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Leverage and Productivity Growth in Emerging Economies: Is There A Threshold Effect?

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Abstract: While credit is essential for investment, innovation and economic growth, there are risks to unfettered credit booms. The present paper provides an innovative micro-economic approach to identify the threshold leverage beyond which corporate indebtedness becomes "excessive". In particular, the paper hypothesizes a non-linear relationship in that moderate leverage could boost growth while very high leverage could restrict total factor productivity growth, through increased likelihood of financial distress and bankruptcy. Estimates of a threshold model for a group of emerging CEE countries confirm the non-linear relationship, after controlling for various firm, industry and financial market characteristics.

Keywords: Excess Leverage; Bank efficiency; Market capitalisation; TFP growth; Threshold model, Non-linear relationship; Transition experience

JEL classification: G32, O16

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1. Introduction

While credit is essential for investment, innovation and economic growth, the current economic crisis has highlighted the risks of lending booms around the world. Economists have long recognized that financial conditions in the private sector could have a powerful effect on macroeconomic outcomes. Increases in leverage can lead to greater probability of default, and in turn higher costs of external financing. This could lower investment, cash flow and therefore output (Kyotaki and Moore, 1997). Increases in corporate leverage could also induce severe slowdowns by amplifying and propagating adverse shocks on the real economy (Bernanke and Gertler, 1995). However lending booms may be a natural consequence of financial and economic development. Hence, the problem for most policy makers is to identify the point beyond which further increases in private sector indebtedness become a cause for concern. In other words, policy makers need to be able to assess the sustainability of leverage, both in order to prevent similar crises in the future and to identify those firms or sectors of the economy that need to go through a deleveraging process following the crisis.

The macroeconomic literature on lending booms has generally focused on aggregate measures of indebtedness such as various debt to GDP ratios (e.g., see Gourinchas et al. (2001)). In the same vein, the literature on early warning systems aims at assessing a country's vulnerability to currency crises (e.g., see Kaminsky and Reinhart, 1999); it allows policy makers to detect underlying economic weaknesses and vulnerabilities using various aggregate indicators. These measures are often too crude to help policy-makers judge whether current levels of leverage in a firm or in a

given sector of the economy are sustainable. In contrast to much of this literature, we focus our attention on some microeconomic aspects of lending booms, namely the sustainability of leverage in the corporate sector in terms of its implications for total factor productivity growth. Specifically, we explore the possible adverse effects of excess leverage on total factor productivity growth. Most importantly, we endogenously identify a threshold level of leverage beyond which further increases in indebtedness result in lower TFP growth. Whether a firm is below or above the threshold can be seen as a measure of "sustainability" of a firm's leverage.

The channel between leverage and productivity has remained virtually unexplored. Corporate leverage decisions are among the most important decisions made by firm executives. Since Modigliani and Miller (1958), research has focused on understanding corporate financial choices and policies around the world, especially in the US. This literature highlights the firm, market and industry characteristics determining optimal leverage and also its dynamic adjustment process in case of a departure from the optimal (e.g., see Fischer, et al, 1989; Goldstein, Ju and Leland 2001; Strebulaev 2007). A parallel literature on financial institutions has also paid attention to different aspects of loans and cost inefficiencies (e.g., see Berger and Humphrey 1992; Bonin et al. 2005). While there exists a limited literature on the relationship between leverage and firm value/performance (e.g., McConnell and Servaes, 1995; Berger and di Patti 2006; Driffield, Mahambare and Pal, 2007), there is very little, if at all, understanding as to how leverage can affect productivity growth.[1]

Higher leverage may reduce the agency costs of outside equity, and increase firm value and efficiency by encouraging managers to act in the interest of

[1] Mendoza and Terrones (2008) analyze microeconomic data and show that during episodes of credit boom leverage at the firm level tends to sharply increase. Their sample is limited to publicly quoted firms and, moreover, they do not analyze the effects of this increase in leverage on firms' productivity.

shareholders (McConnell and Servaes, 1995).[2] Thus, higher leverage is likely to be associated with higher total factor productivity (TFP) growth. We argue that the relationship between leverage and productivity growth is likely to be non-linear: while moderate leverage could undoubtedly boost TFP and therefore the level of output, excessive leverage may be responsible for an economy's vulnerability to adverse shocks, e.g. shortfalls in demand or sharp increases in interest rates. Overleveraged firms may have to focus on cash flow generation in order to service their debts, rather than continued improvements in productivity. Moreover, excessive leverage could create excess capacity and lead to financial distress and a wave of bankruptcies in response to unexpected adverse shocks (Greenspan, 2002).

Our analysis is based primarily on firm-level data from a group of central and eastern European (CEE) transition countries (see section 2). This region is an important case in point for several reasons. Even after more than a decade of reforms, there is a growing feeling that the reforms have failed to spur adequately the development of corporate financing opportunities in central and eastern European (CEE) countries. While a significant proportion of firms still today do not have any access to bank loans, many firms with access to bank loans tend to have loans much in excess of their assets (see further discussion in section 2.2). The recent global crisis has led to extraordinarily sharp output declines since late 2008. While by the third quarter of 2009 there were some signs of a mild recovery, unemployment and the volume of non-performing loans are expected to rise for several quarters to come, complicating and slowing the recovery in many countries, thus justifying our interest in the region.

Unlike much of the literature for developed countries, the literature on capital structure for developing and transition countries has highlighted the

[2] There can also be reverse causation. For example, more efficient firms may choose lower equity ratios (i.e., higher debt) than others, all else equal, because higher efficiency reduces the expected costs of financial distress and bankruptcy (Berger and di Patti, 2006).

importance of excess leverage (e.g., see Driffield and Pal, 2010). An important aspect of our analysis is to analyze the potential relationship between the emergence of excessive leverage in the corporate sector and the level of financial market development in the sample countries. It has indeed become clear that weaknesses in financial sector operations and management have been a major factor contributing to the current financial crisis. We use the Financial Sector Development Indicators, in short, FSDI (see World Bank 2006), focusing particularly on indices of banking efficiency and stock market capitalisation (see section 2). A better understanding of the causes and implications of leverage imbalances for TFP growth is important, especially in the wake of the current credit crisis and the deleveraging process that might ensue. The identification of a threshold level of leverage beyond which total factor productivity growth declines has relevant policy implications.[3] Using a nonlinear threshold model, the paper provides an analysis of debt sustainability at the firm level.

There is evidence from our analysis that TFP growth increases with leverage only up to a certain point. However, beyond a critical threshold, greater leverage lowers TFP growth, even after controlling for various firm-level and institutional characteristics. Results also highlight the beneficial role of greater financial market development, as reflected in the positive effects of higher bank efficiency and market capitalisation on TFP growth. More importantly, the model enables us to endogenously determine some leverage thresholds beyond which further increases in leverage lowers total factor productivity growth, which in turn can be useful for formulating policy tools. It also helps to identify certain groups of firms in a given country that need to go through a deleveraging process. Indeed, it is important that "virtuous" firms, possibly with high but sustainable levels of debt, are not deprived of

[3] A policy-oriented publication like the Transition Report (see EBRD 2009, P. 69-70) used our threshold analysis to assess the relationship between excess leverage and financial integration.

external finance. Our results are robust to alternative specifications and also to use of various sub-samples. Our methodology is general and could be applied to other regions and thus have wider potential implications.

The remainder of the paper is organized as follows. In the next section, we discuss the variables and data set. In Section 3, we discuss the empirical methodology and present our empirical results. Section 4 offers some conclusions.

2. Data Description

Data used for the analysis is primarily taken from Orbis, a rich firm-level dataset, which is provided by Bureau van Dijk electronic publishing. Firm-level data have been supplemented by country-level data from the EBRD and the World Bank. The World Bank (2006) has developed a range of indices to measure the size, efficiency and stability of the banking sector and equity market for a cross section of countries for the period 2001-2005. These are commonly known as the Financial Services Development Indices, FSDI in short.

Our sample consists of manufacturing firms from twelve transition countries, namely Bulgaria, Croatia, the Czech Republic, Hungary, Latvia, Poland, Romania, Russia, Serbia, the Slovak Republic, Slovenia and Ukraine over the period 2001-2005. The choice of sample period has been dictated by the fact that FSDI data are available only for this period. This has been a period of steady growth of domestic credit (as a share of GDP) in the region, which stabilized around 2005 for most of the sample countries (see Figure 1). The total number of observations for the period 2001-2005 is summarized in Table 1 for each sample country.

2.1. Leverage measures - descriptive statistics

We use two different measures of leverage, generally dictated by the availability of

relevant data. First, we use the ratio of total debt (short and long-term debt) to total assets (abbreviated as TDTA). As an alternative, we use the ratio of total liabilities to total assets (abbreviated as TLTA), which is available for a larger proportion of firms. Note that a large proportion of firms does not use any debt finance; thus the sample size is smaller when we use TDTA. While we do not observe market value of equity, there is information on book value of equity; there are however too many missing observations, rendering the use of this data very problematic.

Table 1 shows the average leverage ratios between 2001 and 2005 for our twelve sample countries, using the leverage measures described above. The table shows the average leverage ratios for two samples, "all firms" and "non-zero debt firms". Given the limited use of external finance in some CEE countries, there is a significant proportion of firms with zero debt in our sample,[4] notably in Romania. This reflects the fact that many firms still do not have access to debt markets in these economies and instead make heavy use of internal finance, trade credit and other kinds of liabilities.

Among all firms, the average ratio of total liabilities to total assets ranges between 0.34 (Slovenia) and 0.60 (Slovak Republic). The range for average debt ratios is however much narrower, namely between 0.02 (Romania) and 0.19 (Czech Republic). Since a significant proportion of firms in each of these countries do not have access to any debt, it may be pertinent to focus only on indebted firms (i.e., those with non-zero debt). The average debt ratio goes up somewhat when we consider the subsample of firms with non-zero debt. So caution needs to be exercised when choosing between samples (i.e., all firms versus non-zero debt firms) while analyzing and interpreting debt ratios.[5]

[4] Note also that there are a number of cases when there was very little data for total debt in the sample countries, especially, Croatia and Slovenia (see Table 1).

[5] We have also experimented with alternative leverage measures, namely, debt and liability ratio net of cash-flow, which yielded rather comparable results to those presented here.

Table 2 shows debt ratio percentiles and the distribution of average debt ratios by firm size (proxied by total assets). Clearly, the debt ratios of firms in the lowest quartile are significantly lower than those in the top 5%-10% of the distribution in most sample countries. In fact the average debt ratio exceeds 1 for the top 1% firms in Bulgaria, the Czech Republic and Russia. While a large proportion of firms in the sample countries are deprived of loans, some firms seem to have access to high (maybe excessive) debt financing. Second, while the larger firms tend to have higher leverage in Bulgaria, Croatia, the Czech Republic, Romania, Serbia, the Slovak Republic, the opposite holds for the other sample countries. The correlation between firm size and leverage, as shown in Table 2, suggests a significant positive correlation for Croatia, Serbia and The Slovak Republic while it is significantly negative for Poland, Russia and Ukraine; the correlation coefficient however remains insignificant for other sample countries.

2.3. Financial institutions and leverage – descriptive statistics

It follows from our discussion in the last section that a high proportion of firms in the sample countries do not have any debt, and also that leverage is very high (maybe excessive) among non-zero debt firms. While much of the transition literature focuses on firm-level characteristics in understanding capital structure dynamics, we argue that the observed imbalance in the distribution of leverage in our sample could be a sign of institutional weaknesses in debt issuance, management and recovery. This subsection thus briefly explores the link, if any, between selected institutional characteristics and leverage in our sample countries.

Table 3 summarizes the average values of various financial and legal indices between 2001 and 2005, prepared using information from the EBRD, the World Bank FSDI indices and la Porta et al. (1998). Among others, the table includes measures of size, efficiency and stability of the banking sector, market capitalization

to GDP, share of foreign banks in total banking sector assets, and the quality of creditors' rights. Market capitalization to GDP is generally limited in most of the sample countries, especially in Bulgaria, Latvia, The Slovak Republic and Serbia. Firms' external financing opportunities thus may depend crucially on the size and efficiency of the banking sector. The experience varies widely among the sample countries. Romania not only has the smallest banking sector, but efficiency of the banking sector is also the lowest in our sample. Compared to Romania, scores for average creditors' rights are much higher in Serbia or Ukraine, which may facilitate the growth of debt financing. Another observation relates to the predominance of foreign banks in countries like Poland, Romania or Hungary as opposed to Slovenia, Ukraine or Russia, for example.

Clearly, a more efficient banking sector is able to screen out bad loans while a greater degree of market capitalization not only offers an alternative source of external finance, but could also contribute to improved corporate governance practices. It is thus important to test whether the incidence of high leverage among sample firms is linked to weak financial institutions; in order to facilitate this analysis, we estimate a conventional model of optimal leverage.

In particular, we determine the optimal leverage using the factors commonly identified in the literature as important determinants of leverage (e.g., see Rajan and Zingales, 1995; Flannery and Rangan, 2006; Driffield and Pal, 2010). Further, unlike most of the literature, we include two additional institutional measures, namely, efficiency of the banking sector and market capitalization as a share of GDP. [6] Once one allows for all these factors, the best estimate of optimal leverage is obtained from the following specification:

[6] Note however that we were unable to find a measure of market to book ratio. Also, we tried to include total assets growth and also fixed assets as a share of total assets; however these variables were never significant in any specification and hence we decided to drop them. There could also be potential problem of multicollinearity between share of fixed assets and share of intangible fixed assets that we have included.

$$Leverage_{it} = \beta_0 + \beta_1 \, log(assets)_{it-1} + \beta_2 \, Age_{it-1} + \beta_3 \, (Intangible\ FixedAssets/Total\ Asset)_{it-1} + \beta_5 \, (EBIT/Total\ Assets)_{it-1} + \beta_6 \, inflation_{it-1} + \beta_7 \, (bank\ efficiency)_{it-1} + \beta_8 \, (Market\ capitalization\ rate)_{it-1} + \beta_9 \, Industry\ Median\ Leverage_{t1} + v_i + u_{it} \quad (1)$$ [7]

where i=1, 2,…, N refers to the i-th firm in period t=1, 2,…, T in our sample. v_i is the firm-specific fixed effects while u_{it} refers to i.i.d. errors. Definitions of these variables are provided in a note to Table 4. We use panel data fixed effects to estimate equation (1), using both debt and liability ratios as alternative measures of leverage. The advantage of fixed effects estimates is that it can minimize any potential estimation bias arising from firm-specific time-invariant unobserved factors in the data. Potential simultaneity bias could also bias the estimates. Following much of the literature (e.g., see Driffield and Pal, 2010), we use lagged explanatory variables with a view to minimize this bias.

The fixed effects estimates of leverage are summarized in Table 4. In general, more profitable firms tend to have lower leverage while firms in industries with higher median leverage tend to have higher leverage. The coefficient on market capitalization to GDP is positive, thus suggesting a premium for more capitalized firms in the loan market; the coefficient is however significant only when leverage is measured by the liability ratio. More interestingly, firms from countries with greater bank efficiency tend to have significantly lower leverage. In other words, there is evidence from this initial analysis that the more efficient banking system may restrict corporate leverage through regulation and supervision. In other words, other things remaining unchanged, excessive leverage in relation to assets could highlight institutional weaknesses.

[7] EBIT stands for earnings before interest and taxes.

3. An Empirical Model of Leverage and TFP Growth

The analysis so far has shown that while access to loans is limited for a significant proportion of firms in our sample, high (maybe excessive) leverage is common among firms with positive loans. It has also been established that the presence of high leverage is significantly related to the lower efficiency of the banking sector, other factors remaining unchanged. The central and final task in this paper is to examine the effect of leverage on firm performance measured by total factor productivity (TFP) growth. The underlying hypothesis is that while moderate levels of debt can stimulate TFP growth (through the financing of new technologies, innovation or new capacity), beyond a certain threshold debt becomes a drag on performance. There may be several explanations for this non-linear relationship between leverage and TFP growth. Overleveraged firms may have to focus on cash flow generation in order to service their debts, rather than continued improvements in productivity. Firms with very high debts may also be more vulnerable to unexpected adverse demand shocks and more likely to fall into financial distress following a shock.

In order to test this hypothesis one could possibly use a fixed-effects model to regress total factor productivity growth on leverage (and possibly its non-linear terms), after controlling for other covariates. But this may raise questions, especially because this conventional method does not allow one to *endogenously* determine the particular leverage level beyond which TFP growth is negatively affected by further increases in debt. As a better alternative, we employ the threshold regression analysis of Hansen (2000), which enables the *endogenous* identification of the threshold level of leverage beyond which further increases in leverage could lower TFP growth. We begin by examining this in the aggregate, and subsequently move on to some comparisons across countries, and across different types of firms.

3.1. Leverage and total factor productivity

TFP estimates are generated using the well-knownLevinsohn-Petrin method (Levinsohn and Petrin, 2003). The main endogeneity problem with total factor productivity is that firms anticipate shocks to productivity and accordingly adjust their behaviour. The econometrician only observes this ex post. The use of the Levinsohn-Petrin method allows us to address this problem (see Appendix). Given that we were able to find industry-level price deflators for only 9 out of 12 of our sample countries, the TFP measure could only be constructed for these 9 countries, thus excluding firms from Croatia, Romania and Serbia from our original sample analyzed in section 2.

3.2. An endogenous threshold model

The threshold model is particularly relevant to test our central hypothesis, as it endogenously determines the existence and significance of one or more leverage thresholds (and the corresponding confidence intervals), which in turn allows us to assess the growth effects of leverage as a nonlinear process. Depending on whether leverage is less than, equal to, or greater than the threshold, we can obtain marginal effects associated with different bands of leverage and test whether the marginal effects are significantly different across bands.

Denoting the leverage of the i-th firm in year t by L_{it}, the simplest threshold model for TFP growth of the i-th firm for the period [t, t+1] is as follows:

$$\Delta TFP_{it+1} = \alpha_1 L_{it} + \beta' X_{it} + \nu_{it} \text{ if } L_{it} \leq \gamma \quad (3a)$$

$$\Delta TFP_{it+1} = \alpha_2 L_{it} + \beta' X_{it} + \nu_{it} \text{ if } L_{it} > \gamma \quad (3b)$$

Combining (3a) and (3b), we write:

$$\Delta TFP_{it+1} = \beta' X_{it} + \alpha_1 L_{it} I(L_{it} \leq \gamma) + \alpha_2 L_{it} I(L_{it} > \gamma) + \nu_{it} \quad (4)$$

where L_{it} is one period lagged value of leverage (i.e., debt or liability ratio) and X_{it} is

the set of lagged explanatory variables. I(.) represents an indicator function, indicating whether the leverage measure of the i-th firm at time t is less than, equal to, or greater than a threshold parameter γ. γ is the endogenous threshold value to be estimated from the model. The errors ν_{it} are assumed to be independent and identically distributed with mean zero and finite variance. Depending on whether the actual leverage is smaller, equal to, or larger than the threshold value (γ) to be estimated, observations are divided into two "regimes" where the regimes are distinguished by differing regression slopes, α_1 and α_2.

The central problem here is that threshold or cut-off value that has to be estimated is unknown, it has to be estimated, so that one cannot apply standard econometric theory of estimation. Hansen (2000) developed a distribution theory that allows one to make valid statistical inference on threshold models.

Let $S_n(\beta,\alpha(\gamma))$ represent the sum of squared errors for equation (4), where n is the sample size. Given that the parameters α depend on the threshold parameters γ, we denote them by $\alpha(\gamma)$). Because of this dependence, S(.) is not linear in the parameters but rather a step function where steps appear at some distinct values of the threshold variable γ. But conditional on a given threshold value, say $\gamma = \gamma_0$, S(.) is linear in β and α. Accordingly, $S(\beta,\alpha(\gamma_0))$ can be minimised to yield the conditional OLS estimates $\hat{\beta}(\gamma_0)$ and $\hat{\alpha}(\gamma_0)$. Among all possible leverage values, the estimate of the threshold corresponds to that value of α, which minimises the sum of squared errors $S(\beta,\alpha(\gamma_0))$ for given $\gamma = \gamma_0$. This minimisation problem is solved by a grid search over 393 leverage quantiles {1.00%, 1.25%, 1.50%, …, 98.75%, 99%}. Once the sample splitting value of γ is identified, the estimates of the slope parameters are readily available.

If a threshold effect is identified, i.e.., $\alpha_1 \neq \alpha_2$, one needs to form a confidence interval for the particular threshold value γ in this context. This necessitates us to test the following null hypothesis:

$$Ho : \gamma = \gamma_0$$

Under normality, the likelihood ratio (LR) test statistic is routinely used in standard econometric applications to test for particular parametric values. But Hansen (2000) shows that LRn(γ) does not have a standard chi-square distribution in the threshold model. The correct distribution function and the appropriate asymptotic critical values need to be obtained from the bootstrapped standard errors (see Girma 2005 for further details).

Suppose that the two confidence limits of the threshold γ are given respectively by γ_1 (lower) and γ_2 (upper). This allows us to define three sets of leverage variables as follows. Using debt ratio (TDTA) as the particular leverage measure, we generate tdta- (i.e., tdta$\leq \gamma_1$), tdta= (i.e., γ_1<tdta$\leq \gamma_2$) and tdta+ (i.e., tdta> γ_2); similarly using the liability ratio as an alternative leverage measure, we generate tlta- (i.e., tlta$\leq \gamma_1$), tlta= (i.e., γ_1<tlta$\leq \gamma_2$) and tlta+ (i.e., tlta>γ_2). More generally, denoting leverage of i-th firm in year t by L_{it}, equation (4) is modified as follows:

$$\Delta TFP_{it+1} = \alpha_1 L_{it} I(L_{it} \leq \gamma 1) + \alpha_2 L_{it} I(\gamma_1 < L_{it} \leq \gamma_2) + \alpha_3 L_{it} I(L_{it} > \gamma_2) + \beta' X_{it} + \nu_{it} \quad (5)$$

In addition to different bands of leverage as shown in equation (5), we include one period lagged values of a number of other control variables X_{it}, namely, firm size (SME), age (Young), share of intangible assets (IFATA), ownership (foreign) and also some institutional characteristics, namely, efficiency of the banking sector and also

the extent of market capitalization to GDP.[8] This is because the extent to which debt will act to restrict productivity growth is expected to vary with the size/efficiency of the financial market. The more effective the market, the less likely moral hazard would lead to excess leverage, and the lower the level of debt the firms may accrue before servicing the debt acts as a constraint. The set of lagged explanatory variables X_{it} also includes the lagged value of TFP as a control variable; significance of lagged TFP will capture the importance of Barro's (1998) conditional convergence hypothesis. Use of lagged explanatory variables helps us to minimize the potential endogeneity bias of our estimates. It would however be difficult to address endogeneity this way, if there is a lot of persistence in the data. Persistence is not an issue in the total factor productivity models, as we use total factor productivity growth (and not the level variable).

The final step in this estimation strategy is to establish the asymptotic distribution of the slope coefficients. Although these parameters depend on the estimated threshold limits γ_1 and γ_2, Hansen (2000) demonstrates that this dependence is not of first-order asymptotic importance. Consequently, the usual distribution theory (i.e. asymptotically normal) can be applied to the estimated slope coefficients so that one could use the asymptotic p-values to test whether there is a significant threshold effect, i.e., if $\alpha_1 = \alpha_2 = \alpha_3 = 0$; rejection of the null hypothesis would confirm the presence of a significant threshold effect.[9]

3.3. Threshold estimates

Our threshold estimates are summarized in Tables 5 and Table 6 for all firms and non-zero debt firms respectively. We estimate the 95% confidence interval for the threshold parameter γ. The confidence interval varies somewhat for debt and liability

[8] See note to Table 6 for variable definitions.
[9] This procedure is explained in detail in Girma et al. (2003) and Girma (2005).

ratios while they tend to be robust irrespective of the choice of the sample (all firms versus non-zero debt firms).

Initial value of TFP is insignificant; thus there is no evidence of convergence in our sample. However all three leverage terms relating to different bands of the leverage thresholds are statistically significant and this holds irrespective of the choice of leverage measure, debt or liability ratio. There is thus evidence that, after controlling for all other factors, moderate leverage (leverage$\leq\gamma_2$) boosts TFP growth, while excessive leverage (leverage$>\gamma_2$) lowers it. Our estimates suggest that beyond a debt or liability ratio of around 40% further increases in leverage lower TFP growth. It is also evident that the marginal effect of an increase in leverage is significantly different for different bands of leverage and it decreases as we move from the lower leverage band to the higher one.

The role of institutional factors is also worth highlighting here. Higher efficiency of the banking sector and higher market capitalization are both associated with higher TFP growth, thus confirming the beneficial role of institutions on long-run economic growth. The effect of intangible assets however turns out to be negative. While often intangible assets are taken to be a measure of R&D, they also include overvalued goodwill and patents (which may correspond to the expected future value of intangible assets). Thus it is not unusual for intangible assets to have a negative effect on TFP growth.

The upper threshold level of leverage is about 40% of total assets irrespective of the choice of leverage measure. The results suggest that even if *average* TLTA is much higher than *average* TDTA, the distribution of these ratios in our sample is such that the two thresholds are rather similar, after controlling for all other factors. This

is perfectly possible as the threshold depends on who holds the liabilities and how efficient they are at monitoring bad loans.[10]

Given the possibility of reverse causation (i.e., more efficient firms may choose lower equity ratios and hence higher debt than others), we test the robustness of our estimates by differentiating between more/less efficient firms. In the absence of any better indicator, we consider profitability as an index of efficiency and classify firms according to their (a) profit margin and (b) return on capital employed. We consider two benchmark values for (a) and (b): (1) whether the firm has a positive profit margin or rate of return on capital employed (ROCE) and (2) whether the firm has a profit margin or ROCE in excess of the median values in the sample (which are about 0.04 for both these variables). Threshold estimates for non-zero debt firms for "profitable" and "non-profitable" firms are shown in Table 7. As before, these estimates confirm the significant adverse effect of excessive leverage (beyond the upper threshold) on TFP growth. Naturally, the estimated threshold parameters are somewhat different for different subgroups of firms. The contrast between profitable and non-profitable firms is also interesting. First, the upper threshold value of leverage is higher for more profitable firms. Second, the marginal adverse effects of excess leverage on TFP growth are also different between these two groups of firms. The absolute marginal effect of excessive leverage is significantly higher for non-profitable firms, thus highlighting the significant adverse effect of excessive leverage on the productivity of non-profitable firms.

Further, we split the sample by firm size (proxied by total assets) and the ratio of intangible assets to total assets, with a view to understand the impact of these firm characteristics on the leverage threshold. In each case, we estimate the threshold

[10] For example, if they are held by suppliers who won't supply any more inputs until you pay, or the electricity company who is about to turn you off if you don't pay, then this will bite earlier than a loan to a bank, that may or may not have particularly efficient process for keeping tabs on bad payers.

model using the subsamples of firms above the median firm size and median ratio of intangible assets to total assets. The threshold estimates for each case are summarized in Table 8. Each set of estimates confirms the adverse growth effect of excessive leverage for all different subgroups. In general, the upper threshold estimates are higher for 'all' firms rather than 'all indebted' firms. While the estimates for all larger firms (i.e., firms with more assets) are still around 40% of their assets, the estimate is somewhat higher for more innovative firms (i.e., firms with more intangible assets); in other words, more innovative firms can afford a higher leverage, which could partly be attributed to their higher growth potential, even after controlling for all other factors.

Finally, we use the leverage threshold estimates to calculate the percentage of firms above the upper threshold for each sample country. We focus on non-zero debt firms, distinguishing profitable firms (those with above median profit margin) from others. Results of our analysis are summarized in Table 9. Clearly, a sizeable proportion of all *non-zero debt* firms in many sample countries tend to have debt ratios in excess of the upper threshold. The proportion is significantly lower when we consider more profitable non-zero debt firms. Alarmingly, the proportion of firms with excess leverage is higher among non-profitable firms in most sample countries (with the exception of Slovenia). There is pronounced inter-country variation: considering all non-zero debt firms, the proportion of firms with excessive leverage is the highest in Russia, followed by Latvia and Bulgaria.

Our main conclusion is that while moderate leverage boosts TFP growth, excessive leverage beyond the upper threshold limit significantly lowers TFP growth. This result is robust across various subsamples. The estimated upper leverage limit is about 40% of assets irrespective of the leverage measure used, though it may vary somewhat depending on specific firm characteristics. Our analysis may therefore provide a useful tool to identify the point beyond which corporate indebtedness

becomes "excessive". Unlike much of the macro literature, our analysis puts emphasis on the microeconomic aspects of credit booms, with specific focus on firms' financing decisions and the potential relationship between excessive leverage and institutional characteristics.

3.4. Implications for Financial Institutions

Our sample countries are clearly heterogeneous in terms of efficiency of financial markets and institutions. Our analysis has particularly highlighted the impact of bank efficiency and market capitalization, not only on leverage (Table 5), but also on TFP growth (Tables 6-8). In order to explore the role of financial institutions further, we now estimate the threshold model for individual countries. Table 10 summarizes the threshold estimates for five of the nine sample countries, namely Bulgaria, Poland, Russia, Serbia and Ukraine. We were unable to obtain estimates for the remaining countries, as the grid search process failed to identify the sample-splitting value of the threshold; the sample sizes were too small to identify the thresholds with any degree of confidence (the confidence intervals were too wide). We do not show the full set of estimates for brevity, but they are available on request.

Our central results remain unchanged in that moderate leverage continues to have a positive impact on TFP growth while excessive leverage (beyond the upper threshold limit) affects TFP growth negatively. These results hold for all five countries. Note, however, that the leverage thresholds tend to vary among these five countries: Serbia has the lowest (0.288) while Russia has the highest (0.514) leverage threshold in our sample. Given that these country-specific estimates are available only for 5 countries, it is hard to derive a definite relationship between financial institutions, as proxied by bank efficiency and market capitalization, and the estimated upper leverage threshold (above which TFP growth is affected negatively).

As a rule of thumb, we calculate the correlation between the country-specific threshold levels on the one hand and bank efficiency and market capitalization on the other for the 5 countries included in Table 10. While the correlation coefficients between bank efficiency and leverage threshold are negative (-0.15 and -0.26 respectively for debt ratio and liability ratio), those between market capitalization and the threshold level turn out to be positive (0.85 and 0.81 respectively for debt and liability ratios) for non-zero debt firms in our sample. These simple correlation coefficients perhaps highlight several, possibly conflicting, channels affecting the relationship between selected indices of financial markets and the estimated leverage threshold. For example, greater market efficiency means that loans are channeled to the "right" firms, i.e. those with positive NPV projects that can sustain higher debt levels without running into difficulties (positive impact on upper threshold). In contrast, investors (be it banks or shareholders) in more efficient markets may start imposing discipline earlier, thus resulting in a negative impact on upper threshold (e.g., see 'Bad Management hypothesis' in Berger et al., 1997). A thorough analysis of these channels is however beyond the scope of the present paper – but we hope future research will shed light in this respect.

4. CONCLUSION

While lending booms are a natural outcome of financial and economic development, it is important for policy makers to identify the point beyond which corporate indebtedness becomes "excessive". Our analysis is a first step towards a more microeconomic approach to the study of debt sustainability. The threshold approach may contribute towards the development of tools to monitor the emergence of pockets of excessive leverage in the economy. It may also help identify firms and sectors of the economy that need to go through a deleveraging process following the

financial crisis. Indeed, it is important that "virtuous" firms, possibly those with high but sustainable levels of debt, are not deprived of external finance.

Unlike much of the existing macro literature, our analysis puts emphasis on the microeconomic aspects of lending booms, in particular firms' financing decisions, the potential relationship between excess leverage and institutional characteristics, and most importantly, the link between corporate leverage and TFP growth, a topic that remains virtually unexplored. We explore these issues using firm-level panel data from a group of CEE emerging economies.

We posit a non-linear relationship between leverage and total factor productivity growth. While moderate leverage can stimulate TFP growth through providing finance for new technologies, innovation or new capacity, beyond a certain threshold further increases in leverage become a drag on performance. We use a threshold model (a la Hansen, 2000) to endogenously determine the existence and significance of threshold effects of leverage on TFP growth with a view to test our central hypothesis. Threshold estimates identify an upper threshold limit (about 40% of total assets) beyond which further increases in leverage could adversely affect TFP growth in the sample. Results are robust and hold not only in the full sample, but also in various subsamples including large firms, firms with more intangible assets as well as more profitable firms. It is worth noting that the adverse effects of excessive leverage are particularly high for non-profitable firms. The results also suggest that the leverage threshold varies across countries characterized by different levels of financial development, thus highlighting a possible role of financial institutions on leverage imbalance. Evidence of excessive leverage may reflect microeconomic inefficiencies in credit allocation among firms in the sample countries, especially those with weaker financial markets and institutions. There seems to be a need to further deepen and improve the quality of financial systems in CEE countries. A thorough study of the role of institutions is however beyond the scope of the current

paper and we hope future research will address this topic. Although this is a study of firms in CEE countries, results of our analysis may have wider implications for countries with weak institutions beyond this region.

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Table 1: Cross-country variation in leverages 2001-2005

					All firms				Non-zero debt firms	
					TLTA		TDTA		TLTA	TDTA
Country	Firms	Total Obs.	Obs. With zero debt (%)	Obs. with missing debt info (%)	Mean	SD	Mean	SD	Mean	Mean
Bulgaria	207	1035	18.2	(17.7)	0.59	0.94	0.18	0.33	0.62	0.24
Croatia	129	645	7.3	(86.7)	0.39	0.22	0.06	0.13	0.37	0.13
Czech	68	340	12.6	(28.8)	0.52	0.66	0.19	0.32	0.58	0.23
Hungary	22	110	16.4	(43.6)	0.40	0.21	0.09	0.12	0.43	0.13
Latvia	26	130	10.8	(31.5)	0.49	0.53	0.18	0.20	0.55	0.22
Poland	162	810	25.3	(39.1)	0.53	0.35	0.10	0.13	0.56	0.16
Romania	51	255	78.4	(6.3)	0.45	0.32	0.02	0.06	0.47	0.11
Russia	415	2075	11.6	(31.6)	0.42	0.26	0.13	0.15	0.69	0.24
Serbia	289	1445	13.7	(2.5)	0.37	0.23	0.12	0.15	0.39	0.14
Slovak Republic	119	595	6.9	(20.0)	0.60	1.57	0.12	0.13	0.59	0.13
Slovenia	65	325	0.9	(90.8)	0.34	0.17	0.07	0.06	0.40	0.07
Ukraine	159	795	17.0	(1.1)	0.42	0.26	0.13	0.16	0.45	0.15
All			21.6		0.49	1.92	0.14	0.24	0.52	0.18

Note: TL/TA is the total liability as a share of total assets while TD/TA is total debt (both short and long-run) to total assets.
Source: Authors' own calculation using Orbis data.

Table 2: Distribution of debt ratio among firms with positive debt, 2001-2005

	Leverage percentiles						Average leverage by size (by total assets)		
Country	25%	50%	75%	90%	95%	99%	Small & medium firms	Large	Correlation (size, leverage)
Bulgaria	0.05	0.13	0.28	0.53	0.70	1.55	0.22	0.25	-0.0213
Croatia	0.013	0.11	0.19	0.24	0.42	0.83	0.06	0.18	0.304*
Czech Republic	0.045	0.14	0.27	0.40	0.97	2.19	0.20	0.25	0.013
Hungary	0.009	0.14	0.18	0.24	0.29	0.65	0.13	0.13	-0.054
Latvia	0.07	0.16	0.27	0.52	0.71	0.82	0.27	0.19	-0.163
Poland	0.06	0.13	0.23	0.36	0.44	0.68	0.18	0.15	-0.147*
Romania	0.015	0.07	0.16	0.21	0.27	0.70	0.09	0.12	0.163
Russia	0.06	0.15	0.33	0.51	0.61	1.3	0.27	0.19	-0.19*
Serbia	0.03	0.08	0.21	0.35	0.44	0.65	0.12	0.16	0.217*
Slovak Republic	0.033	0.096	0.18	0.30	0.38	0.64	0.11	0.15	0.153*
Slovenia	0.032	0.07	0.12	0.15	0.17	0.20	-	0.07	0.270
Ukraine	0.036	0.10	0.22	0.38	0.47	0.72	0.17	0.15	-0.093*

Source: Authors' own calculation using Orbis data.

Table 3. Financial institutions in CEE countries 2001-2005

COUNTRY	[1] Size of the banking sector	[1] Efficiency of the banking sector	[1] Stability of the banking sector	[1] Equity market efficiency	[3] Market capitalization to GDP	[2] Creditors' rights	[3] Share of foreign banks	[3] Bank reform	[3] Competition reform
Bulgaria	4.84	5.51	4.64	6.68	8.74	2.00	77.34	3.40	2.38
Croatia	5.76	4.89	4.42	NA	23.69	3.00	89.64	3.74	2.30
Czech Republic	5.35	4.72	5.01	3.55	22.69	3.00	86.10	3.76	2.94
Hungary	5.21	5.37	4.70	4.23	23.51	1.00	76.12	4.00	3.12
Latvia	4.71	5.34	3.47	4.78	10.38	3.00	53.50	3.62	2.60
Poland	5.07	5.67	5.04	5.03	20.77	1.00	72.00	3.38	3.06
Romania	3.95	4.23	4.69	3.85	11.03	1.67	55.36	2.82	2.30
Russian Federation	4.5	5.04	4.82	3.00	46.59	1.67	8.04	2.00	2.30
Serbia	NA	4.51	NA	NA	10.17	2.00	36.46	2.12	1.00
Slovak Republic	5.52	4.76	6.07	NA	7.84	2.00	90.54	3.46	3.12
Slovenia	5.43	5.09	3.77	4.55	23.38	3.00	18.74	3.30	2.70
Ukraine	4.49	4.68	2.05	NA	12.12	2.00	2.30	13.98	3.32

[1]: Source: FSDI, World Bank. [2] Source: La Porta et al. [3] Source EBRD.

Table 4. Determinants of Leverage: Fixed effects estimates of debt and liability ratios

VARIABLES	Debt ratio	Liability ratio
Total assets	0.00520	-0.0178
	(0.00612)	(0.0121)
young	-0.00268	-0.00976
	(0.0114)	(0.0227)
Intangible assets	-0.0643	-0.0134
	(0.107)	(0.214)
Profitability	-0.121***	-0.646***
	(0.0235)	(0.0434)
Industry median	0.118***	0.288***
	(0.0343)	(0.0676)
Bank efficiency	-0.0157**	-0.0563***
	(0.00646)	(0.0127)
Market capitalisation	0.000129	0.00132*
	(0.000347)	(0.000681)
inflation	0.00308***	0.00174
	(0.000902)	(0.00180)
Intercept	0.142**	0.937***
	(0.0686)	(0.136)
F-statistic	18.39	34.46
Observations	3041	3189
R-squared	0.038	0.135
Number of id1	1144	1201

Note: Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1; Total assets are measured in USD thousands; fixed assets are measured in USD thousands. Intangible assets are the ratio of intangible fixed assets to total assets. Profitability is measured as the ratio of earnings before interests and taxes (EBIT) to total assets. Bank efficiency refers to the FSDI Index (1-5) of banking sector efficiency where a higher value means greater efficiency. Market capitalization rate is the ratio of market capitalisation to GDP (in %). Inflation refers to the CPI inflation (in %). Source: Authors' own calculation using Orbis data.

Table 5. Threshold estimation of determinants of TFP growth (all firms)

Variable	(1) Coefficient	t-statistic	Variable	(2) Coefficient	t-statistic
Initial TFP	0.126699	0.959595	**Initial TFP**	0.127223	0.960581
TDTA>0.404	-0.024226	-3.21458**	**TLTA>0.412**	-0.204268	-2.40342**
0.322<TDTA<0.404	0.089215	2.930289**	**0.348<TLTA<0.412**	0.058413	1.915012*
TDTA<0.322	0.350741	1.82689*	**TLTA<0.348**	0.394431	2.36437**
Small/Medium firms	0.143156	2.77914**	**Small/Medium firms**	0.147616	2.88400**
Young firms	-3.34E-03	-0.077172	**Young firms**	-6.97E-03	-0.161321
Foreign firms	0.280277	1.38231	**Foreign firms**	0.295057	1.45004*
Intangible assets	-2.26983	-3.71606**	**Intangible assets**	-2.1469	-3.52047**
Bank efficiency	0.095357	2.57299**	**Bank efficiency**	0.092482	2.49775**
Market capitalisation	0.010349	4.02834**	**Market capitalisation**	0.010322	4.01593**
Intercept	0.449349	1.60934*	**Intercept**	0.365951	1.29955
Sector	Yes		**Sector**	Yes	
R-square	0.042		**R-square**	0.039	
95% CI for γ	0.322-0.404		**95% CI for γ**	0.348-0.412	

Note: * denotes significance at 10% or lower level while '**' denotes the same at 1% or lower level. See note to Table 4 for variable definitions. A firm is defined as young if it is incorporated in or after 1995.These estimates are based on data from 9 of the sample countries and exclude firms from Croatia, Romania and Serbia. This is because we could not find industry-level deflators for these countries and hence we could not calculate the TFP residuals.

Table 6. Threshold estimation of determinants of TFP growth (non-zero debt firms)

Variable	(1) Coefficient	t-statistic	Variable	(2) Coefficient	t-statistic
Initial TFP	0.155852	1.06343	**Initial TFP**	0.168956	1.14858
TDTA>0.399	-0.438213	-4.22543**	**TLTA>0.406**	-0.279262	-5.21194**
0.318<TDTA<0.399	0.088776	2.468972**	**0.354<TLTA<0.406**	0.084452	2.62755**
TDTA<0.318	0.23567	3.118497**	**TLTA<0.406**	0.585551	4.25187**
Small/Medium firms	0.203393	3.64635**	**Small/Medium firms**	0.202249	3.67908**
Young firms	-0.02566	-0.577607	**Young firms**	-0.017047	-0.387835
Foreign firms	0.421101	1.96136**	**Foreign firms**	0.437864	2.03162**
Intangible assets	-1.79247	-2.86757**	**Intangible assets**	-1.6335	-2.64248**
Bank efficiency	0.074301	1.87058*	**Bank efficiency**	0.070297	1.79326*
Market capitalisation	9.31E-03	3.35352**	**Market capitalisation**	9.87E-03	3.59513**
Intercept	0.409825	1.35935	**Intercept**	0.231641	0.766973
Sector	Yes		**Sector**	Yes	
R-square	0.054		**R-square**	**0.04**	
95% CI for γ2	0.318-0.399		**95% CI for γ2**	0.354-0.406	

Note: Note: * denotes significance at 10% or lower level while '**' denotes the same at 1% or lower level. See notes to Table 4 for variable definitions. These estimates are based on data from 9 of the sample countries and exclude firms from Croatia, Romania and Serbia. This is because we could not find industry-level deflators for these countries and hence we could not calculate the TFP residuals.

Table 7. Threshold estimation of determinants of TFP growth for profitable and non-profitable firms with positive debt:

	Firms with profit<0.04		Firms with profit >0.04		firms with ROCE<0.04		Firms with ROCE >0.04	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Initial TFP	0.0271	0.1513	0.2294	1.3229	0.0135	0.0755	0.2279	1.3169
TDTA+	-0.5982	-3.0784**	-0.0227	-3.2838**	-0.7655	-4.187**	-0.1421	-3.1335**
TDTA=	0.5340	2.2141**	-0.0531	-1.5035	-0.0043	-0.0094	0.1067	2.5672**
TDTA-	0.2419	3.5171**	0.1596	2.1746	0.5536	2.0419**	0.2776	1.45586*
Small/medium firms	0.11553	0.9091	0.1561	2.7733**	0.1223	2.9300**	0.1593	2.8338**
YOUNG firms	-0.2041	-1.7376*	0.0077	0.1814	-0.2084	-1.7157*	0.0076	0.1800
FOREIGN firms	0.1367	0.5405	0.6022	2.4505**	0.1272	0.5062	0.5997	2.4458**
Intangible assets	-0.2763	-0.1099	-1.5836	-3.00466**	0.0953	0.0373	-1.7853	-3.3797**
Bank efficiency	0.2745	2.2474**	0.039713	1.1451	0.2648	2.0524**	0.0381	1.0977
Market capitalisation	0.0097	1.0607	0.0088	3.56645**	0.00688	0.711086	0.0084	3.4425**
Sector	Yes		Yes		Yes		Yes	
Intercept	-0.4250	-0.7062	0.5280	1.5874*	-0.2747	-0.4455	0.5668	1.7083*
R-square	0.078		0.063		0.048		0.068	
threshold	0.224		0.577		0.425		0.522	
threshold range	0.187-0.301		0.509-0.624		0.354-0.496		0.453-0.616	

Note: These estimates use effects of debt ratio on TFP growth**.** * denotes significance at 10% or lower level while '**' denotes the same at 1% or lower level. See note to Table 4 for variable definitions. These estimates are based on data from 9 of the sample countries and exclude firms from Croatia, Romania and Serbia. This is because we could not find industry-level deflators for these countries and hence we could not calculate the TFP residuals. TDTA+, TLTA+ refer to values of leverage in excess of the upper threshold; TDTA=, TLTA= refer to the values of leverage between the upper and lower threshold while TDTA-, TLTA refer to the values of leverage below the lower threshold.

Table 8. Threshold estimates of selected sub-samples

Case 1 Firm size	All larger firms		All indebted larger firms			All larger firms		All indebted larger firms	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Variable	Coefficient	t-statistic	Coefficient	t-statistic
TDTA+	-0.0215	-3.8615	-0.4616	-4.6344	TLTA+	-0.231	-2.517	-0.3242	-5.6294
TDTA=	0.0845	3.2176	0.0874	2.7003	TLTA=	0.0697	1.8198	0.0945	2.9145
TDTA-	0.3421	1.9773	0.2142	3.3905	TLTA-	0.4495	2.3502	0.5741	4.7187
95% CI to threshold	0.321-0.403		0.317-0.334		95% CI to threshold	0.337-0.407		0.361-0.399	
Case 2 Intangibles	All firms with high intangibles		All indebted firms with high intangibles			All firms with high intangibles		All indebted firms with high intangibles	
Variable	Coefficient	t-statistic	Coefficient	t-statistic	Variable	Coefficient	t-statistic	Coefficient	t-statistic
TDTA+	-0.0251	-3.0788	-0.4531	-3.71	TLTA+	-0.2003	-2.3491	-0.2632	-6.2404
TDTA=	0.1043	2.7073	0.0853	2.1686	TLTA=	0.0631	1.8018	0.0809	2.9414
TDTA-	0.3586	1.5929	0.2615	3.1402	TLTA-	0.3544	2.785	0.6861	4.8787
95% CI to threshold	0.458-0.504		0.364-0.447		95% CI to threshold	0.401-0.442		0.392-0.426	

Note. TDTA refers to debt ratio while TLTA refers to liability ratio. TDTA+, TLTA+ refer to values of leverage in excess of the upper threshold; TDTA=, TLTA= refer to the values of leverage between the upper and lower threshold while TDTA-, TLTA- refer to the values of leverage below the lower threshold. CI refers to confidence interval. Other control variables are same as in Table 6.

Table 9. Percentage distribution of indebted firms with excess leverage

Country	All non-zero debt firms Debt ratio $\gamma_2 > 0.399$	Profitable non-zero debt firms (by profit margin) Debt ratio $\gamma_2 > 0.577$	Non-profitable non-zero debt firms (by profit margin) debt ratio $\gamma_2 > 0.301$
Bulgaria	0.1657	0.0226	0.0798
Czech Republic	0.1055	0.0101	0.0503
Hungary	0.0455	0.0000	0.0227
Latvia	0.1733	0.0133	0.0533
Poland	0.0625	0.0069	0.0104
Russian Federation	0.1959	0.0348	0.0365
Slovak Republic	0.0322	0.0092	0.0115
Slovenia	0.00	0.0000	0.000
Ukraine	0.0864	0.0108	0.0278

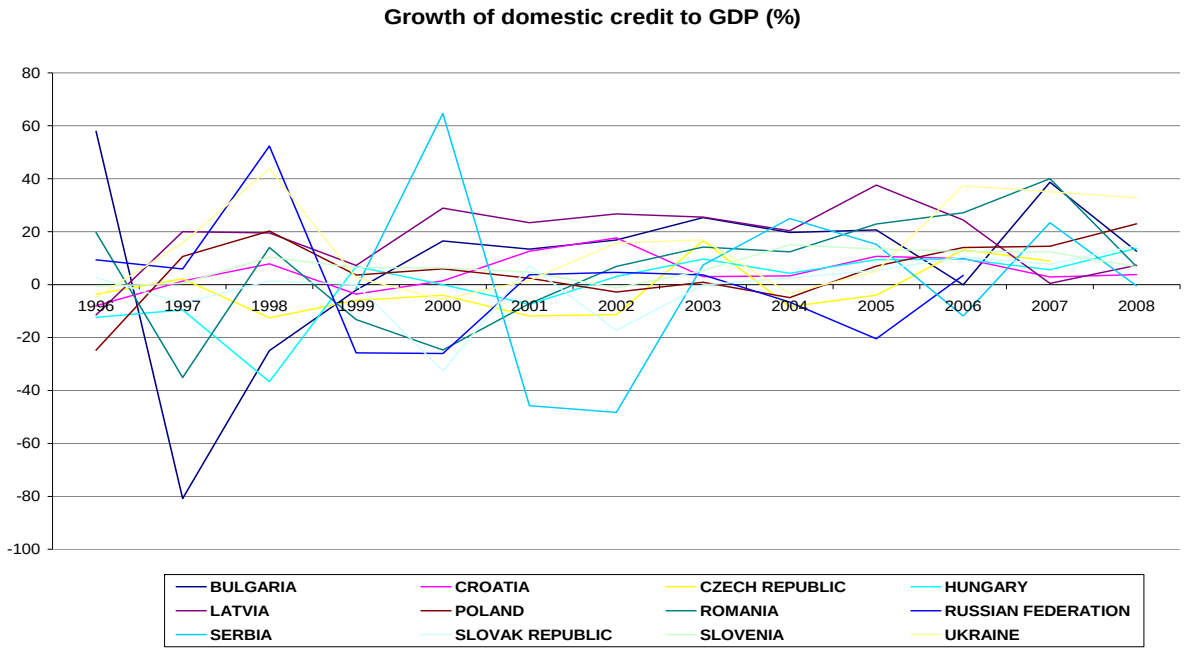
Note: These estimates make use of the threshold parameters obtained in Tables 6 (all non-zero debt firms) and 7 (profitable and non-profitable firms).

Table 10. Inter-country variation in threshold estimates for debt and liability ratios: Selected estimates (95% confidence intervals between brackets)

			Debt ratio		Liability ratio	
	Bank efficiency	**Market capitalization**	**(1) All firms**	**(2) Non-zero debt firms**	**(3) All firms**	**(4) Non-zero debt firms**
Bulgaria	5.51	8.74	0.354 (0.307, 0.387)	0.307 (0.288, 0.367)	0.354 (0.310, 0.366)	0.339 (0.269, 0.384)
Poland	5.07	20.77	0.409 (0.366, 0.437)	0.388 (0.344, 0.441)	0.399 (0.328, 0.451)	0.415 (0.377, 0.463)
Romania						
Russia	5.04	46.6	0.514 (0.439, 0.570)	0.529 (0.446, 0.604)	0.514 (0.491, 0.561)	0.547 (0.449, 0.674)
Serbia	4.51	10.2	0.288 (0.266, 0.344)	0.327 (0.276, 0.388)	0.347 (0.310, 0.397)	0.377 (0.354, 0.406)
Ukraine	4.68	12.12	0.461 (0.377, 0.503)	0.442 (0.394, 0.505)	0.439 (0.399, 0.488)	0.483 (0.450, 0.509)

Note: Columns (1) and (2) show the average values of indices of bank efficiency and market capitalization. Column (3) shows the estimate of leverage threshold and also the lower and upper limits of the leverage threshold (in the parentheses) for debt and liability ratio for all firms as well as indebted firms only.

Figure 1. Growth of domestic credit to GDP in the CEE region



Appendix 1

Appendix

Calculation of TFP

The approach and methodology are well developed and adopted from the existing literature (see e.g., Griffith 1999). This essentially involves estimating the following basic production function:

$$y_{it} = \alpha_k k_{it} + \alpha_l l_{it} + \alpha_m m_{it} + \varepsilon_{it} \qquad \text{(A1)}$$

where subscripts *i, t* refer to firm and year; y_{it}, k_{it}, l_{it}, and m_{it} represent the logarithm of a firm's output (sales) and the production inputs: capital (measured as the book value of fixed assets), labour (number of employees) and material costs respectively. We estimate ε_{it} from (1) as TFP and then determine the log(TFP). To deflate monetary values we use the appropriate producer price index for each manufacturing industry and consumer price index for services available from EU-KLMS (Gottingen) and also WWII (Vienna).

One of the most common econometric problems with the estimation of TFP concerns endogeneity, when regressors and the error terms become correlated. This is because at least a part of the TFP will be observed by the firm at a time early enough so as to allow the firm to change the factor input decision. If that is the case, then profit maximization implies that the realisation of the error term is expected to influence the decision on factor inputs. Consequently the OLS estimates could turn out to be inconsistent. As an alternative we use Levinsohn-Petrin correction, who extend Olley and Pakes (1996) approach by using material inputs as a proxy to control for unobservable productivity shocks, as it is more common for firms to register material costs every year. Accordingly, we generate two series TFP and TFP_LP using the standard and Levinsohn-Petrin methods respectively, although TFP_LP remains our preferred measure.