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Corporate NPL portfolios in CESEE countries: impact of corporate leverage and debt spillovers on firm performance

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Abstract

This paper examines the extent of corporate leverage in central, eastern, and south-eastern Europe (CESEE), and its effects on firm performance. We study an important aspect that was largely overlooked in the literature when dealing with overall financial distress, namely the skewed distribution of excessive debt in the corporate sector and its impact on the economy. A debt spillovers empirical model is estimated for five CESEE countries using firm-level data for 2005-14 to study the impact of firms' own financial distress and of excessive horizontal and vertical debt spillovers generated by the most heavily indebted firms in the same sector and in vertically linked sectors. Apart from the negative impact of firms' own financial distress on employment and investment performance, our results show substantial negative horizontal and vertical debt spillover effects of the most indebted companies on other firms. These effects become aggravated during the financial crisis and are more severe for small and medium-sized firms. These findings suggest that achieving a timely resolution of corporate non-performing loans (NPLs) can have far more widespread effects than previously believed with SMEs as the main "collateral benefiters".

1. Introduction

In most of central, eastern and south-eastern Europe (CESEE), private growth and investment is still hampered by persistent financial distress in the corporate sector, as underlined in the recent IMF publication *Regional Economic Issues* (IMF, 2015). The corporate sector in most CESEE countries took on excessive debt before the 2008 crisis, exposing them to the pressure of having to realign their debt levels in the aftermath of the crisis. This resulted in a typical balance sheet recession with simultaneous and painful deleveraging, which not only aggravated the overall economic downturn but also worsened the prospect of economic recovery. The IMF report shows that seven years into the crisis the debt problem in many CESEE countries is still pervasive, mostly because the institutional frameworks required to ensure a timely and smooth deleveraging were lacking or inefficient.

The obvious way to see how unsustainable debt and limited access to credit affect firm performance is to assess the macroeconomic importance of overleveraged firms in terms of employment, sales, investment, exports and so on. This approach, however, underestimates the true impact of overleveraged firms on aggregate performance of the economies. One important aspect that was largely overlooked in the literature when dealing with overall financial distress is the skewed distribution of excessive debt in corporate sectors and its impact on the economy. As shown by Damijan (2014) for Slovenia, and as demonstrated in section 3 of this paper, the 300 most indebted companies in CESEE on average account for two-thirds of the total corporate debt overhang, contribute about one-sixth of aggregate value added, and one-eighth of aggregate employment. Though these figures constitute a non-negligible overall effect of most indebted companies on overall macroeconomic performance, it is also important to consider the potential indirect effects of these large financially distressed companies on upstream and downstream companies in the national value chains. This may considerably alter the overall macroeconomic importance of the top debtor firms and provide some further justification for preferential treatment of the top 30, top 50 or top 100 debtor firms in terms of financial restructuring.

This aspect becomes even more important in view of the recent advances in empirical analysis and theory of firm dynamics. While standard theory assumes balanced economies where all sectors play roughly symmetric roles as input suppliers to others and where all microeconomic fluctuations are averaged out, recent research shows that when sectors and firms are heterogeneous in terms of size, idiosyncratic microeconomic shocks can lead to a larger macroeconomic downturn than what is predicted under assumptions of a normal distribution. There is a fast-growing body of research showing that when the firm size distribution is "fat-tailed"[1] idiosyncratic shocks to large firms contribute more to aggregate fluctuations (see Gabaix, 2011; Acemoglu et al., 2012, 2015; Di Giovanni et al., 2014). Bernanke et al. (1996) highlight the "small shocks, large cycles puzzle" interaction between the input-output structure and the shape of the distribution of microeconomic shocks as an important potential explanation of the aggregate volatility.

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[1] i.e. when firm size is not normally distributed, but few firms dominate the output by sectors.

Acemoglu et al. (2015) show that the propagation mechanism of microeconomic shocks works through input-output linkages between sectors and firms. In an unbalanced economy, where some sectors and/or companies play a much more important role than others as input suppliers or buyers to the rest of the economy, microeconomic shocks to individual companies or sectors can lead to the emergence of significant macroeconomic fluctuations. In other words, the frequency of large GDP contractions can be highly sensitive to the nature of micro shocks. Damijan et al. (2016) show how a demand shock affecting a large Slovenian company quickly spreads through the network of its suppliers, creating several rounds of first- and second-order adverse effects along the supply chain. Furthermore, Kelly et al. (2013) develop a network model of firm volatility in which larger suppliers have more customers. They show that network effects are essential in explaining the joint evolution of the empirical firm size and firm volatility distributions.

Hence, when a fraction of larger companies in an economy is burdened by excessive debt and facing significant credit constraints and when this period of financial distress is protracted, this may have disproportionately large adverse effects on the whole economy. Depending on their size and intensity of the input-output linkages with the rest of the economy, financially distressed firms pose a potentially significant macroeconomic risk due to their inability to provide services or products to their upstream customers or to meet financial obligations to their downstream suppliers.

Due to the network effects, the occurrence of financially distressed large firms may play a similar role in the propagation of the crisis as systemic banks burdened by the large shares of non-performing loans (NPLs) in their portfolios. It is hence essential to study the network effects of such "systemically important" companies in the economy and to what extent their financial health / distress affects the rest of the economy.

The research in this paper has three main objectives. We aim to:

- study the extent of corporate sector excess leverage in CESEE economies
- identify the largest and "systemically important" companies that are most severely burdened by excessive debt
- analyse their impact on the performance of vertically linked downstream and upstream firms.

The first objective provides an assessment of the extent of corporate sector excess leverage by country. For the second objective we identify groups of the largest companies (from the top 10 to top 300) with regard to their excess leverage, and assess their direct macroeconomic importance in terms of debt, employment, value added and exports. And for the third objective we estimate a debt spillovers model to assess the indirect effects of financial distress on horizontally and vertically linked industries. The model is estimated using firm-level data for five CESEE countries (Bulgaria, Croatia, Hungary, Romania and Serbia) for the period 2005-14. Finally, we use coefficients estimated by the model to simulate indirect impact of reducing the excessive debt held by the 100 and 300 largest debtor firms on sales, employment and investment of vertically linked companies.

These are the major findings of our paper.

- Corporate sectors in six CESEE countries are burdened with large extent of excessive debt. On average, 29 per cent of firms are characterised by excess leverage (defined as (net debt – EBITDA) > 4). In four countries this ratio of firms with excessive debt leverage is even bigger, ranging between 31 per cent (Montenegro) and 42 per cent (Serbia).

- Corporate net debt and excessive debt are highly concentrated across CESSE economies. On average across six CESEE countries, the 20 largest debtor companies account for almost 30 per cent of total debt overhang, while the top 100 and top 300 companies account for almost one half and two-thirds of overall excessive debt, respectively. Bulgaria, Hungary and Serbia reveal the largest concentration of excessive debt, with the 10 most indebted companies holding between 30 and 40 per cent of total debt overhang and the 50 most indebted companies holding between 50 and 60 per cent of total corporate excessive debt.

- On average, the largest 100 financially distressed firms in six CESEE countries account for 8 per cent of total value added and 6 per cent of total employment, while the 300 most indebted firms account for 13 and 16 per cent of overall employment and value added, respectively. To put it differently, 1 in 8 employees and 1 in 6 euros created in the corporate sector are directly affected by the 300 most indebted companies.

- Estimations of our debt spillovers model show that firms' own financial distress was largely tolerated before the crisis, that is, it had no significant impact on firm performance, but became severely taxing on firm performance in the post-crisis period when banks tightened credit standards.

- In addition to this direct effect, firms' performance is significantly affected by the excessive debt of firms in other horizontally or vertically linked industries. There are substantial negative spillovers from overleveraged companies in the same industry as well as vertical debt spillover effects of the most indebted companies in vertically linked firms.

- Firms' performance is more severely affected by the poor financial health of suppliers, rather than customers. Most importantly, these effects are aggravated during the financial crisis and are more severe for small and medium-sized firms.

- Simulations based on our estimated model show that if debt in the largest 100 debtors of our sample was reduced to acceptable levels in line with the investment grade rating, we would expect an additional indirect boost to sales of vertically linked firms by between 0.5 per cent (Croatia), 1 per cent (Bulgaria, Hungary and Serbia) and 2.5 per cent (Romania). Similarly, deleveraging the 100 most indebted firms would indirectly boost employment of other firms by 0.25 to 3 per cent, and investment by up to 1 per cent.

These results enable us to draw important policy implications regarding the need to design policies that support the repair of private companies' balance sheets. Institutional reforms focusing on debt resolution frameworks specifically targeting "systemically important" larger debtor companies may provide essential support to faster economic recovery in some

of the debt-ridden CESEE countries. Our findings suggest that SMEs will also indirectly benefit by a timely resolution of NPLs of the most extremely leveraged companies.

The outline of the paper is as follows. The next section describes the microdata used. Section 3 assesses the extent of corporate leverage of companies in CESEE countries. Section 4 introduces the empirical models estimated, while section 5 presents the main results from various specifications of the model. In section 6 we provide some simulated effects of deleveraging the most indebted firms on individual firm performance in terms of sales, employment and investment. The last section concludes.

2. Data

The data used for this analysis come from different sources. Where possible, national sources of data for whole population of firms were used. Unfortunately, this was possible only for Croatia and Hungary, where local researchers were engaged to work with the provided statistical code on empirical estimations with confidential national micro data.[2]

For Croatia, the data come from Financial Agency (FINA), which collects annual balance sheets and income statements for all firms liable by law. The data cover all companies, with no cut-off in terms of firm size, and covers the period 2002-14.

Hungarian firm-level data used for this study comprise a combination of balance sheet and income statements. The data come from NAV, the Hungarian tax authority, and are made available to the Databank of the research institute CERS-HAS. The data set has universal coverage of companies excluding self-employed and some partnerships across all sectors of the economy. There is no firm size cut-off. The data for this analysis cover the 2005-13 period.

Microdata on firms from Bulgaria, Montenegro, Romania and Serbia come from the Amadeus database. We employ annual financial and accounting data for the period between 2005 and 2014. Amadeus (Bureau van Dijk) includes standardised annual accounts (consolidated and unconsolidated), financial ratios, sectoral activities and ownership data. Additionally, we include supplemental information on ownership indicators (immediate ownership and ultimate ownership data) from the Orbis (Bureau van Dijk) database to improve the overall sample size.

In principle, the full Amadeus database includes information on all firms, but with some exclusion criteria. Banks and insurance entities are excluded, as are firms with no financial data available (assets, debt, etc). Amadeus also does not gather data on firms that have been inactive for more than two years or firms whose last available data are older than six years. Crucially, branches are also not included in the sample. Sole traders/proprietorships that have consolidation code LF (limited financial), NRF (no recent financial) or NRLF (no recent limited financial) and with fewer than two employees (1, 0 or n.a.) and entities that are not obliged to report financial information are also excluded from the database.

For all six countries in our study we performed standard data cleaning, which means that observations with negative or non-existent assets, negative value added, no sales and no employment were eliminated. Depending on the country, this reduced the sample size up to 17 per cent relative to the original data. Naturally, due to missing variables, the actual samples that were used in econometric analysis are considerably smaller.

Table 1: Data sample after cleaning, breakdown by size classes, 2014 (2013 for Hungary)

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[2] Relevant national authorities, such as statistical offices, tax authorities and/or central banks were contacted also in Albania, Montenegro and Serbia. However, the authorities' replies were that either there were no complete microdata available with the necessary financial information (Albania, Montenegro) or the data were confidential or could be purchased for an extremely high fee only (Serbia).

Number of companies

	HR	HU	BG	RO	RS	ME
Micro (0-9)	93,003	370,824	663,617	710,519	80,761	2,049
Small (10-49)	1,243	23,071	40,953	45,966	10,623	472
Medium (50-499)	223	4,868	9,056	9,418	2,747	209
Large (500+)	23	384	375	468	148	9
Total	94,492	399,147	714,001	766,371	94,279	2,739

Distribution by size classes (in %)

	HR	HU	BG	RO	RS	ME
Micro (0-9)	98.5	92.9	92.9	92.7	85.7	74.8
Small (10-49)	1.3	5.8	5.7	6.0	11.3	17.2
Medium (50-499)	0.2	1.2	1.3	1.2	2.9	7.6
Large (500+)	0.0	0.1	0.1	0.1	0.2	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0

Notes: HR – Croatia, HU – Hungary, BG – Bulgaria, RO – Romania, RS – Republic of Serbia, ME – Montenegro.

Sources: FINA, MAV and Amadeus.

Nevertheless, after data cleaning we end up with reasonably large data sets for all countries, except Montenegro (see Table 1). For Croatia and Serbia the latest annual data set (for 2014) comprises nearly 100,000 firms, in Hungary there were 400,000 firms included (latest year is 2013), while in Bulgaria and Romania data were available for more than 700,000 companies for the latest year. It is only in Montenegro where the company sample with available data is very low (2,700 companies in 2014).

Breakdown of data samples by size classes reveals a strong composition bias towards micro and small firms. Disregarding Montenegro, between 85 and 98 per cent of all firms in the sample are micro firms with fewer than 10 employees. Another 1 to 11 per cent of all firms are small firms with between 10 and 50 employees. Only about 0.2 to 3 per cent of all firms in the samples can be classified as either medium-sized (with between 50 and 500 employees) or large (more than 500 employees).

Sample representativeness is traditionally an important concern with firm-level data. Ideally the sample is representative of the population of firms with respect to its most important characteristics, such as the size and industry distribution. Table 2 presents the basic representativeness of our data sample for six countries with respect to firm size. For these purposes we use Eurostat Structural Business Statistics for EU member states (Bulgaria,

Croatia, Hungary and Romania) and data from the national statistical offices and national central banks of Montenegro and Serbia.[3]

Table 2: Representativeness of the sample data with regard to the total population of companies, by size classes, 2013* (in %)

	HR	HU	BG	RO	RS	ME
Micro (0-9)	69.3	78.7	100.0	79.6	42.6	n.a.
Small (10-49)	12.2	95.8	86.9	99.2	87.8	12.1
Medium (50-249)	12.5	n.a.	97.2	89.3	90.9	90.9
Large (250+)	5.7	n.a.	96.2	60.9	82.6	21.4
Total	64.4	79.9	99.2	81.7	48.5	13.0

Notes: The table presents respective fractions of firms in our data sample relative to the total population of firms. The data published by the Statistical Office of the Republic of Serbia was in RS dinars and was converted into euros using the official exchange rate of the National Bank of Serbia for 31 December 2013. The last year of available data from Monstat is 2011. Data for Montenegro are available in euros, so no conversion was required.* 2011 for Montenegro. Country abbreviations are defined in Table 1.

Sources: Statistical Office of the Republic of Serbia, National Bank of Serbia, Monstat (the statistical office of Montenegro; Amadeus and Eurostat Structural Business Statistics for other countries.

Table 2 shows that our data sample is highly representative of all firms across all size classes with overall coverage ranging between 64 and 99 per cent. The only exceptions are Montenegro (in all size classes except medium-sized firms), Croatia (in all size classes except micro firms) and to some extent Serbia (for micro firms only).[4]

Given the above sample characteristics, special attention has to be paid when the estimates are interpreted. Generally, the sample is dominated by micro and small firms (see Table 1), but less so than all firms in respective countries.

Additional data cleaning was done prior to the econometric analyses. Outliers in terms of the 1st and 100th percentile of growth rates of assets, employment, labour productivity and total factor productivity were dropped.

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[3] Due to confidentiality in Eurostat SBS there are no data for medium and large firms in Hungary. There are also differences in definitions of company size classes between Eurostat and national statistics as well as with regard to the definition used in this study, which required some adjusting in Table 2. Eurostat splits the sample of small firms (10-49 employees) into two subsamples (10-19, 20-49), while large firms are defined as those with 250 employees or more (500 employees elsewere).

[4] As we use the total number of firms for Croatia, this apparent low coverage in some of the size classes might be the effect of data cleaning, where companies with negative or missing values have been excluded from the sample.

3. Extent of corporate leverage in CESEE countries

In this section, we provide an assessment of overall corporate leverage of companies in CESEE countries. Section 3.1 shows the overall magnitude of debt and NPLs, while section 3.2 presents the distribution of corporate net debt and debt overhang and an overall assessment of the direct macroeconomic importance of financial distress in the corporate sector.

3.1. Overall extent of NPL and debt leverage

As noted in IMF (2015), despite high deleveraging efforts by the private sector – as measured by the adjustment in the private sector net saving-investment balances – CESEE countries have been unable to reduce their elevated private debt. Furthermore, in most of the countries the private debt burden relative to GDP has increased since 2008 and remains very high. Similarly, the extent of NPLs in most of the countries deteriorated between 2010 and 2014 (Chart 1).

Chart 1: Ratio of NPLs to total bank loans in CESEE countries, 2010 and 2014 (%)
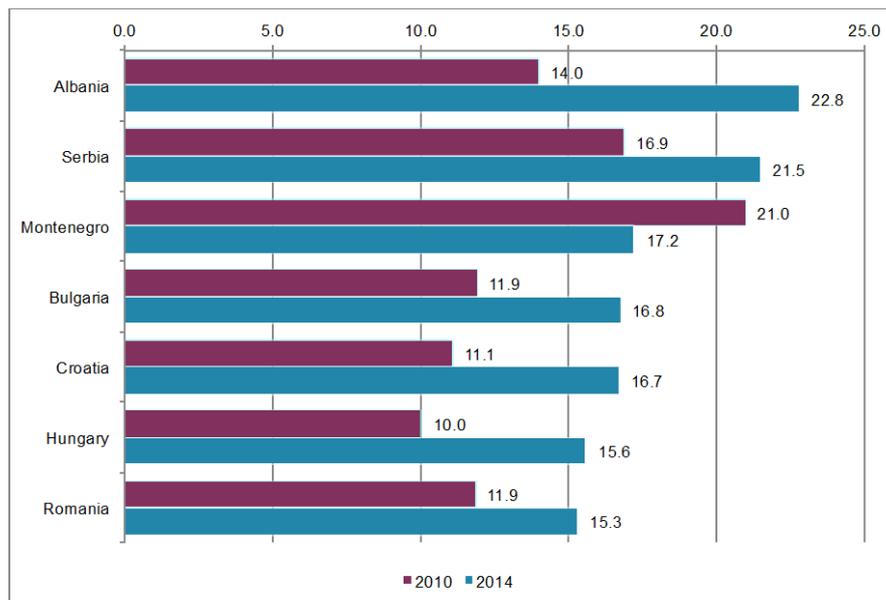
Source: World DataBank, World Development Indicators, 2016.

Chart 2, presenting a breakdown of NPL by type of borrower, indicates that a major source of NPLs in CESEE countries are overdue loans in the corporate sector. The only exception is in Hungary where most NPLs consist of household mortgage loans that used to be denominated in Swiss francs.

In most of the countries the extent of NPLs is further deteriorating along with extensive discussions on possible NPL resolution forms. Up to 2014, the extent of NPLs slightly decreased in Hungary and Albania, mostly due to debt restructuring schemes, while more

effective steps have been taken only in Romania. Romania in 2014 enacted procedures for accelerated NPL disposals and write-offs of corporate NPLs leading to substantial reduction in the NPL ratio from 21.7 per cent in 2013 to 13.9 per cent in 2014.

Chart 2: Breakdown of NPL by borrower type in CESEE countries, 2012-14 (in €million)
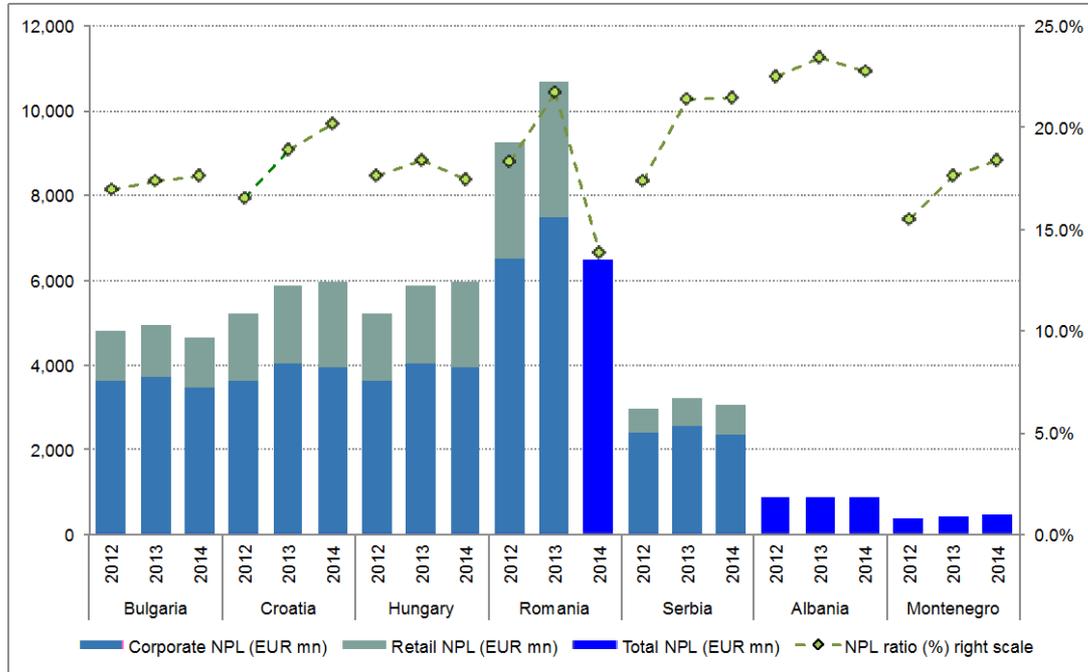
Notes: Total NPL ratio (right scale). Total NPL volumes only are available for Albania and Montenegro. For Romania, only total NPL volumes were published in 2014 due to accelerated NPL disposals and write-offs.

Sources: Deloitte, 2014 and 2015, based on national bank data, Central Bank of Montenegro and World DataBank, World Development Indicators, 2016.

As shown in Chart 3, corporate sectors in most CESEE countries embarked on a prolonged path of debt deleveraging with total loans to corporate sector further decreasing or, at best, stagnating (Montenegro). Reducing the credit exposure of the corporate sector to banks, however, did not result in a significant reduction of NPLs. On the contrary, NPL ratios are further decreasing (with the exception of Albania, Hungary and Romania). This indicates that, first, debt deleveraging in these countries has mostly taken the form of net saving – that is, investment balances were improved by excess saving, but much less through debt restructuring and write-offs; and second, that the slow recovery in aggregate demand is holding back private sector balance sheet improvements and worsening the prospects of debt sustainability, as the most indebted companies cannot grow out of debt. This in turn contributes to further deterioration of bank balance sheets and a widening of the gap between credit demand and supply.

Chart 3: Total loans and NPL ratios for corporate sector, 2012-14 (€million)
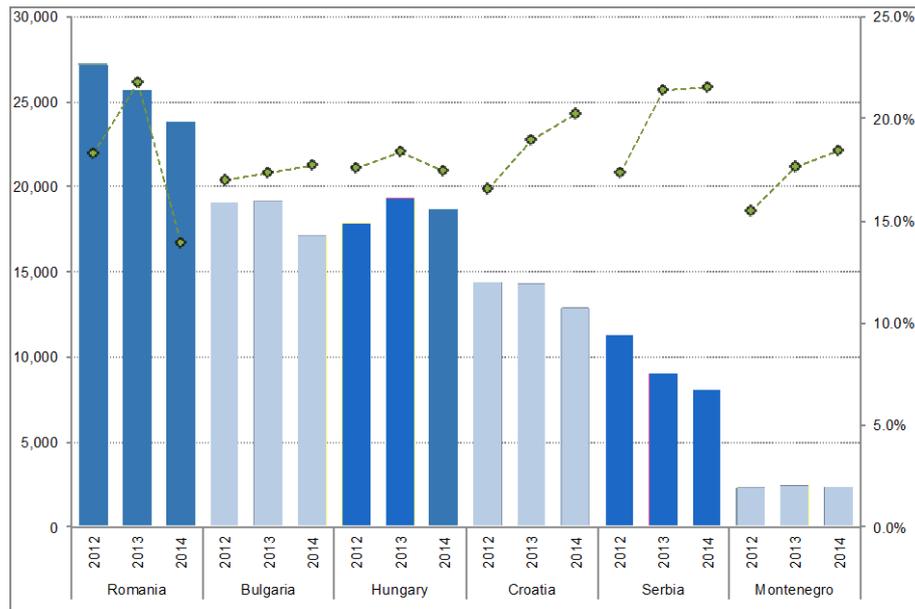
Note: Total NPL ratio only available for Montenegro. For Romania, total NPL ratio for 2014.

Source: As per Chart 2.

In subsequent analysis we switch to company-level data and focus on corporate debt leverage and distribution of excessive debt across the corporate sector. As is standard in the financial literature, we use net debt as a measure of corporate indebtedness, which is defined as total long-term and short-term debt minus cash and cash equivalents.

The overall debt leverage ratio is calculated using the debt-to-EBITDA ratio, which is a common metric used to evaluate companies' ability to pay off incurred debt. The debt-to-EBITDA leverage ratio is calculated as a company's total outstanding net debt relative to its earnings before interest, taxes, depreciation and amortisation (EBITDA). In financial analysis, a leverage ratio in the range of 3 to 4 is taken as an upper bound of still sustainable debt. A ratio higher than 4 or 5 typically indicates that a company is less able to handle its debt burden, which in turn limits its ability to take on the additional debt.[5] There are other metrics possible to assess unsustainable corporate debt levels, such as using different ratings criteria. For instance, one could apply the debt-to-EBITDA ratios that are used by Moody's for corporate ratings Ba and B for individual industries.[6] The Ba rating is associated with an aggregate debt-to-EBITDA ratio amounting to 3.3 (whereby these ratios differ widely across different industries), while a B rating is associated with the aggregate ratio of close to 5 (again, different across industries). We also applied these leverage cut-off criteria for

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[5] These "tolerated" leverage ratios may vary substantially across industries depending on industry-specific capital intensity and liquidity. For instance, in retail and distribution the typical ratios tolerated by banks are higher than on average, while in the highly capital-intensive pharmaceutical industry the ratio tolerated is lower than the aggregate economy average ratio.

[6] See Moody's Financial Metrics Key Ratios by Rating and Industry for Non-Financial Corporations: Europe, Middle East and Africa, December 2012.

unsustainable debt, but while the overall level of excessive debt differs across different leverage cut-offs by some +/- 10 per cent, the variation and distribution of debt overhang do not differ substantially.

We calculate unsustainable debt (subsequently referred to also as debt overhang or excessive debt) as:

$$\text{Debt overhang} = \text{Total net debt} - 4 * \text{EBITDA}, \tag{1}$$

We are aware of the fact that excess debt calculated as net debt - 4*EBITDA might not be the proper measure of the true excess debt, as for some some companies the sustainable level of debt can be either higher or lower. The usual approach taken in corporate finance literature to assess the debt overhang is to calculate the sustainable level of debt and then take the difference between the current level of debt and the sustainable level of debt as a measure of true excess debt.

In the literature there are several methods to assess the debt sustainability of firms and the corresponding excess debt (see Bruggeman, 2013, for a discussion of methods and indicators). Most comprehensive methods that take into account the debt servicing capacity of companies include in particular: (i) the stationarity approach (Cuerpo et al., 2014); (ii) the contingent claims analysis method (Gapen et al., 2004); and (iii) the net free cash flow (NFCF) method (IMF, 2013).

The stationarity approach is based on the idea that a debt is sustainable if it moves in line with total discounted assets. While the advantage of this method is that it does not require defining threshold values of debt, its disadvantage is that the assessment of the imbalance between sustainable and actual debt levels depends on the selection of a reference year for sustainable debt, which is made arbitrarily. The contingent claims analysis method is based on the assessment of corporate probability of default. This method requires data on the market value of listed companies, which is problematic for emerging markets with less developed capital markets and only a small number of listed companies.

The NFCF method is based on the calculation of net free cash flow on firm-level data, which shows if a firm is able to finance liabilities to creditors and owners from current operations. A positive value of NFCF indicates that corporate debt is sustainable – that is, that a firm can finance debt from its current operations. In contrast, if NFCF is negative, the enterprise is unable to generate sufficient cash flow to finance its existing debt level (while retaining the existing level of capital investment and dividend payments), so the company is over-indebted. This method requires projection of NFCF in the medium term, whereby operating cash flow before interest and interest expense are projected, while the other components of NFCF (capital expenditures and dividends) are kept constant. Firms with the debt-to-assets ratio above 30 per cent and a negative projected value of net free cash flow in the medium term are considered over-indebted. For the over-indebted companies, the sustainable debt level is derived as the debt level at which medium-term NFCF equals zero. The difference

between the existing debt level and the sustainable debt level of over-indebted enterprises is then taken as debt overhang.

While the above-mentioned methods are attractive from the academic point of view, they are associated with a number of assumptions and/or arbitrarily chosen thresholds and reference years. Instead, we decided to use a simpler metric (net debt – EBITDA) > 4) that is usually taken in the financial industry as a simple rule of thumb of debt sustainability.

Based on this criterion, we aggregate the total debt overhang across all companies in an individual CESEE economy. Note that when aggregating the net debt of companies, for obvious reasons we exclude firms with either zero debt or negative net debt. In addition, in all charts presented below we exclude companies in the financial sector (that is, Nace Rev. 2 2-digit codes 64, 65 and 66).

Chart 4: Distribution of net debt and debt overhang across the leverage ratios, Croatia, 2014
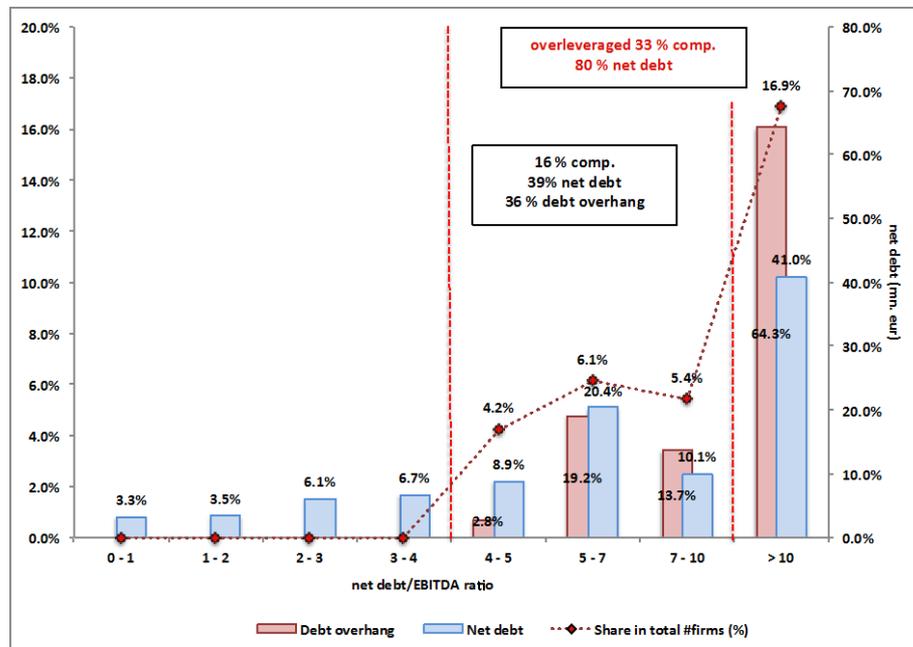
Notes: Firms with positive net debt and non-zero debt only. Figures do not include companies in the financial sector. Leverage ratio is defined as net debt/EBITDA ratio. Debt overhang is defined as (net debt – EBITDA) > 4.

Sources: FINA; own calculations.

As an example of overall corporate debt distribution, Chart 4 shows the distribution of net debt and debt overhang across classes of leverage ratios in Croatia for the last year of the sample (2014). Based on the above criteria, in 2014, one-third of firms (with non-zero debt and positive net debt) held about 80 per cent of total outstanding net debt.[7] Furthermore, 17

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[7] Note that Martinis and Ljubaj (2016) find that using the NFCF debt sustainability analysis approximately one-third (31.2 per cent) of the corporate debt in Croatia is excessive. They find that about 7 per cent of all firms in

per cent of firms were classified as extremely leveraged with a leverage ratio exceeding 10. Those companies accounted for more than 40 per cent of overall corporate net debt and for almost two-thirds of overall corporate excessive debt.

Chart 5: Distribution of debt overhang across the leverage ratio, 2014
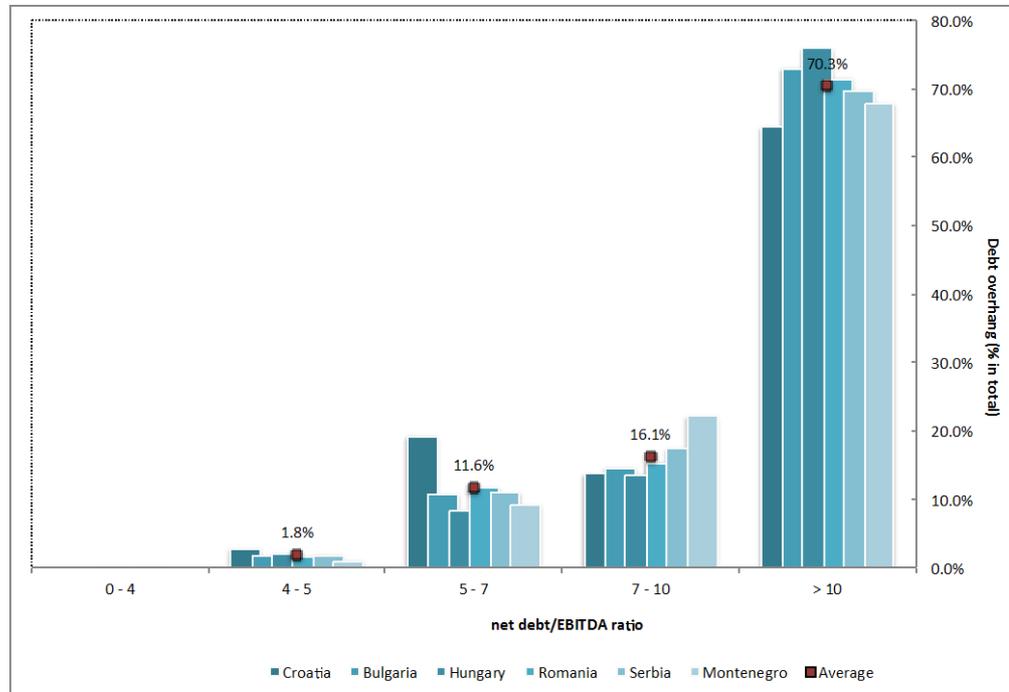
Notes: Firms with positive net debt and non-zero debt only. Figures do not include companies in the financial sector. Leverage ratio is defined as net debt/EBITDA ratio. Debt overhang is defined as (net debt – EBITDA) > 4.

Sources: Amadeus, FINA, MAV; own calculations.

A similar picture can be observed (in Chart 5) in five other CESEE countries with 70 per cent of all excessive debt falling into the category of extreme leverage (exceeding leverage ratio of 10). Moreover, as shown in Table 3, on average 30 per cent of indebted firms account for 70 per cent of overall corporate net debt. There is some variation across countries, with most notably Hungary on the upper extreme and Serbia on the lower bound of debt concentration.

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their sample can be characterised as excessively leveraged (they, however, use the Amadeus data with a sample which is three times smaller than our total number of Croatian firms).

Table 3: Share of overleveraged companies with corresponding share of overall net debt and debt overhang, 2014

	Firms with excess leverage*		Firms with extreme leverage**	
	% of total #firms	% of net debt	% of total #firms	% of debt overhang
Bulgaria	24.0	65.9	9.3	72.9
Croatia	32.6	80.3	16.9	64.3
Hungary	10.9	80.8	4.8	75.8
Montenegro	31.0	47.6	9.0	67.8
Romania	34.4	71.5	12.3	71.4
Serbia	41.8	69.2	17.6	69.7
Average***	29.1	69.2	11.7	70.3

Notes: Debt overhang defined as (net debt – EBITDA) > 4. Firms with positive net debt and non-zero debt only. Figures do not include companies in the financial sector. * Firms with net debt-to-EBITDA ratio > 4; ** Firms with net debt-to-EBITDA ratio > 10; *** Simple average.

Sources: Amadeus, FINA, MAV; own calculations.

3.2. Concentration of debt overhang and macroeconomic implications

Evidence from section 3.1 indicates that corporate net debt and debt overhang are highly concentrated across CESEE economies. This is indeed confirmed when ranking companies according to their net debt or excessive debt and identifying a country's largest individual debtors. On average across countries, the 20 largest debtor companies account for almost 30 per cent of total debt overhang, while the top 100 and top 300 companies account for almost one half and two-thirds of overall excessive debt, respectively (Chart 7). There is some variation across countries with Bulgaria, Hungary and Serbia showing the largest concentration of excessive debt. In these three countries, the top 10 largest debtor companies hold between 30 and 40 per cent of total debt overhang (see Chart 6).[8]

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[8] In a similar analysis, but using the NFCF debt sustainability analysis, Martinis and Ljubaj (2016) also find that debt overhang in the Croatian corporate sector is concentrated in a small number of enterprises. They find that the top 10 firms with the highest debt overhang (in absolute amounts) hold more than one-third of total debt overhang, while the top 100 enterprises with the highest debt overhang hold as much as three-quarters of the entire debt overhang of the sample. Our total population of firm data shows, however, a smaller concentration of debt for Croatia, with the top 10 and top 100 firms with the highest debt overhang holding 14 and 36 per cent of total debt overhang. These differences, again, can be attributed to the differences in sample and possible sample selection issues, whereby our sample consists of total population of firms and is three times larger than the Amadeus sample used by Martinis and Ljubaj (2016).

Chart 6: Concentration of debt overhang in corporate sector of CESEE countries (based on debt-to-EBITDA ratio)
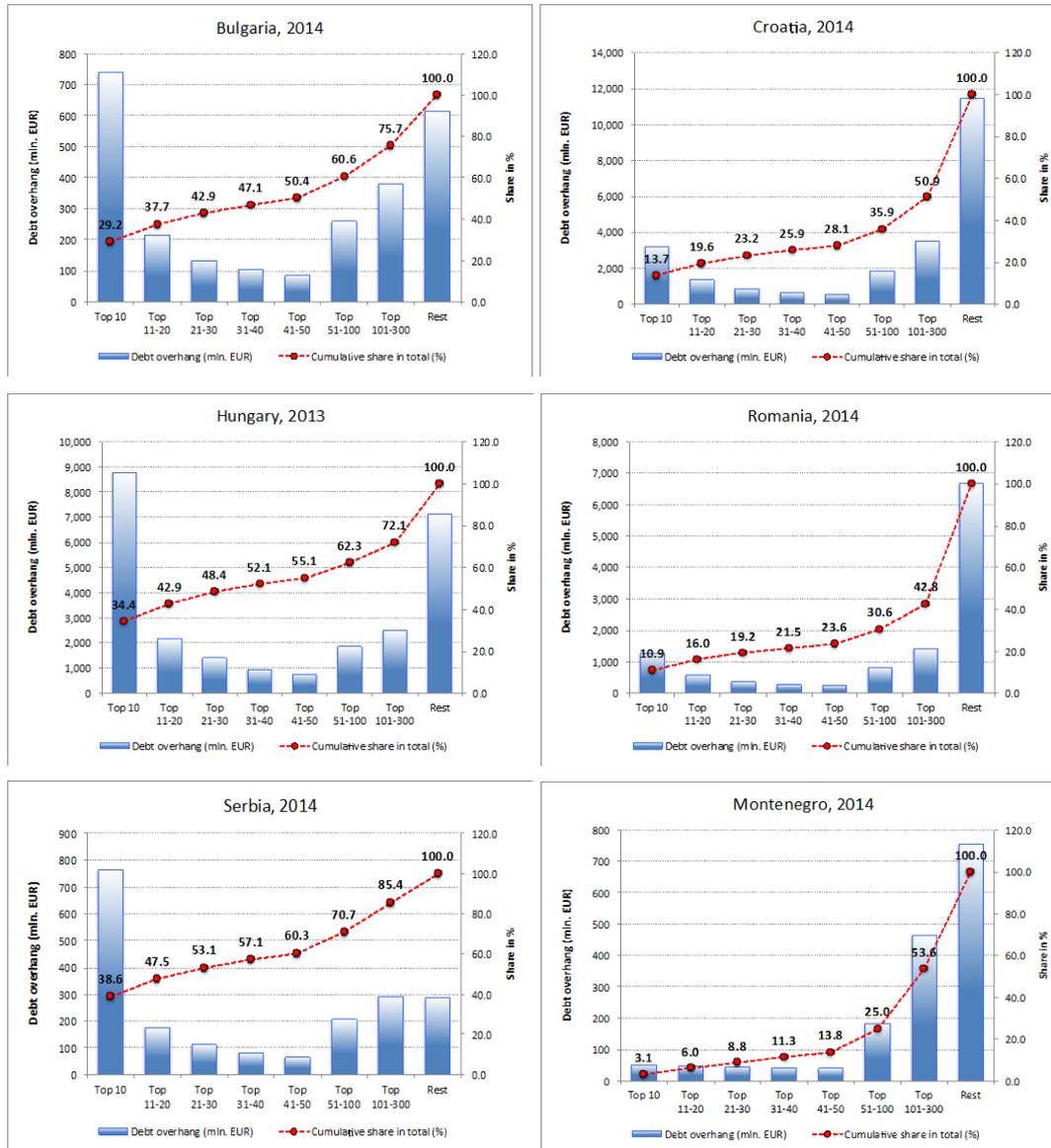
Note: Firms with positive net debt only. Figures do not include companies in the financial sector (Nace Rev. 2 2-digit codes 64, 65 and 66).

Sources: Amadeus, FINA, MAV; own calculations.

Chart 7: Concentration of debt overhang in the top 300 most indebted companies in CESEE countries, 2014 (per cent)
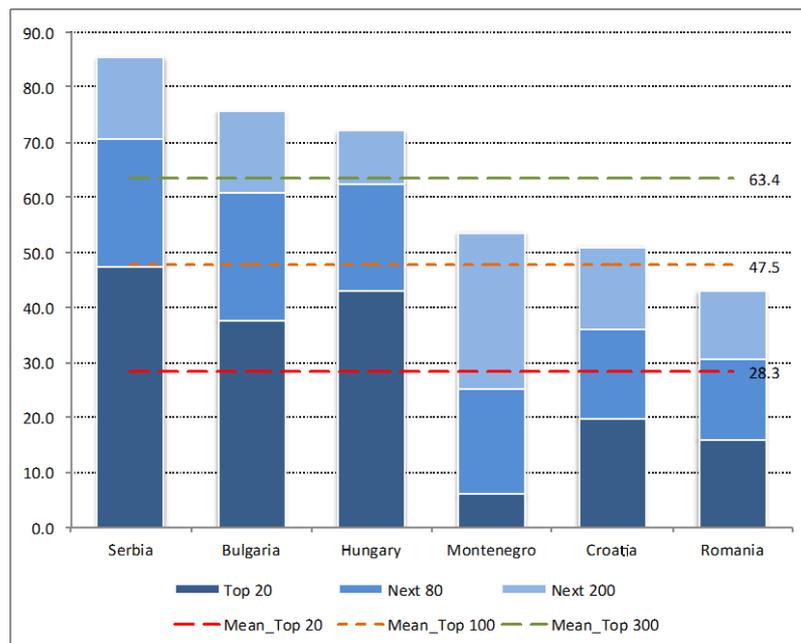
Notes: Firms with positive net debt only. Figures do not include companies in the financial sector.

Sources: Amadeus; FINA, MAV; own calculations.

The large concentration of debt and debt overhang in the top 300 companies, as presented in Charts 6 and 7, is not a standard feature of economic structure in individual countries. While in terms of total sales and employment the CESEE countries follow the standard "20-80 rule" as found in the literature[9] (with 20 per cent of largest companies contributing 80 per cent to total output and a bit less to employment), Chart 8 demonstrates that in terms of debt overhang they follow roughly a "10-90 rule". In other words, 10 per cent of the largest debtor companies account for 90 to 95 per cent of total debt overhang. The exception is Romania where debt concentration is a bit lower (10 per cent of the largest debtors account for 80 per cent of total debt overhang).

Debt concentration is not an issue specific to CESEE countries only but may be characteristic for emerging countries. There is scant evidence on debt concentration for developed economies. Similar results for concentration of debt overhang were found for Slovenia (Damijan, 2014). For Chinese firms, Chivakul and Lam (2015) show that there is substantial concentration of debt as the top 200 most indebted firms held almost three-quarters of all liabilities of non-financial firms in China in 2013 and the top 10 non-financial listed firms account for over 20 per cent of total corporate liabilities among non-financial listed firms, mostly from real estate and construction, and mining and utilities. Echoing these findings, the IMF (2015) finds that the top 10 per cent of indebted firms have increased their leverage ratios from 230 to 350 per cent between 2003 and 2013, while the leverage ratio of the median firm decreased from 108 to 50 per cent in the same period. Along those lines, in

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[9] See Mayer and Ottaviano (2008).

the period between 2003 and 2013 in the emerging markets the share of firms with interest coverage ratio below 1 increased from 11 to 22 per cent. This indicates the surge in debt concentration in a smaller number of increasingly leveraged firms.

Chart 8: Cumulative distribution of sales, employment and debt overhang in CESEE countries
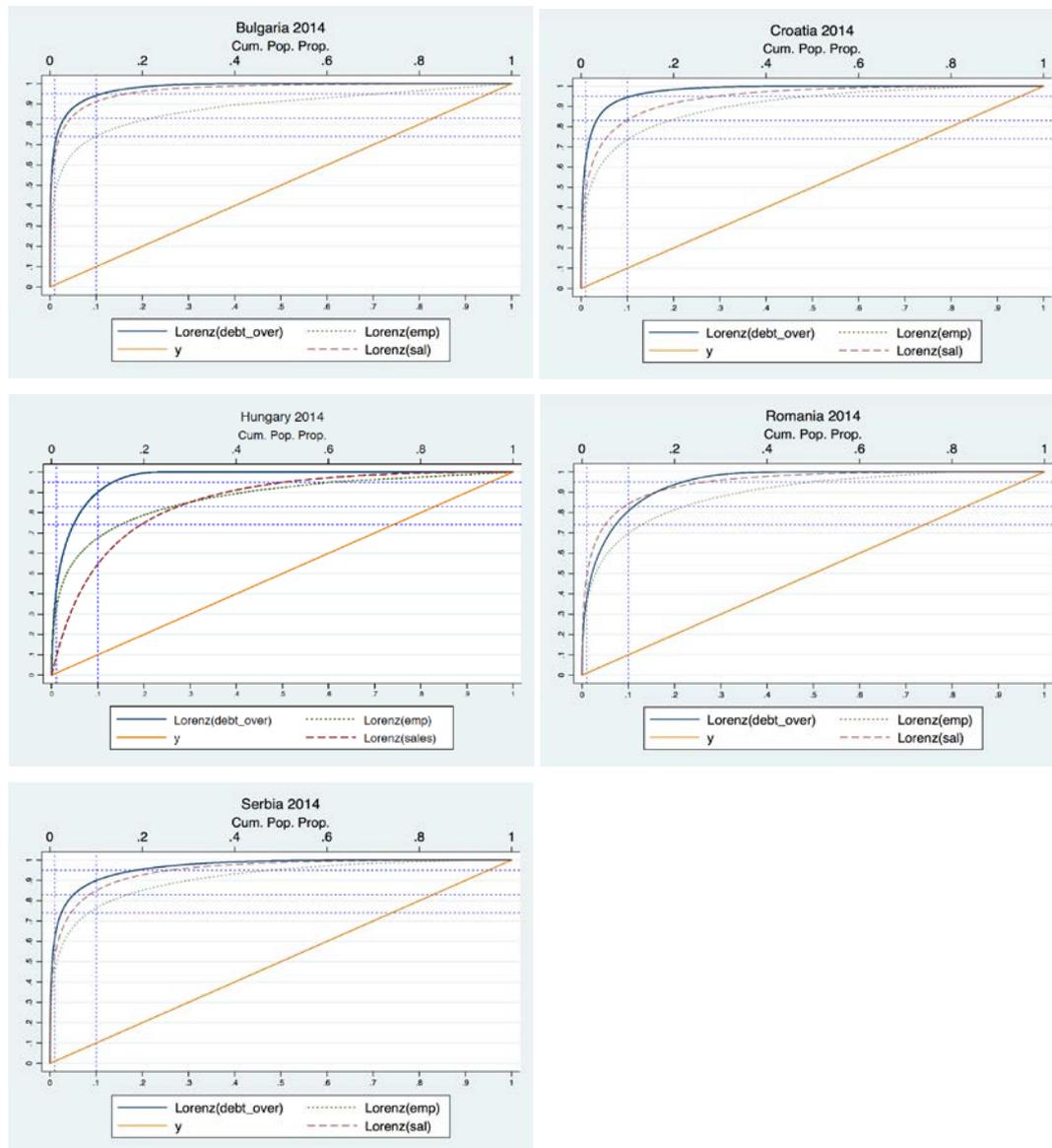
Notes: Figures show Lorenz cumulative distribution of companies according to their shares in total sales, employment and debt overhang. Firms with positive net debt only. Figures do not include companies in the financial sector. The chart for Montenegro was omitted due to a very small sample of companies.

Sources: Amadeus; FINA, MAV; own calculations.

This indicates that concentration of debt is a critical feature in the CESEE economies, which can present a significant drag on economic growth. In a recent paper, Balgova and Plekhanov (2016) find that, in general, when countries ignore the NPL problem the foregone growth due to the overhang of NPLs can amount to 1.5 percentage points annually, until the

problem is resolved. One of the channels through which a large debt overhang impacts growth is directly through the performance of the indebted companies. In addition to restricted access to loans for investments in capacity expansions, overleveraged firms are also limited in their day-to-day business as they cannot borrow even for acquiring working capital or paying the wages to employees. The bigger the fraction of output and employment accounted for by overleveraged firms, the bigger will be the drag on overall economic growth.[10]

Chart 9 shows the macroeconomic importance of the top 300 financially distressed companies in Croatia and Hungary, for which we have data for **all** firms. Although the debt overhang is highly concentrated in the top 50 and top 300 largest debtor companies (where the latter account for 50 to 70 per cent of total excess debt), the direct importance of these companies in terms of overall sales, employment and exports is relatively modest. In Croatia, the top 300 debtor firms with 50 per cent of total debt overhang account for about 15 per cent of total value added and exports, while in Hungary they account for even less than 10 per cent.

Chart 9: Macroeconomic importance of top 300 financially distressed companies in Croatia and Hungary (per cent)
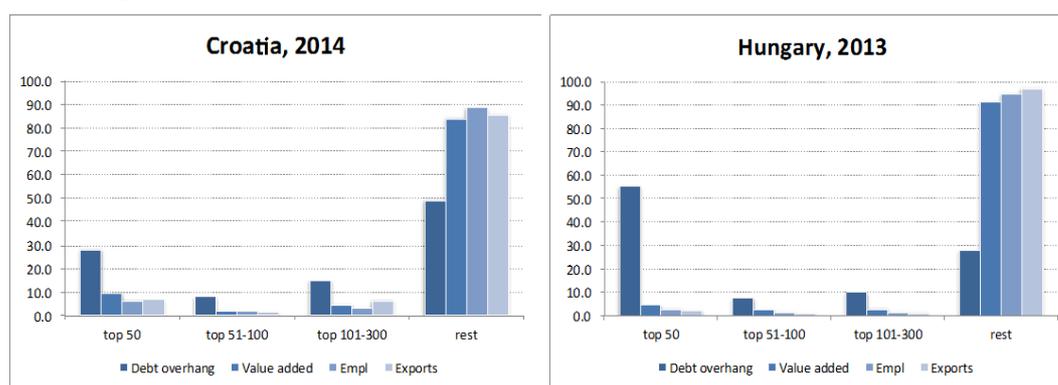
Sources: FINA, MAV; own calculations.

The direct macroeconomic impact of large overleveraged companies, however, as presented in Chart 10, is bigger in Montenegro, Serbia and to some extent also in Bulgaria. On average, the top 100 financially distressed firms in six CESEE countries account for 8 per cent of total value added and 6 per cent of total employment, while the top 300 debtors

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[10] Note that with falling bond interest rates worldwide there is a trend of rebalancing from bank loans towards bonds because bank credit becomes relatively more expensive, reflecting the scarcity of bank equity. Chang et al (2016) develop a dynamic open economy model where these modes of finance are determined endogenously and which enables them to study interactions between modes of finance and macroeconomic fluctuations. While this mode of finance became more significant in the post-crisis period in some European countries, it is however still confined to countries with more developed capital markets (such as Germany, Italy and the Netherlands), but remains quite volatile and low compared with bank financing (see Kaya et al, 2013). For CESEE countries, which are characterised by underdeveloped capital markets, bond financing is still perceived as highly sophisticated and usually employed by the largest firms only.

account for 13 and 16 per cent of overall employment and value added, respectively.[11] To put it differently, 1 in 8 of all employees and 1 in 6 euros created in the corporate sector are directly affected by the top 300 most indebted companies. This suggests that governments in CESEE countries cannot continue to ignore the problem of NPLs, but rather have to undertake some form of NPL resolution to release the brake on economic growth.

Chart 10: Macroeconomic importance of top 300 financially distressed companies in CESEE countries, 2014 (per cent)
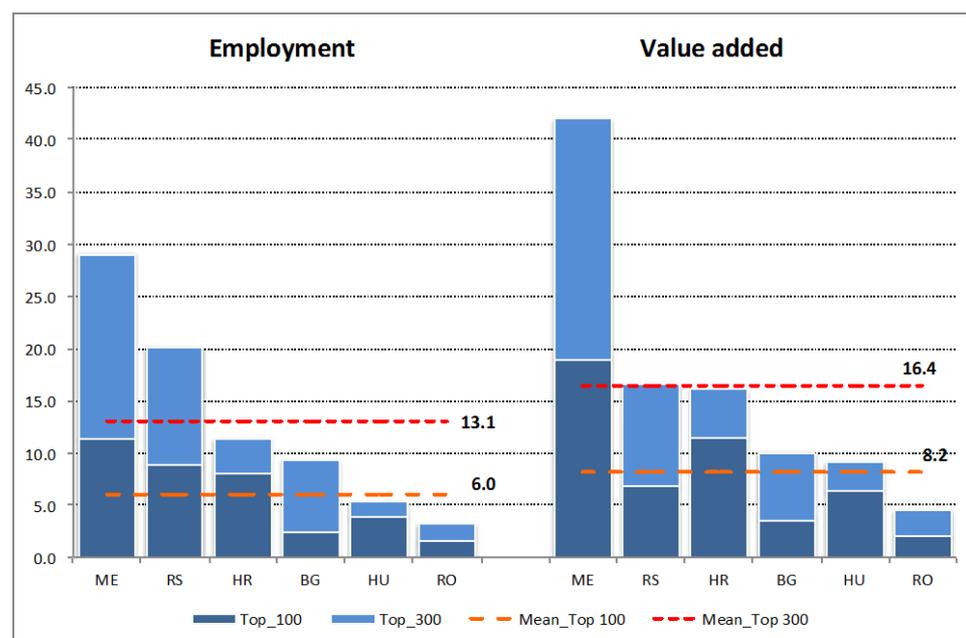
Sources: Amadeus, FINA, MAV; own calculations. Country abbreviations are defined in Table 1.

However, as mentioned above, the direct macroeconomic importance of the most heavily indebted companies understates their true impact on the economy. There is namely also a secondary channel at work here, as large financially distressed firms can exert important network effects. Large overleveraged companies are likely to be important suppliers and/or buyers, which means that they can affect performance of their partners due to their inability to either (i) provide services or products to their upstream buyers, or (ii) sustain demand and/or to meet financial obligations to their downstream suppliers.

The size of these network effects depends on the individual size of financially distressed companies and the intensity of the input-output linkages with other vertically linked companies. The next chapter discusses the relevance of network effects compared with direct effects, while in section 5 we empirically account for their importance.

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[11] Data on exports are available only for Croatia and Hungary, while in Amadeus there is very poor coverage of export figures.

4. Empirical debt spillovers model

We argue that due to potential network effects, the existence of financially distressed large firms may play a similar role in the propagation of the crisis as systemic banks are burdened by the large shares of NPLs in their portfolios. It is essential to study the network effects of such "systemically important" companies in the economy and to what extent their financial health/distress affects the rest of the economy.

In the subsequent analysis we aim to study whether huge debt concentration by individual large debtor companies affects growth not only directly through lower firm activity, but may potentially have a depressing effect on the economy also through negative debt spillover effects on vertically linked firms. We study the importance of the direct and indirect effects of excessive debt of the largest debtor companies, in particular the backward and forward debt spillovers to other sectors and firms.

To study the impact of large debtor companies on their own and on the performance of other firms, the largest debtor firms were divided into two groups – the top 100 and top 300 largest debtor firms. Based on this, their combined impact on the performance of companies in the same industry and on companies that are vertically linked through input-output linkages, are estimated.

We estimate the following debt spillover empirical model:

$$\Delta y_{it} = \alpha + \beta_1 \mathbf{C}_{it} + \beta_2 ROE_{it-1} + \beta_3 ICR_{it-1} + \beta_4 DE_{it-1} + \beta_5 liquidity_{it-1} + \beta_6 Exp_{it}$$
$$+ \lambda Cr + \delta_1 Cr \times D_{it}^{jk} + \delta_2 Cr \times D_{it}^{jk} \times HL_{it}^{jk} + \delta_3 Cr \times D_{it}^{jk} \times BL_{it}^{jk} + \delta_4 Cr \times D_{it}^{jk} \times FL_{it}^{jk}$$
$$+ \gamma \sum_{t=2}^{T} time_t + \phi \sum ind^k + \eta_i + \varepsilon_{it}$$

$$(2)$$

where Δy_{it} is a growth rate of total factor productivity, labour productivity, employment and investment, depending on the choice of left-hand side variable. $\mathbf{C}$ is a vector of firm-specific controls, such as number of employees and capital intensity, labour productivity and export status. The set of control variables differs depending on what performance measures are used as regressants. In the first two specifications we will explore changes in total factor productivity[12] and labour productivity as dependent variables Δy_{it}) and use lagged firm size (employment) and capital intensity (ratio of capital to employment) as control variables. In

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12 Total factor productivity (TFP) is estimated using the approach outlined in Wooldridge (2009). The Wooldridge estimation algorithm addresses the key shortcomings of the two most commonly used methods of estimating total factor productivity (TFP); the Olley-Pakes (OP, 1996) and Levinsohn-Petrin (LP, 2003) methods. As pointed out in Ackerberg, Caves and Fraser (2006), the LP approach potentially suffers from an identification problem in the first estimation stage. Namely, if the labour is optimally determined by the firm, it is also a function of unobserved productivity and state variables and is therefore non-parametrically unidentified. The OP approach, on the other hand, rests only on the subset of firms with positive investments, while relying heavily on proper measurement of the capital variable. Taking on Ackerberg et al. (2006), Wooldridge proposes using a single set of moments, while information on error covariances can be used to address their inefficiencies.

the case of employment and investment growth we additionally include lagged labour productivity as one of the regressors.

The next four variables account for firm i's profitability and financial health. ROE_{it-1} is a firm i's return on equity at time $t-1$; ICR_{it-1} is firm i's interest coverage ratio at time $t-1$; DE_{it-1} denotes firm i's debt-to-EBITDA ratio; and $liquidity_{t-1}$ is the corresponding current ratio (that is, short-term assets to short-term liabilities ratio).

The next five variables account for ownership and input-output linkages interacted with the specific debtor group extent of excess debt. Exp_{it} is an exporter dummy variable indicating whether firm i is exporting in period t. D_t^{jk} denotes debtor group k's (top 100 and top 300) share in overall net debt. HL_t^{jk}, BL_t^{jk} and FL_t^{jk} stand for horizontal intra-industry linkages, backward (upstream) linkages and forward (downstream) linkages of debtor group k's for firms located in industry j, respectively. All variables are interacted with debtor group k's share in overall net debt (D_t^{jk}). In addition, we also include a crisis dummy variable (Cr) that assumes 0 for the period 2005-08 and 1 for the period 2009-14.

Finally, $time_t$ and ind_j are year and industry j fixed effects, respectively. The term η_i denotes firm i fixed effects, while ε_{it} is an identically and independently distributed error term. Year fixed effects are included only in specifications without the crisis dummy variable and corresponding interaction terms with other variables in the model.

In addition to firm i-s indicators of financial health, key variables of interest are related to the impact of specific input-output linkages to which an individual firm is exposed. These linkages effects are the standard approach to study, for example, the impact of spillovers of foreign-owned companies on performance of local firms[13] or to account for the knowledge spillovers from innovative firms to other firms in the economy.[14]

Chart 11: Representation of the debt spillover model
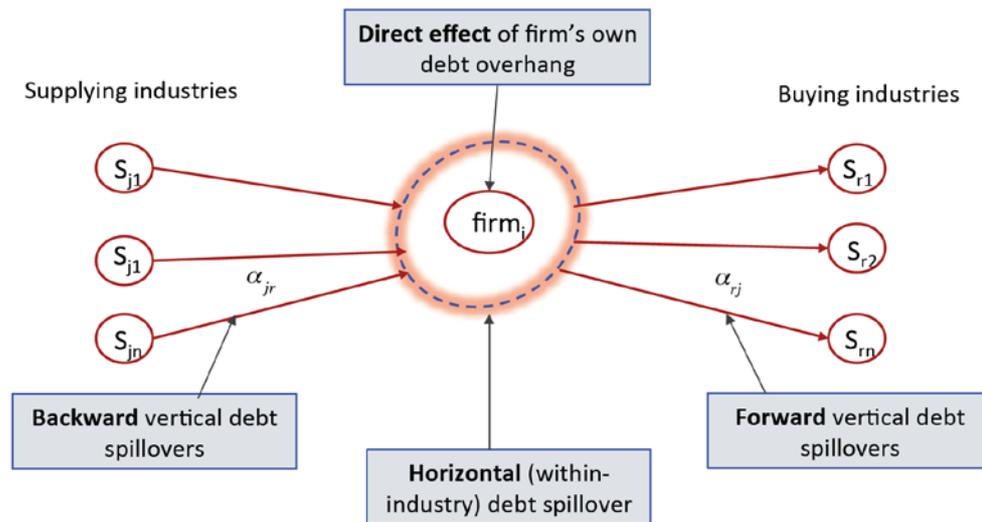
Source: Author's own graphics.

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[13] See Blalock (2001), Schoors and van der Tool (2001), Smarzynska (2002, 2004), Damijan et al. (2003), Kugler (2006), Halpern and Murakozy (2007), Gorodnichenko et al. (2007), and Damijan et al. (2013).
[14] See for example Damijan and Stare (2015).

The mechanism of spillovers in the model is depicted in Chart 11, showing how a firm's performance is affected by its own financial distress and three types of debt spillovers. Horizontal debt spillovers arise from the most heavily indebted firms in the same industry, while backward and forward debt spillovers arise due to financial distress of the largest debtors in supplying (backward linkage) and buying industries (forward linkage).

HL_t^{jk} in model (2) stands for intra-industry spillovers, also called horizontal spillovers, that stem from specific debtor group. These spillovers can be seen either as competition effects within the same industry or as agglomeration effects within the same industry arising from the specific debtor group. Accordingly, we define horizontal spillovers as the share of an industry j's output produced by debtor group k:

$$HL_t^{jk} = \frac{\sum_{k=1}^{m} Y_t^{jk}}{\sum_{i=1}^{n} Y_t^{j}}, \qquad\qquad i=1,\ldots,n; \ \ k=1,\ldots,m \qquad (3)$$

In the next step we account for potential vertical spillovers of highly indebted firms on their upstream customers. We account for these backward linkages BL_t^{jk} as the sum of the output of industries r purchased by firms in industry j weighted by the share of industry j's output produced by debtor group k (HL_t^{jk}):

$$BL_t^{jk} = \sum_{r,j=1}^{n} \left(\alpha_{jrt} \, ^\star \, HL_t^{jk} \right), \qquad\qquad r,j=1,\ldots,n, \ \ k=1,\ldots,m \qquad (4)$$

where α_{jrt} ($0 \leq \alpha_{jrt} \leq 1$) is the proportion of industry r's output consumed by industry j. These direct input requirements are obtained from the input-output tables for a particular country. As the formula suggests, the greater the output share of debtor firms in sectors supplied by industry j and the larger the share of intermediates supplied to industries characterised by higher degree of excess leverage, the higher the value of the variable.

Finally, we also account for forward linkages, whereby FL_t^{jk} is defined as the weighted share of output in upstream (or supplying) sectors produced by firms with excess leverage:

$$FL_t^{jk} = \sum_{m \neq j}^{n} \left(\sigma_{jmt} \, ^\star \, HL_t^{jk} \right), \qquad\qquad m,j=1,\ldots,n, \ \ k=1,\ldots,m \qquad (5)$$

where σ_{jmt} ($0 \leq \sigma_{jmt} \leq 1$) is the proportion of industry j's output consumed by industry m, obtained from the input-output tables for a particular country.

We estimate the effect of financial distress in interaction with network effects using company level data for the sample of countries for which quality firm-level data could be obtained (that is, Bulgaria, Croatia, Hungary, Romania and Serbia).[15] For Croatia and Hungary we were able to use data on total population of firms through our links with local researchers who collaborated in estimating the models according to the provided Stata code. For the other three countries the primary data source is the Amadeus/Orbis database (Bureau van Dijk). See section 2 for a discussion of the data.

To construct the spillover variables through horizontal and vertical linkages between industries we used countries' input-output tables from OECD for 2011 (the latest available). These I-O tables are based on Nace Rev.1 and comprise 34 2-digit sectors). I-O tables were matched to firm-level data using the firms' primary Nace Rev.1 code. Note that companies in the financial sector were excluded from our analysis as well as vertical linkages to the financial sector.

We have a panel structure of the data for 1995-2014 (up to 2013 for Hungary) and employ a fixed-effects (FE) estimator. All variables in model (2), apart from dummy variables, are specified in logs, which enables us to interpret obtained results as elasticities. As a robustness check to our FE estimator we also estimated models using the OLS estimator with dependent variables in first-differences and industry dummies. Results obtained, however, are compatible with the FE-based results.

Another option is to estimate our model (2) using the General Method of Moments (GMM) estimator, which is a preferable approach when variables in the model are endogenously determined and when some variables are highly persistent (auto-correlated, with significant AR1 and AR2 processes). Usually in such an analysis a dynamic (system) version of GMM is applied, where lagged levels of and first differences of variables are used as instruments for each of the variables in the model. The drawback of the GMM approach, however, is that it is not very robust. Since the differenced variables are very weak instruments for variables in levels and vice versa, the results are not very robust and lead to switching signs of the coefficients once the lag structure is changed. We experimented with a number of GMM specifications and obtained, under certain combinations of time lags of dependent and right-hand-side variables, results matching our FE and OLS-based results in terms of sign and significance of the coefficients. Another problem with GMM estimates, which is a general problem of the GMM approach and which prevented us from presenting the GMM results, is the magnitude of the coefficients obtained. The coefficients obtained were usually by factor 10 or 100 or even more off those from the FE and OLS-based estimates and hence not economically meaningful. Because of this downside of GMM we continue with FE and OLS results by knowingly accepting the implicit toll of biased estimates.

Another issue to be addressed here is the appropriate initial level of debt and the corresponding level of debt overhang. One possibility is to fix the debt in the pre-crisis year

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[15] For Albania no firm-level data could be obtained or accessed via its statistical office or central bank. For Montenegro data were, in principle, available from the Amadeus/Orbis database but only for a small sample of firms (fewer than 3,000) and with some better coverage only in most recent years (2013-14).

and then use the difference between the current year debt and this fixed pre-crisis level of debt. There are, however, two problems with this. First, debt level in the pre-crisis year could be too high, which is mostly the case as almost all of the firms accumulated debt before the crisis and started deleveraging soon after that. This means that by using this approach we would actually get negative levels of debt overhang in the post-crisis period as firms struggle to deleverage. Second, in our empirical estimations we use the fixed effects (FE) estimator, which uses a within transformation of data (in order to wipe out the individual fixed effects). By this de-meaning transformation each variable is transformed in the way that a firm's average value (mean over the sample period) is subtracted from the current year's value. This is, in our view, a more reliable approach since the mean value and not the maximum value (usually for 2008 or 2009) is subtracted from the current values to obtain the level of debt overhang in empirical estimations.

5. Results

This section presents results obtained by estimating model (2). There were five different dependent variables used in the model: labour productivity, total factor productivity using Olley-Pakes specification, employment, investment and exports (where available) and several model specifications. The first specification follows closely the specification of model (2), but includes interaction terms between a firm's own debt overhang and other variables in the model. The second specification includes interaction terms of all variables with the crisis dummy, which enables us to analyse whether own debt overhang and excessive debt by the top 100 and top 300 debtors had differential impacts before and after the crisis. The third specification accounts for firm size and differentiates the effects for small companies (fewer than 50 employees), medium-sized companies (between 50 and 250 employees) and large companies (more than 250 employees). As the results for all these specifications and for five countries are quite complex in size and readability, we will mostly present the results in terms of smaller excerpts from the tables and in a graphical form. Full tables with results are reported in the Appendix.

Results for two types of productivity (labour productivity and total factor productivity) are interesting and in line with expectations, though when reporting the results we mostly focus on results for employment and investment, which are more relevant given the aims of this analysis. Exports at the firm level were available only for three countries (Croatia, Hungary and Serbia), so we only briefly present these results for Croatia.[16]

5.1. Base results with reduced form model

In this section we present base results of the reduced-form specification of model (2) that includes interaction terms between a firm's own debt overhang and other variables in the model. To give a flavour of results, we first present some base results for Croatia and then continue with results for all of the countries in our sample.

Table 4 presents results for total factor productivity (TFP) as the dependent variable. As expected, results show that during the crisis, firms' TFP on average declined by some 6 per cent, while exporters fared better with a 10 per cent higher TFP growth. In addition, bigger firms, firms with a higher capital/labour ratio, higher return on assets and lower burden of debt servicing (in terms of interest rate coverage) performed better in terms of TFP growth. Liquidity ratio is negatively related to TFP growth indicating that firms with a better liquidity structure are more likely to expand in terms of TFP.

Among the main variables of interest, as expected, the company's debt overhang is shown to provide a significant negative impact on TFP growth. Increasing debt overhang by 10 per cent leads to a decrease of TFP by some 0.4 to 0.6 per cent. We show results for debt spillovers for three different aggregate debt levels – for the top 100 (columns 1 and 2), top

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[16] All results not reported in the paper can be obtained upon request from the authors.

300 (columns 3 and 4) and all debtor firms (columns 5 and 6). Excessive debt by the top 100, top 300 and all debtor firms in the same industry (horizontal spillovers) negatively impacts the firm's TFP (negative debt horizontal spillovers). A 10 per cent increase in debt overhang of the top 100, top 300 and all debtor firms in the same industry lowers a typical firm's TFP by 0.1, 0.4 and 0.8 per cent, respectively. This indicates that half of the negative horizontal debt spillovers on TFP is generated by the top 300 most indebted companies.

Interestingly, the impact of these negative horizontal debt spillovers remains unaltered when controlling for a firm's own financial distress. For the top 100 and top 300 debtor firms the interaction term for own financial distress is not significant. The interaction term becomes significant only for all debtor firms' horizontal debt spillovers and has a positive sign, but is small in magnitude, which means that horizontal debt spillovers from all debtor firms are less negative when taking into consideration firms' own financial distress. To put it differently, a firm's TFP is negatively affected through spillover effects by financial distress of the largest debtor firms in the same industry, irrespective of its own financial health.

Table 4: Results for TFP for Croatia (reduced form model)

	(1)	(2)	(3)	(4)	(5)	(6)
Crisis dummy	-0.063	-0.060	-0.058	-0.056	-0.057	-0.055
	[-23.01]***	[-22.40]***	[-22.08]***	[-21.43]***	[-21.89]***	[-21.25]***
Exporter dummy	0.107	0.102	0.107	0.102	0.107	0.102
	[23.28]***	[22.64]***	[23.25]***	[22.61]***	[23.17]***	[22.54]***
Size (Log empl.) (t-1)	0.291	0.290	0.292	0.291	0.293	0.292
	[70.00]***	[71.06]***	[70.02]***	[71.05]***	[70.14]***	[71.16]***
Log K/L ratio (t-1)	0.177	0.174	0.178	0.175	0.180	0.176
	[56.28]***	[56.52]***	[56.45]***	[56.67]***	[56.77]***	[56.98]***
Return on equity (t-1)	0.045	0.045	0.045	0.044	0.044	0.044
	[15.48]***	[15.72]***	[15.46]***	[15.70]***	[15.27]***	[15.51]***
Interest rate coverage (t-1)	0.008	0.008	0.008	0.008	0.009	0.008
	[14.95]***	[14.22]***	[14.97]***	[14.22]***	[15.47]***	[14.71]***
Liquidity ratio (t-1)	-0.031	-0.027	-0.031	-0.027	-0.030	-0.026
	[-9.07]***	[-7.89]***	[-9.03]***	[-7.86]***	[-8.79]***	[-7.63]***
Debt overhang	-0.043	-0.058	-0.043	-0.058	-0.043	-0.058
	[-141.74]***	[-140.32]***	[-141.66]***	[-140.29]***	[-141.32]***	[-139.96]***
Hor. spillover (Top-100)	-0.001	-0.001				
	[-1.74]*	[-2.12]**				
Overhang x Hor_Top100		0.001				
		[1.15]				
Backward spillover (Top-100)	0.253	0.256				
	[28.59]***	[29.33]***				
Overhang x Backward_Top100		-0.003				
		[-1.14]				
Forward spillover (Top-100)	-0.247	-0.245				
	[-39.88]***	[-39.97]***				
Overhang x Forward_Top100		0.021				
		[7.54]***				
Hor. spillover (Top-300)			-0.004	-0.004		
			[-7.02]***	[-6.98]***		
Overhang x Hor_Top300				0.000		
				[0.51]		
Backward spillover (Top-300)			0.314	0.320		
			[26.46]***	[27.32]***		
Overhang x Backward_Top300				-0.002		
				[-0.58]		
Forward spillover (Top-300)			-0.295	-0.293		
			[-37.03]***	[-37.34]***		
Overhang x Forward_Top300				0.019		
				[7.30]***		
Hor. spillover (All)					-0.008	-0.008
					[-16.39]***	[-16.21]***
Overhang x Hor_All						0.001
						[2.87]***
Backward spillover (All)					0.464	0.476
					[23.74]***	[24.69]***
Overhang x Backward_All						-0.008
						[-1.86]*
Forward spillover (All)					-0.392	-0.396
					[-25.95]***	[-26.62]***
Overhang x Forward_All						0.014
						[5.48]***
Constant	9.770	9.680	9.545	9.422	10.172	10.002
	[91.08]***	[91.65]***	[77.82]***	[77.99]***	[70.31]***	[70.23]***
Observations	336,193	336,193	336,193	336,193	336,193	336,193
R-squared	0.848	0.853	0.848	0.853	0.848	0.853

Notes: Dependent variable: log of total factor productivity (Olley-Pakes TFP). Fixed effects estimations. Standard errors clustered at industry level. Robust t-statistics in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Among vertical debt spillovers, backward spillovers (financial distress in buying industries) seem to exert a positive impact on firm TFP, while forward spillovers have a negative impact. The magnitude of the debt spillovers in both cases increases with the volume of debt

overhang (that is, the impact doubles from the top 100 debtor firms to the largest debtor firms).

These debt spillovers also have similar effects on other dependent variables (labour productivity, employment, investment and exports). As shown in Table 5, own financial distress, financial distress in the same industry and financial distress in receiving industries negatively impact firm performance in all specifications. These effects are biggest in terms of labour productivity and TFP, followed by investment and exports growth, while being lowest in terms of employment growth.

Table 5: Results for Croatia (reduced form model)

	TFP (1)	Va/emp (2)	Empl. (3)	Invest. (4)	Exports (5)
Crisis dummy	-0.056	-0.054	-0.004	-0.018	-0.123
	[-21.43]***	[-20.32]***	[-2.51]**	[-7.79]***	[-9.59]***
Exporter dummy	0.102	0.079	0.062	0.065	
	[22.61]***	[17.19]***	[20.63]***	[17.17]***	
Size (Log empl.) (t-1)	0.291	0.062	0.594	0.648	0.641
	[71.05]***	[14.98]***	[170.16]***	[140.80]***	[33.31]***
Log K/L ratio (t-1)	0.175	0.155	0.044	0.530	0.270
	[56.67]***	[50.08]***	[25.38]***	[100.39]***	[19.03]***
Return on equity (t-1)	0.044	0.038	0.018	0.015	0.036
	[15.70]***	[13.36]***	[11.44]***	[5.21]***	[2.35]**
Interest rate coverage (t-1)	0.008	0.006	0.006	0.002	0.002
	[14.22]***	[10.05]***	[16.47]***	[4.18]***	[0.61]
Liquidity ratio (t-1)	-0.027	-0.029	0.008	0.026	-0.021
	[-7.86]***	[-8.52]***	[4.43]***	[9.33]***	[-1.55]
Debt overhang	-0.058	-0.056	-0.007	-0.019	-0.040
	[-140.29]***	[-135.09]***	[-31.43]***	[-56.92]***	[-22.78]***
Hor. spillover (Top-300)	-0.004	-0.003	-0.002	-0.002	-0.001
	[-6.98]***	[-5.62]***	[-6.57]***	[-4.93]***	[-0.48]
Overhang x Hor_Top300	0.000	0.000	0.000	-0.000	-0.001
	[0.51]	[0.49]	[0.21]	[-0.57]	[-0.24]
Backward spillover (Top-300)	0.320	0.292	0.059	0.199	0.151
	[27.32]***	[24.45]***	[8.37]***	[19.42]***	[2.86]***
Overhang x Backward_Top300	-0.002	-0.003	0.002	-0.004	-0.012
	[-0.58]	[-1.12]	[1.28]	[-1.77]*	[-1.00]
Forward spillover (Top-300)	-0.293	-0.231	-0.156	-0.205	-0.142
	[-37.34]***	[-28.87]***	[-33.08]***	[-28.47]***	[-3.94]***
Overhang x Forward_Top300	0.019	0.020	-0.000	0.017	0.027
	[7.30]***	[7.56]***	[-0.02]	[8.46]***	[2.44]**
Constant	9.422	9.074	1.205	5.760	7.396
	[77.99]***	[73.61]***	[16.57]***	[56.03]***	[12.38]***
Observations	336,193	336,234	349,226	364,867	73,508
R-squared	0.853	0.790	0.952	0.960	0.862

Notes: Dependent variable: log of headline variable. Fixed effects estimations. Standard errors clustered at industry level. Robust t-statistics in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6 presents results for all five CESEE countries for main variables of interest with TFP, employment and investment as the dependent variables (without controlling for the crisis and firm size).[17] In line with expectations, results show that in all five countries firms' own debt overhang is a big drag on firm performance, reducing TFP growth as well as employment

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[17] See full results in Tables A1 to A3 in the Appendix.

and investment growth. The only exceptions relate to investment growth in Hungary and Bulgaria, where the coefficients are insignificant, and in Serbia where the coefficient is positive and significant. Similarly, high debt leverage of the 300 most indebted companies in the same industry drives down a company's performance in terms of TFP, employment and investment. Where insignificant (for example in Romania), these horizontal debt spillovers turn negative and significant once controlling for firms' own debt overhang.

For most of the countries, backward debt spillovers from the 300 most indebted firms in the downstream industries are surprisingly positive. On the other side, financial distress in supplying industries has a general negative impact on firm TFP, employment and investment growth. These effects are aggravated when interacted with a firm's own financial distress. This suggests that a firm's performance is more severely affected by financial health of its suppliers rather than customers. In other words, push factors seem to be more important than pull factors in terms of financial distress.

However, it remains to be seen how these relationships evolve once controlling for the crisis period. The next section presents these results.

Table 6: Results for TFP, employment and investment (reduced-form model)

	HR	HU	BG	RO	RS
			TFP		
Debt overhang	-0.058	-0.044	-0.081	-0.113	-0.160
Hor. spillover (Top-300)	-0.004	-0.001	-0.069	0.031	0.037
Overhang x Hor_Top300	-0.004	-0.001	0.031	-0.025	0.037
Backward spillover (Top-300)	0.320	-0.036	0.365	-0.125	0.551
Overhang x Backward_Top300	0.320	-0.036	0.245	-0.125	0.575
Forward spillover (Top-300)	-0.293	0.039	-0.226	0.060	-0.295
Overhang x Forward_Top300	-0.274	0.050	-0.226	0.132	-0.341
			Employment		
Debt overhang	-0.007	-0.004	-0.016	-0.026	-0.018
Hor. spillover (Top-300)	-0.002	0.000	-0.012	-0.007	0.000
Overhang x Hor_Top300	-0.002	0.000	-0.012	-0.007	0.000
Backward spillover (Top-300)	0.059	0.012	-0.469	0.000	0.113
Overhang x Backward_Top300	0.059	0.021	-0.445	0.033	0.113
Forward spillover (Top-300)	-0.156	-0.013	0.222	-0.006	-0.152
Overhang x Forward_Top300	-0.156	-0.019	0.199	-0.036	-0.152
			Investment		
Debt overhang	-0.019	-0.001	0.003	-0.026	0.020
Hor. spillover (Top-300)	-0.002	-0.005	-0.034	0.004	0.068
Overhang x Hor_Top300	-0.002	-0.005	-0.034	-0.035	0.068
Backward spillover (Top-300)	0.199	0.000	0.209	-0.036	0.700
Overhang x Backward_Top300	0.195	0.000	0.186	0.015	0.733
Forward spillover (Top-300)	-0.205	-0.001	-0.143	0.032	-0.297
Overhang x Forward_Top300	-0.188	0.012	-0.125	0.032	-0.297

Notes: Dependent variables: log of TFP, employment and investment, respectively. Fixed effects estimation. Shaded cells indicate coefficients are significantly different from zero at 10 per cent. Cells shaded light red indicate negative coefficients, while cells shaded light blue indicate positive coefficients. Coefficients for interaction between correspondent variable and firms' own debt overhang are calculated as the sum of the coefficient of correspondent variable and the interaction term coefficient. Country abbreviations are defined in Table 1.

Source: Tables A1 to A3 in the Appendix.

5.2. Results with control for the crisis effect

This section presents results for estimating the full model where all variables are interacted with the crisis dummy. This makes the output tables more complex. To simplify the presentation of results and make it clearer we drop t-statistics from the presentation tables and calculate effects for individual variables accounting for the interaction terms with the crisis period. We present coefficients for pre-crisis and post-crisis period, whereby the latter are calculated as the sum of the pre-crisis coefficients and the interaction term coefficients.

We present only results for two dependent variables of interest – employment and investment.[18]

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18 Results for two productivity variables (TFP and labour productivity) are similar in vein to results for employment and investment. These results are available upon request.

5.2.1. Results for employment

Probably the most interesting finding in Table 7 refers to the pre- and post-crisis effect of firms' own financial distress. Before the crisis, firms' own financial distress was generally tolerated in all of the countries, that is employment growth was not negatively affected regardless of whether a firm was in financial distress or not. Only in Croatia was this effect on employment growth slightly negative. It is only after the start of the crisis in late 2008 when firms got punished for their pre-crisis excess borrowing. Banks put a stop on further borrowing/refinancing. Along with this, the signs of own debt overhang coefficients generally turn from positive to negative, indicating that firms started a painful deleveraging process along with laying off of workers once "the hard stop" hit in 2009 and after.

Table 7: Pre- and post-crisis effects of own financial conditions and debt spillovers on employment

	Crisis	HR	BG	RO	RS	HU
Return on equity	pre-	0.006	0.000	0.000	0.005	0.030
	post-	0.006	0.025	0.024	0.026	0.060
Interest rate coverage	pre-	0.002	0.034	-0.001	0.013	0.000
	post-	0.004	0.014	0.002	0.013	0.000
Liquidity ratio	pre-	-0.005	-0.026	-0.022	0.000	-0.011
	post-	-0.005	-0.026	-0.022	0.000	-0.004
Own debt overhang	pre-	-0.0002	0.007	0.001	0.004	0.001
	post-	-0.004	-0.025	-0.029	-0.025	-0.007
Hor. spillover (top 100)	pre-	0.000	-0.008	-0.008	0.000	0.001
	post-	0.000	-0.015	-0.002	0.000	-0.001
Backward spillover (top 100)	pre-	-0.0003	-0.041	0.018	-0.056	0.009
	post-	0.004	-0.033	0.018	-0.053	0.018
Forward spillover (top 100)	pre-	-0.058	0.010	-0.024	0.026	-0.010
	post-	-0.040	0.004	-0.010	-0.073	-0.004
Hor. spillover (top 300)	pre-	0.000	0.001	-0.009	0.000	0.001
	post-	0.000	-0.011	-0.004	-0.023	-0.001
Backward spillover (top 300)	pre-	-0.001	-0.075	0.025	-0.006	0.012
	post-	0.005	-0.063	0.025	-0.003	0.015
Forward spillover (top 300)	pre-	-0.063	0.042	-0.029	-0.017	-0.013
	post-	-0.047	0.027	-0.018	-0.109	-0.026

Notes: Dependent variable: log employment. Fixed effects estimation. Shaded cells indicate coefficients are significantly different from zero at 10 per cent. Cells shaded light red indicate negative coefficients, while cells shaded light blue indicate positive coefficients. Coefficients for interaction between correspondent variable and crisis dummy are calculated as the sum of the coefficient of correspondent variable and the crisis interaction term coefficient. Country abbreviations are defined in Table 1.

Source: Table A4 in the Appendix.

In terms of debt spillovers, we generally don't observe such abrupt changes. Coefficients for horizontal and vertical spillovers mostly remain significant and consistent both before and after the crisis. In most cases the negative debt spillovers become even stronger after the

outburst of the crisis. In other words, excessive debt of largest debtor firms either in the same industry (horizontal spillovers) or in the buying and supplying industries has a negative impact on firm employment growth for the most part, but it became even more pronounced after the crisis began. These results are more pronounced for the top 300 most indebted firms.

Chart 12: Forward debt spillover effects of the top 100 and top 300 debtor firms on employment in the post-crisis period
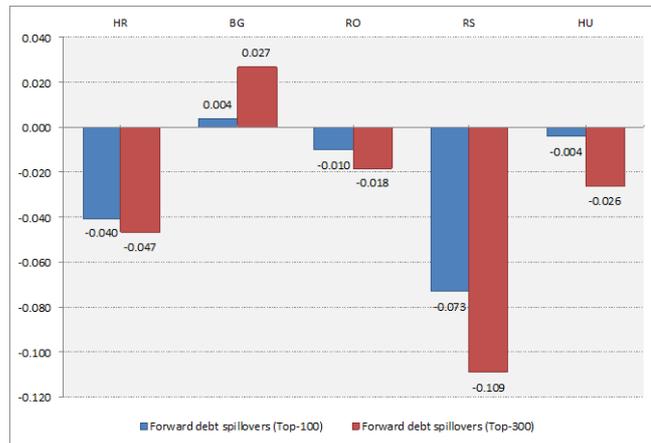
Notes: Coefficients for post-crisis period. If not highlighted, the corresponding coefficient is not significantly different from zero. Country abbreviations are defined in Table 1.

Source: Table A4 in the Appendix.

Chart 12 shows the post-crisis forward debt spillover effects of debt overhang of the 100 and 300 largest debtor firms on employment growth. With the exception of Bulgaria these effects are largely negative. The economic interpretation of the results is as follows: an increase in debt overhang by the top 100 most indebted companies in downstream industries by 10 per cent leads to lower employment growth in the post-crisis period by 0.1-0.7 per cent. For the top 300 most indebted customers these effects increase to the range of 0.2 and 1.0 per cent. The strongest debt spillover effects can be observed in Serbia and the weakest in Romania. Note that in Bulgaria it is the backward debt spillovers that have a negative impact on employment growth.

5.2.2. Results for investment

Results obtained for investment as a dependent variable show a similar negative impact of own financial distress (which appears to have been mostly tolerated before the crisis) and of financial distress in the same industry and downstream industries. The only differences compared with the employment variable are that backward debt spillovers seem to be less taxing on investment growth than forward debt spillovers (from suppliers). The latter, however, become even more punitive after the crisis, in particular when considering the impact of the 300 most indebted companies. In Hungary it is the backward debt spillovers that have the punitive impact on investment made by upstream firms.

Table 8: Pre- and post-crisis effects of own financial conditions and debt spillovers on investment

	Crisis	HR	BG	RO	RS	HU
Return on equity	pre-	0.014	0.000	0.000	-0.047	0.019
	post-	0.014	0.025	-0.012	0.030	0.149
Interest rate coverage	pre-	0.004	0.061	0.038	0.057	0.000
	post-	0.006	0.033	0.029	0.057	0.027
Liquidity ratio	pre-	0.013	-0.060	-0.090	-0.069	0.029
	post-	0.013	-0.060	-0.090	-0.155	0.032
Own debt overhang	pre-	-0.002	0.043	0.019	0.005	0.002
	post-	-0.011	-0.001	-0.028	0.002	-0.014
Hor. spillover (top 100)	pre-	0.000	-0.039	0.014	0.001	0.000
	post-	-0.0004	-0.003	0.000	0.001	-0.001
Backward spillover (top 100)	pre-	0.093	0.055	0.029	0.035	0.005
	post-	0.078	0.001	0.034	0.033	0.008
Forward spillover (top 100)	pre-	-0.039	0.157	0.059	0.010	0.000
	post-	-0.066	0.008	-0.035	-0.015	0.032
Hor. spillover (top 300)	pre-	-0.0001	-0.068	0.016	0.002	0.000
	post-	-0.0001	-0.022	0.001	0.004	-0.001
Backward spillover (top 300)	pre-	0.128	0.123	0.030	0.050	-0.005
	post-	0.113	0.060	0.036	0.047	-0.002
Forward spillover (top 300)	pre-	-0.062	0.119	0.057	-0.008	0.007
	post-	-0.087	-0.033	-0.037	-0.032	0.039

Notes: Dependent variable: log investment. Fixed effects estimation.Shaded cells indicate coefficients are significantly different from zero at 10 per cent. Cells shaded light red indicate negative coefficients, while cells shaded light blue indicate positive coefficients. Coefficients for interaction between correspondent variable and crisis dummy are calculated as the sum of the coefficient of correspondent variable and the crisis interaction term coefficient. Country abbreviations are defined in Table 1.

Source: Table A5 in the Appendix.

As further highlighted in Chart 13, on average, an increase in debt overhang by the top 100 most indebted upstream customers by 10 per cent leads to lower investment growth by 0.2-0.7 per cent. Again, these effects get stronger when taking into account the top 300 instead of the top 100 largest debtor companies. In terms of investment, the effects are strongest in Croatia and weakest in Bulgaria and Serbia.

Chart 13: Forward debt spillover effects of the top 100 and top 300 debtor firms on investment in the post-crisis period
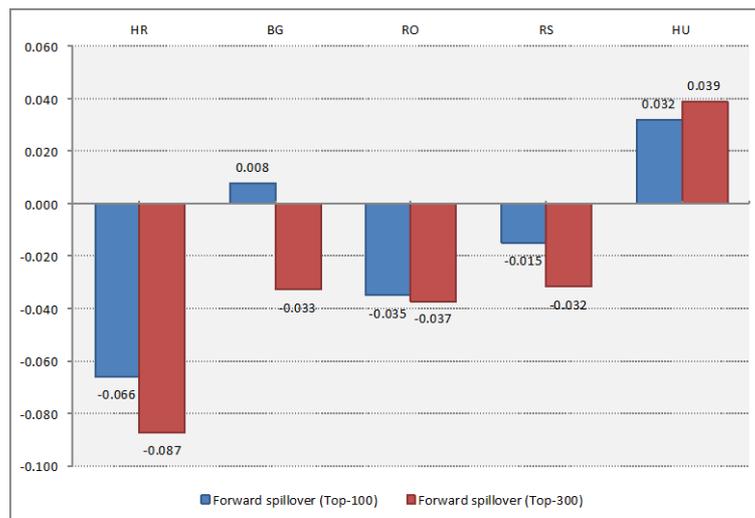
Notes: Coefficients for the post-crisis period. If not highlighted, the corresponding coefficient is not significantly different from zero. Country abbreviations are defined in Table 1.

Source: Table A5 in the Appendix.

5.3. Results with controls for firm size

Financial distress becomes even more important when accounting for firm size. Smaller firms are believed to be more severely affected by their own financial distress and by negative debt spillovers from other firms and industries. In our last specification we estimate the model separately for three size classes of firms, that is for small companies (below 50 employees), medium-sized (between 50 and 250 employees) and large companies (more than 250 employees). Results (see Chart 14 based on Tables A6 to A10 in the Appendix) show that own financial distress becomes a drag on employment only after the crisis and that small and medium-sized companies are indeed more likely to be affected by their own financial distress and mostly so after the start of the crisis. Only in Romania and Serbia do large firms seem to be as severely affected by firms' own excessive debt as small and medium firms.

Chart 14: Impact of own financial distress before and after the crisis on employment when controlling for firm size
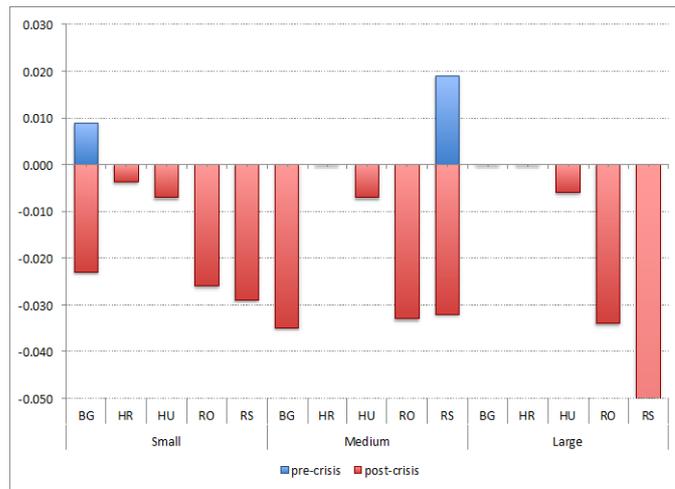
Notes: Coefficients for interaction between correspondent variable and crisis dummy are calculated as the sum of the coefficient of correspondent variable and the crisis interaction term coefficient. If not highlighted, the coefficient is not significantly different from zero. Country abbreviations are defined in Table 1.

Source: Tables A6 – A10 in the Appendix.

These firm-size dependent effects can also be observed in terms of debt spillovers. As shown in Chart 15, with regard to the employment growth, forward debt spillovers of largest 300 debtor firms become negative after the start of the crisis, whereby they are most severely taxing on small and medium-sized firms, but less so large firms (with the exception of Bulgaria and partly in Serbia). A negative shock of a 10% increase in debt overhang of downstream buyers can reduce employment growth of small and medium firms by between 0.5 and 2 percent.

Chart 15: Post-crisis forward debt spillovers of the top 300 debtor firms on employment when controlling for firm size

Very similar effects of vertical debt spillovers can be observed also in terms of investment: it
is predominantly small and medium-sized companies that are negatively affected by large
excessive debt of the largest downstream firms (see Chart 16).

Chart 16: Post-crisis forward debt spillovers of the top 300 debtor firms on investment when controlling for firm size
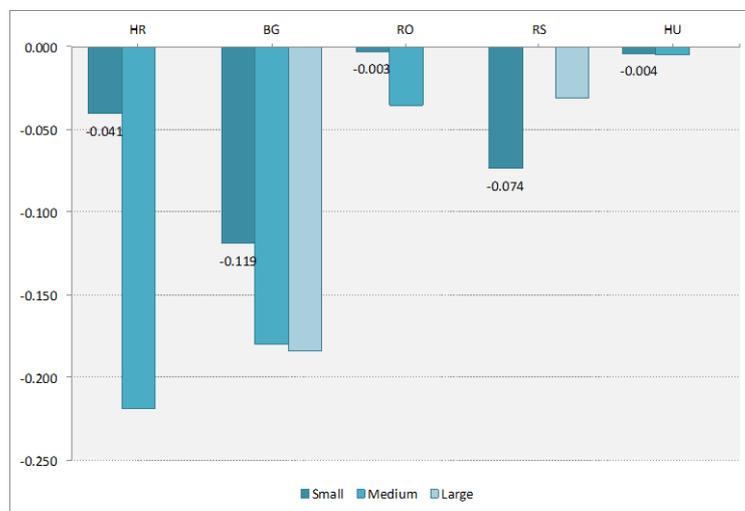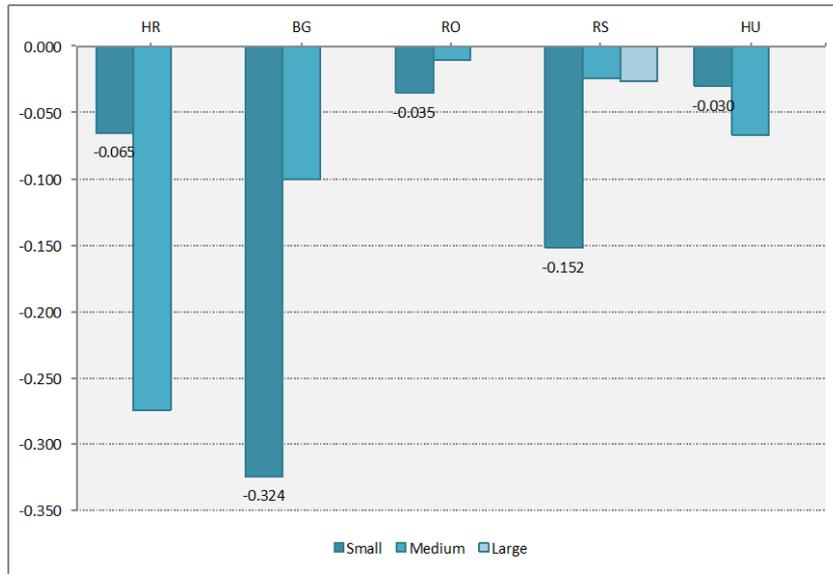
Notes: Dependent variable: log investment. Fixed effects estimation. If not highlighted, the
corresponding coefficient is not significantly different from zero. Country abbreviations are defined in
Table 1.

Source: Tables A6 – A10 in the Appendix.

6. Economic impact of resolution of excess debt

Firms with excessive debt have a disproportionately large impact on the aggregate economy by affecting other firms within the sector as well as, through forward and backward linkages, other sectors in the economy. Large entities with debt overhang in particular affect a broad segment of the economy, paralysing other potentially successful firms in addition to the negative direct effect on their own performance. In the following section we explore the potential aggregate economic effects that the deleveraging process would bring to the CESEE countries.

Given that the negative effects of prolonged excessive indebtedness on firms have been well established and that important indirect effects on associated sectors amplify the damage to the economy, the easing of the debt burden of the hardest hit firms is in the interest of the whole economy. In order to gauge the overall effect of the deleveraging of the worst stricken firms on other companies, we present a simulation of the debt reduction on a number of key variables.

Our estimated aggregate effects will be based on the point estimates of elasticities of employment, sales and investment with respect to debt overhang. Calculations are based on estimated elasticities for the post-crisis period.[19] We will combine the direct effect of the resolution of excessive debt with the (also beneficial) indirect effects, stemming from the benefits accruing to horizontally or vertically linked firms. For the sake of simplicity we will assume that the impact of debt reduction remains constant both between and within firm types. Furthermore, we also assume that the resolution of the debt burden happens proportionally across all sectors of the economy or that weighted average across sectors is equal to the proposed debt reduction.

In the simulation of the resolution of the excessive debt problem we anticipate three scenarios:

Scenario 1: Elimination of 20 per cent of debt overhang by the top 100 (300) most indebted firms by government debt-reduction policies

Scenario 2: Elimination of 50 per cent of debt overhang by the top 100 (300) most indebted firms

Scenario 3: Elimination of 100 per cent of debt overhang by the top 100 most indebted firms.

The outcomes of the three scenarios for deleveraging the top 100 debtor firms are presented in charts 17-19 for sales, employment and investment, respectively. Simulations of effects stemming from deleveraging the top 300 debtor firms are in the Appendix (see charts A1-A3).

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[19] See estimated elasticities for employment and investment in Table 6, while for sales additional estimations of elasticities were performed (see Table A11 in the Appendix).

Chart 17: Overall effects of deleveraging the top 100 most indebted firms on a typical firm's sales (change in firm's sales in per cent)
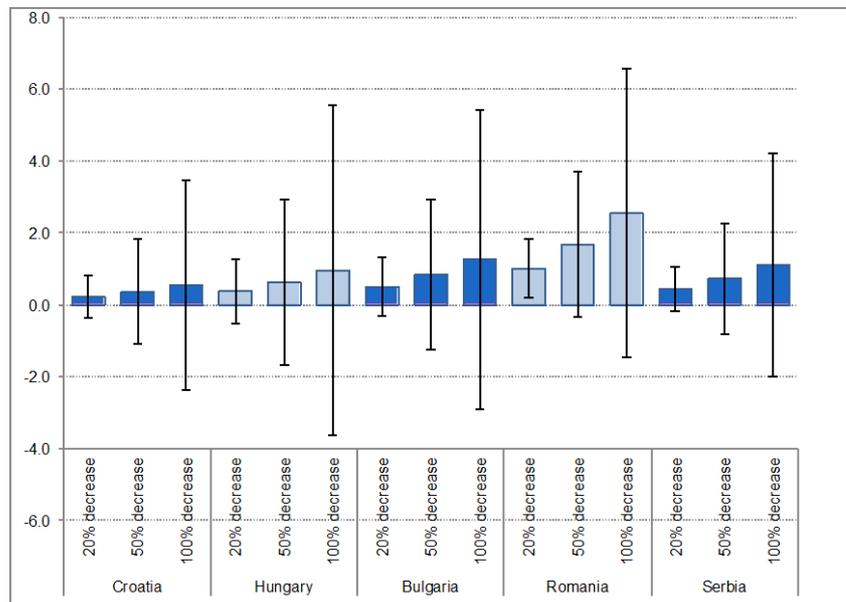
Notes*:* Simulation of elimination of 20 per cent, 50 per cent and 100 per cent of debt overhang by the top 100 most indebted firms on an individual firm's change in sales. Calculations based on estimated elasticities for post-crisis period (Table A11 in the Appendix); 90 per cent confidence intervals.

Source: Own calculations.

Our simulations show that, in terms of sales (see Chart 17), deleveraging of the top 100 most indebted firms would most benefit companies in the Romanian economy, with the projected increase in individual firm's sales ranging between 1 (20 per cent decrease in debt overhang) and 2.5 per cent (100 per cent decrease in debt overhang). The effects for the remaining countries are smaller – up to 1 per cent in Hungary, Bulgaria and Serbia, and up to half a per cent only in the most optimistic scenario in Croatia. The 90 per cent confidence intervals, however, indicate large volatility of deleveraging spillover effects across firms, in particular in Bulgaria, Hungary and Romania. This implies that some firms may indirectly benefit from a deleveraging of the top 100 most indebted firms by a larger degree, while some may be hurt.

Chart 18 focuses on employment effects of the easing of the debt burden. We find that firms in Serbia and Bulgaria are likely to experience the largest benefits of deleveraging the top 100 most indebted firms. The projected impact on an individual firm's employment in both countries is between 2 and 3 per cent for a 100 per cent decrease in debt overhang. Companies in Croatia and Romania are also projected to experience sizeable effects with a between 0.5 and 0.8 per cent increase in an individual firm's employment, respectively. The impact is very small in Hungary – below 0.25 per cent. Again, dispersion of the indirect gains is wide, in particular in Bulgaria, Hungary and Romania.

Chart 18: Overall effects of deleveraging the top 100 most indebted firms on a typical firm's employment (change in firm's employment in per cent)
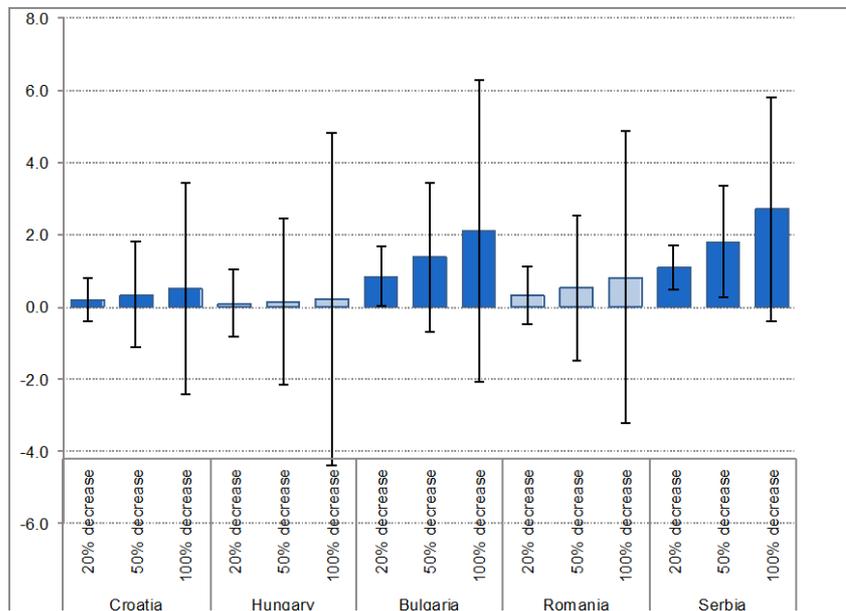
Notes: Simulation of elimination of 20 per cent, 50 per cent and 100 per cent of debt overhang by the top 100 most indebted firms on an individual firm's change in employment. Calculations based on estimated elasticities for post-crisis period (Table A4 in the Appendix). 90 per cent confidence intervals.

Source: Own calculations.

Finally, Chart 19 depicts the projected effects of deleveraging the top 100 most indebted firms on an individual firm's investment. The growth of firm investment as a consequence of excessive debt resolution of the largest debtor firms is expected to be most in Romania and Hungary. The effects, though, are comparably smaller relative to those for sales and employment, as investment in both countries is only expected to grow by about 1 per cent in the best scenario. The impact on firm investment in other countries in our sample is even smaller, with effects in Bulgaria and Serbia ranging between 0.2 and 0.4 per cent, while firms in the Croatian economy are barely expected to notice a change in investment due to the deleveraging of the most indebted firms. As before, dispersion of the indirect gains is wide in Hungary, Bulgaria and Romania.

Chart 19: Overall effects of deleveraging the top 100 most indebted firms on a typical firm's investment (change in firm's investment in per cent)
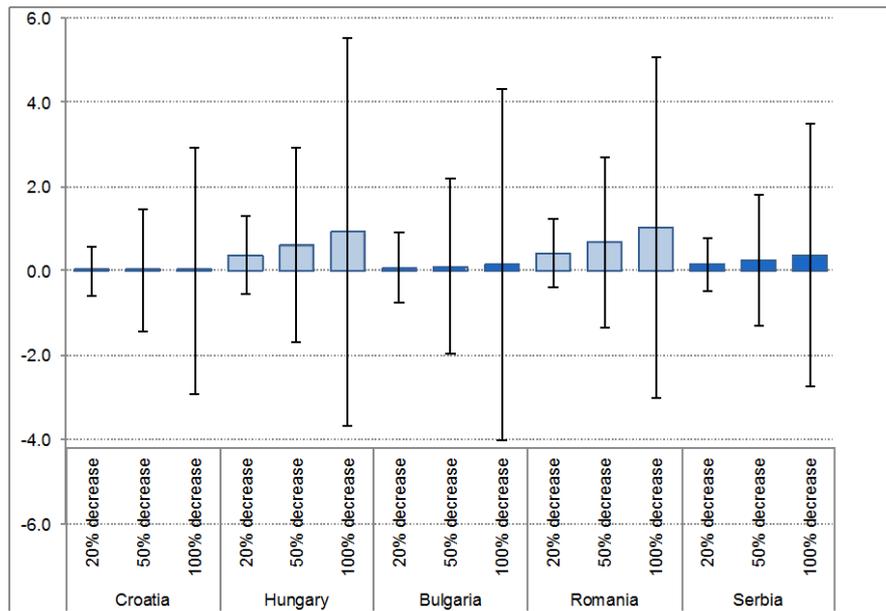

Notes: Simulation of elimination of 20 per cent, 50 per cent and 100 per cent of debt overhang by the top 100 most indebted firms on an individual firm's change in investment. Calculations based on estimated elasticities for post-crisis period (Table A5 in the Appendix). 90 per cent confidence intervals.

Source: Own calculations.

We also simulated the effects stemming from deleveraging the top 300 debtor firms (see charts A1 to A3 in the Appendix). The effects of deleveraging on firms' sales, employment and investment are bigger, but by the order of magnitude lower than 1. This indicates that most of the debt reduction spillover effect comes from excessive debt reduction of the top 100 firms.

Note that the projected effects of deleveraging are additional effects only to firms' own deleveraging, that is they represent spillover effects of deleveraging the top 100 (top 300) most indebted firms. The size of the effects depend solely on the current debt overhang held by the top 100 (top 300) most indebted firms as well as on the estimated elasticities of debt overhang for sales, employment and investment. The point estimates on investment are very small compared with sales and employment, leading to the conclusion that investment during the period in question is not very responsive to changes in debt overhang.

7. Conclusions

This research studies the impact of corporate sector excess leverage on the performance of firms in CESEE economies. We first assess the extent of corporate sector excess leverage by country and identify groups of the largest companies (from the top 10 to top 300) with regard to their excess debt, and then assess their direct macroeconomic importance in terms of debt, employment, value added and exports. The main part of the paper deals with estimating a debt spillovers model to assess the direct and indirect effects of financial distress on horizontally and vertically linked industries. The model is estimated using firm-level data for five CESEE countries (Bulgaria, Croatia, Hungary, Romania and Serbia). Our results show that firm financial distress was largely tolerated before the crisis, but has become severely taxing on firm performance in the post-crisis period. We find substantial negative horizontal and vertical debt spillover effects of the most indebted companies on other horizontally or vertically linked firms. We also find that a firm's performance is more severely affected by financial distress among its suppliers rather than its customers, indicating that "push" factors seem to be more important than "pull" factors in terms of financial distress. Most importantly, these effects became aggravated during the financial crisis and are more severe for small and medium-sized firms.

Our results indicate that financial distress has negative spillover effects on the whole economy, whereby the "collateral victims" are usually small and medium-sized companies that are more heavily dependent on the financial health of their large suppliers and customers. Our empirical findings hence suggest that countries need to address the issue of excess leverage of the largest debtor companies and design policies supporting the repair of their balance sheets. Institutional reforms focusing on debt-resolution frameworks specifically targeting "systemically important" larger debtor companies may provide essential support to faster economic recovery in some of the debt-ridden CESEE countries. Our findings suggest that achieving a timely resolution of NPLs can have far more widespread effects than previously believed. SMEs will be the main collateral beneficiaries of such a policy.

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Appendix

Tables

Table A1: Results for TFP (reduced form model)

	HR (1)	HU (2)	BG (3)	RO (4)	RS (5)
Crisis dummy	-0.056	-0.061	-0.044	-0.180	0.171
	[-21.43]***	[-17.81]***	[-5.07]***	[-54.01]***	[38.96]***
Exporter dummy	0.102	0.060			0.007
	[22.61]***	[8.86]***			[0.18]
Size (Log empl.) (t-1)	0.291	0.042	0.039	0.090	0.081
	[71.05]***	[6.47]***	[1.85]*	[15.55]***	[8.90]***
Log K/L ratio (t-1)	0.175	0.004	-0.011	0.064	0.040
	[56.67]***	[1.40]	[-0.61]	[16.81]***	[6.76]***
Return on equity (t-1)	0.044	0.012	0.046	0.054	0.058
	[15.70]***	[4.76]***	[8.99]***	[27.32]***	[23.14]***
Interest rate coverage (t-1)	0.008	-0.003	0.012	0.048	0.019
	[14.22]***	[-0.60]	[2.25]**	[24.00]***	[7.47]***
Liquidity ratio (t-1)	-0.027	-0.024	-0.041	-0.045	-0.042
	[-7.86]***	[-6.23]***	[-7.06]***	[-12.03]***	[-9.77]***
Debt overhang	-0.058	-0.044	-0.081	-0.113	-0.160
	[-140.29]***	[-64.89]***	[-10.34]***	[-24.10]***	[-49.33]***
Hor. spillover (Top-300)	-0.004	-0.001	-0.069	0.031	0.037
	[-6.98]***	[-2.13]**	[-3.98]***	[24.41]***	[4.61]***
Overhang x Hor_Top300	0.000	0.001	0.100	-0.056	0.011
	[0.51]	[0.95]	[2.78]***	[-4.00]***	[0.78]
Backward spillover (Top-300)	0.320	-0.036	0.365	-0.125	0.551
	[27.32]***	[-7.60]***	[3.88]***	[-15.28]***	[12.00]***
Overhang x Backward_Top300	-0.002	0.000	-0.120	-0.029	0.024
	[-0.58]	[0.03]	[-2.98]***	[-0.74]	[1.85]*
Forward spillover (Top-300)	-0.293	0.039	-0.226	0.060	-0.295
	[-37.34]***	[9.12]***	[-2.84]***	[7.28]***	[-7.42]***
Overhang x Forward_Top300	0.019	0.011	-0.012	0.072	-0.046
	[7.30]***	[2.39]**	[-0.47]	[2.36]**	[-4.05]***
Constant	9.422	9.526	2.464	3.156	0.082
	[77.99]***	[156.72]***	[10.75]***	[198.81]***	[0.79]
Observations	336,193	238,838	31,306	194,100	64,837
R-squared	0.853	0.937	0.902	0.705	0.797

Notes: Dependent variable: Log of total factor productivity (Olley-Pakes TFP). Fixed effects estimation. The model includes time fixed effects. Standard errors clustered at industry level. Robust t-statistics in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Country abbreviations are defined in Table 1.

Table A2: Results for employment (reduced form model)

	HR (1)	HU (2)	BG (3)	RO (4)	RS (5)
Crisis dummy	-0.004	-0.049	0.070	-0.027	0.045
	[-2.51]**	[-23.71]***	[38.70]***	[-17.18]***	[27.04]***
Exporter dummy	0.062	0.048			0.072
	[20.63]***	[11.38]***			[3.89]***
Size (Log empl.) (t-1)	0.594	0.242	0.358	0.556	0.562
	[170.16]***	[48.44]***	[82.34]***	[155.97]***	[119.33]***
Log K/L ratio (t-1)	0.044	0.044	0.019	0.015	0.015
	[25.38]***	[24.47]***	[6.62]***	[10.20]***	[7.73]***
Return on equity (t-1)	0.018	0.025	0.025	0.028	0.020
	[11.44]***	[17.44]***	[24.98]***	[29.47]***	[21.02]***
Interest rate coverage (t-1)	0.006	0.003	0.019	-0.002	0.010
	[16.47]***	[1.19]	[16.61]***	[-2.64]***	[10.89]***
Liquidity ratio (t-1)	0.008	-0.003	-0.011	-0.017	-0.001
	[4.43]***	[-1.49]	[-10.21]***	[-9.35]***	[-0.61]
Debt overhang	-0.007	-0.004	-0.016	-0.026	-0.018
	[-31.43]***	[-11.19]***	[-10.27]***	[-14.49]***	[-16.17]***
Hor. spillover (Top-300)	-0.002	0.000	-0.012	-0.007	-0.005
	[-6.57]***	[0.42]	[-3.14]***	[-11.86]***	[-1.58]
Overhang x Hor_Top300	0.000	-0.000	-0.008	-0.008	-0.002
	[0.21]	[-0.83]	[-0.97]	[-0.93]	[-0.38]
Backward spillover (Top-300)	0.059	0.012	-0.469	0.003	0.113
	[8.37]***	[4.18]***	[-21.89]***	[0.74]	[6.14]***
Overhang x Backward_Top300	0.002	0.009	0.024	0.033	0.002
	[1.28]	[2.87]***	[2.56]**	[1.84]*	[0.35]
Forward spillover (Top-300)	-0.156	-0.013	0.222	-0.006	-0.152
	[-33.08]***	[-5.50]***	[12.18]***	[-1.61]	[-9.46]***
Overhang x Forward_Top300	-0.000	-0.006	-0.023	-0.030	-0.001
	[-0.02]	[-2.20]**	[-3.46]***	[-2.12]**	[-0.32]
Constant	1.205	0.796	3.738	1.071	1.173
	[16.57]***	[25.86]***	[78.74]***	[110.18]***	[26.61]***
Observations	349,226	321,696	459,258	303,145	188,759
R-squared	0.952	0.971	0.934	0.950	0.943

Notes: Dependent variable: Log of employment. Fixed effects estimation. The model includes time fixed effects. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1. Country abbreviations are defined in Table 1.

Table A3: Results for investment (reduced form model)

	HR (1)	HU (2)	BG (3)	RO (4)	RS (5)
Crisis dummy	-0.018	-0.045	0.028	0.002	0.153
	[-7.79]***	[-11.84]***	[8.26]***	[0.81]	[38.43]***
Exporter dummy	0.065	0.048			0.089
	[17.17]***	[6.77]***			[2.09]**
Size (Log empl.) (t-1)	0.648	0.279	0.275	0.306	0.523
	[140.80]***	[42.15]***	[37.58]***	[62.58]***	[64.42]***
Log K/L ratio (t-1)	0.530	0.206	0.050	0.073	0.142
	[100.39]***	[38.32]***	[8.32]***	[24.01]***	[25.95]***
Return on equity (t-1)	0.015	0.045	0.017	-0.006	0.005
	[5.21]***	[17.05]***	[8.93]***	[-3.75]***	[2.26]**
Interest rate coverage (t-1)	0.002	-0.002	0.039	0.041	0.061
	[4.18]***	[-0.30]	[18.73]***	[23.84]***	[26.46]***
Liquidity ratio (t-1)	0.026	0.003	-0.056	-0.091	-0.115
	[9.33]***	[0.85]	[-25.78]***	[-26.28]***	[-26.53]***
Debt overhang	-0.019	-0.001	0.003	-0.026	0.020
	[-56.92]***	[-1.22]	[1.21]	[-7.74]***	[8.54]***
Hor. spillover (Top-300)	-0.002	-0.005	-0.034	0.004	0.068
	[-4.93]***	[-10.37]***	[-5.13]***	[3.87]***	[8.71]***
Overhang x Hor_Top300	-0.000	0.001	0.007	-0.039	-0.012
	[-0.57]	[1.27]	[0.53]	[-2.80]***	[-1.01]
Backward spillover (Top-300)	0.199	0.004	0.209	-0.036	0.700
	[19.42]***	[0.89]	[5.30]***	[-5.18]***	[16.33]***
Overhang x Backward_Top300	-0.004	-0.007	-0.023	0.051	0.033
	[-1.77]*	[-1.33]	[-1.57]	[1.74]*	[2.41]**
Forward spillover (Top-300)	-0.205	-0.001	-0.143	0.032	-0.297
	[-28.47]***	[-0.13]	[-4.14]***	[4.64]***	[-7.92]***
Overhang x Forward_Top300	0.017	0.013	0.018	-0.009	-0.009
	[8.46]***	[2.70]***	[1.83]*	[-0.40]	[-1.14]
Constant	5.760	6.936	2.324	3.655	-2.816
	[56.03]***	[112.33]***	[23.64]***	[254.18]***	[-24.72]***
Observations	364,867	320,143	307,218	262,638	162,543
R-squared	0.960	0.972	0.932	0.892	0.890

Notes: Dependent variable: Log of investment. Fixed effects estimation. The model includes time fixed effects. Standard errors clustered at industry level. Robust t-statistics in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Country abbreviations are defined in Table 1.

Table A4: Results for employment (full model)

	HR (1)	HU (2)	BG (3)	RO (4)	RS (5)
Crisis dummy	-0.451	-0.306	0.027	-0.281	1.199
	[-8.78]***	[-4.79]***	[0.30]	[-24.13]***	[11.70]***
Exporter dummy	0.040	0.061			0.063
	[21.74]***	[24.04]***			[3.21]***
Size (Log empl.) (t-1)	0.666	0.484	0.351	0.554	0.535
	[81.13]***	[178.35]***	[79.52]***	[154.45]***	[99.44]***
Log K/L ratio (t-1)	0.017	0.094	0.021	0.017	0.016
	[22.53]***	[56.28]***	[7.13]***	[10.93]***	[6.73]***
Return on equity (t-1)	0.006	0.030	0.006	0.009	0.005
	[5.66]***	[9.49]***	[2.36]**	[6.91]***	[2.67]***
Crisis x return on equity (t-1)	-0.001	0.030	0.025	0.024	0.021
	[-0.90]	[7.53]***	[10.19]***	[16.31]***	[11.04]***
Interest rate coverage (t-1)	0.002	0.004	0.034	-0.001	0.013
	[6.12]***	[1.47]	[17.02]***	[-0.42]	[7.60]***
Crisis x int. rate cover. (t-1)	0.002	0.000	-0.020	0.003	-0.002
	[6.30]***	[0.14]	[-9.86]***	[1.85]*	[-1.24]
Liquidity ratio (t-1)	-0.005	-0.011	-0.026	-0.022	0.000
	[-4.34]***	[-8.05]***	[-9.82]***	[-8.04]***	[-0.02]
Crisis x liquidity ratio (t-1)	0.009	0.007	0.015	0.008	0.000
	[8.61]***	[5.12]***	[5.51]***	[3.03]***	[-0.01]
Debt overhang	-0.0002	0.001	0.007	0.001	0.004
	[-1.06]	[4.98]***	[1.75]*	[0.21]	[1.86]*
Crisis x debt overhang	-0.004	-0.008	-0.032	-0.030	-0.029
	[-19.73]***	[-30.11]***	[-7.77]***	[-6.19]***	[-11.83]***
Hor. spillover (Top-300)	-0.0001	0.001	0.001	-0.009	0.014
	[-0.31]	[3.09]***	[0.09]	[-9.76]***	[2.64]***
Crisis x Hor_Top-300	-0.001	-0.002	-0.012	0.005	-0.023
	[-5.08]***	[-5.62]***	[-3.11]***	[5.23]***	[-6.55]***
Backward spillover (Top-300)	-0.001	0.012	-0.075	0.025	-0.006
	[-0.18]	[5.27]***	[-36.15]***	[5.60]***	[-0.27]
Crisis x Backward_Top-300	0.006	0.003	0.012	0.001	0.003
	[7.63]***	[2.47]**	[3.12]***	[0.52]	[1.07]
Forward spillover (Top-300)	-0.063	-0.013	0.042	-0.029	-0.017
	[-17.35]***	[-6.61]***	[20.69]***	[-7.13]***	[-0.83]
Crisis x Forward_Top-300	0.016	0.013	-0.015	0.011	-0.092
	[5.88]***	[3.17]***	[-1.55]	[3.95]***	[-10.50]***
Constant	1.127	-0.090	4.179	1.175	0.837
	[28.18]***	[-4.34]***	[42.39]***	[83.99]***	[7.96]***
Observations	364,995	694,769	459,258	303,145	154,684
R-squared	0.947	0.947	0.933	0.950	0.931

Notes: Dependent variable: Log of Employment. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1. Country abbreviations are defined in Table 1.

Table A5: Results for investment (full model)

	HR (1)	HU (2)	BG (3)	RO (4)	RS (5)
Crisis dummy	0.759	-0.626	1.546	0.462	2.725
	[5.82]***	[-8.84]***	[8.55]***	[20.89]***	[11.25]***
Exporter dummy	0.073	0.066			0.067
	[18.47]***	[25.11]***			[1.51]
Size (Log empl.) (t-1)	1.309	0.521	0.273	0.307	0.501
	[105.09]***	[179.35]***	[37.36]***	[62.77]***	[55.26]***
Log K/L ratio (t-1)	0.492	0.454	0.050	0.070	0.157
	[97.12]***	[156.98]***	[8.27]***	[23.17]***	[24.50]***
Return on equity (t-1)	0.014	0.019	-0.004	0.003	-0.047
	[3.55]***	[3.64]***	[-0.72]	[1.42]	[-11.45]***
Crisis x Return on equity (t-1)	0.004	0.130	0.025	-0.012	0.077
	[0.76]	[18.98]***	[4.33]***	[-4.26]***	[17.24]***
Interest rate coverage (t-1)	0.004	0.003	0.061	0.038	0.057
	[4.47]***	[0.88]	[13.09]***	[12.86]***	[14.08]***
Crisis x Int. rate cover. (t-1)	0.002	0.027	-0.028	-0.009	0.001
	[2.50]**	[8.47]***	[-5.86]***	[-2.55]**	[0.17]
Liquidity ratio (t-1)	0.013	0.029	-0.060	-0.090	-0.069
	[3.20]***	[16.83]***	[-9.37]***	[-15.91]***	[-6.28]***
Crisis x Liquidity ratio (t-1)	0.003	0.003	0.004	-0.002	-0.086
	[0.87]	[1.80]*	[0.58]	[-0.33]	[-7.83]***
Debt overhang	-0.002	0.002	0.043	0.019	0.048
	[-6.47]***	[8.48]***	[7.11]***	[1.91]*	[9.68]***
Crisis x Debt overhang	-0.009	-0.016	-0.044	-0.047	-0.027
	[-21.18]***	[-54.54]***	[-6.83]***	[-4.46]***	[-4.94]***
Hor. spillover (Top-300)	-0.0001	0.000	-0.068	0.016	0.017
	[-0.24]	[0.27]	[-6.28]***	[8.98]***	[1.43]
Crisis x Hor_Top-300	0.000	-0.001	0.046	-0.015	0.023
	[0.04]	[-4.35]***	[5.32]***	[-7.39]***	[2.90]***
Backward spillover (Top-300)	0.128	-0.005	0.123	0.030	0.504
	[11.69]***	[-2.13]**	[3.22]***	[3.60]***	[10.57]***
Crisis x Backward_Top-300	-0.015	0.003	-0.063	0.006	-0.037
	[-7.49]***	[1.86]*	[-6.90]***	[1.17]	[-4.97]***
Forward spillover (Top-300)	-0.062	0.007	0.119	0.057	-0.078
	[-6.89]***	[3.22]***	[3.09]***	[7.64]***	[-1.62]
Crisis x Forward_Top-300	-0.025	0.032	-0.152	-0.094	-0.240
	[-3.86]***	[7.47]***	[-8.36]***	[-17.33]***	[-11.79]***
Constant	3.857	5.436	1.028	3.221	-2.255
	[39.09]***	[173.02]***	[5.32]***	[135.89]***	[-9.07]***
Observations	364,867	707,674	307,218	262,638	144,582
R-squared	0.957	0.970	0.932	0.892	0.885

Notes: Dependent variable: Log of investment. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1. Country abbreviations are defined in Table 1.

Table A6: Results accounting for company size, Croatia

	Employment			Investment		
	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)
Crisis dummy	-0.428	-2.683	-27.187	0.711	5.918	4.557
	[-8.60]***	[-1.09]	[-1.32]	[5.46]***	[2.93]***	[1.11]
Exporter dummy	0.039	0.186	-0.189	0.073	0.255	0.054
	[21.85]***	[1.62]	[-0.49]	[18.39]***	[2.62]***	[0.36]
Size (Log empl.) (t-1)	0.663	0.705	0.861	1.322	0.853	0.654
	[80.90]***	[5.91]***	[1.92]*	[109.30]***	[5.44]***	[6.57]***
Log K/L ratio (t-1)	0.017	-0.065	-0.081	0.493	0.469	0.335
	[22.87]***	[-0.60]	[-0.13]	[97.13]***	[4.18]***	[1.72]*
Return on equity (t-1)	0.007	-0.402	2.827	0.014	-0.154	0.319
	[6.12]***	[-1.52]	[1.21]	[3.55]***	[-0.89]	[1.09]
Crisis x Return on equity (t-1)	-0.002	0.506	-2.976	0.004	0.226	0.109
	[-1.21]	[1.96]*	[-1.14]	[0.70]	[1.29]	[0.36]
Interest rate coverage (t-1)	0.002	-0.035	-0.003	0.004	-0.019	-0.044
	[6.62]***	[-0.94]	[-0.01]	[4.51]***	[-0.69]	[-0.79]
Crisis x Int. rate cover. (t-1)	0.002	0.054	0.380	0.002	-0.093	-0.077
	[5.99]***	[1.51]	[1.01]	[2.58]***	[-1.66]*	[-0.91]
Liquidity ratio (t-1)	-0.005	-0.116	0.175	0.013	-0.109	0.050
	[-4.30]***	[-1.07]	[0.14]	[3.26]***	[-1.45]	[0.15]
Crisis x Liquidity ratio (t-1)	0.009	-0.087	-0.050	0.003	0.292	-0.249
	[8.69]***	[-0.99]	[-0.05]	[0.81]	[2.49]**	[-1.04]
Debt overhang	-0.000	-0.002	0.022	-0.003	0.009	-0.003
	[-1.26]	[-0.55]	[0.63]	[-6.62]***	[3.10]***	[-0.23]
Crisis x Debt overhang	-0.004	0.001	-0.019	-0.009	-0.012	-0.012
	[-20.32]***	[0.09]	[-0.58]	[-21.13]***	[-2.24]**	[-1.32]
Hor. spillover (Top-300)	0.000	0.002	0.119	0.000	-0.002	0.000
	[0.90]	[0.42]	[1.14]	[0.05]	[-0.40]	[0.02]
Crisis x Hor_Top-300	0.000	-0.003	-0.059	-0.000	0.009	-0.036
	[-2.03]**	[-0.86]	[-0.45]	[-1.22]	[1.28]	[-1.86]*
Backward spillover (Top-300)	-0.000	0.151	-1.240	0.093	-0.109	-0.278
	[-0.06]	[1.16]	[-0.88]	[11.29]***	[-0.73]	[-1.51]
Crisis x Backward_Top-300	0.004	-0.016	0.157	-0.014	-0.035	0.000
	[5.90]***	[-0.68]	[0.62]	[-7.45]***	[-1.24]	[-0.00]
Forward spillover (Top-300)	-0.057	-0.218	0.145	-0.040	0.108	0.362
	[-18.90]***	[-2.27]**	[0.12]	[-5.31]***	[1.16]	[2.23]**
Crisis x Forward_Top-300	0.017	0.146	1.276	-0.025	-0.275	-0.177
	[7.23]***	[1.23]	[1.43]	[-4.23]***	[-2.91]***	[-0.94]
Constant	1.111	3.670	19.285	3.856	7.365	8.736
	[28.25]***	[1.58]	[1.12]	[39.05]***	[4.36]***	[2.12]**
Observations	363,697	1,226	72	363,569	1,226	72
R-squared	0.941	0.754	0.554	0.956	0.918	0.990

Notes: Dependent variable: Log of column headline variable. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A7: Results accounting for company size, Hungary

	Employment			Investment		
	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)
Crisis dummy	-0.304	-0.290	-0.482	-0.600	-1.190	-0.722
	[-4.62]***	[-0.98]	[-0.42]	[-8.19]***	[-4.67]***	[-1.13]
Exporter dummy	0.062	0.040	0.104	0.067	0.053	0.039
	[23.81]***	[3.19]***	[2.15]**	[24.58]***	[4.66]***	[1.07]
Size (Log empl.) (t-1)	0.480	0.578	0.464	0.522	0.532	0.450
	[181.23]***	[24.24]***	[7.19]***	[179.60]***	[23.18]***	[7.84]***
Log K/L ratio (t-1)	0.094	0.107	0.097	0.452	0.529	0.503
	[56.64]***	[4.42]***	[1.48]	[154.78]***	[23.50]***	[8.88]***
Return on equity (t-1)	0.030	0.116	-0.048	0.021	-0.038	-0.123
	[9.34]***	[2.94]***	[-0.62]	[3.89]***	[-0.86]	[-1.46]
Crisis x Return on equity (t-1)	0.029	0.152	0.192	0.128	0.288	0.218
	[7.26]***	[1.72]*	[1.65]*	[18.45]***	[5.28]***	[1.87]*
Interest rate coverage (t-1)	0.004	0.003	-0.017	0.004	-0.001	-0.007
	[1.30]	[0.47]	[-0.40]	[1.29]	[-0.10]	[-0.31]
Crisis x Int. rate cover. (t-1)	0.001	-0.009	0.020	0.026	0.017	0.028
	[0.43]	[-1.20]	[0.47]	[7.55]***	[2.11]**	[1.18]
Liquidity ratio (t-1)	-0.011	-0.017	-0.017	0.028	0.076	0.133
	[-8.01]***	[-0.84]	[-0.25]	[16.20]***	[4.49]***	[3.01]***
Crisis x Liquidity ratio (t-1)	0.007	-0.012	0.038	0.004	0.007	-0.055
	[5.13]***	[-0.68]	[0.75]	[2.21]**	[0.51]	[-1.49]
Debt overhang	0.001	0.001	0.002	0.002	0.006	0.004
	[4.90]***	[1.37]	[0.90]	[7.35]***	[6.69]***	[1.84]*
Crisis x Debt overhang	-0.008	-0.007	-0.006	-0.017	-0.009	-0.006
	[-29.20]***	[-6.39]***	[-2.39]**	[-53.46]***	[-9.19]***	[-2.97]***
Hor. spillover (Top-300)	0.001	0.000	-0.000	-0.000	0.000	-0.000
	[3.73]***	[0.51]	[-0.21]	[-0.25]	[0.54]	[-0.24]
Crisis x Hor_Top-300	-0.002	-0.001	-0.002	-0.001	-0.000	-0.000
	[-7.80]***	[-1.20]	[-0.83]	[-3.32]***	[-0.51]	[-0.04]
Backward spillover (Top-300)	0.009	0.017	0.028	0.004	0.005	-0.011
	[3.91]***	[1.95]*	[1.14]	[1.73]*	[0.62]	[-0.60]
Crisis x Backward_Top-300	0.009	-0.000	-0.008	0.004	-0.002	0.013
	[5.45]***	[-0.03]	[-0.40]	[2.13]**	[-0.42]	[0.97]
Forward spillover (Top-300)	-0.010	-0.018	-0.029	-0.001	-0.002	0.010
	[-4.64]***	[-2.20]**	[-1.24]	[-0.48]	[-0.29]	[0.56]
Crisis x Forward_Top-300	0.006	0.013	0.029	0.030	0.067	0.031
	[1.63]	[0.81]	[0.54]	[7.69]***	[5.19]***	[0.98]
Constant	-0.139	0.884	2.098	5.393	6.223	7.657
	[-6.69]***	[3.04]***	[2.80]***	[170.52]***	[21.16]***	[9.23]***
Observations	671,312	20,643	2,814	684,196	20,660	2,818
R-squared	0.928	0.796	0.770	0.965	0.964	0.969

Notes: Dependent variable: Log of column headline variable. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A8: Results accounting for company size, Bulgaria

	Employment			Investment		
	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)
Crisis dummy	0.039 [0.38]	-0.309 [-1.40]	-0.699 [-1.02]	1.599 [7.98]***	1.251 [3.37]***	-1.018 [-0.65]
Exporter dummy						
Size (Log empl.) (t-1)	0.332 [69.87]***	0.573 [33.05]***	0.56 [9.55]***	0.274 [34.35]***	0.305 [14.29]***	0.139 [2.59]***
Log K/L ratio (t-1)	0.022 [6.36]***	0.002 [0.30]	0.035 [2.11]**	0.056 [8.39]***	0.005 [0.42]	-0.062 [-1.53]
Return on equity (t-1)	0.005 [1.89]*	0.016 [2.58]***	0.005 [0.35]	-0.004 [-0.58]	-0.008 [-0.65]	-0.055 [-1.18]
Crisis x Return on equity (t-1)	0.025 [9.16]***	0.012 [1.70]*	0.028 [1.72]*	0.024 [3.76]***	0.032 [2.51]**	0.094 [1.85]*
Interest rate coverage (t-1)	0.040 [18.14]***	-0.004 [-0.86]	-0.026 [-1.95]*	0.068 [13.16]***	0.025 [2.27]**	-0.050 [-1.87]*
Crisis x Int. rate cover. (t-1)	-0.023 [-10.31]***	0.005 [0.97]	0.019 [1.18]	-0.032 [-6.13]***	-0.017 [-1.44]	0.056 [1.75]*
Liquidity ratio (t-1)	-0.026 [-9.18]***	-0.021 [-2.17]**	0.030 [0.38]	-0.061 [-9.01]***	-0.063 [-3.33]***	0.047 [0.53]
Crisis x Liquidity ratio (t-1)	0.015 [5.31]***	0.005 [0.51]	-0.07 [-0.85]	0.006 [0.89]	-0.01 [-0.54]	-0.086 [-0.99]
Debt overhang	0.009 [1.99]**	0.003 [0.33]	-0.018 [-1.50]	0.044 [6.66]***	0.042 [2.69]***	0.000 [-0.00]
Crisis x Debt overhang	-0.032 [-7.21]***	-0.035 [-3.45]***	-0.056 [-1.60]	-0.042 [-6.12]***	-0.064 [-3.77]***	-0.021 [-0.42]
Hor. spillover (Top-300)	-0.014 [-2.89]***	0.017 [2.09]**	0.028 [2.48]**	-0.053 [-5.48]***	0.039 [2.09]**	0.025 [0.25]
Crisis x Hor_Top-300	-0.003 [-0.67]	-0.019 [-2.56]**	-0.036 [-3.00]***	0.048 [5.23]***	-0.034 [-1.97]**	-0.033 [-0.35]
Backward spillover (Top-300)	-0.428 [-25.99]***	-0.072 [-1.76]*	-0.044 [-0.33]	0.060 [1.90]*	0.107 [1.32]	0.057 [0.20]
Crisis x Backward_Top-300	0.005 [1.18]	0.001 [0.10]	0.021 [1.33]	-0.064 [-6.07]***	0.005 [0.32]	0.024 [0.41]
Forward spillover (Top-300)	0.119 [7.01]***	-0.180 [-4.20]***	-0.184 [-1.84]*	0.166 [5.02]***	0.060 [0.76]	0.152 [0.55]
Crisis x Forward_Top-300	-0.008 [-0.77]	0.043 [1.83]*	0.077 [1.07]	-0.158 [-8.05]***	-0.101 [-2.60]***	0.065 [0.41]
Constant	4.191 [38.97]***	4.230 [16.62]***	4.694 [5.94]***	0.944 [4.45]***	1.973 [4.50]***	2.656 [1.51]
Observations	432,434	24,097	2,727	290,314	16,042	862
R-squared	0.907	0.731	0.698	0.929	0.870	0.887

Notes: Dependent variable: Log of column headline variable. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A9: Results accounting for company size, Romania

	Employment			Investment		
	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)
Crisis dummy	-0.322 [-24.78]***	-0.085 [-3.06]***	-0.070 [-1.04]	0.471 [19.98]***	0.378 [6.03]***	0.297 [1.08]
Exporter dummy						
Size (Log empl.) (t-1)	0.543 [145.59]***	0.630 [45.93]***	0.723 [17.75]***	0.303 [58.92]***	0.366 [21.60]***	0.177 [3.11]***
Log K/L ratio (t-1)	0.019 [11.29]***	0.000 [0.06]	0.005 [0.54]	0.071 [21.86]***	0.059 [7.82]***	0.015 [0.38]
Return on equity (t-1)	0.008 [5.85]***	0.014 [3.77]***	0.018 [2.16]**	0.004 [1.46]	-0.001 [-0.08]	-0.008 [-0.24]
Crisis x Return on equity (t-1)	0.024 [14.86]***	0.023 [5.04]***	0.014 [1.13]	-0.012 [-4.06]***	-0.015 [-1.75]*	0.045 [1.36]
Interest rate coverage (t-1)	0.001 [0.81]	-0.014 [-4.04]***	-0.002 [-0.19]	0.041 [12.89]***	0.009 [1.24]	0.046 [1.17]
Crisis x Int. rate cover. (t-1)	0.004 [1.83]*	0.008 [2.00]**	-0.002 [-0.16]	-0.009 [-2.42]**	-0.006 [-0.72]	-0.004 [-0.09]
Liquidity ratio (t-1)	-0.024 [-8.06]***	-0.021 [-2.00]**	-0.002 [-0.05]	-0.086 [-14.60]***	-0.138 [-7.00]***	-0.296 [-3.34]***
Crisis x Liquidity ratio (t-1)	0.012 [4.15]***	-0.009 [-1.04]	0.013 [0.37]	-0.007 [-1.25]	0.066 [3.45]***	0.132 [1.62]
Debt overhang	-0.002 [-0.29]	0.002 [0.52]	0.001 [0.06]	-0.003 [-0.25]	0.053 [3.41]***	0.034 [0.90]
Crisis x Debt overhang	-0.026 [-3.22]***	-0.033 [-5.78]***	-0.034 [-1.74]*	-0.023 [-1.76]*	-0.091 [-5.44]***	-0.036 [-0.60]
Hor. spillover (Top-300)	-0.010 [-9.61]***	-0.004 [-2.63]***	0.001 [0.34]	0.015 [8.07]***	0.012 [3.19]***	0.009 [0.55]
Crisis x Hor_Top-300	0.008 [7.07]***	0.000 [0.27]	0.000 [0.01]	-0.014 [-7.04]***	-0.014 [-3.24]***	-0.001 [-0.03]
Backward spillover (Top-300)	0.011 [2.35]**	0.057 [6.14]***	0.034 [1.57]	0.034 [4.23]***	-0.027 [-1.42]	0.08 [0.94]
Crisis x Backward_Top-300	0.002 [0.72]	-0.009 [-1.72]*	-0.004 [-0.41]	0.000 [0.03]	0.034 [3.31]***	-0.044 [-0.96]
Forward spillover (Top-300)	-0.021 [-5.00]***	-0.035 [-4.12]***	-0.027 [-1.37]	0.055 [7.51]***	0.097 [5.36]***	0.056 [0.69]
Crisis x Forward_Top-300	0.018 [5.58]***	-0.009 [-1.40]	-0.006 [-0.40]	-0.09 [-15.38]***	-0.107 [-7.28]***	-0.1 [-1.47]
Constant	1.077 [74.63]***	1.686 [24.23]***	1.660 [6.68]***	3.149 [126.64]***	3.887 [41.75]***	4.45 [12.73]***
Observations	265,638	33,735	3,772	242,248	19,309	1,081
R-squared	0.922	0.785	0.784	0.887	0.835	0.784

Notes: Dependent variable: Log of column headline variable. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A10: Results accounting for company size, Serbia

	Employment			Investment		
	Small (1)	Medium (2)	Large (3)	Small (1)	Medium (2)	Large (3)
Crisis dummy	1.192 [11.63]***	1.145 [1.53]	22.067 [2.41]**	2.659 [10.76]***	5.244 [4.81]***	16.612 [3.01]***
Exporter dummy	0.064 [3.26]***	-0.142 [-2.59]***	-1.264 [-1.27]	0.067 [1.51]	0.063 [0.52]	-0.057 [-0.07]
Size (Log empl.) (t-1)	0.534 [101.34]***	0.553 [9.85]***	0.382 [0.86]	0.505 [54.93]***	0.350 [7.82]***	0.411 [1.97]*
Log K/L ratio (t-1)	0.016 [6.55]***	0.027 [1.28]	0.480 [1.57]	0.157 [24.20]***	0.116 [4.55]***	0.355 [2.89]***
Return on equity (t-1)	0.005 [2.98]***	-0.024 [-1.41]	-0.014 [-0.07]	-0.046 [-11.02]***	-0.056 [-2.38]**	0.008 [0.07]
Crisis x Return on equity (t-1)	0.021 [10.75]***	0.034 [1.70]*	0.189 [1.01]	0.076 [16.79]***	0.086 [3.45]***	0.012 [0.10]
Interest rate coverage (t-1)	0.013 [7.31]***	0.018 [1.48]	0.022 [0.18]	0.056 [13.48]***	0.047 [2.31]**	0.072 [0.84]
Crisis x Int. rate cover. (t-1)	-0.002 [-0.99]	0.000 [-0.02]	-0.155 [-1.04]	0.003 [0.64]	-0.034 [-1.46]	-0.018 [-0.16]
Liquidity ratio (t-1)	-0.001 [-0.13]	0.024 [0.45]	-0.238 [-0.32]	-0.069 [-6.25]***	-0.033 [-0.52]	0.397 [0.80]
Crisis x Liquidity ratio (t-1)	0.002 [0.42]	-0.215 [-2.49]**	-0.202 [-0.19]	-0.087 [-7.78]***	-0.144 [-2.25]**	-0.649 [-0.84]
Debt overhang	0.004 [1.55]	0.019 [1.82]*	0.131 [1.33]	0.050 [9.75]***	-0.002 [-0.12]	0.011 [0.13]
Crisis x Debt overhang	-0.029 [-11.30]***	-0.051 [-3.37]***	-0.178 [-1.47]	-0.027 [-4.90]***	-0.024 [-1.19]	-0.002 [-0.02]
Hor. spillover (Top-300)	0.020 [5.76]***	0.025 [0.88]	1.655 [3.26]***	0.010 [1.27]	0.009 [0.25]	0.198 [0.83]
Crisis x Hor_Top-300	-0.024 [-7.61]***	-0.041 [-1.45]	-1.494 [-2.85]***	0.002 [0.32]	-0.024 [-0.74]	-0.228 [-0.98]
Backward spillover (Top-300)	-0.057 [-4.27]***	0.097 [0.91]	-0.766 [-0.98]	0.350 [11.08]***	0.121 [0.79]	-0.267 [-0.47]
Crisis x Backward_Top-300	0.003 [1.04]	-0.018 [-0.86]	0.538 [2.01]*	-0.017 [-2.32]**	-0.086 [-2.89]***	-0.174 [-1.03]
Forward spillover (Top-300)	0.025 [1.74]*	-0.091 [-0.77]	1.879 [2.13]**	0.095 [2.76]***	0.391 [2.40]**	1.444 [2.15]**
Crisis x Forward_Top-300	-0.099 [-11.17]***	-0.044 [-0.71]	-1.236 [-1.66]	-0.247 [-11.66]***	-0.415 [-4.52]***	-1.217 [-2.52]**
Constant	0.831 [7.90]***	1.745 [2.52]**	-23.833 [-2.59]**	-2.252 [-8.88]***	-0.997 [-0.92]	-10.363 [-1.93]*
Observations	151,929	2,668	87	142,137	2,365	80
R-squared	0.922	0.812	0.829	0.881	0.888	0.959

Notes: Dependent variable: Log of column headline variable. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table A11: Results for sales (full model)

	HR (1)	HU (2)	BG (3)	RO (4)	RS (5)
Crisis dummy	0.723	-0.861	0.510	-0.456	0.115
	[3.56]***	[-4.08]***	[3.97]***	[-16.02]***	[15.61]***
Exporter dummy	0.180	0.176			0.338
	[31.90]***	[17.27]***			[10.47]***
Size (Log empl.) (t-1)	1.549	0.481	0.390	0.656	0.443
	[89.15]***	[107.46]***	[79.43]***	[108.54]***	[76.07]***
Log K/L ratio (t-1)	0.219	0.266	0.084	0.304	0.046
	[49.14]***	[69.36]***	[31.65]***	[60.06]***	[17.46]***
Return on equity (t-1)	0.061	0.053	0.103	0.067	0.153
	[12.07]***	[16.59]***	[26.42]***	[25.45]***	[42.83]***
Crisis x Return on equity (t-1)	-0.013	-0.006	-0.021	-0.015	-0.042
	[-1.95]*	[-2.00]**	[-6.28]***	[-9.04]***	[-13.80]***
Interest rate coverage (t-1)	0.013	-0.012	0.017	0.033	0.032
	[12.76]***	[-4.01]***	[4.47]***	[16.16]***	[12.05]***
Crisis x Int. rate cover. (t-1)	0.006	0.018	-0.008	-0.014	0.002
	[4.84]***	[6.13]***	[-2.11]**	[-6.67]***	[0.72]
Liquidity ratio (t-1)	-0.035	0.006	-1.814	-0.016	-0.019
	[-6.48]***	[1.61]	[-25.69]***	[-5.93]***	[-3.57]***
Crisis x Liquidity ratio (t-1)	0.007	-0.041	1.714	0.001	-0.015
	[1.29]	[-10.48]***	[16.77]***	[0.31]	[-2.74]***
Debt overhang	-0.028	-0.019	-0.039	-0.126	-0.024
	[-55.40]***	[-12.10]***	[-21.57]***	[-45.86]***	[-14.64]***
Crisis x Debt overhang	-0.017	-0.023	-0.033	0.021	-0.038
	[-28.30]***	[-14.92]***	[-17.63]***	[6.55]***	[-22.47]***
Hor. spillover (Top-300)	0.001	0.006	0.009	-0.021	-0.033
	[0.81]	[6.32]***	[4.35]***	[-16.36]***	[-11.65]***
Crisis x Hor_Top-300	-0.003	-0.007	-0.012	0.014	0.027
	[-5.00]***	[-6.67]***	[-5.48]***	[10.25]***	[9.02]***
Backward spillover (Top-300)	0.152	-0.099	-0.099	0.077	-0.002
	[10.68]***	[-6.88]***	[-6.12]***	[8.04]***	[-0.76]
Crisis x Backward_Top-300	-0.026	-0.001	-0.060	-0.004	0.005
	[-9.87]***	[-0.20]	[-12.67]***	[-1.67]*	[1.54]
Forward spillover (Top-300)	-0.149	-0.279	0.106	-0.042	-0.035
	[-12.81]***	[-15.66]***	[5.60]***	[-23.51]***	[-11.81]***
Crisis x Forward_Top-300	-0.018	0.066	0.015	0.050	0.001
	[-1.95]*	[4.65]***	[1.35]	[25.34]***	[0.28]
Constant	8.497	8.748	4.332	2.633	4.568
	[60.28]***	[35.95]***	[44.68]***	[23.37]***	[330.68]***
Observations	353,283	551,244	327,667	262,506	206,716
R-squared	0.914	0.960	0.941	0.942	0.904

Notes: Dependent variable: Log of Sales. Fixed effects estimation. Standard errors clustered at industry level. Robust t-statistics in brackets. *** p<0.01, ** p<0.05, * p<0.1. Country abbreviations are defined in Table 1.

Charts

Chart A1: Overall effects of deleveraging the top 300 most indebted firms on a typical firm's sales
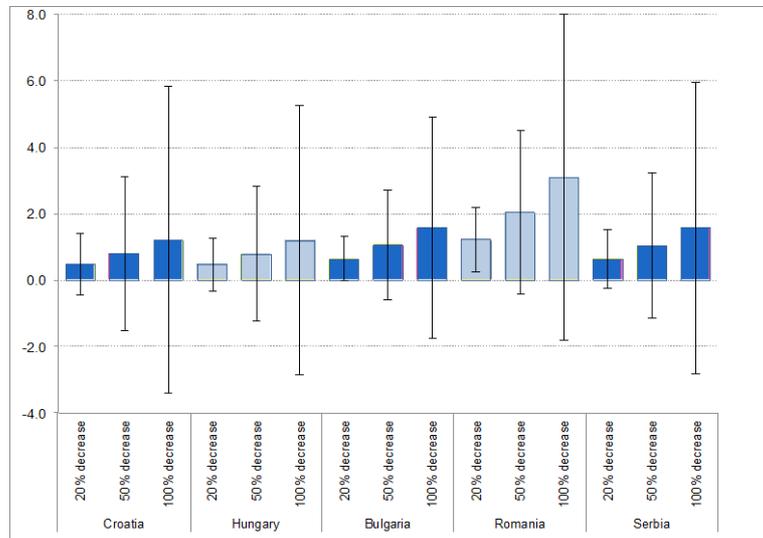
Notes: Change in firm's sales in per cent. Simulation of elimination of 20 per cent, 50 per cent and 100 per cent of debt overhang by the top 300 most indebted firms on an individual firm's change in sales. Calculations based on estimated elasticities for post-crisis period. 90 per cent confidence intervals.

Source: Own calculations.

Chart A2: Overall effects of deleveraging the top 300 most indebted firms on a typical firm's employment
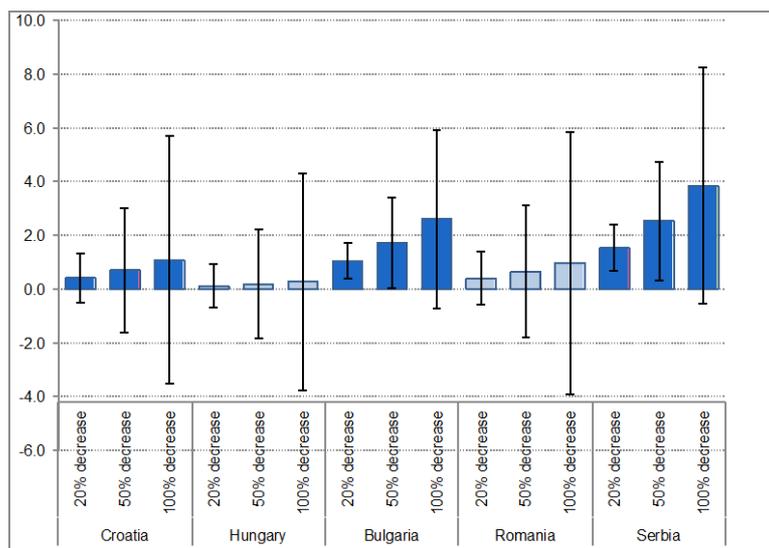
Notes: Change in firm's employment in per cent. Simulation of elimination of 20 per cent, 50 per cent and 100 per cent of debt overhang by the top 300 most indebted firms on an individual firm's change in employment. Calculations based on estimated elasticities for post-crisis period. 90 per cent confidence intervals.

Source: Own calculations.

Chart A3: Overall effects of deleveraging the top 300 most indebted firms on a typical firm's investment

Notes: Change in firm's investment in per cent. Simulation of elimination of 20 per cent, 50 per cent and 100 per cent of debt overhang by the top 300 most indebted firms on an individual firm's change in investment. Calculations based on estimated elasticities for post-crisis period. 90 per cent confidence intervals.

Source: Own calculations.