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Abstract:

Banking capital ratios show a steadily decline in almost Central and Eastern European Countries (CEECs) since 2001, despite unchanged capital adequacy rules. Using a dynamic panel-analysis based on country-level data for CEECs, we empirically assess the determinants of capital buffers. Main results are as follows. First, there are large and significant adjustment costs in raising capital. Second, banks behave pro-cyclically, depleting their buffers in upturns to benefit from unanticipated investment opportunities. Third, there is a significant negative relationship between *current* levels of non-performing loans (NPLs) and capital buffers, suggesting that banks in CEECs are risk-takers. Banking sectors with large *past* NPLs however tend to have larger buffers. Finally, the access to external capital may appear still somewhat limited, with banks relying on internally generated funds to raise buffers.

Keywords : G21,G28,P2
JEL codes : capital adequacy ratio, business cycles, Central and Eastern European Countries

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PART I : INTRODUCTION

The financial crises in CEECs during their transition to market-based banking systems left them with a huge overhang of bad loans. In some countries, regulators raised minimum capital requirements in response to these crises, especially to reduce riskier behaviour in lending practices. Then, in the corner of the new millennium, banks' portfolios began to look healthier and more profitable, especially under the impetus of foreign ownership bringing access to new capital and know-how. The result was a steadily decline in capital buffers (*i.e.* the amount of capital above regulatory minimum requirements). For 2005, capital hold by banks of CEECs was thus in average 1.5 times higher than regulatory minimum requirements, which is on line with capital surplus observed in other EU countries (Figure 1). That contrasts with capital buffers observed in 2001 when banking sectors in CEECs began to embark on soundness: capital hold by banks of CEECs was then 2 times higher than regulatory minimum requirements. With capital adequacy rules roughly unchanged since 2001, this suggests that *markets* or *shareholders* – rather than *regulators* – have required a lower coverage of risk-weighted assets over the last few years. By 2005, Bulgaria, Croatia and the Baltic States still have a minimum regulatory ratio inherited from the 90's and above the 8 % stipulated by Basel (with Lithuania shifting back to 8 % in 2005). For the other CEECs, the minimum regulatory ratio stands to 8 % since the ten or twelve last years (Table A in the appendix).

But what do these buffers tell us about the way banks manage their risks in CEECs? And what does this imply for lending? Answering these issues is important as "too" high capital buffers may have also negative effects in the form of smaller banking sectors and reduced lending (Schoors, 2002). This may in turn hamper the economic growth and exacerbate the business cycle[1].

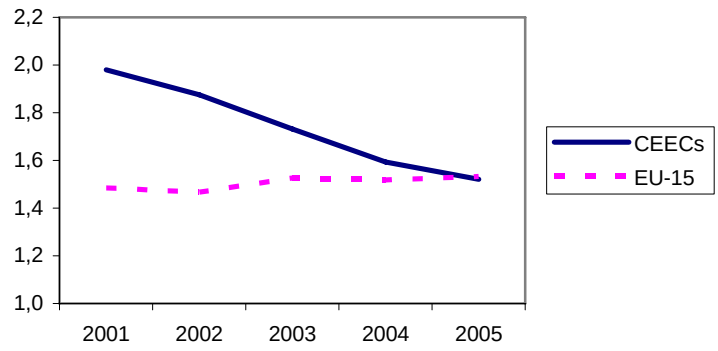
The purpose of this paper is to assess the determinants of bank capital buffers in CEECs using dynamic panel estimations. Our methodology is roughly similar to the one used by a small but growing literature on the determinants of capital buffers. This allows for a direct comparison of our results with theirs, especially those of Ayuso et al. (2002, 2004) based on Spanish banks. Other (very close) empirical studies include Alfón et al. (2005) for the United

1. We take as granted that a well-developed banking sector is conducive of higher economic growth. For instance, using a regression analysis based on CEECs, Coricelli and Masten (2004) find that the development of credit markets plays a significant role in affecting both growth and volatility. They show that progress in credit market development, through the convergence of the depth and efficiency of credit markets towards the level prevailing in advanced market economies, could have a major impact on growth and would sharply reduce output volatility in CEECs.

Kingdom, Lindquist (2003) for Norway and, Kleff and Weber (2005) for Germany. Furfine (2000) conducts an earlier study for the United States, but his methodology is somewhat different[2]. De Bondt and Prast (1999), as well as Bikker and Metzemakers (2004), attempt cross-country studies of capital determinants.

The rest of the paper is structured as follows. Part II presents the benchmark econometrical model while Part III reports the results. Part IV is about robustness tests. Part V concludes.

Figure 1: Surplus of regulatory capital*



* Ratio of regulatory capital to regulatory minimum requirements (risk-weighted assets).
Source: Global Financial Stability Report (2006). Own computations of (unweighted) average for CEECs and EU-15.

PART II: ECONOMETRICAL MODEL

For our econometrical work, we use data of the aggregated banking sector for eleven CEECs, as micro-banks data of good quality are not available over long time spans. For sure, information about individual banks is lost in the process of aggregating. However, the high degree of concentration in most banking sectors of CEECs reduces considerably the loss of information. Given that a very small number of institutions control the great majority of assets in each country, it is reasonable to assume our results would not differ significantly if individual bank data were used. Data come from various sources: mainly, the IMF International Finance Statistics (IFS) complemented with some IMF country reports, some ECB EU Banking Structures and Banking Stability reports, various EBRD Transition reports

2. Based on a micro-founded model, his approach consists in analysing the dynamic responses of bank's portfolio and capital base to exogenous shocks.

and national financial stability reports. Annual data cover 1997-2005 for Croatia and the ten new EU members from Central and Eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia).

Following the theoretical and empirical literature on capital buffers, we specify our benchmark model as:

$$BUF_{i,t} = \beta_0 BUF_{i,t-1} + \beta_1 ROE_{i,t} + \beta_2 NPL_{i,t} + \beta_3 GDPG_{i,t} + \eta_i + \varepsilon_{i,t} \qquad (1)$$

where $BUF_{i,t}$ is the excess of capital over regulatory requirements divided by requirements for country *i* at time *t*. We use this measure to eliminate the effects of changes in regulations. On the right-hand side of equation (1), the lagged endogenous is introduced to reflect the presence of **adjustment costs** in attaining the desired level of capital for banks (Ayuso et al., 2002, 2004; Estrella, 2004). Thus we expect its sign to be positive ($\beta_0 > 0$)[3].

We use the return on equity (ROE) as a measure for the **cost of capital**. A negative sign would indicate that banks see holding an excess of capital as a cost in that it has to be remunerated (Ayuso et al., 2004). A positive sign however would imply that banks retain profits as a cheap alternative to external funds in order to raise capital. Finally, the sign of β_1 is an empirical matter. Nevertheless, given the difficulties faced by CEECs' banks in accessing capital, we could reasonably expect that $\beta_1 > 0$.

The **risk** of banks' portfolio is proxied by the ratio of non-performing loans to total loans (NPL). A significant positive coefficient would indicate that higher risk leads to higher capital buffers. The theory predicts this coefficient should be positive since higher risks increase the probability of meeting regulatory capital constraints and facing the related costs such as market discipline and supervisory intervention (Furfine, 2000; Estrella, 2004). Riskier banks should therefore raise capital. A negative coefficient however would indicate ″moral hazard*"* behaviour, where banks assume higher risks with lower buffers. It could also indicate more sophisticated risk management systems, allowing banks to hold lower buffers for the same amount of risk (Alfón *et al*., 2005). We can thus expect either $\beta_2 > 0$ or $\beta_2 < 0$.

A variable of GDP **growth** in volume ($GDPG$) is included to assess whether the business cycle has an additional effect on the capital buffer held by banks. A negative coefficient would indicate that, in a downturn, for instance, when risks are more likely to materialise, capital requirements might increase. Thus capital and output growth will move in opposite

3. See Ayuso et al.(2004) et Estrella (2004) for theoretical derivations of this partial adjustment model.

direction. But, if capital requirements increase, banks would have to reduce their loans and the subsequent credit squeeze would add to the downturn. In that sense, capital buffers are said procyclical because they might amplify the fluctuations of business cycles (Ayuso et al., 2002). A positive coefficient would indicate a counter-cyclical behaviour of banks, meaning that banks rebuild their capital during upturns in order to face a likely increase in requirements during the next downturn. Consequently, we can expect either $\beta_3 < 0$ or $\beta_3 > 0$.

Finally, η_i stands for a country-specific, time-invariant fixed effect and $\varepsilon_{i,t}$ is a random shock.

As variables in equation (1) are defined in levels while some (such as *NPL*) are likely to be correlated with η_i , we transform equation (1) into first differences to obtain unbiased estimates. Moreover, as the lagged dependent endogenous variable is included among regressors, an estimation procedure based on General Method of Moments (GMM) seems the most appropriate (Arellano and Bond, 1991)[4]. The GMM estimator also enables us to consider explicitly the endogeneity of other (predetermined) explanatory variables. As pointed out by Berger (1995), capital buffers might influence banks profitability: we therefore include instruments for *ROE*. Similarly, as capital requirements and risk are interrelated, we have to instrument *NPL*. In the benchmark model, the numbers of lags for *NPL* and *ROE* as instrumental variables have been chosen to maximise the *p-value* of nil second-order autocorrelation in the residuals. Table 2 gives a statistical summary of variables used while Table 3 reports the partial autocorrelations between variables.

Table 1: Summary statistics for key variables

In %	*BUF*	*GDPG*	*ROE*	*NPL*
Mean	79.0	4.5	11.2	9.3
Maximum	267.0	11.1	34.3	58.5
Minimum	-16.2	-5.4	-61.2	0.2
Std. Dev.	56.2	2.7	12.9	9.2
Observations	92	92	92	92

Sample period: 1997/2005 (annual data).

4. See Kleff and Weber (2005), Ayuso et al. (2004), Alfon et al. (2005) on that point. All these previous authors use GMM procedure. Lindquist (2004) and De Bondt and Prast (1999) use Generalised Least Squares (GLS) Random-Effects Model procedure while BIkker and Metzemakers.

Table 2: Partial correlations for main variables

	BUF	*GDPG*	*ROE*	*NPL*
BUF	1.00	-0.16	0.09	0.04
GDPG		1.00	0.39	-0.60
ROE			1.00	-0.40
NPL				1.00

PART III: ECONOMETRICAL RESULTS AND DISCUSSION

The results of our estimates for the benchmark model are reported in Table 3 as model (1).

Regarding the coefficient of lagged capital buffers, we find a point estimate of near 0.6 (significant at the 1% level) which reveals the existence of non-negligible short-term adjustment costs[5].

The cost of capital proxied by *ROE* has a positive impact (albeit insignificant) on the capital surplus. This would mean that, over the last eight years, banks in CEECs either had a limited access to capital markets and/or preferred to retain profits to increase capital. For the earlier years in our sample, limited access might have been the dominant factor, as foreign ownership in banking sectors was yet in its infancy and capital markets were virtually inexistent. In the latter period, retained profits were an important source for raising capital in countries like the Czech Republic and Hungary[6]. However, due to the non significance of coefficients related to *ROE* in our estimates, our previous interpretation must be considered with due caution.

Interestingly, the non-performing loans have a negative impact on capital buffers, with a level of significance of 1 %. We will discuss this result further below.

We find a negative relationship between the capital buffer and the GDP growth (significant at 1 % level). This result confirms the assumption of capital buffers are pro-cyclical. It implies

5. Ayuso et al. (2002, 2004) find lower albeit non negligible adjustments costs in Spain with a point estimate of 0.4.

6. Kleff and Weber (2004) find that profitability is positively related to capital, especially for banks with difficulties in accessing external finance. De Bondt and Prast (1999) find that ROE is only negative and significant in countries with large stock markets (the United States, the United Kingdom and the Netherlands) suggesting that the argument of "opportunity cost of capital" holds only in countries were shareholder value is important and access to external finance relatively cheap.

that banks in CEECs deplete their capital buffer in upturns to benefit from unexpected investment opportunity, and raise it during recessions, thus amplifying the business cycle[7]. Finally, the fitting of model (1) is quite reasonable: there is a significant negative first-order autocorrelation in the residuals (m1 statistic of 0.5 %) and nil second-order correlation (m2 statistic of 54.7 %)[8].

Before turning to robustness tests, let's compare further our estimates with those of Ayuso *et al*. (2002, 2004) obtained on a sample of Spanish banks. It is worth noting that the capital buffers are less sensitive to risk and business cycles in CEECs than in Spain[9]. Put differently, banks in CEECs seem to be less risk-lover and less prone to adopt a pro-cyclical behaviour. However, there are other possible explanations. First, the *current* non-performing loans may result from *unexpected shocks on economic environment* (*e.g.* a downturn) rather from a true willingness of risk-taking by the banks[10]. Second, in a context of transition towards market economy, high volatility in the economic environment (Coricelli and Masten, 2004) results in large uncertainty for the banks to evaluate "viable" investment projects and thus the true risks associated with the projects. The difficulties in distinguishing between good and bad investments are exasperated by the lacking bank track-records of new private entrepreneurs. Even though most of the CEECs dispose now of a credit registry with increasing coverage, informational problems remain persistent. Moreover, screening and monitoring procedures may have been inefficient in CEECs, at least until the entry of foreign investors. Indeed, before the entry of foreign banks, banking expertise was lacking. Under the former regime investments decisions were imposed by the plan and not taken after careful screening according to highest return. Finally, before the entry of foreign investors, banks were largely state-owned. During that period the negative relation between risk and capital might reflect Gorton and Winton's (1998b) theory that governments subsidised bank loans by bailing out their major clients.

From an econometrical point of view, the previous discussion shows that *current* NPL may not a good proxy of risk taking. We will take up this point in the robustness tests.

7. Note this is true only if assets increase in upturns due to higher credit. Running Granger tests with GDP and and private credit in total bank assets (both variables in growth rates) indicates that GDP growth causes banks to increase their share of private credit in total assets (significant at the 5% level from 1-to-4 lags).
8. We are aware of the fact that a Sargan test for validity of the instruments would confirm the fitting of model.
9. The point estimates associated to *NPL* and *GDPG* are respectively -1.99 and -4.09 in Ayuso et al. (2002, 2004), compared to -0.942 and -1.059 in our econometrical work.
10. As reported in Table 2, there is a strong partial correlation between current NPL and GDP growth (-0.60).

Table 3: Econometric results for models 1-7

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
BUF_{t-1}	0.584*** (0.067)	0.647*** (0.074)	0.669*** (0.075)	0.656*** (0.072)	0.661*** (0.072)	0.576*** (0.067)	0.647*** (0.073)
ROE_{t}	0.126 (0.243)	0.296 (0.251)	0.306 (0.257)	0.177 (0.245)	..	0.128 (0.244)	0.175 (0.247)
NPL_{t}	-0.942** (-0.461)	..	..	-2.259*** (-0.641)	-2.512*** (-0.579)	-1.006** (-0.456)	-2.209*** (0.648)
$GDPG_{t}$	-1.059*** (-0.256)	-0.568** (0.245)	-0.635** (-0.289)	-0.737* (-0.279)	-0.755*** (-0.282)	-1.124*** (-0.262)	-0.793*** (-0.292)
NPL_{t-1}	..	..	0.376 (0.467)	1.825*** (0.613)	1.902*** (0.593)	..	1.711*** (0.633)
M_1 (*p-value*)	0.005	0.005	0.004	0.001	0.001	0.005	0.001
M_2 (*p-value*)	0.547	0.590	0.576	0.450	0.514	0.512	0.438
Lags/Leads on instruments	NPL -4 ROE -4	NPL -4 ROE -4	NPL -4 ROE -4	NPL -4 ROE -4	NPL -4 ROE -4	NPL -4/1 ROE -4	NPL -4/1 ROE -4
Number of observations	86	87	87	86	90	84	84

(1) t-statistics in brackets
(2)*** ,**,*: significant 1%, 5%, 10%
(3) F1 statistic: nil first-order autocorrelation.
F2 statistic: nil two-order autocorrelation

PART IV: ROBUSTNESS TESTS

As argued by Ayuso *et al*. (2002), our estimates may be influenced by the fact that the non-performing loans ratio is a markedly cyclical variable (see footnote 27 in their paper). This variable could influence the sign and the significance of GDP growth. Following Ayuso *et al*. (2004), we have estimated a model excluding the non-performing loans. As reported in Table 3 (model 2), the impact of GDP growth is still negative albeit to a lesser extent, and with a lower level of significance (5 %). Changes in the point estimate of GDP growth and in its significance reveal that a relevant variable is now omitted from the equation.

To examine more precisely the behaviour of banks with respect to risk-taking, it may be useful to estimate the model with the *lagged NPL* (eventually combined with *current NPL*). Interestingly, models (3)-(5) show a positive relationship between *lagged NPL* and capital buffers, implying that banks with large previous *NPL* burdens tend to have higher current capital buffers. We can then reasonably assume that banks that have suffered from high *NPLs* in the past use the additional capital buffer to improve their reputation ("past *NPL* burden" hypothesis). Combining both *lagged* and *current NPL*, we find that these two variables are significant explanatory variables of capital buffers. Moreover, the coefficient of the lagged capital buffer remains positive (and significant) while the one of GDP growth remains negative (and significant). No gain in terms of significance is obtained for the positive coefficients of *ROE* in models (3)-(5).

As argued by Ayuso *et al*. (2004), capital buffers may be also maintained to cover problem of loans in future periods. A simple way of controlling for these effects is to use *future* values of NPL as instruments. The models (6)-(7) of Table 3 show that the main conclusions of model (1) are not altered when *future NPL* are used as instruments. Moreover, model (7) confirms the assumption of "past NPL burden": *lagged NPL* and buffer capital are negatively (and significantly) related.

We also performed other robustness tests that are not reported here for sake of conciseness[11]. For instance, we have estimated the model with the share of bank credit to the private sector (*BCPS*) in total banking assets, considering this variable as another proxy of risk taken by the banks[12]. In almost all cases, this variable is found to be negatively related to

11. They are available upon request.
12. Alfón *et al*. (2005) for instance use the part of assets in total assets that are weighted at 100%, which are mainly corporate loans.

the capital buffer (with a quite high level of significance). Its introduction does not alter our main conclusions. Interestingly, the point estimate of GDP growth (in absolute values) tends to be higher than in model (1), confirming the assumption of Berger *et al*. (1995) that banks holds capital buffers to be able to benefit from unexpected investment opportunity in upturns. A negative relationship between *BCPS* in total assets and capital buffer reveals also that the capital buffer goes down as a result of more risk-taking (*i.e.* banking credit to private sector carries a higher risk-weight than other banking assets). In that sense, we can conclude as Lindquist (2004) that the implementation of Basel II will increase the risk sensitivity of capital buffers and ensure a better financial stability of banking sectors in CEECs.

We also run a model using the degree of concentration of the banking sector measured by the market share held by the three largest banks (*CR3*) as a proxy for size. According to the hypothesis of "too big to fail", large banks may be inclined to hold lower capital buffers since they know that in the event of difficulties they will receive support from the regulator (Ayuso et al., 2002). However, introducing *CR3* in our econometrical model does not give better point estimates. While it may be argued that *CR3* is a very bad proxy of the bank size in aggregate data, it is important to note that even studies using micro-bank data do not systematically find a significant relation between bank capital and size[13]. Indeed, it appears that the *type* of bank is a more relevant factor. In our case, contrasting foreign and domestic banks would have been particularly relevant, but unfortunately data was unavailable. The introduction of *CR3*, while it does not alter the sign of variables, deteriorates in most cases the significance of estimates.

Finally, a dummy controlling for the Russian crisis does not alter the results, neither do dummies controlling for banking crisis specific to individual countries.

13. While most studies (with the exception of Kleff and Weber, 2005) find significant negative relations, the results depend on the type of bank studied. Lindquist (2004) for instance finds different results for commercial and saving banks.

PART V: CONCLUSIONS

Our econometrical model confirms the existence of adjustment costs in raising capital, as captured by the lagged dependant variable. It also confirms the procyclical behaviour of buffers, suggesting that banks deplete their capital in upturns instead of rebuilding it. This depletion in capital could reflect the willingness of banks to benefit from unexpected investment opportunity in recovery phases. Such behaviour leaves the sector vulnerable to negative shocks, and notably a bursting of the housing bubble that would have a devastating effect on collateral. The positive (but insignificant) sign on the variable *ROE* signals that banks in CEECs may have still a limited access to external capital and/or prefer retained earnings for funding their increase in capital. *Current* non-performing loans interact negatively with the capital buffer, signalling that banks do not adopt a conservative behaviour and take risks. At the same time, and fortunately, banks with a burden of *past* non-performing loans tend to hold additional buffers. All in all, banks in CEECs appear not to be more risk-lover than banks in other developed countries. However, the temptation to take risks is strong, because of high profitability. The introduction of Basel II is therefore to be welcomed as a source of stability, since it will force banks to assess their risks more adequately. Moreover, it is worth noting that, except for *NPL* and *ROE* for reasons given above, coefficients associated with the lagged buffer and GDP growth are not so far from those found in previous econometrical studies using bank-level panel data. This means that running estimates on aggregate data for banking sectors rather than on micro-bank data does not introduce a strong bias in our point estimates. Such a result may be reasonably explained by the high degree of concentration in the banking sector of CEECs.

The importance of capital buffers for lending calls for a more thorough analysis of the bank capital channel in CEECs. Further research is needed to establish the impact of foreign bank ownership on bank capital and the impact this has on lending, especially to SMEs.

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Appendix

Table A: Capital adequacy rules (risk-weighted assets, in %)

	2001	*2002*	*2003*	*2004*	*2005*
Bulgaria	12	12	12	12	12
Croatia	10	10	10	10	10
Czech republic	8	8	8	8	8
Estonia	10	10	10	10	10
Hungary	8	8	8	8	8
Latvia	10	10	10	10	10
Lithuania	10	10	10	10	8
Poland	8	8	8	8	8
Romania	8	8	8	8	8
Slovakia	8	8	8	8	8
Slovenia	8	8	8	8	8

Sources: various reports of central banks.