

ACCESS TO CREDIT OF SMES IN THE CZECH REPUBLIC DURING THE FINANCIAL CRISIS AND IN THE POST-CRISIS PERIOD

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Abstract

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We investigate the impact of the financial crisis on the access of small and medium-sized enterprises in the Czech Republic to external financing. We apply the non-parametric kernel density estimation on a firm-level measure of financing constraints and evaluate its distribution on a balanced panel of SMEs. We focus on financing constraints related to financial health of companies since they determine the commercial banks' lending behaviour. Our results reveal that firms were more constrained during the crisis and their financing constraints did not largely improve after the end of financial crisis. We argue that enterprises were financially constrained during the crisis because of reduced cash-flow and cash holdings.

Keywords: financing constraints, KZ index, credit crunch, financial accelerator, nonparametric estimation, kernel density

INTRODUCTION

The impact of the financial crisis is in the forefront of interest of economic policy makers as well as the issue of many economic studies. As Hernando and Villanueva (2012) and Ivashina and Scharfstein (2010) argue the recent financial crisis significantly affected the interbank market in the Eurozone and this crucial source of liquidity started to experience significant tensions. Also several Central and Eastern European economies were hit particularly hard by the financial crisis. Czech economy suffered from the impact of the crisis with the decline of GDP by 4.6 per cent in 2009 (Fidrmuc and Wörgötter, 2014) and the liquidity of Czech banks declined between 2007 and 2009 (Vodová, 2013). The crisis resulted in consideration of alternative tools to support aggregate demand (Koráb, Kapounek, 2013).

Focusing on the difficulties on the credit market in the Czech Republic raises the question whether the Czech small and medium-sized firms were financially constrained. By financial constraints

we mean frictions which prevent a firm to realize all desired investments not only due to credit constraints but also due to the inability to issue equity or due to problems to issue new bonds (as suggested by Lamont *et al.*, 2001). Since our dataset consists of SMEs, we use the term for access to bank credit. Credit decline may be reasoned either by shortage of bank capital, due to the impact of a macroeconomic shock, by weak performance of borrowers or by the drop in demand for credit (Bernanke and Lown, 1991). In this paper we are working with firm-level observations and examine the performance of borrowers as the determinant of credit provided during the financial crisis.

The aim of the paper is to investigate the impact of the financial crisis on external financing constraints of small and medium-sized enterprises in the Czech Republic. We apply non-parametric kernel density estimation on the measure of financing constraint, namely the KZ index, which is taken as standard method of financing constraints identification.

Usually, the KZ index is used for classification of firms into categories according to their rate of financing constraints (see Li, 2011; Almeida *et al.*, 2002; Yena *et al.*, 201; and Behr *et al.*, 2013). We instead focus on the firm-level distribution of KZ index during the financial crisis, which we date from 2008–2009, and the pre-crisis and post-crisis periods. Because the financial crisis is already taken as finished, it enables us to compare the pre-crisis, crisis and post-crisis levels of financing constraints and argue for the impact of the financial crisis.

The paper is structured as follows: after the introduction in the first part we present the methodology and the data, the following part introduces the results and in the last part we make conclusions.

MATERIALS AND METHODS

Data

The dataset consists of panel data of small and medium-sized enterprises (SMEs) from the Amadeus Bureau van Dijk database. Sample selection process significantly reduced the sample size. We focus on Limited Liability companies¹ and we work with balanced sample of firms for the whole coverage period excluding firms with missing values. Our sample consists of yearly observations of 10 123 firms in the Czech Republic in the period 2005–2011. We excluded observations where sales, tangible fixed assets, long-term debt or loans had negative values to eliminate data collection constraints.

For KZ index calculation firms need to provide data on all of the components of the index for the whole coverage period (2005–2011). This sample selection strategy excludes the enterprises which went bankrupt. The difference between balanced and unbalanced panel accounts to approx. 5 % of firms. We assume that these differences do not significantly change the results. Instead, we observe financing constraints of identical sample of firms which enables us to identify the differences more clearly.

Methodology of KZ Index

KZ index has been proposed for evaluation of external financing constraints of companies by Lamont *et al.* (2001). The KZ index is calculated as follows:

$$KZ_{it} = -1.001909 \frac{CF_{it}}{K_{it-1}} + 3.139193 \frac{B_{it}}{TK_{it}} - 39.3678 \frac{D_{it}}{K_{it-1}} - 1.314759 \frac{C_{it}}{K_{it-1}} + 0.2826389 Q_{it}, \quad (1)$$

where

CF....cash-flow,

K.....refers to property, plant and equipment,

B.....long-term debt plus short-term loans,

TK....total capital which comprises long-term debt, short-term loans and total shareholder's funds,

D.....refers to total dividends,

C.....to cash holdings,

Q.....the Tobin Q, for a firm *i* in time *t*.

We face difficulties with empirical estimation of Tobin Q. Tobin Q is typically defined as the market value of the firm over the book value of its assets. As the firms in our sample are unlisted, we are unable to assess their market value. We follow Konings *et al.* (2003), Bakucs *et al.* (2009), Guariglia *et al.* (2010) and Behr *et al.* (2013) and the firm's sales growth as the proxy for Tobin Q. The proxy for Tobin Q is then calculated as:

$$Q_{it} = - \left(\frac{S_{it}}{S_{it-1}} \right), \quad (2)$$

where

S.....denotes sales of a firm *i* in time *t*.

The negative coefficient of Tobin Q proxy reflects the fact that an investor or a bank are less willing to finance a firm with negative sales growth since it signals worse company performance, risk of decreasing creditworthiness or risk of lower possible future revenues from the investment.

The KZ index is a relative measurement of external financing constraints. Companies with higher KZ index scores are more likely to experience difficulties when financial conditions tighten since they may have difficulty financing their ongoing operations. Increasing KZ index values imply rising external financing constraints. The KZ index in (1) reflects the determinants of external financing constraints, the cash-flow, indebtedness, cash holdings, dividend payments and Tobin Q which captures a firm's investment opportunities.

The coefficients of the KZ index in (1) are adopted by Lamont *et al.* (2001) from an ordered logit model in Kaplan and Zingales (1997) on the sample of low-dividend paying firms. We use the exact specification of the KZ index according to Lamont *et al.* (2001), but use the dataset from Amadeus Bureau van Dijk database.² Within Amadeus we measure property, plant and equipment with tangible fixed assets. The value of *D* always takes the value of 0 since we work with Limited Liability companies which, by law, do not pay dividends.

The KZ index is usually applied for classification of firms into "constrained" and "unconstrained" groups when the first tercile of firms are classified as constrained, the lower tercile then as unconstrained (see Lamont *et al.*, 2001; Almeida *et al.*, 2002; Kaplan

1 The legal form is in the Czech Republic called "Společnost s ručením omezeným", abbreviated as s. r. o.

2 The Lamont *et al.* (2001) results were estimated using COMPUSTAT database.

and Zingales, 1997; Behr *et al.*, 2013). We instead study the development of distribution of KZ index as the relative measure of financing constraints during the period of financial crisis (2008–2009), and pre-crisis (2005–2007) and post-crisis (2010–2011) periods. The shift of the distribution toward higher values of KZ index implies that enterprises face higher financing constraints, i.e. their access to credit worsened, relative to other years.

Methodology of Density Estimate

For the estimation of distribution of given data set we apply non-parametric density estimate. As argued by Wand and Jones (1995) the kernel density estimate is a suitable approach in such cases when corresponding distribution is not known. Cameron and Trivedi (2005) argue that this type of estimator is smoother compared to the histogram and therefore provides better comparability.

The kernel density estimator is a generalization of histogram centered at:

$$\hat{f}(x_0) = \frac{1}{N \times h} \sum_{i=1}^N \frac{1}{2} \times 1\left(\frac{x_i - x_0}{h} < 1\right), \tag{3}$$

where

$x_i, i = 1, \dots, N$ the measured KZ index values,
 h the bandwidth (Rice, 1984).

The estimator $\hat{f}(x_0)$ gives all observations in $\hat{f}(x_0) \pm h$ equal weight. The kernel density estimator can be written in the form (Cameron and Trivedi, 2005):

$$\hat{f}(x_0) = \frac{1}{N \times h} \sum_{i=1}^N K\left(\frac{x_i - x_0}{h}\right), \tag{4}$$

where the weighting function $K(\cdot)$ is called kernel function and satisfies specific mathematical conditions (see Wand and Jones, 1995). The density $\hat{f}(x_0)$ is calculated at a wide range of x_0 values. For the forming of histogram, evaluation at sample values x_1, \dots, x_N , as the density estimator is used. From the group of kernels we use Epanechnikov kernel (Cameron and Trivedi, 2005; Poměnková, 2008).

Decomposition of KZ Index

In the last step of empirical analysis we aim to identify the determinants of financing constraints of SMEs in our sample. We therefore decompose the KZ index to its individual ratios and study their development. Specifically, we calculate each ratio of the KZ index and observe its median value development over time.

RESULTS

In the empirical analysis, we in the first step calculate the KZ index. Consequently, we proceed with calculation of kernel density estimates for each year on the basis of formula (4). The KZ index calculations were performed in Stata 12 and calculations of kernel density estimates were done in Matlab 2011b. Finally, we decompose the KZ index into its components and study their development over time.

In the preliminary analysis we firstly calculate descriptive statistics of the annual KZ index values. The results are presented in Tab. I below. Median values of yearly KZ indexes in Tab. I suggest that during the financial crisis enterprises were more financially constrained (increase to -0.942 in 2009 from -1.459 in 2006). Differences in means between 2006 and 2009 are strongly affected by outlying observations.

Large differences between minimum values and 1st percentile, and maximum values and 99th percentile suggest that a number of firms in the sample have extremely good performance with very low financing constraints, and the data also contain enterprises which face high financing constraints due to their very bad indicators.

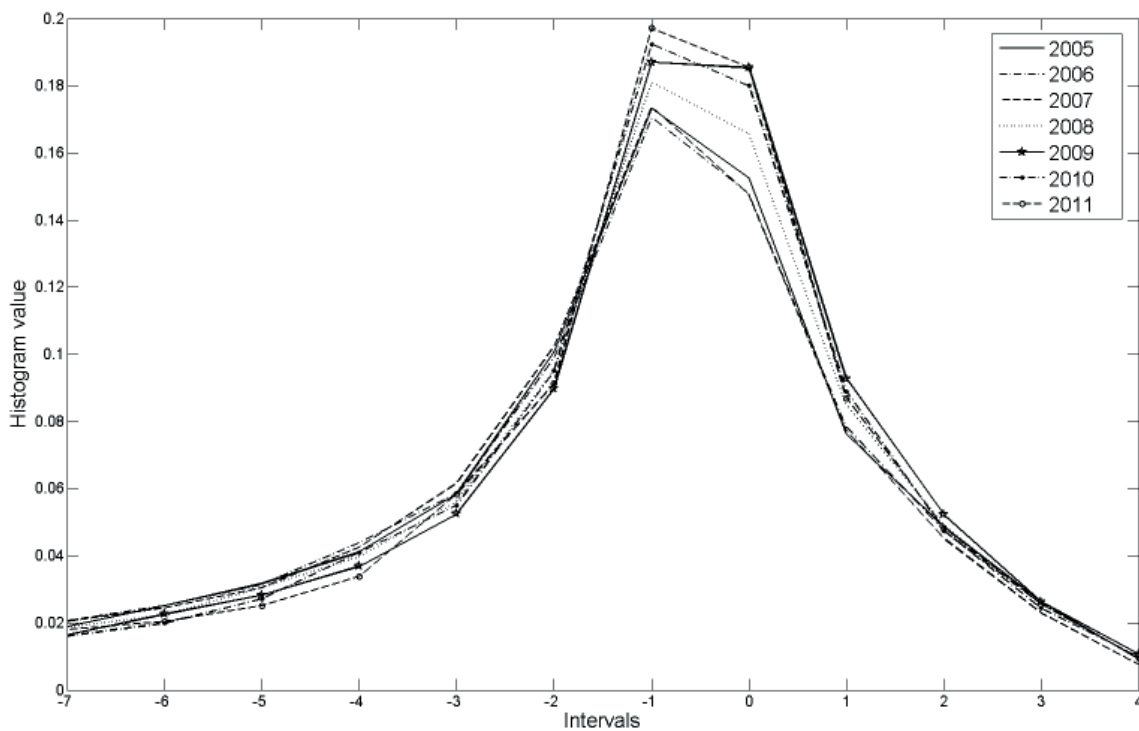
Consequently, we estimate kernel densities. The results are presented in both the two-dimensional and three-dimensional charts (Figs. 1 and 2). The two-dimensional charts of estimated densities provide a graphical comparison of individual density estimate corresponding to each year in 2005–2011 (x -axis denotes intervals of histograms and y -axis value of kernel density estimates of the KZ index corresponding to each year).

Figs. 1 and 2 present slow increase of maximum density estimate as the years increase. In the first two

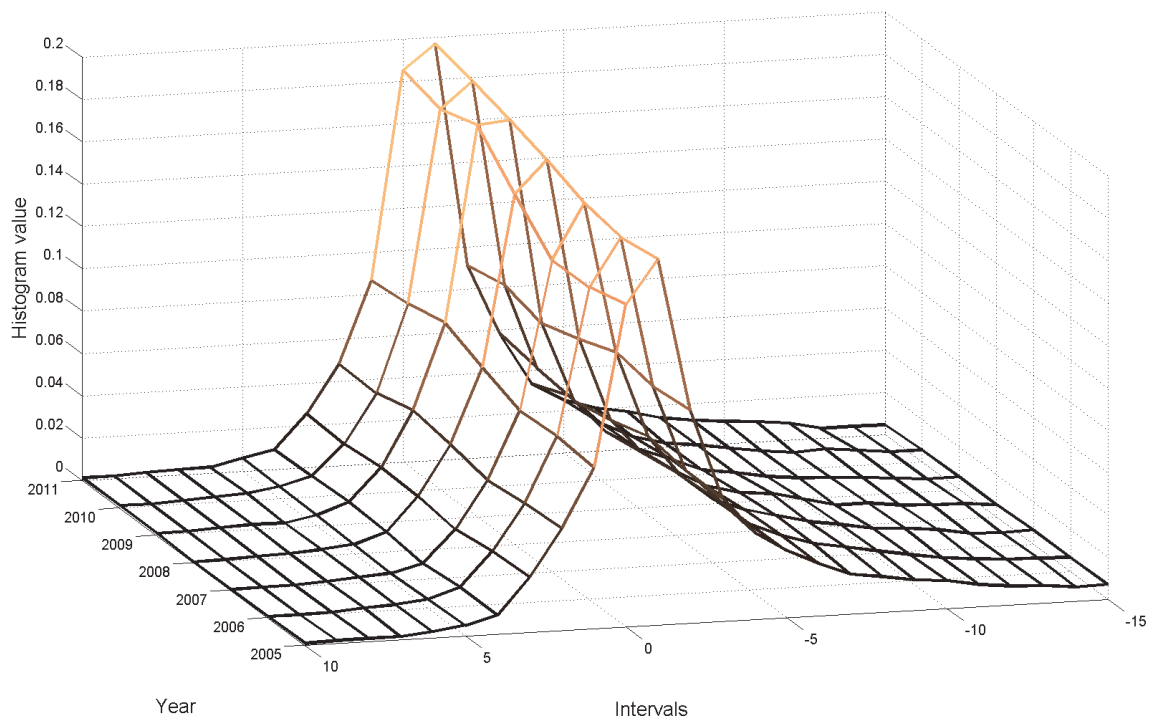
I: Summary statistics of KZ index

| Year | Mean | Median | Min. | Max. | Lowest perc. | Highest perc. | Obs. |
|------|---------|--------|------------|-----------|--------------|---------------|-------|
| 2005 | -15.498 | -1.409 | -9275.931 | 608.903 | -201.916 | 7.421 | 10123 |
| 2006 | -16.702 | -1.459 | -9448.063 | 262.593 | -234.644 | 7.126 | 10123 |
| 2007 | -17.660 | -1.513 | -31119.813 | 6108.823 | -237.784 | 6.789 | 10123 |
| 2008 | -14.479 | -1.189 | -7906.299 | 363.434 | -211.356 | 8.060 | 10123 |
| 2009 | -10.797 | -0.942 | -6175.043 | 2207.197 | -176.453 | 10.551 | 10123 |
| 2010 | -9.643 | -1.008 | -7535.740 | 6816.708 | -185.056 | 10.918 | 10123 |
| 2011 | -10.284 | -0.943 | -9998.732 | 11600.570 | -185.239 | 12.606 | 10123 |

Note: Table reports mean, median, minimum (Min.), maximum (Max.), first percentile (Lowest perc.), 99th percentile (Highest perc.) and number of observations (Obs.) of calculated KZ indexes for countries in the sample
 Source: own calculation



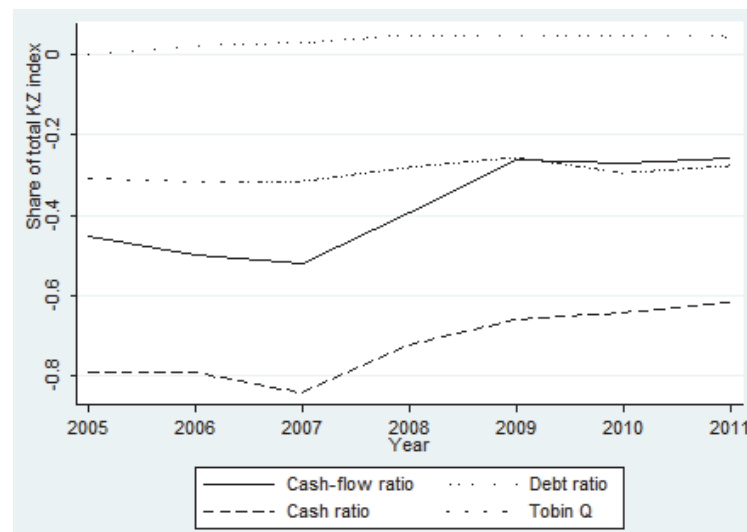
1: Non-parametric density estimates of KZ index, two-dimension



2: Non-parametric density estimates of KZ index, three-dimension

years (2005 and 2006) the maximum value of density estimate is comparable, while after the year 2007 we observe a larger increase. The distribution function shifted towards higher KZ index values after the financial crisis started in 2008, which signals that SMEs had more difficulties to access credit.

As the last step, we decompose the KZ index into individual ratios. Fig. 3 presents the development of median values of cash-flow, debt, cash and Tobin Q ratios. The ratios represent their share on the overall KZ index values for each year. Our results suggest that SMEs experienced worse access to external



3: Decomposition of KZ index for the Czech Republic

financing during the financial crisis because of reduced cash-flow and cash holdings. These two ratios hold negative coefficients within KZ index calculation. Their reduction therefore causes an increase of both ratios and consequently the KZ index as well. Cash flow and cash holdings ratios increased between 2007 and 2009 indicating that these two factors drove the difficulties of SMEs to obtain credit during the financial crisis.

DISCUSSION

Our results reveal that Czech SMEs in our sample were more financially constrained during the crisis mainly because of problems with reduced cash-flow and cash holdings. Financial crisis and consequent decline of GDP affected SMEs' performance which was then reflected in increased rejection of loan applications. Banks tended to refuse new applications since the balance sheet indicators of

applicants indicated risks of low creditworthiness. Theoretically, this link was described by Bernanke *et al.* (1996) and Bernanke *et al.* (1999) who introduced the financial accelerator theory. The principle of financial accelerator refers to the amplification of initial macroeconomic shocks brought about by changes in credit-market conditions. Economic decline leads to worse performance of firms resulting in deterioration of their balance sheet indicators. Consequently, new loan applications are more likely rejected because of the risk of lower creditworthiness. This credit rationing process further amplifies the recession.

We also argue that access to credit did not largely improve after the end of the financial crisis. This is due to the fact that even after the financial crisis ended Czech economy was still in recession. The above mentioned factors were therefore still determining the access to credit of Czech SMEs.

CONCLUSION

The paper investigates the impact of the financial crisis on external financing constraints of small and medium-sized enterprises in the Czech Republic. We evaluate every firm's financing constraints with the KZ index and study the distribution of this financing constraint measure during the financial crisis (2008–2009), and in pre-crisis (2005–2007) and post-crisis (2010–2011) years. We focus on financing constraints related to financial health of companies since they determine the commercial banks' lending behaviour. Our results reveal that SMEs were more constrained during the crisis and that their financing constraints did not largely improve after the end of financial crisis. We argue that enterprises were financially constrained during the crisis because of the problems with reduced cash-flow and cash holdings. The contribution of the paper is in methodological approach studying financing constraints of SMEs through the analysis of non-parametric kernel estimation.

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