estimated in the same way but with the Tier 1 capital ratio as an additional input factor in Eq. (1).
ROA before Tax and Risk refers to the standard return on assets definition. The sum of net interest income, dividends income from equity, net fee and commission income and net other non-interest income is divided by total assets.
Dev ROA refers to the deviation of the ROA of bank i in year t in country j from the average ROA of all banks in country j in year t.

Appendix B. Details on the Lerner Index Derivation

In this appendix we provide details on the derivation of the Lerner index. Following the literature, we assume that a bank i faces the same optimization problem in every time period t,

$$\max_{q_{it}} \Pi_{it} = p_{it}(Q, z) \cdot q_{it} - C(q_{it}, W_{it}) \,, \tag{B.1}$$

where Π_{it} is the profit function and p_{it} is the price of the aggregate bank output. The price of the aggregate bank output is the sum of interest income, fee and commission service income, income from investment and other income divided by total assets. The variable q_{it} refers to the total output of bank i at time t and is approximated by total assets. The term $Q_t = \sum_{i=1}^{N} q_{it}$ represents the total banking industry output and z refers to exogenous variables affecting the inverse demand function. $C(q_{it}, W_{it})$ denotes the cost function with q_{it} as output and W_{it} is the vector of input factors $(w_{1it}, w_{2it}, w_{3it})$, where w_{1it} denotes interest rate expenses, w_{2it} denotes staff expenses, and w_{3it} are other operating expenses of bank i at time t. In an extended version of the cost function, we use the equity ratio (w_{4it}) as an additional input variable.

The corresponding first order condition to Eq. (B.1) reads as

$$p_{it}(Q_t, z_{it}) - \frac{\partial C(q_{it}, W_{it})}{\partial q_{it}} + q_{it} \frac{\partial p_{it}(Q_t, z_{it})}{\partial Q_t} \frac{\partial Q}{\partial q_j} = 0 \,, \tag{B.2}$$

where $MC = \frac{\partial C(q_j, w_j)}{\partial q_j}$ refers to marginal cost and $MR = p_j(Q, z) + q_j \frac{\partial p_j(Q,z)}{\partial Q} \frac{\partial Q}{\partial q_j}$ to marginal revenue. The mark-up $q_j \frac{\partial p_j(Q,z)}{\partial Q} \frac{\partial Q}{\partial q_j}$, which would be zero under perfect competition (i.e. $MR = MC$), can be further broken down into the terms

$$\Theta_{it} = \frac{\partial Q / \partial q_{it}}{Q / q_{it}} \,, \tag{B.3a}$$

$$\tilde{\epsilon}_{it} = \frac{\partial Q_t / \partial p_{it}}{Q_t} < 0 \,. \tag{B.3b}$$

Θ_{it} is the conjectural elasticity of total industry output with respect to the output of the i^{th} bank at time t. The conjectural elasticity measures the conjectured reaction of the other $n-1$ banks in the market to a change in quantity produced by bank i.[12] The second term $\tilde{\epsilon}$ is the market demand semi-elasticity to the price.

For estimating Eq. (B.3) and Eq. (B.3b) separately, we would need to define a supply equation and a demand equation. To estimate the bank's overall market power it is sufficient to identify and estimate the ratio $\zeta_{it} = \frac{\Theta_{it}}{\tilde{\epsilon}_{it}}$ in Eq. (B.4),

$$p_{i,t}(Q_t, z) = \frac{\partial C(q_{it}, W_{it})}{\partial q_{it}} - \frac{\Theta_{it}}{\tilde{\epsilon}_{it}} \,. \tag{B.4}$$

Appendix C. Cost and Marginal Revenue Estimation Results

In the banking literature only a few papers report the estimation output for the standard translog cost function. Table C.13 shows the 3SLS estimation results for the cost equation (Eq. (1)) and the marginal revenue equation (Eq. (2)). Our results are comparable to Clark and Speaker (1994) for US bank data and Feldkircher and Sigmund (2017) for Austrian banks and their subsidiaries in Central and South Eastern Europe. The coefficients from the marginal revenue equation are restricted to be equal to the corresponding coefficients in the cost equation. As mentioned earlier, Bresnahan (1989) suggests these restrictions to increase the precision of the estimated coefficients.

To test the validity of our results, we apply the following strategy. First, we check the quality of instruments (F-test and p-values) for both equations. Then we use the Hansen system overidentification test for a system of simultaneous equations (Wooldridge, 2010, p.201) to test whether the instruments are exogenous. The results of the Hansen overidentification test in Table C.13 suggest that 3SLS is the preferred estimation method. The F-test in the cost equation indicates that all exogenous variables are jointly significant. The F-test in the marginal revenue equation is a test for weak instruments. The test

[12] Under perfect competition $\Theta_{it} = 0$ and in a monopoly $\Theta_{it} = 1$.

indicates that the instruments are strong.

Table C.13: 3SLS: Cost and Marginal Revenue Functions

	Cost Equation	Marginal Revenue
log(TA)	0.9338***	
	(0.0086)	
log(TA) squared	−0.0002	
	(0.0003)	
log(interest expenses over TA)	0.0584***	
	(0.0132)	
log(labor costs over TA)	0.2533***	
	(0.0273)	
log(Provision and other expenses over TA)	0.5090***	
	(0.0261)	
log(TA) x log(interest expenses over TA)	0.0121***	
	(0.0005)	
log(TA) x log(labor costs over TA)	−0.0041**	
	(0.0017)	
log(TA) x log(Provision and other expenses over TA)	−0.0168***	
	(0.0013)	
log(interest expenses over TA) x log(labor costs over TA)	−0.0645***	
	(0.0018)	
log(interest expenses over TA) x log(Provision and other expenses over TA)	−0.0742***	
	(0.0019)	
log(labor costs over TA) x log(Provision and other expenses over TA)	−0.0565***	
	(0.0031)	
log(interest expenses over TA) squared	0.0570***	
	(0.0006)	
log(labor costs over TA) squared	0.0536***	
	(0.0015)	
log(Provision and other expenses over TA) squared	0.0606***	
	(0.0024)	
log(Tier 1 capital ratio)	0.1669***	
	(0.0216)	
log(Tier 1 capital ratio) squared	0.0010	
	(0.0011)	
log(TA) x log(Tier 1 ratio)	−0.0130***	
	(0.0011)	
log(Tier 1 ratio) x log(interest expenses over TA)	0.0130***	
	(0.0017)	
log(Tier 1 ratio) x log(labor costs over TA)	−0.0194***	
	(0.0041)	
log(Tier 1 ratio) x log(Provision and other expenses over TA)	0.0045	
	(0.0043)	
Total costs over TA		0.9338***
		(0.0086)
total costs over TA x log(TA)		−0.0002
		(0.0003)
total costs over TA x log(interest expenses over TA)		0.0121***
		(0.0005)
total costs over TA x log(labor costs over TA)		−0.0041**
		(0.0017)
total costs over TA x log(Provision and other expenses over TA)		−0.0168***
		(0.0013)
total costs over TA x log(Tier 1 ratio)		−0.0130***
		(0.0011)
SSM dummy		−0.1016***
		(0.0190)
Number of Observations	18688	18688
Number of Groups	2228	2228
Obs per group: min/avg/max	3/8.39/15	3/8.39/15
McElroy R-squared	0.99	0.99
Hansen overid test statistics/p-value	16.07/0.31	
Weak instruments: F-test: statistics/p-value	648, 228/0	901/0

Source: SNL, Own Calculations. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.
This table shows the three stages least squares regression results for Eq. (1) and Eq. (2) simultaneously.
The dependent variable in the column "Cost Equation" is the logarithm of total costs. The dependent variable in the column "Marginal Revenue Equation" is total income divided by total assets (TA).
The translog cost function includes: Logarithm of TA (log(TA)), Logarithm of TA squared (log(TA) squared), the log of interest expenses divided by TA, the log of labor costs divided by TA (log(labor costs over TA)), the log of provisions and other expenses divided by TA (log(Provision and other expenses over TA)), the log of TA times the log of interest expenses divided by TA (log(TA), log(interest expenses over TA)), the log of TA times the log of labor costs divided by TA (log(TA), log(labor costs over TA)), the log of total asset times the log of provisions and other expenses divided by TA (log(TA), log(Provision and other expenses over TA)), the log of interest expenses divided by TA times the log of labor costs divided by TA (log(interest expenses over TA), log(labor costs over TA)), the log of labor costs divided by TA times the log of provisions and other expenses divided by TA (log(labor costs over TA), log(Provision and other expenses over TA)), the log of interest expenses divided by TA squared (log(interest expenses over TA) squared), the log of labor costs divided by TA squared (log(labor costs over TA) squared), the log of provisions and other expenses divided by TA squared (log(Provision and other expenses over TA) squared), the log of Tier 1 capital ratio (log(Tier 1 capital ratio)), the log of Tier 1 capital ratio squared (log(Tier 1 capital ratio) squared), the log of Tier 1 capital ratio times the log of labor costs divided by TA (log(tier 1), log(labor costs over TA)), the log of Tier 1 capital ratio times the log of labor costs divided by TA (log(tier 1 ratio), log(labor costs of TA)) and the log of Tier 1 capital ratio times the log of provisions and other expenses divided by TA (log(tier 1 ratio), log(Provision and other expenses over TA)).
The marginal revenue function includes: Total costs of TA (Total costs over TA), total costs divided by TA times log of TA (total costs over TA, log(TA)), total costs divided TA times log of interest expenses divided by TA (total costs over TA, log(interest expenses over TA)), total costs divided by TA times log of labor costs divided by TA (total costs over TA, log(labor costs over TA)), total costs divided by TA times the log of provisions and other expenses divided by TA (total costs over TA, log(Provision and other expenses over TA)) and total costs over TA times the log of Tier 1 capital ratio (total costs over TA, log(Tier 1 ratio)).

Appendix D. Persistence of Profits ROA Median Deviation

Table D.14: SSM effects on persistence of median ROA: AT to GR

	EA	AT	BE	CY	DE	ES	FI	FR	GR
Dev median ROA (-1)	0.4008^{***}	0.2643^{***}	0.5770^{***}	0.4268^{**}	0.4339^{***}	0.3562^{***}	0.2618^{***}	0.4809^{***}	0.3889^{***}
	(0.0256)	(0.0524)	(0.1819)	(0.1975)	(0.0469)	(0.0656)	(0.0487)	(0.1006)	(0.1002)
Dev median ROA (-1) x SSM	0.2888^{***}	0.1225	0.0747	0.6239	0.1381	−0.0357	0.2104	0.0739	0.3795
	(0.0642)	(0.1628)	(0.1956)	(0.4025)	(0.1431)	(0.1889)	(0.2770)	(0.2031)	(0.6958)
SSM dummy	−0.0043	0.1141^{**}	0.0107	−0.1287	−0.0650	0.1612^{**}	-0.1711^{***}	−0.0193	0.1311
	(0.0160)	(0.0579)	(0.0460)	(0.1028)	(0.0582)	(0.0785)	(0.0572)	(0.0390)	(0.1316)
constant	0.0047	0.0025	0.0294	0.0198	−0.0018	−0.0071	0.0474^{**}	−0.0031	-0.1744^{***}
	(0.0051)	(0.0110)	(0.0408)	(0.0384)	(0.0070)	(0.0318)	(0.0233)	(0.0227)	(0.0598)
Number of Observations	17574.0000	2970.0000	306.0000	148.0000	6938.0000	664.0000	554.0000	1584.0000	164.0000
Number of Groups	2484.0000	440.0000	38.0000	21.0000	915.0000	118.0000	77.0000	187.0000	23.0000
Obs per group: min	1.0000	1.0000	1.0000	3.0000	1.0000	1.0000	2.0000	1.0000	1.0000
avg	7.1000	6.8000	8.1000	7.0000	7.6000	5.6000	7.2000	8.5000	7.1000
max	13.0000	13.0000	13.0000	13.0000	13.0000	13.0000	13.0000	13.0000	13.0000
Hansen statistics:	93.0866	10.6133	12.4696	4.0533	51.5950	15.4712	16.7026	27.6412	5.3263
nof para:	11.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000
p-value:	0.0000	0.3884	0.2549	0.9449	0.0000	0.1158	0.0812	0.0021	0.8683

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table D.15: SSM effects on persistence of median ROA: IE to SK

	IE	IT	LU	MT	NL	PT	SI	SK
Dev median ROA (-1)	0.7288^{***}	0.4140^{***}	0.4259^{***}	0.6884^{***}	0.4127	0.2181^{**}	0.3503^{***}	0.3374^{*}
	(0.2005)	(0.0397)	(0.1652)	(0.2203)	(0.2663)	(0.0858)	(0.0778)	(0.1804)
Dev median ROA (-1) x SSM	0.2166	0.0865	−0.1742	−1.9102	0.4202	0.3821^{***}	-0.4418^{*}	0.3447
	(0.2781)	(0.2794)	(0.2780)	(1.8230)	(0.3106)	(0.0913)	(0.2308)	(0.4708)
SSM dummy	0.0481	−0.0957	−0.0119	0.0436	0.0102	0.0300	0.4755^{***}	−0.1496
	(0.0986)	(0.0900)	(0.1103)	(0.1610)	(0.0534)	(0.0868)	(0.1067)	(0.2106)
constant	−0.0316	0.0232^{*}	0.0625	0.0172	−0.0341	0.0260	−0.0139	0.0170
	(0.0295)	(0.0123)	(0.0560)	(0.0651)	(0.0527)	(0.0397)	(0.0668)	(0.1422)
Number of Observations	228.0000	2470.0000	451.0000	114.0000	277.0000	454.0000	144.0000	108.0000
Number of Groups	29.0000	393.0000	77.0000	16.0000	45.0000	68.0000	21.0000	16.0000
Obs per group: min	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	2.0000
avg	7.9000	6.3000	5.9000	7.1000	6.2000	6.7000	6.9000	6.8000
max	13.0000	13.0000	13.0000	13.0000	13.0000	13.0000	13.0000	11.0000
Hansen statistics:	10.7808	11.7264	17.5024	7.1306	14.0358	6.0940	5.2582	7.1805
nof para:	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000
p-value:	0.3748	0.3038	0.0640	0.7131	0.1714	0.8073	0.8733	0.7083

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$