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Working Paper No. 11-05

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an Endogenous Threshold Analysis**

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April 2011

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Optimal Leverage and Firm Performance:
An Endogenous Threshold Analysis

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15 April 2011

Abstract: The paper aims to bridge the gap between the literature on optimal capital structure and the literature on finance-output-growth nexus. On the basis of the trade-off theory of capital structure, we posit a non-linear relationship between leverage and productivity growth at the firm level. We test this hypothesis using both standard and IV threshold regression models, which in contrast to conventional estimates, allows us to endogenously determine optimal leverage despite firms' temporary deviations from the optimum. Estimates for a sample of Central and Eastern European countries confirm a non-linear hump-shaped relationship between leverage and productivity growth, thus endogenously identifying an optimal leverage ratio. We show how our paper relates to and contributes to the literature on optimal capital structure and finance-output-growth literature.

Keywords: Trade-off theory; optimal leverage; TFP growth; non-linear relationship; threshold regression; Instrumental variable.

JEL classification: G32, O16

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1. Introduction

Corporate leverage decisions are among the most important decisions made by firm executives, and have been the focus of intense scrutiny since Modigliani and Miller (1958). Financial conditions in the corporate sector not only affect firm performance but, as macroeconomists have long recognized, they can have a powerful effect on macroeconomic outcomes. The literature on "financial accelerators" is concerned with the role of financial conditions in amplifying shocks to the economy (see e.g. Bernanke et al. (1999)) while the literature on the finance-growth nexus (e.g., see Ang (2008) for a recent survey) is concerned with their contribution to long-term growth. The present paper aims to bridge the gap between the literature on optimal capital structure and the macro literature on finance-output-growth linkages. We employ endogenous threshold regressions to investigate the impact of leverage on total factor productivity (TFP) growth at the firm level, and the extent to which this varies across types of firms. Our focus on productivity growth as an index of firm performance is further justified in view of a recent McKinsey Global Institute Report (2010) which argues that productivity rather than profitability needs to be the focus of the companies during a period of public spending austerity in Europe because increased productivity will directly result in improved profitability. Estimates for a sample of Central and Eastern European countries suggest that TFP growth increases with leverage until the latter reaches a critical threshold that we label optimal leverage beyond which leverage becomes "excessive" and lowers TFP growth. We extend the existing work in this area by employing an instrumental variable (IV) threshold model following Kourtellos et al. (2009). In what follows, we show how our paper relates to and contributes to the literature on optimal capital structure and finance-growth literature.

Our paper builds upon trade-off theories of optimal capital structure, which explain firms' choice of leverage by a trade-off between the benefits and costs of debt. The hypothesis goes back to Kraus and Litzenberger (1973) who weigh bankruptcy costs against the benefits of interest tax shields. The benefits of debt also include the mitigation of agency problems. In particular, debt has a

disciplining role due to the associated reduction in free cash flow (Jensen, 1986). The costs of debt include debt overhang (Myers (1977)), risk-shifting (Jensen and Meckling (1976)), bankruptcy costs (Warner (1977)), and asset fire sales (Schleifer and Vishny (1992)). The trade-off theory predicts that net benefits to debt financing rise for companies with low debt but decrease as leverage becomes high, implying that net benefits are a nonlinear function of leverage. The empirical literature tests this hypothesis (against the competing pecking order theory) by typically running cross-sectional or panel regressions of leverage on various firm-level, industry-level and market characteristics that determine optimal leverage (see Frank and Goyal (2009) for a review of the literature). While the literature has explored the relationship between leverage and firm value or performance (e.g., McConnell and Servaes (1995); Berger and di Patti (2006); Driffield, Mahambare and Pal (2007)), it has remained silent on the relationship between leverage and productivity. With both benefits and costs to leverage, we posit a hump-shaped relationship between leverage and productivity growth at the firm level. At low levels of leverage, higher leverage is likely to be associated with higher TFP growth as the benefits to leverage outweigh the costs and debt is used to finance productive investment. As leverage increases, the costs of debt become larger and erode the net benefits to leverage. Highly-levered firms not only suffer from a debt overhang problem, which reduces their incentives to invest in productive investment, their attention is also diverted from productivity improvements by the need to generate cash flow in order to service their debts.

Central and eastern European transition countries are an important case in point. The transition experience has long been described as a "natural experiment" (see for example, Eicher and Schreiber (2010)). While transition countries started the transition process from similar (though not identical) positions in terms of liberalisation, institutional reform has progressed in varying ways and to different degrees. Even after more than a decade of reforms, there is a growing feeling that the latter have failed to spur adequately the development of corporate financing opportunities. There is a striking proportion of firms in our sample with zero outstanding debt, including both short- and long-term debt. The "mystery of zero-leverage firms" (Strebulaev and Yang (2006)) is very pronounced in transition countries. This puzzle is augmented by another one: among those firms with outstanding debt, many tend to have very high, potentially excessive, leverage. Unlike much of the literature on developed countries, the literature on capital structure in developing and

transition countries has highlighted the importance of excess leverage (e.g. see Driffield and Pal (2010)). Second, many CEE countries have experienced rapid credit growth in recent years, in particular the Baltic States, Southern Eastern Europe and Ukraine. While the benefits of rapid credit growth have been recognized, the risks related to credit booms have been highlighted by the recent financial crisis, which has hit some CEE countries very hard. Assessing the sustainability of firm-level credit growth and developing appropriate policy tools remains one of the priorities of many policymakers and international organizations active in this region. In addition, the continued practice of soft budget constraints in this region may contribute to the negative impact of excessive leverage on TFP growth[1] in our sample. Soft budget constraints (SBCs) imply that government or financial institutions are willing to provide additional financing to firms with negative NPV projects (see e.g. Dewatripont and Maskin (1995)). If firms take advantage of SBCs, borrowed funds may be used inefficiently rather than for productive investment. Research has indeed shown that one of the detrimental impacts of SBCs on the economy is a lack of R&D (Kornai (2001) and Brücker et al. (2005)). The sample thus provides sufficient inter-temporal and cross-sectional variation to be informative, without generating excessive heterogeneity.

Our estimates confirm that TFP growth increases with leverage until the latter reaches a critical threshold beyond which leverage becomes "excessive" and lowers TFP growth. We confirm the robustness of this result by estimating an IV threshold model using two different instruments following Kourtellos et al. (2009). This result points to the existence of an optimal leverage ratio where the net benefits of debt in terms of productivity gains are exhausted. Our paper reaches some qualitatively similar conclusions to Korteweg (2010). Using a different methodology and a market-based assessment of the net benefits to leverage, the author finds that as leverage increases, net benefits to leverage first increase and then decrease, and finally turn negative for distressed firms. In addition, our analysis sheds light on how optimal leverage varies with firm characteristics, particularly profitability and size. Our results provide support for the trade-off theory of capital structure. In particular, they highlight a positive (negative) relationship between profitability (size) and optimal leverage, unlike existing studies that use traditional cross-sectional or panel regressions. The threshold model allows us to determine optimal leverage despite firms' temporary

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[1] Evidence indicates that soft budget constraints remain into later stages of transition (e.g. Konings et al. (2003)).

deviations from the optimum in contrast to existing empirical evidence, which is based on observed leverage ratios (e.g. Korajczyk and Levy (2003)). Korteweg (2010) reaches similar conclusions.

Our paper also contributes to the burgeoning maco literature on finance-growth nexus. Best practice in the recent literature on finance and growth uses industry-level data to overcome endogeneity problems typical of analyses that rely on aggregate data and identify the channel through which finance affects growth. In their seminal contribution, Rajan and Zingales (1998) find that industries that are relatively more dependent on external finance grow disproportionately faster in countries with more developed financial markets. Our paper provides an alternative approach for studying the finance-growth nexus by directly linking firms' financial structure to TFP growth. In addition, our paper is related to the literature on the macroeconomic risks associated with lending booms. Kiyotaki and Moore (1997) show how increases in corporate leverage lead to higher costs of external financing due to a higher default probability. This could lower investment and therefore output. Kiyotaki and Moore (1997) and Bernanke et al. (1999) show how high indebtedness in the corporate sector can induce severe slowdowns by amplifying and propagating adverse shocks to the economy. Our analysis provides a tool for policy-makers to identify the point at which corporate sector indebtedness becomes a cause for concern. Indeed, whether a firm is below or above the threshold can be seen as a measure of "sustainability" of a firm's leverage. The recent financial crisis has highlighted the risks of lending booms and the associated buildup of excessive indebtedness. 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 a crisis. The empirical literature on lending booms has generally focused on various aggregate measures of indebtedness such as various debt-to-GDP ratios (e.g. see Gourinchas et al. (2001)), or the growth rate of the domestic credit to GDP ratio as in the literature on banking and currency crises (e.g. see Kaminsky and Reinhart (1999)). Our paper extends this literature by looking at the sustainability of credit at the firm level.

The remainder of the paper is structured as follows. In Section 2, we describe the data set and the variables used in the empirical analysis. In Section 3, we discuss the empirical methodology and present our results. Section 4 summarizes our main results.

2. Data set and descriptive statistics

2.1. Sample and sources

The empirical test of our central hypothesis is based on firm-level data for a group of Central and Eastern European (CEE) countries. 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 institutional data from the European Bank for Reconstruction and Development (EBRD). Our sample consists of manufacturing firms from sixteen transition countries, namely, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Republic of Moldova, Romania, Russia, Serbia, the Slovak Republic, Slovenia and Ukraine over the period 1999-2008. As can be seen from Figure 1, all these countries have on average experienced strong growth of domestic credit between 1998 and 2008. The effects of the Russian crisis, the bursting of the dotcom bubble and the financial crisis starting in 2007 visibly translated into a slowdown.

[Insert Figure 1 here]

2.2. Leverage measures and descriptive statistics

We use two different measures of leverage, generally dictated by data availability. First, we use the ratio of total debt (short-term and long-term debt) to total assets (abbreviated as TDTA). Second, we use the ratio of total liabilities to total assets (abbreviated as TLTA)[2]. As can be seen from Table 1, there is a significant proportion of zero-leverage firms, without any outstanding debt, as well as a significant proportion of firms for which debt data is missing. 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. Accordingly, the sample size is larger when leverage is measured by TLTA.

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[2] While we do not observe the market value of equity, there is information on the book value of equity; there are however too many missing observations for this data to be of use.

[Insert Table 1 here]

Table 1 shows the two average leverage ratios for each sample country. The table shows the average leverage ratios for two subsamples, "all firms", including zero-leverage firms, and "non-zero debt firms", excluding zero-leverage firms. Among all firms, the average ratios of total liabilities to total assets range between 0.33 (Moldova) and 0.47 (Poland, Romania), while average debt ratios range between 0.05 (Romania) and 0.20 (Latvia and Lithuania). Among non-zero debt firms, the average debt ratios are unsurprisingly higher in all the sample countries, ranging from 0.13 in Romania to 0.25 in Latvia[3]. Table 2 shows the percentile distribution of debt ratios in each country. One can identify a general trend from these distributions; clearly, the debt ratios increase monotonically as we move from the lowest quartile to the top end of the distribution. In particular, debt ratios among the top 1% firms tend to be significantly higher than those for the median firms. Debt ratios for this group of firms exceed 50% in all but one country (Estonia). The maximum average leverage for this group is 89% in Croatia, closely followed by 85% in Latvia.

[Insert Table 2 here]

Table 2 also summarizes the distribution of debt by firm size. We split the sample between "small" and "large" firms, where small firms are defined as those in the first two quartiles of the distribution of total assets. The correlation between firm size and the debt ratio is mostly positive, although it is quite small in some cases. A large positive correlation is found in Bulgaria, Croatia, Moldova, Serbia, which is in line with the US and international cross-sectional evidence that large firms tend to have higher leverage ratios than small firms[4].

As mentioned earlier, institutional reforms in the financial sector have progressed at varying speeds across countries in our sample. Table 3 summarizes the average values of the EBRD banking sector reform index and stock market capitalization to GDP for the period 1999-2008. The extent of stock market capitalization as a share of GDP is generally limited in most of the sample countries, especially in Bulgaria, Latvia, Romania and the Slovak Republic. Therefore, firms' external

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3 We have also experimented with alternative leverage measures, namely, debt and liability ratios net of cash-flow, which yield comparable results to those presented here.
[4] See for example Rajan and Zingales (1995).

financing opportunities may depend crucially on the size and efficiency of the banking sector. The extent of banking sector reforms varies widely across countries as can be seen from Table 3.

[Insert Table 3 here]

Although a full investigation of the role of institutions is beyond the scope of this paper, we will include these two "institutional" variables in the threshold regression. It can be argued that a more efficient banking sector is better able to screen out bad loans while a better developed stock market not only offers an alternative source of external finance, but also contributes to improved corporate governance practices. Given the variation in the extent of institutional reforms across our sample countries, it may be important to control for the quality of financial institutions when assessing the effect of leverage on TFP growth.

3.   Empirical model of leverage and productivity growth

We use the threshold regression framework of Hansen (2000) in order to test the hypothesis of a non-linear relationship between leverage and productivity growth[5]. As a robustness check, we account for the potential endogeneity of leverage using an instrumental variable (IV) threshold model following Kourtellos et al. (2009). Finally, we look at the relationship between the identified threshold and firm characteristics, namely profitability and size.

3.1.   Total factor productivity estimates

TFP estimates are generated using the well-known Levinsohn-Petrin method (Levinsohn and Petrin (2003)). This method allows us to address a potential endogeneity problem which arises because firms anticipate shocks to productivity and accordingly adjust inputs throughout the production process. Appendix 1 explains how the Levinsohn-Petrin method helps to address this problem.

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[5] In order to identify the non-linear effects of leverage on total factor productivity growth, one could use a fixed-effects regression of total factor productivity growth on leverage and its non-linear terms, after controlling for other covariates. However this conventional method does not allow one to endogenously determine the existence and significance of a threshold beyond which TFP growth is negatively affected by further increases in debt.

3.2.   A threshold regression model

The current approach to threshold analysis was pioneered by Hansen (2000). The fundamental advantage of this approach is that the threshold model endogenously determines the existence and significance of one or more breaks (and the corresponding confidence intervals around the values), if one believes there exist nonlinearities in relationships between variables. In this case, we investigate the threshold values in the relationship between leverage and tfp growth, which in turn enables us to obtain a direct estimation of optimal leverage (despite allowing for firm's temporary deviations from the optimum). Denoting the leverage of the i-th firm in year t by L_{it}, the simplest threshold model of TFP growth for the period [t, t+1] is given by

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

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

where ν_{it} is an error term and γ is the threshold parameter to be estimated. X_{it} is a set of lagged explanatory variables, including: firm size (dummy for small and medium firms that includes firms in the first two quartiles of total assets), age (dummy for young firms established in or after 1995), the share of intangible assets in total assets (IFATA), foreign ownership (a dummy indicating whether the firm is foreign-owned), lagged TFP to account for convergence effects (Barro (1998)), and sectoral dummies. As mentioned above, we also include two variables that capture the quality of financial market institutions: the EBRD index of banking sector reforms and stock market capitalization as a share of GDP. The use of lagged explanatory variables helps us to minimize the potential endogeneity bias of our estimates. However, if there is a lot of persistence in the data, this is unlikely to be a sufficient remedy. Therefore, we deal explicitly with endogeneity problems by estimating an IV threshold model following Kourtellos et al. 2009 in section 3.6. Combining (3a) and (3b), we can write:

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

I(.) is an indicator function, indicating whether the leverage of the i-th firm at time *t* is less than, equal to, or greater than the threshold parameter γ. 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 different regression slopes, α_1 and α_2. 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 parameter γ, we denote them by $\alpha(\gamma)$. Because of this dependence, $S_n(.)$ is not linear in the parameters but rather a step function where steps appear at some distinct values of the threshold variable γ. However, conditional on a given threshold value, say $\gamma = \gamma_0$, $S_n(.)$ is linear in β and α. Accordingly, $S_n(\beta, \alpha(\gamma_0))$ can be minimised to yield the conditional OLS estimates $\beta^{\wedge}(\gamma_0)$ and $\alpha^{\wedge}(\gamma_0)$. Among all possible values for the leverage threshold, the estimate of the threshold corresponds to that value of α, which minimises the sum of squared errors $S_n(\beta, \alpha(\gamma_0))$ for $\gamma = \gamma_0$. This minimisation problem is solved by a grid search over 393 leverage quantiles {1%, 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 is identified, i.e. $\alpha_1 \neq \alpha_2$, one can form a confidence interval for the particular threshold value γ. This amounts to testing the following null hypothesis:

$$H_0: \gamma = \gamma_0$$

Under the normality assumption, the likelihood ratio test statistic is routinely used in standard econometric applications to test for particular parametric values. But Hansen (2000) shows that $LR_n(\gamma)$ 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).

On the basis of the trade-off theory of capital structure, we expect a single threshold, which is equivalent to an optimal level of leverage where TFP growth is maximized. However, the confidence interval around the point estimate allows us to identify three bands of leverage. Suppose that the limits of the confidence interval around γ_0 are given by γ_1 (lower limit) and γ_2 (upper limit). The first band corresponds to a leverage ratio below the lower limit (i.e. leverage $\leq \gamma_1$), the second to an intermediate leverage ratio (i.e. $\gamma_1 <$ leverage $\leq \gamma_2$), and the third to "excessive" leverage (i.e. leverage $> \gamma_2$). Accordingly, we modify equation (4) as follows

$$\Delta\text{TFP}_{it+1} = \alpha_1 L_{it} I(L_{it} \leq \gamma 1) + \alpha_2 L_{it} I(\gamma_1 < L_{it} \leq \gamma_2) + \alpha_3 L_{it} I(L_{it} > \gamma_2) + \beta' X_{it} + v_{it} \tag{5}$$

The final step in our 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 can use the asymptotic p-values to test whether there is a significant threshold effect, i.e. whether $\alpha_1 = \alpha_2 = \alpha_3 = 0$. Rejection of this null hypothesis would confirm the presence of a significant threshold effect.[6]

3.3.   Baseline threshold estimates

The threshold estimates of model (5) are summarized in Tables 4 and 5 for all firms and non-zero debt firms respectively. The tables report the coefficient estimates for all the explanatory variables (except sectoral dummies), including the slope coefficients for the three bands of leverage identified by the 95% confidence interval around the threshold. Despite some variation depending on the sample and the measure of leverage, the confidence interval estimates seem quite robust. The upper threshold limits are 0.386 for the debt ratio and 0.403 for the liability ratio for all firms. For indebted firms, the corresponding ratios are 0.397 and 0.429 for the debt and liability ratios respectively[7]. The initial value of TFP is insignificant, indicating the absence of convergence effects. Importantly, the slope coefficients for the three endogenously identified bands of leverage are all significant, irrespective of the sample and measure of leverage used. The slope coefficients provide evidence that moderate leverage (leverage $\leq \gamma_2$) boosts TFP growth (α_1 and α_2 are positive), while excessive leverage (leverage $> \gamma_2$) lowers it (α_3 is negative), after controlling for firm-level, sectoral and market characteristics.

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[6] This procedure is explained in detail in Girma et al. (2003) and Girma (2005).
[7] Although average *observed* TLTA is higher than average *observed* TDTA (see Table 1), the upper threshold limit for the liability ratio is only slightly higher than for the debt ratio (about 39-40% for debt and 40-43% for liabilities), after controlling for all other factors.

[Insert Tables 4 and 5 here]

The marginal effect of leverage on TFP growth decreases as leverage increases from the lower band through the intermediate one to the upper band where the effect finally becomes negative. In other words, at low levels of leverage an increase in leverage has a large positive impact on TFP growth. This impact diminishes as leverage increases and ultimately turns negative. Based on the estimates of Table 5, a firm with a debt ratio (liability ratio) of 0.2 (i.e. below the lower threshold), for example, reaps net benefits from leverage in the form of 4.24% (10.13%) extra TFP growth compared with an unlevered firm. For a firm with a debt ratio (liability ratio) of 0.37 (in the mid-range), the net benefits amount to 3.14% (3.73%) of extra TFP growth. Finally, a firm with a debt ratio (liability ratio) of 0.5 (i.e. an overlevered firm) has negative net benefits amounting to 23.56% (17.96%) of forgone TFP growth compared with an unlevered firm.

Clearly leverage is not the only factor affecting TFP growth. Among the firm-specific factors, firm size, share of intangible assets and ownership are significant determinants of TFP growth. In general, TFP growth is significantly higher for small and medium sized firms, foreign firms (this is significant at 10% level for indebted firms only) and firms with large intangible assets. The role of institutional factors is also worth highlighting here. A higher efficiency of the banking sector (as captured by a higher index of banking sector reforms) significantly increases TFP growth. The marginal effect of banking sector reforms is about 10% for all firms and 5-6% for indebted firms. In comparison, the marginal effect of market capitalization is small (about 1% for both samples), but positive and statistically significant too. These estimates confirm the beneficial role of better financial institutions on TFP growth in our sample.

3.4. Optimal leverage and firm characteristics

We test the robustness of our estimates by splitting the sample between more and less profitable firms and subsequently focusing on a subsample of large firms. In addition to confirming the robustness of the threshold, these robustness checks allow us to investigate the relationship between optimal leverage and firm characteristics. The trade-off theory predicts a positive relation between optimal leverage and profitability. An increase in earnings increases the tax advantage to

debt and reduces the expected costs of distress and bankruptcy, and hence results in an increase in leverage (Strebulaev (2007)). In addition, the trade-off theory predicts a negative relation between optimal leverage and size (e.g. Kurshev and Strebulaev (2006)). However, previous studies using cross-sectional or panel regressions tend to find a negative (positive) relation between profitability and leverage (size) (see e.g. Frank and Goyal (2009)). These conflicting results may be driven by the fact that studies typically rely on the implicit assumption that firms are always at their optimal capital structures. By contrast, the threshold model allows us to determine optimal leverage despite firms' temporary deviations from the optimum and may therefore enable us to examine the empirical validity of the theoretical relationships.

We use two alternative measures of profitability, namely a firm's profit margin and return on capital employed (ROCE). We split the sample based on the median values of those two profitability measures, i.e. a less (more) profitable firm is defined as one with a profit margin or ROCE below (above) the median profit margin or ROCE (approx. 0.04 for both measures). The threshold estimates for more and less profitable firms (indebted firms only) are presented in Table 6.

[Insert Table 6 here]

These estimates confirm the significant adverse effect of excessive leverage (beyond the upper threshold) on TFP growth and the positive benefits to leverage below that point. Interestingly, the estimated threshold parameters differ significantly for more or less profitable firms. The upper and lower threshold values of the debt and liability ratios are significantly higher for more profitable firms. For example, the upper (lower) threshold limit is approx. 60% (47%) for more profitable firms as opposed to approx. 30% (20%) for less profitable firms when profitability is measured by the profit margin. In addition, Table 6 shows that the negative effect of excessive leverage on TFP growth is significantly higher in absolute value for less profitable firms. In other words, more profitable firms are able to sustain significantly higher level of debts without hurting their productivity growth. This suggests a positive relationship between profitability and optimal leverage in line with the trade-off theory and the empirical results of Korteweg (2010). Previous studies using cross-sectional or panel regressions tend to find a negative relation between

profitability and leverage (see e.g. Frank and Goyal (2009)). This is because high profits mechanically lower observed leverage ratios and previous studies rely on the implicit assumption that firms are always optimally levered. Strebulaev (2007) shows formally that cross-sectional regressions will produce misleading results on the relation between leverage and profitability. Specifically, he shows that even if firms in simulated economies follow the prescriptions of the dynamic trade-off theory, higher profitability lowers the current leverage of a firm unless it refinances in that period. Hence, the presence of frictions that result in firms diverging from their optimal capital structures may complicate empirical work on the trade-off theory. By contrast, the threshold model allows us to determine optimal leverage despite firms' temporary deviations from the optimum.

Finally, we focus on the subsample of relatively larger firms, defined as firms with total assets above the sample median. Again, we restrict our attention to non-zero debt firms. The confidence interval for the debt ratio is 0.263-0.446[8], against 0.312-0.397 for all non-zero debt firms. The upper threshold is larger than in the full sample, indicating that large firms are able to carry more debt. However, the lower threshold, 0.263, is significantly lower for large firms than in the full sample. This suggests that on average debt starts hurting the productivity of large firms earlier. In other words, the net benefits to leverage in terms of productivity gains fade away earlier for large firms, suggesting a negative relationship between size and optimal leverage. Again, this contradicts the results of prior studies that tend to find a positive relation between firm size and leverage and our descriptive statistics in section 2.2. This is in line with Kurshev and Strebulaev (2006) who show that despite having a relatively higher optimal leverage ratio, small firms have lower observed ratios on average because they wait longer between refinancings.

3.5. Incidence of excess leverage

We use the leverage threshold estimates to calculate the percentage of firms above the upper threshold for the debt ratio (TDTA) in each of our sample countries. We obtain these estimates for all non-zero debt firms, but also for more and less profitable non-zero debt firms (where

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[8] For brevity, we do not report the full results. There was no significant threshold for smaller firms, i.e. firms with total assets below the median.

profitability is based on the profit margin). The results are summarized in Table 7.

[Insert Table 7 here]

There is evidence of a significant proportion of firms in most of our sample countries with debt ratios in excess of the upper debt threshold. There is also pronounced inter-country variation: considering all non-zero debt firms, the proportion of firms with excessive leverage is the highest in Russia (above 20% of firms), closely followed by Bulgaria (about 19% of firms). In contrast, the proportion of non-zero debt firms with excessive leverage is the lowest in Hungary (little less than 3%), closely followed by Slovakia (little above 3%). These results combined with the finding that many firms have zero leverage (see section 2.2) highlight the presence of a double puzzle, the puzzle of zero-leverage firms and the puzzle of overlevered firms. In columns 2 and 3 of Table 7, we split the sample to focus on more and less profitable firms. The figures suggest that the proportion of firms with excessive leverage is higher among relatively less profitable firms in most sample countries. This result may point to an inefficient allocation of corporate loans in the CEE region. However, Korteweg (2010) finds that the degree of overleverage is higher for low-profit firms in a US sample, so this may not be a phenomenon that is limited to transition countries.

3.6. Instrumental variable threshold estimates

One criticism of the Hansen (2000) approach is that often the variable of interest is one subject to the decision making process of the firm, and is therefore endogenous. Typically, the literature has resorted to employing lags to resolve this problem, but in panel data with a good deal of persistence, this is unsatisfactory. As such the threshold estimates may be biased or rendered inconsistent by the endogeneity of leverage. Therefore, we check the robustness of our estimates by estimating an IV threshold model following Kourtellos et al. (2009). The authors show how to obtain a consistent estimate of the threshold parameter using an instrumental variable, when the threshold variable is endogenous. Using a similar set of assumptions as in Hansen (2000) and Caner and Hansen (2004), they demonstrate that these IV estimators are consistent if the threshold variable is potentially endogenous.

This methodology of course requires one to identify appropriate instruments, in this case variables that are correlated with debt ratios, but uncorrelated with firm level productivity. The data suggests that there is a good deal of inter-industry variation in debt levels, we therefore employ the industry median debt ratio. In addition, we also employ the fitted value of the debt ratio obtained from the estimates of equation (A2) in Appendix 2[9]. To check for the validity and relevance of our IVs, we look at their correlation with the firm-level debt ratio and TFP growth. First, both median and fitted debt ratios are strongly correlated with the actual debt ratios. In particular, the correlation between the firm-level debt ratio and the industry median debt ratio (fitted debt ratio) is 0.5515 (0.8091). In addition, both IVs are uncorrelated with the error term in the TFP growth equation. This can be seen from the low correlation between the IVs and the estimated error from the TFP growth equation (5). In particular, the correlation between the industry median debt ratio and the estimated residual is 0.0578 and the correlation between the fitted debt ratio and the residual is 0.0945 in the sample of all firms.

The IV threshold estimates for the debt ratio (TDTA) are summarised in Table 8 for all firms and indebted firms. They confirm the non-linear effects of leverage on TFP growth: while moderate leverage boosts productivity growth, excessive leverage (beyond the upper threshold limit) hampers productivity growth. The estimated confidence interval is 0.318-0.382 for all firms and 0.354-0.427 for indebted firms. The corresponding figures from the non-IV threshold model were 0.330-0.386 and 0.312-0.397 for all firms and indebted firms respectively. In other words, estimates of the upper threshold limits (0.382 and 0.427) obtained from the IV model for all firms are within 2 percentage points of the non-IV estimates (0.386 and 0.397), suggesting that the non-IV estimates only slightly underestimate the true parameters. It is also worth noting that the IV threshold estimates are roughly the same irrespective of the choice of IV.

[Insert Table 8 here]

When leverage is instrumented using median leverage (fitted leverage), a firm with a debt ratio of

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[9] Note that the variables that explain the fitted debt ratio in equation (A2) are not exactly the same as those determining TFP growth in equation (5). In particular, the log of total assets and the inflation rate are included in equation (A2), but not in equation (5). In addition, equation (5) includes initial TFP and also different bands of leverage depending on the two threshold limits obtained from the estimation of the threshold model. See further discussion in Appendix 2.

0.2 (i.e. below the lower threshold) reaps net benefits from leverage in the form of 12.43% (12.57%) extra TFP growth compared with an unlevered firm. For a firm with a debt ratio of 0.37 (in the mid-range), the net benefits amount to 2.83% (3.16%) of extra TFP growth. Finally, a firm with a debt ratio of 0.5 (i.e. an overlevered firm) has negative net benefits amounting to 14.29% (13.50%) of forgone TFP growth compared with an unlevered firm. The estimates for the mid-range are very similar to those obtained in Table 5, i.e. around 3%. By contrast, the estimated gains for underlevered firms are higher when leverage is instrumented for, i.e. approx. 12% versus approx. 4%. Also, the estimated costs for overlevered firms are lower when leverage is instrumented for, i.e. around 14% versus approx. 24%. Hence, despite the robustness of the threshold estimates, it appears that the endogeneity of leverage affects the estimated coefficients for the two most extreme bands of leverage.

Table 9 provides an overview of all the debt ratio threshold estimates that we have obtained so far. All the results point to the existence of a non-linear relationship between leverage and TFP growth. The presence of a single threshold in each case is compatible with the theory of optimal capital structure, where the threshold is associated with maximum TFP growth. The threshold estimates vary with firm characteristics, in particular profitability and size, in a way consistent with the trade-off theory of capital structure. The estimates are robust to the potential endogeneity of leverage.

3.7. Threshold estimates for 2000-2006

Given that the sample period 1999-2008 includes two crises, namely the Russian crisis of 1998-99 and the recent financial crisis of 2007, that had impact on the CEE region, we also estimate both the standard and IV threshold models for the subsample of "normal years" 2000-2006. The corresponding threshold estimates are summarized in Table 9.

[Insert Table 9 here]

They appear to be in line with those for the full sample 1999-2008 irrespective of whether we consider all firms or only indebted firms. For example, the IV estimate of the lower threshold is 0.32 in the full sample of all firms as opposed to 0.34 in the 2000-2006 sample. The IV estimate of the upper threshold is 0.382 in the full sample of all firms as opposed to 0.371 in the 2000-2006

sample. In conclusion, the results do not appear to be driven by the choice of sample period.

4. Conclusions

The paper aims to bridge the gap between the literature on optimal capital structure and the wider macro literature on finance-growth nexus. On the basis of the trade-off theory of capital structure, we posit a non-linear relationship between leverage and productivity growth at the firm level. We test this hypothesis using a threshold regression model following Hansen (2000). Estimates for a sample of Central and Eastern European countries confirm that TFP growth increases with leverage until the latter reaches a critical threshold beyond which leverage becomes "excessive" and lowers TFP growth. This result points to the existence of an optimal leverage ratio where the net benefits of debt in terms of productivity gains are exhausted. Despite some variation depending on the sample and the measure of leverage, the estimates seem quite robust. The estimates of the slope coefficients for the three bands of leverage (low, intermediate and excessive) suggest that the productivity gains (costs) to leverage are substantial for underlevered (overlevered) firms.

We examine the link between the endogenously determined leverage thresholds and firm characteristics, in particular profitability and size. Our results highlight a positive (negative) relationship between profitability (size) and optimal leverage, unlike existing studies that use traditional cross-sectional or panel regressions. In contrast to existing empirical evidence based on observed leverage ratios, the threshold model allows us to endogenously determine optimal leverage despite firms' temporary deviations from the optimum. Korteweg (2010) reaches similar conclusions.

Using the leverage threshold estimates, we find evidence of a significant proportion of firms with debt ratios in excess of the upper debt threshold. Our results suggest that the proportion of firms with excessive leverage is higher among relatively less profitable firms in most sample countries. This result may point to an inefficient allocation of corporate loans in the CEE region. However, Korteweg (2010) finds that the degree of overleverage is higher for low-profit firms in a US sample, so this may not be a phenomenon that is limited to transition countries.

Following Kourtellos et al. (2009) we confirm the robustness of our threshold estimates by estimating an IV threshold model using two different instruments for firm-level leverage, namely the industry median debt ratio and a fitted value of the debt ratio. Our results suggest that the baseline estimates only slightly underestimate the true parameters. However, whether one uses the baseline model or the IV estimation matters for the estimated magnitude of the benefits to leverage. The slope coefficients are sensitive to the estimation method for the lower and upper bands of leverage. Finally, we show that our results are robust to the choice of sample period, by excluding from our sample two crisis episodes that significantly affected the CEE region.

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Table 1: Cross-country variation in leverage 1999–2008

Country	Firms	Total obs.	Zero debt (%)	Missing debt (%)	All firms TLTA Mean	All firms TLTA SD	All firms TDTA Mean	All firms TDTA SD	Non-zero debt firms TLTA Mean	Non-zero debt firms TDTA Mean
Bosnia and Herzegovina	146	1362	19.5	20.7	0.36	0.27	0.11	0.14	0.38	0.13
Bulgaria	232	2034	16.7	27.6	0.42	0.24	0.13	0.16	0.45	0.17
Croatia	135	1264	5.8	87.7	0.39	0.23	0.08	0.14	0.42	0.14
Czech Republic	71	642	10.7	38.3	0.41	0.20	0.12	0.13	0.44	0.15
Estonia	10	94	2.1	40.4	0.40	0.24	0.16	0.14	0.45	0.17
Hungary	22	203	8.9	53.2	0.39	0.18	0.10	0.12	0.39	0.12
Latvia	26	239	12.1	34.3	0.45	0.24	0.20	0.22	0.52	0.25
Lithuania	30	281	3.2	49.1	0.46	0.19	0.20	0.17	0.48	0.21
Poland	159	1467	16.4	52.1	0.47	0.19	0.10	0.13	0.52	0.15
Republic of Moldova	195	1806	21.0	46.5	0.33	0.25	0.11	0.17	0.43	0.19
Romania	236	2062	44.9	26.8	0.47	0.23	0.05	0.10	0.52	0.12
Russian Federation	656	6021	15.4	34.5	0.46	0.25	0.15	0.18	0.50	0.20
Serbia	742	6925	15.1	13.2	0.40	0.26	0.12	0.16	0.42	0.15
Slovak Republic	124	1137	5.7	33.0	0.44	0.21	0.12	0.12	0.45	0.13
Slovenia	56	526	1.3	78.9	0.40	0.18	0.18	0.16	0.43	0.19
Ukraine	391	1443	17.1	2.6	0.42	0.25	0.14	0.16	0.45	0.17
All	3231	27506	16.9	31.1	0.42	0.25	0.12	0.16	0.45	0.16

Note: TLTA is the ratio of total liabilities to total assets and TDTA is the ratio of total debt (both short and long-run) to total assets.

Table 2: Distribution of debt among firms with positive debt 1999-2008 in our sample

Country	Leverage percentiles						Average leverage by size		Corr(size, leverage)
	25%	50%	75%	90%	95%	99%	Small	Large	
Bosnia and Herzegovina	0.03	0.07	0.19	0.32	0.42	0.61	0.11	0.12	0.02
Bulgaria	0.04	0.12	0.24	0.42	0.51	0.68	0.08	0.19	0.13
Croatia	0.03	0.11	0.19	0.33	0.46	0.89	0.04	0.15	0.20
Czech Republic	0.04	0.12	0.21	0.32	0.39	0.62	0.11	0.13	0.02
Estonia	0.02	0.18	0.28	0.36	0.44	0.48	0.16	0.20	0.09
Hungary	0.01	0.07	0.17	0.29	0.44	0.54	0.09	0.10	0.01
Latvia	0.07	0.19	0.35	0.62	0.71	0.85	0.22	0.15	-0.17
Lithuania	0.07	0.19	0.32	0.45	0.53	0.66	0.20	0.20	0.05
Poland	0.05	0.12	0.22	0.33	0.40	0.59	0.11	0.11	0.03
Republic of Moldova	0.04	0.13	0.30	0.46	0.56	0.72	0.06	0.18	0.21
Romania	0.04	0.08	0.17	0.28	0.34	0.55	0.04	0.06	0.12
Russian Federation	0.05	0.13	0.29	0.47	0.58	0.75	0.14	0.17	0.01
Serbia	0.03	0.09	0.21	0.38	0.49	0.69	0.09	0.17	0.17
Slovak Republic	0.04	0.10	0.18	0.29	0.35	0.58	0.10	0.16	-0.01
Slovenia	0.05	0.16	0.32	0.42	0.47	0.73	0.21	0.18	-0.13
Ukraine	0.03	0.11	0.25	0.41	0.51	0.71	0.13	0.12	-0.01

Note: Size is measured by total assets. "Small firms" are defined as firms in the first two quartiles of the distribution of total assets.

Table 3: Quality of Financial Institutions, 1999–2008

Country	Stock market capitalization	Banking reform index
Bosnia & Herzegovina	44.54	2.53
Bulgaria	15.74	3.38
Croatia	32.62	3.7
Czech Republic	23.97	3.74
Estonia	30.03	3.85
Hungary	25.10	4
Latvia	9.4	3.58
Lithuania	18.18	3.34
Poland	23.87	3.46
Moldova	26.92	2.56
Romania	13.04	2.91
Russia	59.49	2.15
Serbia	23.21	2.09
Slovakia	7.09	3.41
Slovenia	26.17	3.3
Ukraine	21.54	2.46
All	31.08	2.65

Note: Banking reform index: Average EBRD index of banking sector reform (1 to 4.3, with a higher number indicating a better score); Stock market capitalization: Average stock market capitalization in per cent of GDP. **Source:** EBRD

Table 4: Threshold estimates for total factor productivity growth, all firms

	(1) Debt ratio			(2) Liability ratio		
Variable	Coefficient	t-statistic	Variable	Coefficient	t-statistic
Initial TFP	0.1094	0.8432	Initial TFP	0.1357	0.8421
TDTA>0.386	-0.0247***	-3.4236	TLTA>0.403	-0.1676**	-2.2951
0.330<TDTA<0.386	0.0966***	2.5993	0.339< TLTA <0.403	0.0575**	2.0061
TDTA<0.330	0.3249*	1.737	TLTA <0.339	0.3349**	2.4239
Small/Medium firms	0.1644***	3.2732	Small/Medium firms	0.1273***	2.8871
Young firms	-0.0027	-0.0866	Young firms	-0.0057	-0.1393
Foreign firms	0.2965	1.4025	Foreign firms	0.3415	1.3094
Intangible assets	0.2535***	4.4287	Intangible assets	0.204***	3.0401
Bank Reform	0.0963**	2.383	Bank reform	0.0941***	2.7301
Market capitalization	0.0085***	3.7362	Market capitalization	0.0095***	4.0223
Intercept	0.4183*	1.817	Intercept	0.4368	1.2236
Sector dummies	yes		Sector dummies	Yes	
R-square	0.0395		R-square	0.0436	
95% CI for γ	0.330-0.386		95% CI for γ	0.339-0.403	
Observations	7276		Observations	7276	

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Table 5: Threshold estimates for total factor productivity growth, firms with outstanding debt > 0

Variable	(1) Debt ratio		Variable	(2) Liability ratio	
	Coefficient	t-statistic		Coefficient	t-statistic
Initial TFP	0.1246	1.434	Initial TFP	0.1606	1.0525
TDTA>0.397	-0.4711***	-4.4027	TLTA >0.406	-0.3591***	-4.1582
0.312<TDTA<0.397	0.0848***	4.0394	0.366< TLTA <0.429	0.1007**	2.2809
TDTA<0.312	0.2121***	3.9798	TLTA <0.366	0.5063***	4.9196
Small/Medium firms	0.2827***	3.2036	Small/Medium firms	0.2183***	3.7566
Young firms	-0.0184	-0.6056	Young firms	-0.0104	-0.3224
Foreign firms	0.4598*	1.7453	Foreign firms	0.4722*	1.8367
Intangible assets	0.1461***	3.0295	Intangible assets	0.1103***	3.4344
Bank reform	0.0584*	1.7651	Bank efficiency	0.0498**	2.2909
Market capitalization	0.0144*	1.9062	Market capitalization	0.0079***	4.508
Intercept	0.3079	1.4412	Intercept	0.2503	0.5869
Sector dummies	Yes		Sector dummies	Yes	
R-square	0.038		R-square	0.0609	
95% CI for γ	0.312-0.397		95% CI for γ2	0.366-0.429	
Observations	7276			7276	

Note: *** p-value< 0.01, ** p-value<0.05, * p-value<0.1

Table 6: Threshold estimates for TFP growth for profitable and non-profitable firms (indebted firms only)

Variable	profit margin < 0.04		profit margin > 0.04		ROCE < 0.04		ROCE > 0.04	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Initial TFP	0.0282	0.1882	0.2513	0.8998	0.0111	0.0785	0.2218	1.0221
TDTA > γ_2	-0.5383***	-2.871	-0.0205***	-3.7415	-0.6522***	-3.1142	-0.1924**	-2.5415
γ_1 <TDTA< γ_2	0.7244**	2.4022	0.074*	1.8906	-0.0035	-0.0122	0.1114****	2.9813
TDTA< γ_1	0.297***	3.4799	0.1978*	1.7339	0.5892**	2.2228	0.1943*	1.7429
Small/medium firms	0.0851	0.9762	0.1994****	3.2601	0.0995***	2.9089	0.0998**	2.4722
Young firms	-0.2595**	-2.1802	0.0105	0.1656	-0.1512**	-2.0046	0.0091	0.1824
Foreign firms	0.1295	0.4785	0.61**	2.2618	0.1606	0.6445	0.6175***	2.9946
Intangible assets	0.1692***	3.0924	0.2001***	2.6732	0.0977***	3.0465	0.3336***	4.4063
Bank efficiency	0.2476***	2.8049	0.0343	1.471	0.2102	1.4692	0.0243	1.0896
Market capitalization	0.0123	1.3506	0.0108****	3.7178	0.0075	0.7625	0.0066***	4.5869
Sector dummies	Yes		Yes		Yes		Yes	
Intercept	-0.4456	-0.6346	0.5858	1.4961	-0.3274	-0.357	0.3975	1.0763
R-square	0.0543		0.059		0.06		0.076	
95% CI for γ	0.207-0.314		0.469-0.601		0.337-0.502		0.477-0.695	

Note: *** p-value<0.01 , ** p-value<0.05 , * p-value<0.1

Table 7: Distribution of firms above the upper threshold limits

| | Non-zero debt firms | | |
| | All firms | Profitable firms (by profit margin) | Non-profitable firms (by profit margin) |
	Debt ratio $\gamma_2 >$ 0.399	Debt ratio $\gamma_2 >$ 0.577	Debt ratio $\gamma_2 >$ 0.301
Bosnia and Herzegovina	0.1519	0.0146	0.0467
Bulgaria	0.1886	0.0204	0.0856
Croatia	0.1042	0.0127	0.0540
Czech Republic	0.1088	0.0107	0.0565
Estonia	0.0841	0.0144	0.0456
Hungary	0.0290	0.0004	0.0145
Latvia	0.1276	0.0082	0.1152
Lithuania	0.1119	0.0198	0.0263
Poland	0.0625	0.0069	0.0104
Republic of Moldova	0.0875	0.0004	0.0875
Romania	0.1129	0.0090	0.0063
Russian Federation	0.2008	0.0515	0.0448
Serbia	0.1014	0.0074	0.0713
Slovakia	0.0322	0.0092	0.0115
Slovenia	0.0934	0.0083	0.0603
Ukraine	0.0830	0.0102	0.0462

Table 8: IV threshold estimates

Variable	All firms				Firms with debt > 0			
IV	Median debt		Fitted debt		Median debt		Fitted debt	
	coeff	t-stat	coeff	t-stat	coeff	t-stat	coeff	t-stat
Initial TFP	0.204269*	1.6877	0.301256*	1.79094	0.0915	0.899	0.124	0.8522
TDTA > γ_2	-0.372046**	-2.19638	-0.270078**	-2.4011	-0.2858***	-6.7814	-0.2699***	-5.9029
γ_1 < TDTA < γ_2	0.493331***	3.03804	0.647452***	9.23256	0.0765***	2.8038	0.0855***	3.0221
TDTA < γ_1	0.132922**	2.54923	0.322625***	9.34825	0.6213***	2.6709	0.6286***	2.6879
Small/Medium firms	-0.25907***	-9.17033	0.092922	1.24081	0.1385***	3.8485	0.153***	3.039
Young firms	-1.00E-01	-0.027	-0.847963	-0.66617	-0.0247	-0.448	-0.0252	-0.4645
Foreign firms	0.05701**	2.0105	0.205678***	3.03257	0.3589	1.3891	0.4988	1.5798
Intangible assets	0.566225***	2.92244	2.14715***	3.04656	2.3361***	4.5525	2.1105***	4.0377
Bank reform	0.386627***	10.0109	0.15445***	8.66049	0.0425	1.4815	0.056	1.2326
Market capital	4.09E-02***	4.72081	2.39E-02	1.13267	0.0076***	4.1359	0.0082***	3.9699
Intercept	0.036924	0.297123	-0.315614	-1.08341	0.3126	0.7482	0.3899	0.71
Sector dummies	Yes		Yes		yes		yes	
R-square	0.04		0.035		0.045		0.04	
95% CI for γ	0.318-0.382		0.318-0.382		0.354-0.427		0.354-0.427	

Note: *** p-value<0.01, ** p-value<0.05, * p-value<0.1

Table 9: A summary of threshold estimates

	Debt ratio thresholds	
	Lower limit	Upper limit
All firms	0.336	0.386
Non-zero-debt firms	0.312	0.397
All firms (IV)	0.318	0.382
Non-zero-debt firms (IV)	0.354	0.427
All firms (2000–2006)	0.342	0.377
Non-zero-debt firms(2000–2006)	0.328	0.376
All firms (IV) (2000–2006)	0.323	0.371
Non-zero-debt firms (IV) (2000–2006)	0.366	0.408
	Non-zero debt firms only	
More profitable firms	0.469	0.601
Less profitable firms	0.207	0.314
More profitable firms(2000–2006)	0.472	0.599
Less profitable firms(2000–2006)	0.248	0.301
Large firms	0.263	0.446

Figure 1: Percentage changes in domestic credit in the CEE region 1998–2008
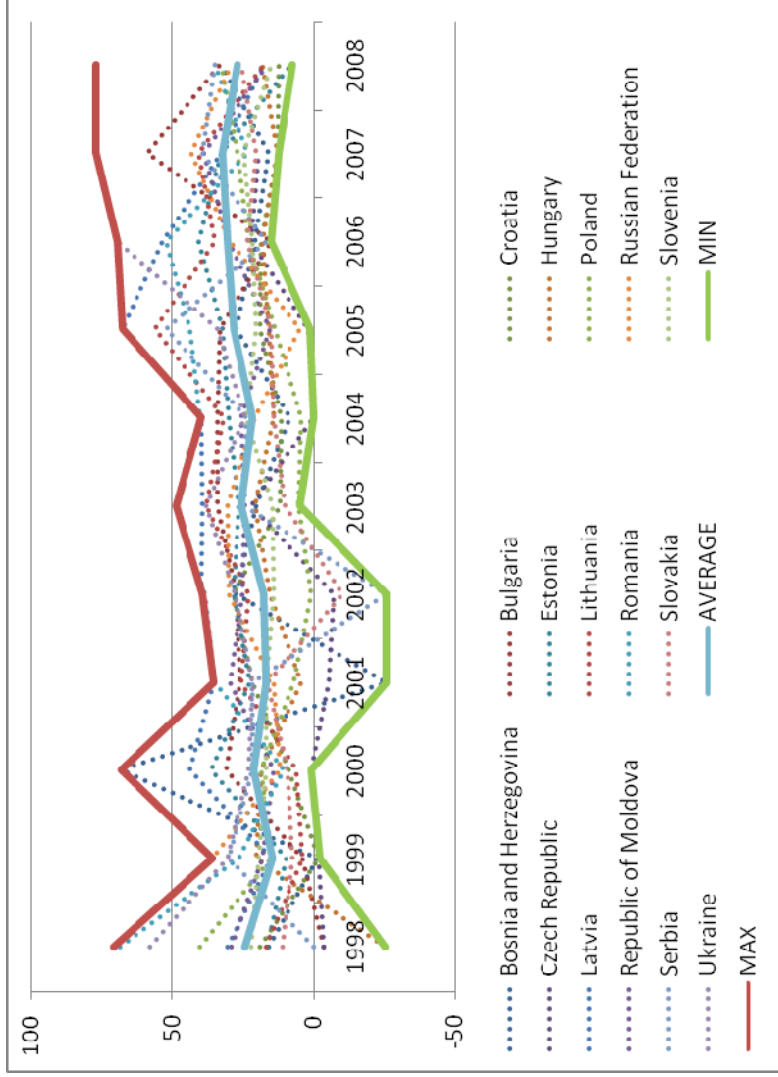
Source: EBRD

Appendix 1

Calculation of TFP

The approach for estimating TFP is based on the existing literature (see e.g., Griffith 1999). This essentially involves estimating the following production function:

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

where subscripts i, and 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), labor (number of employees) and material costs respectively. We estimate ε_{it} from (A1) as TFP and then compute log(TFP). To deflate monetary values we use the consumer price index due to the lack of available industrial price deflators for many of our sample countries.

One of the most common econometric problems with the estimation of TFP is endogeneity. Typically, the regressors will be correlated with the error term because firms change their factor inputs in the anticipation of TFP changes. If that is the case, then profit maximization implies that the realization of the error term is expected to influence the decision on factor inputs. Consequently the OLS estimates could be inconsistent. Therefore, we use the Levinsohn-Petrin correction. Levinsohn and Petrin (2003) extend Olley and Pakes (1996) by using material inputs as a proxy to control for unobservable productivity shocks.

Appendix 2: Estimation of a fitted debt ratio

Our approach is based on the existing literature, which identifies a number of firm-specific factors that determine corporate leverage (e.g. see Rajan and Zingales, 1995; Flannery and Rangan, 2006; Driffield and Pal, 2010). Following our discussion in section 2, we also include some country specific institutional variables, namely an index of banking sector reforms (that captures banking sector efficiency) and stock market capitalization as a share of GDP. Accordingly, we estimate the following leverage equation for firm i in year t (t=1999... 2008):

$$Leverage_{it} = \beta_0 + \beta_1 \log(assets)_{it-1} + \beta_2 Age_{it-1} + \beta_3 (Intangible\ Fixed\ Assets/Total\ Assets)_{it-1} + \beta_5 (EBIT/Total\ Assets)_{it-1} + \beta_6 Inflation_{it-1} + \beta_7 (Bank\ efficiency)_{it-1} + \beta_8 (Stock\ market\ capitalization)_{it-1} + \beta_9 Industry\ Median\ Leverage_{t1} + v_i + u_{it}$$

(A2)

where EBIT stands for earnings before interest and taxes, v_i is a firm-specific fixed effect and u_{it} is the error term [10]. The firm-specific fixed effects account for various unobserved firm-specific factors that may also influence leverage. We use panel data fixed effects to estimate equation (A2), using both debt and liability ratios as alternative measures of leverage. In order to mitigate a potential simultaneity bias, we follow the general convention (e.g., see Driffield and Pal (2010) and use (one year) lagged explanatory variables. For simultaneity to bias the estimates, all firms need to correctly predict productivity one year in advance, which we rule out. The fixed effects estimates are summarized in Table A1 below. In general, more profitable firms tend to have lower leverage. Foreign firms and firms in industries with higher median leverage tend to have higher leverage. The bank reform coefficient is positive but remains insignificant. The coefficient on stock market capitalization to GDP is however positive and significant for both measures of leverage, thus highlighting a leverage premium for firms operating in countries with better stock market development.

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[10] Note that we do not have data on market-to-book ratios. In alternative specifications, the growth of total assets was included and always found to be insignificant. Fixed assets as a share of total assets are also excluded from (A2) because there could also be a problem of multicollinearity with the share of intangible fixed assets.

Table A1: Determinants of Leverage: Fixed effects estimates of debt and liability ratios, 1999–2008

VARIABLES	Debt ratio	Liability ratio
Total assets	0.00170	-0.0133
	(0.00360)	(0.0131)
Small/medium firms	-0.0256***	-0.0105
	(0.00579)	(0.00918)
Young firms	0.00103	-0.000113
	(0.00122)	(0.00240)
Foreign	0.0736***	0.107***
	(0.00677)	(0.0178)
Median debt	0.257***	
	(0.0593)	
Median liability		0.189*
		(0.103)
Share of intangible assets	0.0501	-0.110
	(0.0339)	(0.0694)
Profitability	-0.0535**	-0.166***
	(0.0228)	(0.0479)
Inflation	-0.000343	-0.00368***
	(0.000224)	(0.000883)
Market capitalization	0.000702***	0.000869*
	(0.000196)	(0.000441)
Banking reforms	0.00526	0.0217
	(0.00750)	(0.0332)
Constant	0.0129	0.410**
	(0.0747)	(0.176)
Observations	9310	10433
R-squared	0.090	0.132
Number of firms	2243	2379

Note: Robust standard errors in parentheses; *** p-value<0.01, ** p-value<0.05, * p-value<0.1