European Bank
for Reconstruction and Development

Microeconomic implications of credit booms: evidence from emerging Europe

Fabrizio Coricelli, Nigel Driffield, Sarmistha Pal and Isabelle Roland

Abstract

While credit is essential for investment, innovation and economic growth, there are risks related to excessive indebtedness in the corporate sector in the form of increased likelihood of financial distress and bankruptcy. The recent global crisis has highlighted the macroeconomic risks of credit booms. This paper focuses on microeconomic implications of high leverage and provides an innovative firm-level approach to endogenously identify the threshold leverage beyond which corporate indebtedness becomes "excessive". Estimates for emerging central and eastern European countries suggest that total factor productivity (TFP) growth increases with leverage until it reaches a critical threshold. Beyond this threshold, higher leverage lowers TFP growth.

Keywords: excess leverage; bank efficiency; market capitalisation; TFP growth

JEL classification: G32, O16

Contact details: Fabrizio Coricelli, Université Paris 1, Panthéon-Sorbonne

Email: fabrizio.coricelli@gmail.com

Fabrizio Coricelli is Professor at Université Paris 1, Panthéon-Sorbonne and Research Fellow at CEPR. Nigel Driffield is Professor at Aston Business School. Sarmistha Pal is Associate Professor at Brunel University and Research Fellow at IZA. Isabelle Roland is a PhD candidate at the London School of Economics.

An earlier version of the paper was circulated as "Excess Leverage and Productivity Growth in Emerging Countries - Is there a threshold effect?" Financial support to Nigel Driffield and Sarmistha Pal from ESRC grant RES-062-23-0986 is gratefully acknowledged. We are indebted to Stijn Claessens for FSDI data, Michael Landesman for the sectoral price deflator data and Sourafel Girma and Michael Henry for assistance with the estimation of the threshold model. We thank Yama Temouri for research assistance and Erik Berglof, Ralph de Haas, Peter Sanfey, Jeromin Zettelmeyer and seminar participants at Aston Business School, UCL, the EBRD and CICM conference, London for helpful comments and suggestions on an earlier draft.

Working Paper No. 119 **Prepared in October 2010**

1. Introduction

While credit is essential for investment, innovation and economic growth, the current economic crisis has highlighted the risks of lending booms and excessive indebtedness around the world. Economists have long recognised that financial conditions in the private sector could have a powerful effect on macroeconomic outcomes. Increases in corporate leverage lead to higher probability of default, and in turn higher costs of external financing. This could lower investment, cash flow and therefore output (Kiyotaki and Moore, 1997). Increases in corporate leverage could also induce severe slow-downs by amplifying and propagating adverse shocks to 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 undergo a deleveraging process following a crisis.

The macroeconomic literature on lending booms has generally focused on aggregate measures of indebtedness such as various debt-to-GDP ratios (for example, 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 (for example, see Kaminsky and Reinhart, 1999). 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 (TFP) growth. Specifically, we explore the possible adverse effects of very high leverage on TFP 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.

Corporate leverage decisions are among the most important 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 United States. 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 level (for example, see Fischer, et al., 1989; Goldstein, Ju and Leland, 2001; Strebulaev, 2007). A parallel literature on financial institutions has also paid attention to various aspects of loans and cost inefficiencies (for example see Berger and Humphrey, 1992; Bonin et al., 2005). However, the channel linking leverage and productivity has remained virtually unexplored. While there exists a limited literature on the relationship between leverage and firm value/performance (for example McConnell and Servaes, 1995; Berger and di Patti 2006; Driffield, Mahambare and Pal, 2007), there is very little, if any, understanding as to how leverage can affect TFP growth.[1] Higher leverage is likely to be associated with higher TFP growth. It may reduce the agency costs of outside equity, and increase firm value and efficiency by encouraging managers to act in the interest of shareholders (McConnell and Servaes, 1995).[2] However, we argue that the relationship between leverage and productivity growth is likely to be non-linear: while moderate leverage could undoubtedly boost TFP growth and therefore the level of output, excessive leverage may reduce it. 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 or sharp increases in interest rates and more likely to fall into financial distress following such a shock (Greenspan, 2002).

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

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

The empirical test of this non-linearity hypothesis is based on firm-level data from a group of central and eastern European (CEE) transition countries (see Section 2). We believe this is an interesting sample for several reasons. This provides sufficient inter-temporal and cross-sectional variation to be informative, without generating excessive heterogeneity. The study of the development of these countries has long been described as a "natural experiment" (see for example Eicher and Schreiber 2010), while they have started from similar positions (though not identical) in terms of liberalisation, institutional reform has progressed in varying ways and to different degrees. The relationship between leverage and TFP growth is not only driven by firm-level characteristics but also potentially by these policy, legal and regulatory factors. Hence, capturing these variations within a relatively homogeneous sample adds to the analysis. Second, many CEE countries have experienced rapid credit growth in recent years, in particular the Baltic states, south eastern Europe and Ukraine. While the benefits of rapid credit growth have been recognised, the risks related to credit booms have been highlighted by the recent financial crisis, which has hit some CEE countries very hard. 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. Assessing the sustainability of credit growth and developing appropriate policy tools remains one of the priorities of many policy-makers and international organisations active in this region. Third, even after more than a decade of reforms, there is a growing feeling that the reforms have failed to adequately spur the development of corporate financing opportunities in CEE countries. While a significant proportion of firms still do not have any access to bank lending, many firms with access to bank loans tend to have very high, potentially excessive, indebtedness (see further discussion in Section 2.2). We argue that these imbalances may be due to weaknesses in financial market institutions. 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 (for example see Driffield and Pal, 2010). An important aspect of our analysis is 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 sector efficiency and stock market capitalisation (see Section 2).

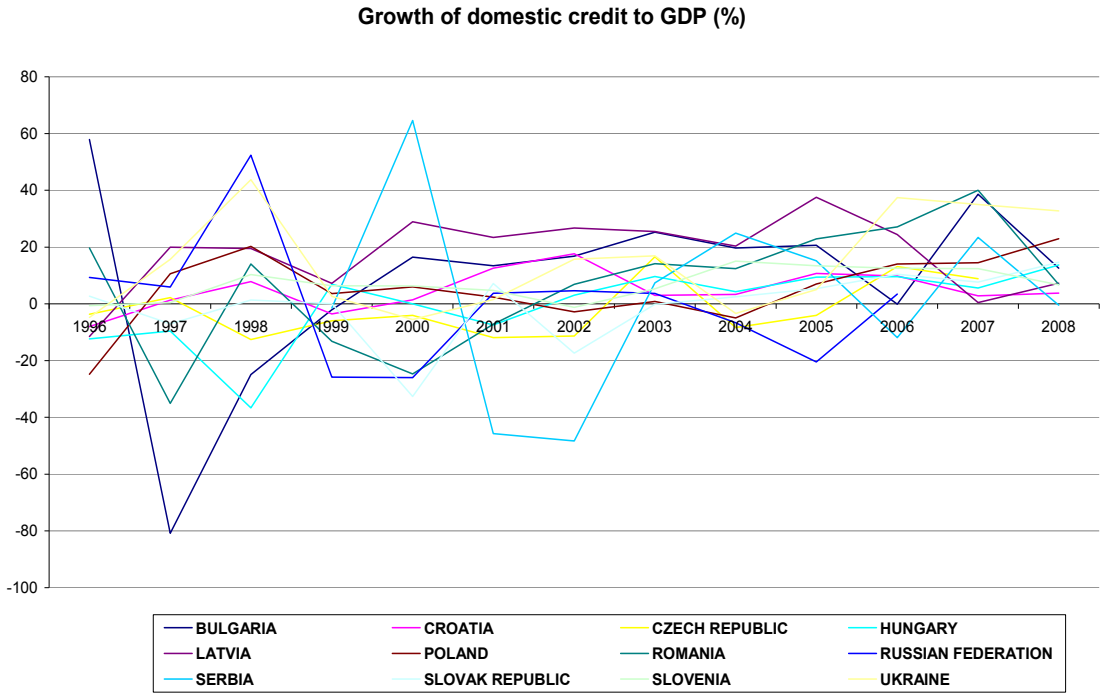
A better understanding of the causes and implications of leverage imbalances for TFP growth is important, especially in the wake of the current credit crisis and the deleveraging process that might ensue. The identification of a threshold level of leverage beyond which TFP growth declines has relevant policy implications. Using a non-linear threshold model, the paper provides an analysis of debt sustainability at the firm level. Our analysis shows that TFP growth increases with leverage only up to a certain point. Beyond a critical threshold level, higher leverage lowers TFP growth, even after controlling for various firm-level and institutional characteristics. Importantly, the model enables us to *endogenously* determine the leverage threshold beyond which further increases in leverage lower TFP growth. This approach can be useful for formulating policy tools. It may for instance help 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 external finance. 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. Our results are robust to alternative specifications and in various subsamples.

The remainder of the paper is organised as follows. In Section 2, 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 2001-05. These are commonly known as the Financial Services Development Indices, FSDI in short. Our sample consists of manufacturing firms from 12 transition countries, namely Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Poland, Romania, Russia, Serbia, Slovak Republic, Slovenia and Ukraine over the period 2001-05. 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 stabilised around 2005 for most of the sample countries (see Figure 1). The total number of observations for the period 2001-05 is summarised in Table 1 for each sample country.

Chart 1: Growth of domestic credit to GDP in the CEE region



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,[3] 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.

[3] 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).

Table 1: Cross-country variation in leverages 2001-05

					All firms				Non-zero debt firms	
					TLTA		TDTA		TLTA	TDTA
	Firms	Total obs.	Obs. with zero debt (%)	Obs. with missing debt info (%)						
Country					**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 Republic	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: TLTA is the total liability as a share of total assets while TDTA is total debt (both short and long-run) to total assets. Source: Authors' own calculation using Orbis data.

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 (that is, those with non-zero debt). The average debt ratio goes up somewhat when we consider the subsample of firms with non-zero debt. Therefore, caution needs to be exercised when choosing between samples (that is, all firms versus non-zero debt firms) while analysing and interpreting debt ratios.[4] Table 2 shows average debt ratios (TDTA) by firm size percentiles, where firm size is proxied by total assets. Clearly, the debt ratios of firms in the lowest quartile are significantly lower than those in the top end of the distribution in all sample countries. In

[4] 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.

fact the average debt ratio exceeds 1 for the top 1 per cent firms in Bulgaria, the Czech Republic and Russia. This is in line with US and international cross-sectional evidence that large firms tend to have higher leverage ratios than small firms[5].

Table 2: Distribution of debt ratio among firms with positive debt, 2001-05

	Average TDTA per firm size 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*

Note: Authors' own calculations using Orbis data.

2.2 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 firms with access to loans. 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.

[5] See for example Rajan and Zingales (1995).

Table 3 summarises 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 capitalisation to GDP, share of foreign banks in total banking sector assets, and the quality of creditors' rights. Market capitalisation 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 with 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 Serbia, Slovenia, Ukraine or Russia, for example[6].

[6] Note that the figures reported in Table 3 are averages for 2001-05. Many CEE countries have witnessed rapid changes in recent years and the current picture may look very different from the average over our sample period. For instance, the share of foreign banks has dramatically increased in several countries, notably Serbia.

Table 3: Financial institutions in CEE countries 2001-05

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 capitalisation 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
Russia	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

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

Clearly, a more efficient banking sector is better able to screen out bad loans while a greater degree of market capitalisation 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 (for example 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 capitalisation as a share of GDP. [7] Once one allows for all these factors, the best estimate of optimal leverage is obtained from the following specification:

$$\textit{Leverage}_{it} = \beta_0 + \beta_1 \textit{log(assets)}_{it-1} + \beta_2 \textit{Age}_{it-1} + \beta_3 \textit{(Intangible FixedAssets/Total Asset)}_{it-1} + \beta_5 \textit{(EBIT/Total Assets)}_{it-1} + \beta_6 \textit{inflation}_{it-1} + \beta_7 \textit{(bank efficiency)}_{it-1} + \beta_8 \textit{(Market capitalization rate)}_{it-1} + \beta_9 \textit{Industry Median Leverage}_{t1} + v_i + u_{it} \quad \textbf{(1)}$$

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.[8] 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. Potential simultaneity could also bias the estimates. For example, just as more profitable firms may have lower leverage, firms with lower leverage may have lower profitability. Following the general convention in the literature (for example see Driffield and Pal, 2010), we use lagged explanatory variables to minimise this potential simultaneity bias.[9]

[7] 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 a potential problem of multi-collinearity between the share of fixed assets and the share of intangible fixed assets that we have included.
[8] EBIT stands for earnings before interest and taxes.
[9] Later we also test the robustness of our estimates by considering various sub-samples (see Section 3.3).

The fixed effects estimates of leverage are summarised 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 capitalisation to GDP is positive, thus suggesting a premium for more capitalised 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 a more efficient banking system may rein in corporate leverage, for example through regulation and supervision. In other words, other things remaining unchanged, very high leverage could highlight underlying weaknesses of financial institutions in CEE.

Table 4: 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 thousands of US dollars; fixed assets are measured thousands of US dollars. 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. The market capitalisation rate is the ratio of market capitalisation to GDP (in %). Inflation refers to the CPI inflation (in %). Source: Authors' own calculations using Orbis data.

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 Total factor productivity estimates

TFP estimates are generated using the well-known Levinsohn-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 analysed in Section 2.

3.2. An endogenous threshold model

The threshold model is particularly relevant to test our central non-linearity hypothesis, as it endogenously determines the existence and significance of one or more leverage thresholds (and the corresponding confidence intervals) beyond which further increases in leverage reduce TFP growth. 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 (that is, 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 the threshold or cut-off value that has to be estimated is unknown, 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:

$$H_o : \gamma = \gamma_0$$

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 $LR_n(\gamma)$ 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).

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- (that is, 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= (that is, 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:

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

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 capitalisation to GDP.[10] 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 minimise 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

[10] See note to Table 6 for variable definitions.

asymptotic importance. Consequently, the usual distribution theory (that is, 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, that is, if $\alpha_1 = \alpha_2 = \alpha_3 = 0$; rejection of the null hypothesis would confirm the presence of a significant threshold effect.[11]

3.3. Threshold estimates

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

[11] This procedure is explained in detail in Girma et al.. (2003) and Girma (2005).

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.

The role of institutional factors is also worth highlighting here. Higher efficiency of the banking sector and higher market capitalisation 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 research and development (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 per cent 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.[12]

Given the possibility of reverse causation (for example 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 (ROCE). We consider two benchmark values for (a) and (b): (1) whether the firm has a positive profit margin or 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 relatively more profitable and relatively less profitable firms are shown in Table 7.

[12]Trade credit liabilities to suppliers may well bite earlier than a loan provided by a bank, which may or may not have particularly efficient processes for monitoring borrowers.

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: * (**) denotes significance at 10% (1%) or lower level. See notes to Table 4 for variable definitions. Estimates are based on data from 9 sample countries, excluding firms from Croatia, Romania and Serbia because we could not find industry-level deflators for these countries and hence we could not calculate the TFP residuals. TDTA+ and TLTA+ refer to values of leverage above the upper threshold; TDTA= and TLTA= refer to values of leverage between the upper and lower thresholds while TDTA- and TLTA- refer to the values of leverage below the lower threshold.

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 relatively more profitable and relatively less profitable firms is also interesting. First, the upper threshold value of leverage is higher for more profitable firms, suggesting that the latter can sustain higher level of debts without hurting productivity. Second, the negative marginal effect of excessive leverage on TFP growth is significantly higher in absolute value for relatively less profitable firms, thus highlighting the significant adverse effect of excessive leverage on the productivity of less profitable firms.

Furthermore, we split the sample by firm size (proxied by total assets) and the ratio of intangible assets to total assets (a proxy for firms' innovativeness), in order to perform further robustness checks and to understand the impact of these firm characteristics on the leverage threshold. In each case, we estimate the threshold 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 summarised in Table 8. Each set of estimates confirms the adverse growth effect of excessive leverage for all different subgroups. While the threshold estimate for all larger firms (that is, firms with more assets) is still around 40 per cent of their assets, the estimate is somewhat higher for more innovative firms (that is, 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.

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.

Lastly, 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 relatively more profitable firms (those with above median profit margin) from others. The results are summarised 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. 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. The proportion is significantly lower when we consider relatively more profitable non-zero debt firms. Alarmingly, this suggests that the proportion of firms with excess leverage is higher among relatively less profitable firms in most sample countries (with the exception of Slovenia).

Table 9: Percentage distribution of indebted firms with excess leverage

Country	All non-zero debt firms Debt ratio γ_2> 0.399	Profitable non-zero debt firms (by profit margin) Debt ratio γ_2> 0.577	Non-profitable non-zero debt firms (by profit margin) debt ratio γ_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
Russia	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).

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 per cent

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 capitalisation, 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 summarises the threshold estimates for five of the nine sample countries, namely Bulgaria, Poland, Russia, Serbia and Ukraine[13].

[13] 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.

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 cap.**	**(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)
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 capitalisation. Column (3) shows the estimate of leverage threshold and also the lower and upper limits of the leverage threshold (in parentheses) for debt and liability ratio for all firms as well as indebted firms only.

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 across countries. Serbia has the lowest (0.288) while Russia has the highest (0.514) leverage threshold in our sample. Given that country-specific estimates are available only for five countries, it is hard to derive a definite relationship between financial institutions, as proxied by bank efficiency and market capitalisation, and the estimated upper leverage threshold. As a rule of thumb, we calculate the correlation between the country-specific threshold levels on the one hand and bank efficiency and market capitalisation on the other for the five 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 capitalisation 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 market institutions and the estimated leverage threshold. For example, greater market efficiency means that loans are channeled to the "right" firms, that is, those with positive NPV projects that can sustain higher debt levels without running into difficulties (positive impact on upper threshold). In contrast, investors (be they banks or shareholders) in more efficient markets may start imposing discipline earlier, thus resulting in a negative impact on upper threshold (for example 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 by providing finance for new technologies, innovation or new capacity, beyond a certain threshold further increases in leverage become a drag on productivity. Unlike the conventional approach, 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 per cent of total assets) beyond which further increases in leverage could adversely affect TFP growth in the sample. Adverse effects of high leverage 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. Note, however, that the adverse effects of high leverage are relatively higher for more vulnerable firms, for example non-profitable or less innovative firms. The results also suggest that the leverage threshold

varies across countries characterised by different levels of financial development, thus highlighting a possible effect of financial institutions on leverage imbalances. The prevalence of excessive leverage may reflect microeconomic inefficiencies in credit allocation among firms in CEE countries, especially those with weaker financial markets and institutions. A thorough examination of the role of institutions on leverage threshold is, however, beyond the scope of this paper and is an important area for future research.

References

Almeida, H, M. Capello and M. Weisbach (2005), "Cash Flow Sensitivity of Cash", *The Journal of Finance*, vol.59, issue 4, 1777-1804.

Antoniou, A., Y. Guney and K. Poudiyal (2008), "The Determinants of Capital Structure: Capital Market Oriented Versus Bank Oriented Institutions", *Journal of Finance and Quantitative Analysis* 43(1).

Barro, R. (1998), "Determinants of Economic Growth: A Cross-Country Analysis", MIT Press.

Beck, T, A. Demirgüc-Kunt and V. Maksimovic (2002), "Financing Patterns Around the World: The Role of Institutions", World Bank Policy Research Working Paper 2905.

Berger, A.N. and D.B. Humphrey (1992), "Measurement and Efficiency Issues in Commercial Banking" in Z. Griliches (ed.) "Output Measurement in the Service Sectors", NBER studies in Income and Wealth, Vol. 56, University of Chicago Press, 245-79.

Berger, A., J.K. Johnson, W. Qinyu and R. De Young (1997), "Problem Loans and Cost Efficiency in Commercial Banks", *Journal of Banking and Finance* 21, 849-870.

Berger, A. and di Patti, E. B. (2006), "Capital structure and firm performance: a new approach to testing agency theory and an application to the banking industry", *Journal of Banking and Finance*, 30(4) 1065-1102.

Bernanke, B. and M. Gertler (1995), "Inside the Blackbox: Credit Channel of Monetary Policy Transmission", *Journal of Economic Perspectives* 9, 27-48.

Bonin, J. P. Wachtel and I. Hasan (2005), "Privatization Matters: Bank Efficiency in Transition Countries", *Journal of Banking and Finance* 29(8/9) 2155-2178.

Booth, L. V. Aivazian, A. Demirgüc-Kunt and V. Maksimovic (2001), "Capital Structure in Developing Countries", *Journal of Finance*, 56.

De Haas, R.T.A. and H.M.M. Peeters (2006), "The dynamic adjustment towards target capital structures of firms in transition economies", *Economics of Transition*, 14(1), 133-169.

Demirgüc-Kunt, A. and V. Maksimovic (1995), "Stock Market Development and Firm Financing Choices", Policy Research Working Paper 1461, The World Bank, Policy Research Department, Finance and Private Sector Development Division, Washington, D.C.

Driffield, N. and S. Pal. (2010), "Evolution of Capital Structure in East Asia: Corporate Inertia or Endeavours?", *Journal of Royal Statistical Society (Series A)*, 173(1), 1–29.

Demirguc-Kunt, A. and V Maksimovic (1998), "Law, Finance, and Firm Growth", *The Journal of Finance*, 1998 - Blackwell Synergy.

Eicher, T.S. and T. Schreiber (2010), "Structural policies and growth: Time series evidence from a natural experiment", *Journal of Development Economics*, 91(1), 169-179.

EBRD (2009), *Transition Report*: Transition in crisis?

Evans, D.S. (1987), "Tests of Alternative Theories of Firm Growth", *The Journal of Political Economy*, 1987, vol. 95(4).

Faria, A. and Paolo Mauro (2004), "Institutions and the External Capital Structure of Countries", IMF Working Paper WP/04/236.

Fischer, E.O., R. Heinkel, and J. Zechner (1989), "Dynamic capital structure choice: theory and tests", *Journal of Finance*, 44, 19–40.

Flannery, M.J. and K. Rangan (2006), "Partial Adjustment Toward Target Capital Structures", *Journal of Financial Economics* 79, 469-506.

Frank, M. and B. Goyal. (2009), "Capital Structure Decisions: Which Factors are Reliably Important?", *Financial Management,* 38(1), 1-37.

Girma, S. (2005), "Absorptive Capacity and Productivity Spillovers from FDI: A Threshold Regression Analysis", *Oxford Bulletin of Economics and Statistics* 67(3) 281-306.

Girma,S., M. Henry, R. Kneller and C. Milner (2003), "Threshold and Interaction Effects in the Openness-Productivity Growth Relationship: The Role of Institutions and Natural Barriers", GEP working paper 2003/32, Nottingham.

Goldstein, R., N. Ju and H. Leland (2001), "An EBIT based Model of Dynamic Capital Structure", Journal of Business 74(4).

Gourinchas, Pierre-Olivier, Rodrigo Valdes, and Oscar Landerretche (2001), "Lending Booms: Latin America and the World", *Economia*, Spring, 47-99.

Greenspan, A. (2002), "Testimony of Chairman Alan Greenspan Federal Reserve Board's Semi Annual Monetary Policy Report to the Congress Before the Committee on Financial Services", US House of Representatives February 27.

Griffith, R. (1999), "Using the ARD establishment level data to look at foreign ownership and productivity in the United Kingdom", *Economic Journal*, 109, 416-42.

Hansen, B. E. (2000), “Sample splitting and threshold estimation”, *Econometrica*, Vol.68, 575–603.

Hovakimian, A., G. Hovakimian., and H. Tehranian (2004), “Determinants of target capital structure: The case of dual debt and equity issues”, *Journal of Financial Economics*, Volume 71 (3), 517-540.

Kaminsky, G. and C. Reinhart (1999), “The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," *American Economic Review*, vol. 89(3), 473-500.

Kiyotaki, N. and J. Moore (1997), “Credit Cycles”, *Journal of Political Economy*, 105, 211-248.

Lang, L., E. Ofek and R. M. Stulz (1996), “Leverage, investment, and firm growth”, Journal *of Financial Economics*, 40, 3-29.

Levinsohn, J. and Petrin, A. (2003), “Estimating production functions using Inputs to control for unobservables”, *Review of Economic Studies*, 70, 317-341.

Mendoza, Enrique G. and Marco E. Terrones (2008), “An Anatomy of Credit Booms: Evidence from Macro Aggregates and Micro Data”, IMF Working Paper WP/08/226.

Myers, S.C. (1984), “Capital Structure Puzzles”, *Journal of Finance*, 39, 575-92.

Myers, S.C. and N. Majluf (1984), “Corporate Financing and Investment Decisions when Firms Have Information Investors do not Have”, *Journal of Financial Economics*, 13, 187-221.

Nivorozhkin, E. (2005), “The Dynamics of Capital Structure in Transition Economies”, *Economics of Planning*, 37 (1), 25-45.

Olley, S. and Pakes, A. (1996), “The Dynamics of Productivity in the Telecommunications Equipment Industry”, *Econometrica*, 64 (6), 1263-98.

Rajan, R. and L. Zingales (1995), “What Do We Know About Capital Structure? Some evidence from international data”, *Journal of Financ*e, 50, 1421-1460.

Rogoff, K. (1999), “International Institutions for Reducing Global Financial Instability”, *Journal of Economic Perspectives*, American Economic Association, 13(4), 2.

Sarkar, S. and F. Zapatero (2003), “The Trade-off Model with Mean Reverting Earnings: Theory and Empirical Tests”, *Economic Journal*, Vol.113, 834-860.

Strebulaev, I. (2007), “Do Tests of Capital Structure Theory Mean What They Say?”, *Journal of Finance*, 62, 1747-1788.

Appendix

Calculation of TFP

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

$$y_{it} = \alpha_k k_{it} + \alpha_l l_{it} + \alpha_m m_{it} + \varepsilon_{it}$$

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 maximisation 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 the 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.