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Estimation of the competitive conditions in the Czech banking sector

Daniel Stavárek, Iveta Řepková

Abstract

The paper uses New Empirical Industrial Organization approach, especially Panzar-Rosse model to estimate the level of competition of the banking industry in the Czech Republic during the period 2001–2009. We apply Panzar-Rosse model to estimate H statistic for a panel of 15 banks, which represent almost 90 % of the market. This paper also measures and compares the degree of banking competition in two sub-periods, 2001–2005 and 2005–2009, in order to investigate development of the competitive structure of the Czech banking industry. We found that the market was in equilibrium during most of the estimation period, which is a necessary condition for sound evaluation of the competition level. While the market can be described as perfectly competitive in 2001–2005, the intensity of competition decreased after joining the EU in 2004 and the market can be characterized as one of monopolistic competition in 2005–2009. The monopolistic competition in the Czech banking market was also revealed if the full sample 2001–2009 is considered.

Keywords: Panzar-Rosse model, competition, banking sector, Czech Republic

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The literature on the measurement of competition can be divided into two major streams: structural and non-structural approaches. The structural approach to the measurement of competition embraces the Structure-Conduct-Performance paradigm (SCP) and the efficiency hypothesis. The two former models investigate whether a highly concentrated market causes collusive behavior among the larger banks resulting in superior market performance, and whether it is the efficiency of larger banks that enhances their performance. These structural models link competition to concentration. Non-structural models for the measurement of competition, namely the Iwata model (Iwata, 1974), the Bresnahan model (Bresnahan (1982) and Lau (1982)), and the Panzar-Rosse (P-R) model (Panzar and Rosse, 1987), were developed in reaction to the theoretical and empirical deficiencies of the structural models. These New Empirical Industrial Organisation (NEIO) approaches test competition and the use of market power, and stress the analysis of banks' competitive conduct in the absence of structural measures (Bikker and Haaf, 2000, p. 17).

While tests of market power carried out employing the traditional SCP approach, observe the structure of the market (e.g. concentration levels, number of firms) and relate this to the conduct (e.g. pricing policies) and performance (e.g. ROA, ROE) of firms; in nonstructural approaches empirical studies do not observe the competitive environment but they attempt to measure/infer it. Probably the most important advantage of non-structural approaches is that it cannot be assumed a priori that concentrated markets are not competitive because contestability may depend on the extent of potential competition and not necessarily on market structure. Another advantage of non-structural models is that there is no need to specify a geographic market, since the behavior of individual banks gives an indication of their market power. Non-structural measures of competition are mainly based on the Lerner (1934) measure of monopoly power (Casu and Girardone, 2006, p. 3–4).

The Panzar and Rosse model has proven to be a useful tool for observing competition. This model is based on the comparative static properties of the reduced-form bank revenue equation. The Panzar-Rosse model uses data for individual banks, which tend to be available in sample quantities, allowing fairly precise estimations of competition (Bikker and Haaf, 2002). A disadvantage of the P-R approach is its assumption that banks provide one banking product only. It does not

allow us to distinguish between different products or geographical markets, which by the way would also be hampered by a lack of required data, e.g. bank-level interest rates and production figures.

The aim of the paper is to examine the degree of competition within the Czech Republic banking industry during the period 2001–2009. The Czech Republic's financial system is traditionally bank-based and banks play an important role in the economy on the side of corporations and business as well as households. Furthermore, the banking sector in the Czech Republic went through serious crisis in late 1990s followed by a period of consolidation that included, among others, failures of small banks, privatization of large state-owned banks combined with their recapitalization and cleaning their loan portfolios. The Czech Republic joined the European Union in 2004 and the banking sector cannot stand apart from the ongoing process of financial integration within the European Union. Therefore, the analysis of competition in industry with so many important development milestones is of high interest.

Concentration of the banking sector

Concentration ratio (*CR*) shows the degree to which an industry is dominated by a small number of large firms or made up of many small banks. Higher *CR* reflects a more concentrated market. Summing over the market shares of the *k* largest banks in the market, it takes the form:

$$CR_k = \sum_{i=1}^k s_i . \quad (1)$$

Bikker and Haaf (2000) defined Herfindahl-Hirschman index (*HHI*) as the sum of the squares of the bank sizes measured as market shares. The *HHI* index ranges between $\frac{1}{n}$ and 1, reaching its lowest value, the reciprocal of the number of banks, when all banks in a market are of equal size, and reaching unity in the case of monopoly (in a market with only one bank). *HHI* takes the form:

$$HHI = \sum_{k=1}^n \left(\frac{q_k}{Q} \right)^2 = \sum_{k=1}^n r_k^2, \quad (2)$$

where n is the number of banks in the banking sector,

q_k is the volume of the output of bank k , $k = 1, 2, \dots, n$,

Q is the volume of the output of the banking sector,

r_k is the share of the output of the bank k to the output of the banking sector.

Tab. I illustrates the structural characteristics of the Czech's banking sector from 2001 to 2009. The common measures of concentration, which are the concentration ratio and Herfindahl-Hirschman index (HHI), are calculated. It is used the three largest bank concentration ratio ($CR3$), the five largest bank concentration ratio ($CR5$) and the ten largest bank concentration ratio ($CR10$), which defined as the ratio of the total assets of the three, five and ten largest banks to the total assets of all the banks in a given year.

I: Concentration of the Czech banking sector

	2001	2002	2003	2004	2005	2006	2007	2008	2009
<i>CR3</i>	58.77	57.18	56.88	54.35	55.63	54.32	54.68	50.63	51.22
<i>CR5</i>	68.38	65.75	65.77	63.97	65.49	64.15	65.70	62.02	62.41
<i>CR10</i>	80.60	79.78	79.38	77.96	79.31	77.63	79.87	78.34	79.08
<i>HHI</i>	0.130	0.120	0.117	0.110	0.115	0.110	0.114	0.101	0.103

Source: Authors' calculations

In general, CR and HHI show a trend of modest decrease, meaning that market concentration changed appreciably over the sample period. The Czech banking market could be described as a moderately concentrated market over the period of 2001–2009.

Literature review

Gelos and Roldós (2004), Yildirim and Philippatos (2003), Claessens and Laeven (2004), Drakos and Konstantinou (2005) and Pawlowska (2005) found the

monopolistic competition using the Panzar-Rosse model in the Czech banking sector during the 1990s. Staikouras and Koutsomanoli-Fillipaki (2006) indicated the monopolistic competition in the Czech banking industry in 1998–2002. Bikker *et al.* (2007) found that competition is substantially lower in countries with socialist legal history, such as Eastern Europe, where large banks are less competitive than other countries. For the Czech Republic they identified the monopolistic competition using Panzar-Rosse model in 1995–2004. Bikker and Spierdijk (2008) determined by Panzar-Rosse approach the monopolistic competition in the Czech Republic in 1999–2004. Pruteanu-Podpiera *et al.* (2008) showed in the Czech credit market growth in the absence of competition by Lerner index during the privatization period (1999–2002). This is surprising, because with the growth of the entry of foreign investors in the banking sector should increase its competitiveness. In 2002–2005 they recorded a decline of competition, which was caused by offering relatively riskier and more expensive products after 2002. Bikker *et al.* (2009) identified the Czech banking sector as a monopolistic competition in the period 1986–2004.

Panzar-Rosse Model

The method developed by Panzar and Rosse (1987) determines the competitive behavior of banks on the basis of the comparative static properties of reduced-form revenue equations based on cross-section data. Panzar and Rosse show that if their method is to yield plausible results, banks need to have operated in a long-term equilibrium, while the performance of banks needs to be influenced by the actions of other market participants. The model assumes a price elasticity of demand, e , greater than unity, and a homogeneous cost structure. To obtain the equilibrium output and the equilibrium number of banks, profits are maximized at the bank as well as the industry level. That means, first, that bank i maximizes its profits where marginal revenue equals marginal cost:

$$R_i'(x_i, n, z_i) - C_i'(x_i, w_i, t_i) = 0, \quad (1)$$

where R_i is the total revenue,

C_i is the total expenses,
 x_i is the output of bank i ,
 n is the number of banks,
 w_i is a vector of m factor input prices of bank i ,
 z_i is a vector of exogenous variables that shift the bank's revenue function,
 t_i is a vector of exogenous variables that shift the bank's cost function.

In equilibrium, the zero profit constraint holds at the market level:

$$R_i^*(x^*, n^*, z) - C_i^*(x^*, w, t) = 0. \quad (2)$$

Variables marked with * represent equilibrium values. Market power is measured by the extent to which a change in factor input prices (δw_{k_1}) is reflected in the equilibrium revenues (δR_i^*) earned by bank i . Panzar and Rosse define a measure of competition, the H statistic as the sum of the elasticities of the reduced form revenues with respect to factor prices:

$$H = \sum \left(\frac{\delta R_i^*}{\delta w_{k_1}} \right) \left(\frac{w_{k_1}}{R_i^*} \right). \quad (3)$$

The estimated value of the H statistic ranges between $-\infty < H \leq 1$. In particular, the H statistic is non-positive if the market structure is a monopoly, a perfectly colluding oligopoly, or a conjectural-variation, short-run oligopoly. In such a case, an increase in input prices will increase marginal cost of the bank and reduce equilibrium output as well as total revenue accordingly. The monopoly analysis includes the case of price-taking competitive firms, as long as the prices they face are truly exogenous, that is, as long as their equilibrium values are unaffected by changes in the other exogenous variables in the model. An empirical refutation of 'monopoly' constitutes a rejection of the assumption that the revenues of the banks in question are independent of the decisions made by their actual or potential rivals. Panzar and Rosse prove that under

monopoly, an increase in input prices will increase marginal costs, reduce equilibrium output and subsequently reduce revenues; hence H will be zero or negative.

If H lies between zero and unity, the market structure is characterized by monopolistic competition. Under monopolistic competition, total revenues increase less than proportionately to changes in input prices, since the demand facing individual banks is inelastic. Assuming some sort of product differentiation between the outputs of the different banks, the profit maximizing firms are confronted with a falling aggregate demand curve and behave like monopolists, which results in equalizing marginal costs and marginal revenues in the equilibrium state. By market exit and entry of imperfect substitutes, the demand curve always shifts in a way that the monopolist just earns zero profits (Panzar and Rosse, 1987, p. 448–451).

The H statistic is unity if the market structure is characterized as perfect competition. Under this condition, any increase in input prices will increase both marginal and average costs without changing the equilibrium output of any individual bank. This is true since those institutions that cannot cover the increase in input prices through increased revenue will be forced to exit the market. The exit of some banks increasing the demand for the remaining ones and a simultaneous increase of output prices. As a result, industry revenues raise equivalent to the rise in costs. The H statistic is also equal to one for a natural monopoly operating in a perfectly contestable market and a sales-maximizing bank subject to break-even constraints. Tab. II summarizes the discriminatory power of H .

II: Panzar-Rosse H statistic

$H \leq 0$	Monopoly equilibrium or perfect cartel
$0 < H < 1$	Monopolistic competition
$H = 1$	Perfect competition

Source: Authors' compilation

An important feature of the H statistic is that it must be performed on observations that are in long-run equilibrium, as suggested in previous studies such as Bikker and Haaf (2002), Claessens and Laeven (2004), Casu and Girardone (2006), Matthews *et al.* (2007), Fu (2009) and Rezitis (2010). This suggests that competitive

capital markets will equalize risk-adjusted rates of return across banks such that, in equilibrium, rates of return should be uncorrelated with input prices (Matthews *et al.*, 2007, p. 2030). The equilibrium test is carried out with the return on assets (or equity), replacing bank revenue as the dependent variable in the regression equation for the H statistic. The E statistic is derived from the equilibrium test and measures the sum of elasticities of rate of return with respect to input prices (Fu, 2009). If the E statistic is equal to zero, it indicates long-run equilibrium, while $E < 0$ reflects disequilibrium. Tab. III summarizes the discriminatory power of E statistic.

III: Equilibrium test

$E = 0$	Equilibrium
$E < 0$	Disequilibrium

Source: Authors' compilation

Methodology and Data

Several specifications of the Panzar-Rosse model have been used in empirical literature. One of the crucial differences among studies is the definition of the dependent variable applied in the estimation of H statistic. Chan *et al.* (2007), Pawlowska (2005), Deltuvaitė (2007) or Lee and Nagano (2008) use interest income (revenues). Alternatively, Hempell (2002), Bikker *et al.* (2009) or Rezitis (2010) apply a total income or net income (de Rozas, 2007). Some authors analyze the competition in banking using a combination of more than one equation. For example, Chun and Kim (2004) or Fu (2009) have total revenues and interest revenues as dependent variables. The dependent variable in Eq. (4) chosen for the present paper is defines total revenue to total assets, rather than only the interest part, in order to account for the fact that the importance of non-interest income has increased greatly in recent years in the Czech Republic's banking sector. This view is supported, among others, by Casu and Girardone (2006), Pererera *et al.* (2006) and Rezitis (2010), who argue that in a more competitive environment, the distinction between interest and non-interest income becomes less relevant, as banks are competing on both forms. The existence of accounting differences across countries is an additional argument in favor of having

a comprehensive view of bank revenues. And the dependent variable is divided by total assets in order to account for size differences as suggested by Casu and Girardone (2006).

$$\ln TREV_{it} = \alpha_0 + \alpha_1 \ln PL_{it} + \alpha_2 \ln PK_{it} + \alpha_3 \ln PF_{it} + \beta_1 \ln ASSET_{it} + \beta_2 \ln ASSET_{it} + \beta_3 \ln RISKAS_{it} + \varepsilon_{it}, \quad (4)$$

where $TREV_{it}$ is ratio of total revenue to total assets,

PL_{it} is ratio of personnel expenses to number of employees,

PK_{it} is ratio of other expenses to fixed assets,

PF_{it} is ratio of annual interest expenses to total loanable funds (deposits + tradable securities + subordinated instruments).

Bank-specific and market-specific variables include:

$ASSET_{it}$ is sum of total assets,

BR_{it} is the ratio of the number of branches of a bank to the total number of branches of all banks,

$RISKASS_{it}$ is the ratio of provisions to total assets,

i denotes the bank ($i = 1, \dots, N$), t denotes time ($t = 1, \dots, T$).

PL_{it} , PK_{it} and PF_{it} correspond to the three input prices, i.e., labor, capital and funds. Consistently with the intermediation approach, we assume that banks use all the three inputs. Other explanatory variables are chosen to account for bank-specific and market-specific factors. Bank-specific factors are additional explanatory variables which reflect differences in risks, costs, size and structures of banks and should, at least theoretically, stem from the marginal revenue and cost functions underlying the empirical Panzar-Rosse Eq. (4). Similar variables are used also in Chun and Kim (2004), Matthews *et al.* (2007), Fu (2009) or Rezitis (2010).

The total asset variable ($ASSET_{it}$) is included to take account of possible scale economies. The ratio of the number of branches of each bank to the total number of branches of the whole banking industry variable (BR_{it}) is used in order to account for bank size. Branching has been viewed as a means for maintaining market share by

providing consumers with close-quarter access to financial services, mitigating to some extent price competition.

The provisions to total assets variable ($RISKASS_{it}$) is a measure of the riskiness of the bank's overall portfolio. It is used to account for firm specific risk and it is expected to be positively correlated to the dependent variables, since higher provisions should lead to higher bank revenues. An increase in provisions is a diversion of capital from earnings, which could have a negative effect on revenue. In contrast, a higher level of provisions indicates a more risky loan portfolio and therefore a higher level of compensating return.

The model assumes a one-way error component as described by

$$\varepsilon_{it} = \mu_i + \mathcal{G}_{it}, \quad (5)$$

where μ_i denotes the unobservable bank-specific effect and \mathcal{G}_{it} denotes a random term which is assumed to be IID. The H statistic is given by

$$H = \alpha_1 + \alpha_2 + \alpha_3. \quad (6)$$

For obtaining equilibrium conditions the model is defined as follows:

$$\begin{aligned} \ln ROA_{it} = & \alpha_0' + \alpha_1' \ln PL_{it} + \alpha_2' \ln PK_{it} + \alpha_3' \ln PF_{it} + \beta_1' \ln ASSET_{it} + \\ & + \beta_2' \ln ASSET_{it} + \beta_3' \ln RISKAS_{it} + u_{it} \end{aligned} \quad (7)$$

$$u_{it} = \theta_i + \mathcal{G}_{it}, \quad (8)$$

where ROA is the return on assets ratio, θ_i is the bank-specific effect and \mathcal{G}_{it} is an IID random error. The banking market is deemed to be in equilibrium if

$$E = \alpha_1' + \alpha_2' + \alpha_3' = 0. \quad (9)$$

The dataset used in the analysis covers all major Czech banks of the period 2001–2009 and has been collected from the annual bank reports and BankScope database. Over the sample period, the sample banks controlled on average about 87 % of the Czech banking market with the remaining share controlled by branches of foreign banks in the Czech Republic and “special” credit institutions (building societies, State banks of special purpose, and others). The dataset consists of 15 banks over 9 years. Due to some missing observations we have an unbalanced panel of 127 bank-year observations. To allow for heterogeneity across the banks, we use an error-component model, with the bank-specific error components estimated as fixed effects. Descriptive statistics is presented in Tab. IV.

IV: Descriptive statistics

	TREV	PL	PK	PF	ASSET	BR	RISKASS	ROA
Mean	0.065	0.779	2.615	0.024	167831	0.070	0.005	0.011
Median	0.058	0.691	1.448	0.020	52410	0.015	0.002	0.010
Maximum	0.261	2.262	13.44	0.111	788177	0.449	0.036	0.076
Minimum	0.029	0.326	0.326	0.002	930.7	0.000	0.000	-0.027
Std. Dev.	0.030	0.302	2.389	0.017	221495	0.106	0.007	0.012

Source: Authors' calculations based on data from BankScope

Empirical Analysis and Results

The empirical analysis begins with a test for market equilibrium. Since the Czech Republic's banking sector went through dynamic development during the period of estimation it would be very ambitious to test only for equilibrium over the full sample. Instead, we run regressions of two 5-year sub-periods with 2005 as an overlap and also a rolling regression of a 4-year window in order to reveal periods of market disequilibrium. Tab. V reports the results of estimation of Eq. (7). To conserve the space only elasticities required to the equilibrium test (Eq. 9) are presented.

The results suggest that market was in equilibrium over the whole estimation period and in most of the sub-periods. Only in one sub-period the market is in disequilibrium. As argued in Matthews *et al.* (2007) the restriction that $E=0$ (market equilibrium) is necessary for the perfect competition case but not for the monopolistic competition case.

V: Equilibrium tests (rolling sample) dependent variable lnROA

	lnPL	lnPK	lnPF	Sum	H0: E=0	Eq./Diseq.
2001-2009	0.0205	-0.0065	-0.0030	0.0108	$F(1, 106) = 2.460$	Equil.
2001-2005	0.0400	-0.0165	-0.0024	0.0210	$F(1, 53) = 1.7977$	Equil.
2005-2009	0.0008	-0.0030	0.0003	-0.0018	$F(1, 47) = 0.0616$	Equil.
2001-2004	0.0515	-0.0222	-0.0036	0.0256	$F(1, 38) = 1.6696$	Equil.
2002-2005	0.0229	-0.0237	-0.0065	-0.0073	$F(1, 39) = 0.1367$	Equil.
2003-2006	0.0089	-0.0200	-0.0111	-0.0222	$F(1, 39) = 5.4080^b$	Diseq.
2004-2007	0.0042	-0.0055	-0.0065	-0.0078	$F(1, 38) = 1.1599$	Equil.
2005-2008	-0.0006	-0.0028	-0.0016	-0.0051	$F(1, 35) = 0.5427$	Equil.
2006-2009	0.0001	-0.0042	0.0015	-0.0026	$F(1, 32) = 0.0686$	Equil.

^b denotes significance at 5% level

Source: Authors' calculations

Next, we can proceed with estimation of Eq. (4) and calculation of the H statistic as in Eq. (6). Regarding competitive condition tests, based on the market concentration measures CR shown in Tab. I, it is expected that the H statistic for testing the competitive positions in the Czech banking sector will vary between zero and unity. This would imply that banks in the Czech Republic operated under conditions of monopolistic competition during the sample period.

The results presented in Tab. VI show that all explanatory variables have consistent coefficients as far as the sign is concerned. However, the magnitude and significance vary considerably across the periods. Negative and significant coefficients of total assets document that the bank size has a negative effect on total revenues and, thus, indicate negative economies of scale in the Czech Republic's banking sector. Price of funds was significant over the full sample and in the first sub-period (before joining

the EU) demonstrating an ability of banks to offset more expensive funds by higher revenues. Number of branches seems to be significant determinant of total revenues in the second sub-period and in full sample. The positive coefficient suggests that positive effects of maintaining a proximity to customers dominate the increased cost of higher branch network. Such a result confirms a return of customers' preferences to standard face-to-face banking in brick-and-mortar branches. Although the riskiness of bank's portfolio is not significant in any of the sub-periods, a significantly positive impact on total revenues was found for the whole estimation period. One can see this as a confirmation of the mutual relation between taken risk and generated revenues.

VI: Test of competitive conditions dependent variable lnTREV

Variable	2001–2009	2001–2005	2005–2009
<i>Intercept</i>	2.9433 ^a (3.6089)	5.2043 ^a (2.7842)	1.5158 (1.1045)
<i>lnPL</i>	0.5160 ^a (3.8066)	0.7732 ^b (2.4656)	0.6534 ^a (4.1669)
<i>lnPK</i>	-0.0690 (-1.1030)	-0.0089 (-0.0701)	-0.0472 (-0.7315)
<i>lnPF</i>	0.1770 ^a (4.3685)	0.2203 ^a (2.9090)	0.0306 (0.5351)
<i>lnASSET</i>	-0.3908 ^a (-6.3112)	-0.6010 ^a (-3.4153)	-0.3102 ^a (-3.1877)
<i>lnBR</i>	0.0965 ^b (2.5849)	0.0467 (0.5948)	0.1298 ^b (2.0669)
<i>lnRISKASS</i>	0.0213 ^b (2.2985)	0.0177 (1.1908)	0.0090 (0.7217)
H0: $\mu_i=0$	$F(14, 106) = 14.0967^a$	$F(14, 53) = 6.4132^a$	$F(14, 47) = 13.2803^a$
H0: H=0	$F(1, 106) = 15.7543^a$	$F(1, 53) = 7.0866^b$	$F(1, 47) = 16.9483^a$
H1: H=1	$F(1, 106) = 5.7187^b$	$F(1, 53) = 0.0017$	$F(1, 47) = 5.5111^b$
H	0.6240	0.9846	0.6368

^{a, b, c} denote significance at 1%, 5% and 10% level, t-values in parentheses

Source: Authors' calculations

The null hypothesis that the bank fixed effects are jointly zero (H0: $\mu_i = 0$) is rejected at the 1% significance level for the full sample, for the first sub-sample as well as for the second sub-sample. This indicates the usefulness of the fixed effects panel model and suggesting that the base levels of the dependent variables differ.

A significance test on the sum of the input elasticities show that the H statistic lies between zero and unity in the full sample and second sub-period. By contrast, the H statistic in the first sub-period is not significantly different from unity. The results show that the null hypotheses $H = 0$ and $H = 1$ can both be rejected at the 5% significance level for the second sub-sample and full sample, which indicates the monopolistic competition. For the first sub-sample the null hypotheses $H = 0$ can be rejected at the 1% significance level, but null hypothesis $H = 1$ cannot be rejected at the 10% significance level, which indicates perfect competition.

Thus, we can conclude that the Czech banking market in monopolistic-competitive in general. However, the disaggregated picture of competitive conditions shows that competition in banking decreased over the estimation period after the Czech Republic joined the EU in 2004. Whereas the Czech banking sector can be characterized as one with perfect competition in 2001–2005, the intensity of competition decreased to the level of monopolistic competition in 2005–2009.

Conclusion

The aim of the paper was to estimate the level of competition in the Czech banking market during the period 2001–2009. Applying the Panzar-Rosse model we came to conclusion that the competitive conditions worsened over time analyzed. Whereas the banking market during the first sub-period 2001–2005 was found to be perfectly competitive, the structure of monopolistic competition was revealed during the second sub-period 2005–2009. More concretely, the H statistic computed for the full sample is 0.6240, the H statistic for the first sub-period is 0.9846, and the H statistic for the second sub-period 0.6368. Such a substantial worsening in competitive conditions after joining the EU is rather surprising.

Therefore, to shed more light on this question we suggest conducting of separate analyses of competitive conditions for core banking business and non-core activities. Furthermore, we also suggest application of the Bresnahan-Lau model that can, due to its nature and data requirements, reveal some additional information on the nature of competition.

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