How Do Capital Requirements Affect the Performance of the Real Sector? Microevidence from Selected EU Countries

(Job Market Paper) *

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Abstract

I analyze the response of small versus large firms to changes in banking capital position. I study how this response varies with firms' dependence on external finance as well as their age using an annual firm-level dataset containing information on more than half a million public and private firms in selected EU countries. The results reveal statistically significant effects of changes in banking capital on real sales growth of small and medium firms while large firms are not affected. They also indicate that a change in banking sector capital position has a stronger impact on small firms in industries with higher dependence on external finance. Another major finding is that although small and medium firms depend much more on external finance in their earlier ages, changes in bank capital position affect them more in their late ages. Intuitively, this may indicate that banks are reluctant to provide credit to a large number of young firms in European Union.

KEYWORDS: Firm Size, External Finance, Banking Regulation, Capital Requirements

JEL CLASSIFICATIONS: G21, G28, E44, L25

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1 Introduction

Well capitalized financial institutions are crucial for the operation of a modern economy. This has been brought into stark focus by the recent credit crunch in the United States and its repercussions worldwide. The massive writedowns and credit losses tied to the 2007–2008 collapse of the U.S. subprime mortgage market have constrained banks' ability as well as reduced their willingness to supply credit to the real sector. The U.S. government even decided to inject $250 billion of capital directly into banks by buying their stocks in October 2008 in an effort to recapitalize them and prevent an economic slowdown. My hypothesis is that one of the major factors constraining banking credit supply is the ability of banks to meet capital requirements. If a bank faces difficulties in meeting them it has to either decrease the amount of risky assets or substitute it by the assets with a lower risk weight until a bank raises its capital. For example, Bank of America Corp sold $6 billion of perpetual preferred shares and $6 billion of convertible preferred stock in January 2008 to meet the target level of capitalization. Among the largest U.S. banks who sold stocks, shares or debt to raise capital in 2007–2008 are Bear Sterns, Citigroup, Morgan Stanley, Merrill Lynch. However, raising capital might be costly if the bank is in a weak financial position or borrowing conditions are tight at the credit market. A reduction in the availability of bank credit might affect the real sector, especially small firms for which banks is the prime source of finance.

According to the regulatory framework, adopted by major developed countries, financial intermediaries must maintain a required ratio of own capital to risk–weighted assets.[1] I examine whether the changes in this ratio have had an impact on real sector performance in European Union (EU) countries. In particular, I examine whether this impact, if it exists, varies with firm's size as well as industry's dependence on external finance. The effect of changes in banking capital ratio on firms' performance is estimated using annual firm level AMADEUS dataset for the period 1997–2004 for thirteen EU countries. Current empirical research on the effect of financial sector on the real one lacks empirical studies using firm-level data. In addition, most available studies exploring firm-level data are based on datasets containing only publicly traded companies whose reliance on bank finance is much smaller than that of smaller firms. In the AMADEUS dataset only about 0.3% of companies are listed at the stock exchange, which allows me to estimate the impact of changes in banks' capital position on the growth of small and medium firms. I find that an increase in banks' total capital ratio has a negative impact on sales and employment of small and medium firms while large firms are not affected. Furthermore, the effect is stronger for small firms than for medium ones. Another major finding is that the impact of changes in bank capital on firms' growth varies with industry only for small firms. An increase in the total capital ratio has a more negative effect on output in industries where small firms rely more heavily on external finance.

[1] Assets and off-balance sheet items are divided into four broad categories according to perceived risks and a weight from 0 percent to 100 percent is assigned to each category.

There is a well documented relationship between the size of the firm and the form of its external financing. The informational opaqueness of small businesses without an established reputation for quality prevents them from attracting external finance in public markets. Therefore, small firms rely heavily on bank lending as a prime source of external finance while large public companies may substitute bank credit by credit in a form of equity, public debt or commercial paper. If banks face difficulties to meet capital requirements and have to cut their lending to the real sector then bank dependent borrowers like small businesses suffer the most (Peek and Rosengren (1995)). The hypothesis of capital requirements' implementation as a primary cause of credit crunch in the United States in early 90s was explored in Berger and Udell (1994), Bernanke and Lown (1991), Peek and Rosengren (1995), etc. The response of small versus large manufacturing firms to tightening monetary conditions was well documented in Gertler and Girlchrist (1994). They found that small firms experienced a much bigger decline that followed tightening monetary policy.

This paper aims at partially filling the gap in the current empirical literature on the connection between financial intermediaries and firm performance based on firm-level data representing not only public but also small private firms. I use a comprehensive panel dataset containing firm-level information for more than half a million construction and manufacturing firms in thirteen EU countries. The vast majority of the sample is represented by small private firms which allows me to differentiate the impact of changing

banking conditions on the economic activity at the firm level. I use the growth rate of real sales as an indicator of firm's economic activity and find a statistically significant negative relationship between an increase in the total capital ratio and small and medium firms' performance in European Union.

I estimate the impact of banking capital regulation on real sector performance for various subsamples, partitioned on the basis of firms' size and age. Thus, firms were divided into big, medium and small according to their turnover, total assets or the number of employees. They were also partitioned into the young and old category according to the age of the firm. As a measure of changes in banking sector capital I use a change in the total capital ratio for a particular country in a given year. The results suggest that banking capital regulation affects primarily small and medium firms. I also find the stronger negative impact of banking credit shortage on small firms in industries with high external financial dependence and the effect varies with firms' age. This may indicate that there is less bank credit available to young small and medium firms until they establish credit and/or performance history while bank finance is not a prime source of finance for big firms.

There is an extensive literature on financial development and industry dependence on external finance. Rajan and Zingales (1998) find that industries that more heavily depend on external finance should benefit more on the level of country's financial development. Larrain (2006) show that industrial volatility is higher in countries with higher bank credit.

Following the methodology of Rajan and Zingales (1998) and using the same dataset I computed the index of external financial dependence for the U.S. industries in 1990-2004. The major advantage of such methodology is that it allows me to avoid endogeneity problems if I estimate the impact of industries' financial dependence on firms growth in the EU. First, I establish the degree of financial dependence is decreasing with the size of the firm although it remains statistically significant in all specifications. Second, a more interesting finding is that the impact of banks' credit availability measured as a change in the total capital ratio varies by industry's external financial dependence only for small firms. Intuitively, this may suggest that medium firms have longer credit history as well as are able to provide better collateral while bank financing is not a prime source for large firms.

There is a fast growing literature on real effects of financial sector condition on either firm or industry growth. Beck et al. (2005b) established that industries in the countries with better developed financial markets grow faster. Demirguc-Kunt and Maksimovich (1998) investigated the relationship between the development of the financial sector and externally financed growth of the firm. According to their results, obtained on a sample of the largest manufacturing firms in thirty countries, the usage of external finance is positively related to the size of the banking sector and the efficiency of the legal system. Beck et al. (2005a) found that smaller firms benefit the most from the financial development since the development of the financial sector weakens a number of barriers to firm

growth.

The paper is organized as follows. Section II provides a literature review on the impact of financial sector on the real sector performance and describes the potential impact of capital adequacy requirements on real sector. Section III describes my data. Section IV describes the empirical strategy and discusses the empirical results. Section V concludes.

2 Background

2.1 Firms' dependency on bank finance

My hypothesis, that changes in banking capital position may have a significant impact on real sector performance, builds on the significance of bank credit to the sectors likely to be bank dependent. Thus, shocks to banking sector and the consecutive change in the availability of bank credit to the economy may disproportionably affect small and large firms. Bank credit is a prime source of small business finance. As noted in Demyanyk et al. (2007), the informational opaqueness of small business without an established reputation for quality prevents them from attracting external finance in public markets. Using the 1993 National Survey of Small Business Finances (NSSBF), Berger and Udell (1998) document that bank debt is the most important source of external finance for small firms. At the same time "large" public companies have much better access to capital market

and may substitute the bank credit by issuing different forms of equity, public debt or commercial paper (Kashyap et al. (1993)).

In addition, I expect that firms in industries with higher dependence on bank finance demonstrate a stronger response to changes in bank capital positions. Rajan and Zingales (1998) (henceforth RZ) first documented that industries that more heavily depend on external finance should also benefit more on the level of country's financial development. They assumed that some industries depend more on external finance just because of technological reasons and these technological differences between industries are persistent across countries. Making such assumptions allowed them to use an industry's dependence on external funds in the United States that has a relatively frictionless financial system as a measure of its dependence in other countries. As long as the index of external financial dependence is calculated only for U.S. industries and technology factors influencing external finance dependence are constant across countries, this index can be used to evaluate the impact of country's financial development on industries or/and firm growth. Using this methodology RZ find that higher financial development has a strong positive impact on industries that heavily rely on external finance. Using approach similar to that of RZ, Beck et al. (2005b) discover that industries composed of smaller firms grow faster in countries with more developed financial markets. Cetorelli and Gambera (2001) present another interesting finding on the connection between industries' growth and financial markets. They show that industries with higher dependence on external

finance are growing faster in countries with higher concentration of the banking sector.

Banking finance appears to be an important source of funds for small businesses in all years of their performance. According to Berger and Udell (1998), bank debt is about 16% of total assets for "infant" firms (0-2 years) and reaches almost 31% for "adolescent" firms (3-4 years). Although it goes down to 17% for small firms that are 5 years or older, bank debt still remains the most important source of external finance for such firms. At the first glance, provision of so much credit to young firms ("infant" and "adolescent" in Berger and Udell (1998) classification) looks perhaps surprising. However, as noted in Demyanyk et al. (2007) and Berger and Udell (1998), it might be explained by an important characteristic of small business finance — the financial intertwining of owners and their businesses. Thus, substantial part of small business loans is guaranteed by personal assets and business owners will incur much of the total losses if the loans are not repaid.[2] In addition, the evaluation of the business owner's credit report allows a financial institution to assess the creditworthiness of the borrower and probability of loan repayment.

There is a fast growing literature on real effects of financial sector condition on either firm or industry growth.[3] Demirguc-Kunt and Maksimovich (1998) investigated the relationship between the development of the financial sector and externally financed growth

[2]Ang (1992) finds that about 40% of small business loans are guaranteed or secured by personal assets.

[3]For an excellent survey of theoretical and empirical research on the connection between finance and economic growth see Levine (2004).

of the firm. According to their results, obtained on a sample on the largest manufacturing firms in thirty countries, the usage of external finance is positively related to the size of the banking sector and the efficiency of the legal system. Beck et al. (2005a) found that smaller firms benefit the most from the financial development since the development of the financial sector weakens a number of barriers to firm growth. Cetorelli (2004) shows that higher concentration in banking sector results in larger firms' size in financially dependent sectors. However, the influence of bank concentration on firms size is substantially lower in EU countries due to pro-competitive banking regulation. Firms have better access to external funds in competitive environment that reduces the average firm size.

2.2 Capital adequacy requirements and availability of bank credit

In 1988, the G-10 countries agreed to implement common capital adequacy requirements by adopting the Basel I Accord. The major purpose of these requirements was to promote higher stability of the banking system by imposing restrictions on banks' assets according to perceived risks. Since then, the Accord has been implemented in about 100 countries (Furfine et al. (1999)). [4]

[4]EU first implemented Basel I Accord by adopting the Solvency Ratio Directive (89/647/EEC) and the Own Funds Directive (89/299/EEC) that took into force in January 1991. These directives were repealed and replaced by the Banking Consolidation Directive (2000/12/EC). The 1993 Capital Adequacy Directive (93/6/EEC) introduced additional provisions to market risk calculation while the Capital Adequacy Directive II (98/31/EC) provided banks with possibility to calculate capital requirements using internal models. At the beginning of 2008 EU substituted Basel I Accord by a new, much more sophisticated, capital requirement regulations (Basel II Accord).

According to the adopted regulatory framework, assets and off-balance sheet items are divided into four broad categories and a weight from 0 percent to 100 percent is assigned to each category. For example, cash and government securities have a 0% weight, interbank and securitized loans have 20% and 50% weight respectively, while ordinary loans have to be weighted at 100%. Financial intermediaries subject to this regulation must maintain a ratio of own capital to the sum of risk-weighted assets of at least 8 percent (total capital ratio (TCR)). Thus, banks have two options to meet the capital standards. First, they may raise new capital. [5] It should be mentioned that large, publicly traded banks have more options compared to small ones to raise new capital. The former are able to issue new stock, sell more subordinated debt, merge with stronger banks or attract outside investor while the latter are just limited to the last two. Second, banks can decrease the amount of risky assets in their portfolios by cutting lending or substitute them by the assets with a lower risk weight.[6] However, there is tradeoff between these two options. Raising capital might be costly if bank is in a weak financial position while decreasing risky assets hurts profitability. Therefore, banks adjust their capital ratios to meet the requirements in the manner they believe to be the most cost efficient. Available research is consistent with this view (Furfine et al. (1999)). Banks are cutting back their lending

[5]For example, Bank of America Corp sold USD 6 billion of perpetual preferred shares and USD 6 billion of convertible preferred stock. According to the company's CEO Kenneth Lewis, the purpose was to meet the target level of the capital ratio (source: `http://www.bloomberg.com/apps/news?sid=aOmfse2oLF9Y&pid=20601087`). Among other biggest U.S. banks who sold stocks or shares after a massive writedowns and credit losses tied to 2007 collapse of the U.S. subprime mortgage market to raise capital were Bank of America, Bear Sterns, Citi, Morgan Stanley, Merrill Lynch.

[6]For example, substitute ordinary or/and securitized loans by interbank loans or/and government securities.

only if it is too costly for them to raise new capital.

On average, banks need about 1.6 years to restore their capital positions after becoming undercapitalized (Barakova and Carey (2001)). Hancock et al. (1995) estimates that it takes up to a year for a bank capital to adjust to a capital shock. If economic conditions are unfavorable for raising new capital during this period then banks will have to cut their lending to meet the capital standards, which, in turn, might create the credit crunch affecting the real economy. As was discussed in the previous subsection, bank credit is a prime source of finance for small businesses while most of the large firms have a possibility to substitute the bank credit by issuing different forms of equity, public debt or commercial paper. Therefore, especially small firms are likely to be affected the most by banks' decision to cut lending in order to meet capital requirements after capital shock.

The empirical framework of this paper is based on a theoretical model developed by Bernanke and Blinder (1988). The model describes the response of output and interest rates to the credit supply shock. I am following the version of this model presented in Freihas and Rochet (1997), however, preserving some notation from the original paper. There is a world with one good, three bank assets (reserves, R; bonds, B^b; loans, L^b), bank liabilities: deposits, D^b and four type of agents: households, firms, banks and the government (superscript b refers to banks). Real savings of the households $S(y, i)$ depend

on real income y, interest rate on bonds i and are allocated between the two assets:

$$S(\underset{+}{y}, \underset{+}{i}) = D^h(\underset{+}{y}, \underset{-}{i}) + B^h(\underset{+}{y}, \underset{+}{i}), \tag{1}$$

where superscript h denotes households and + or – refer to the sign of partial derivatives.

Firms finance their investments $I(i, \rho)$ that depend on interest rates on bonds i and loans ρ by attracting external finance in a form of bonds, B^f or bank loans L^f.

$$I(\underset{-}{i}, \underset{-}{\rho}) = B^f(\underset{-}{i}, \underset{+}{\rho}) + L^f(\underset{+}{i}, \underset{-}{\rho}), \tag{2}$$

where superscript f denotes firms.

Assuming that bank portfolio does not contain excess reserves, the balance constraint for banks' loanable funds:

$$L^b + B^b + R = D^b, \tag{3}$$

may be rewritten as:

$$L^b + B^b = \frac{1-\tau}{\tau} R, \tag{4}$$

where τ is the required reserve rate and $R = \tau * D^b$.

Banks allocate loanable funds by optimizing:

$$\begin{cases} L^b = \mu(\underset{-}{i}, \underset{+}{\rho})R \\ B^b = \upsilon(\underset{+}{i}, \underset{-}{\rho})R, \end{cases}$$

with $\mu(i,\rho) + \upsilon(i,\rho) = \frac{1-\tau}{\tau}$.

Government in this model finances real expenditures G by borrowing from banks' reserves R and by issuing bonds B^g:

$$G = R + B^g. \tag{5}$$

The equilibrium in the money market is described by LM curve:

$$D^h(\underset{+}{y}, \underset{-}{i}) = \frac{1}{\tau}R. \tag{6}$$

Equilibrium in the credit market is:

$$L^f(\underset{+}{i}, \underset{-}{\rho}) = \mu(\underset{-}{i}, \underset{+}{\rho})R, \tag{7}$$

and equilibrium in the goods market is:

$$I(\underset{-}{i}, \underset{-}{\rho}) + G = S(\underset{+}{y}, \underset{+}{i}). \tag{8}$$

Using the signs of partial derivatives, equation (7) can be solved for ρ:

$$\rho = \phi(\underset{+}{i}, \underset{-}{R}). \tag{9}$$

Substituting equation (9) into (8) results in a curve defined by Benanke and Blinder as the commodities and credit (CC) curve:

$$I(\underset{-}{i}, \phi(\underset{+}{i}, \underset{-}{R})) + G = S(\underset{+}{y}, \underset{+}{i}). \tag{10}$$

A graphical illustration of the model is presented in Figure 1. The intersection of CC and LM curves determines the equilibrium level of interest rates and output. The negative credit supply shock is represented by the downward shift of the credit supply function $\mu(i, \rho)$ in this model. It pushes the CC curve downward to CC' along the fixed LM curve. Interest rates on bonds i and output y are both declining but the interest rate on loans ρ rises. Therefore, according to the model, such shock would reduce bank credit to the real sector, GDP and interest rate on government bonds. At the same time, interest rate on

bank loans would go up.

The hypothesis that capital requirements was a primary cause of credit crunch in the United States in early 90s was explored in Berger and Udell (1994), Bernanke and Lown (1991), Peek and Rosengren (1995), Hancock and Wilcox (1998), etc. Hancock and Wilcox (1998) show that real economic activity was dampened by a decline in bank capital and small banks reduced their activity by larger amounts than large banks. Peek and Rosengren (1995) investigate the link between banks' capital regulations and bank lending behavior and find a significant drop in bank lending to bank dependent sectors. Bernanke and Lown (1991) report statistically significant but overall small effect of capital shortage on the availability of loans. They also find little evidence on the link between capital asset ratio and real economic activity. Berger and Udell (1994) find no evidence that this particular credit crunch was a consequence of implementation of risk based capital regulations.

In summary, bank facing a negative capital shock has to either increase bank capital or decrease risky assets in the portfolio to meet capital requirements. Unfavorable macroeconomic conditions might result in the latter choice causing a reduction of bank credit supply. A shortage of loanable funds would result in a slowdown of the real sector, especially hurting small firms that are most vulnerable to bank finance. Now I would like to test whether this hypothesis fits data composed primarily of small private firms in thirteen EU countries.

3 Data

In my analysis, I use annual data on the firm, industry and country level from 1997 to 2004 for thirteen EU countries. The firm–level data are obtained from AMADEUS database that contains financial and ownership information on over 10 million public and private companies from 41 countries. The data on bank capital position are from BANKSCOPE that provides financial information on over 28,000 banks worldwide. The index of industries dependence on external finance was calculated from COMPUSTAT North America that has information on more than 24,000 U.S. and Canadian publicly traded companies. The country level data are obtained from Penn World Tables. This section describes the data extracted from these four sources in detail and provides information on how the variables used in empirical analysis are calculated.

3.1 Firm-level data

AMADEUS (Analyse MAjor Databases from EUropean Sources) database is the cornerstone of this paper's empirical framework. It is a commercial database compiled by Bureau van Dijk. It contains financial and ownership information on over 10 million public and private companies from 41 countries. AMADEUS provides data in a standard company report that includes: 22 balance sheet items, 25 profit and loss account items and 26 financial ratios. The dataset also reports other important firm-level information such as

different industry classification codes, years of companies' incorporation, etc. I use the US Standard Industry Classification (SIC) code system to assign an index of industry's dependence on external finance to each firm. I calculate this index according to RZ using COMPUSTAT North America dataset instead of AMADEUS (detailed procedure and reasons behind this calculation are explained in Section 3.3 below). I also use the year of a company's incorporation to calculate each firm's age.

In my analysis, I initially selected fifteen countries that formed European Union before its enlargement in 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. These countries are similar in terms of financial development and regulatory environment. I restricted my sample to active firms only and excluded firms from Finland that do not have information on firm's operation status. I also excluded Luxembourg due to a very small number of total filings. In addition, I dropped all self-employed businesses (firm with only one employee). To evaluate the effect of credit supply shortage stemming from deteriorated bank capital position on the performance of the real sector, I further restricted my sample to only construction and manufacturing firms (US SIC codes 1500-1799 and 2000-3999 respectively). In my empirical analysis, I use the growth rate of real sales as a measure of firm's performance. The requirement of two consecutive observations on firm's real sales, along with the above-mentioned requirements, leaves me with the final sample of slightly more than two million observations.

A short description of each variable used in empirical analysis is presented in Table 1. Table 2 reports summary statistics. I use exchange rates and consumer price index from BANKSCOPE (a database also compiled by Bureau van Dijk described in the next subsection) to convert firms' sales into EUROs and calculate real sales growth. Now I would like to explain how each variable from the AMADEUS dataset is calculated.

Firms' growth of real sales: I measure it as a logarithmic change of real sales $\log(\frac{S_{kijt}}{cpi_{it}}) - -\log(\frac{S_{kijt-1}}{cpi_{it-1}})$, where S denotes firm sales in current prices and subscripts k, i, j, and t denote firm, country, industry, and time respectively. As was just mentioned above, before dividing by the country's CPI, I converted all nominal figures in real EURO. I chose 1995 as a base year. Figure 2 plots the density of real sales growth along with a density function of normal distribution with the same first and second moments. Taking into account the sample size, there are some tails but inspection at 99% and 95% shows that they are not heavy. Further inspection indicates that distribution looks symmetric but observations are more concentrated around the mean compared to the normal distribution (see Figure 3). Such distribution suggested the estimation strategies robust to the presence of outliers that are discussed below in subsection 4.1.

Firms' employment growth: Although firms employment growth is often used as an indicator of the real sector activity, AMADEUS data on firms' employment making the usage of such measure very problematic. Graphical inspection clearly reveals that firms' employment growth, defined as a logarithmic change of employment, is not normally

distributed (see Figure 4 and Figure 5). This is consistent with intuition that the sample is dominated by small firms, some of them are organized as family businesses. Such firms do not demonstrate any employment growth even though businesses are expanding and real sales are constantly going up. Therefore, I made a decision to concentrate on sales growth as a main measure of real sector activity.

Quoted company: The variable takes the value of one if a company is listed on a Stock Exchange and zero otherwise.

Age: I define company's age as $\log(age_{kijt} + 1)$, where age_{kijt} is equal to current year minus the year of company's incorporation.

Big Company: I took this definition from the AMADEUS database. The variable takes the value of one if the company satisfies at least one of the following size criteria: for the UK, Germany, France and Italy — operating revenue equal to at least 15 million EURO, total assets equal to at least 30 million EURO, number of employees equal to at least 150; for all other countries — operating revenue equal to at least 10 million EURO, total assets equal to at least 20 million EURO, number of employees equal to at least 100.

Medium Company: As a previous variable I followed the AMADEUS definition. The variable takes the value of one if the company satisfies at least one of the following size criteria: for the UK, Germany, France and Italy — operating revenue equal to at least 1.5 million EURO, total assets equal to at least 3 million EURO, number of employees

equal to at least 15; for all other countries — operating revenue equal to at least 1 million EURO, total assets equal to at least 2 million EURO, number of employees equal to at least 10.

3.2 Banking data

The ideal way to assess an impact of changes in bank capital on firms' performance would be to match firm's sales and employment growth with changes in capital ratio of a bank which is a source of external finance of a particular firm. Unfortunately, AMADEUS does not contain such information. I am able to measure changes in bank position only at the country level.

I am taking information on total capital ratio from the BANKSCOPE database. As the AMADEUS, it is a commercial database compiled by Bureau van Dijk. BANKSCOPE contains balance sheet and income statement totalling up to 200 data items and 36 pre-calculated ratios per bank for about 28,000 banks worldwide. The panel appeared to be highly unbalanced and I could not calculate a reliable total capital ratio for a country as the ratio of total bank capital to total risk weighted assets. Therefore, I define the *total capital ratio* as a median total capital ratio for large banks (banks with total assets above the one billion 1995 EURO).

3.3 Industry and other data

I cannot use the AMADEUS database to calculate the individual firms' or industries' dependence on external finance due to potential endogeneity bias of such measure. Therefore, I calculated the external finance dependence at the industry level following a procedure described in RZ. I use the COMPUSTAT North America database, the same database that RZ used in their paper, to calculate this index for U.S. industries but compute the index using the 1990–2004 sample.[7] RZ argue that capital markets in the U.S. are among the most advanced in the world and large public companies face the least frictions in accessing finance. Therefore, the index of external financial dependence for U.S. industries, calculated on the sample of these firms, should serve as a very good proxy for external finance dependency of foreign firms in the same industries. In accordance with RZ, foreign firms in the same industries would have liked to raise the same amount of external finance if the markets in their countries were as developed as markets in the U.S.

According to RZ, I calculate the index of external financial dependence as the median $\frac{CE_{kj}-CF_{kj}}{CE_{kj}}$, where CE and CF denote capital expenditure and cash flow respectively. I am exactly replicating the calculation of capital expenditure and cash flow (see RZ, p. 564 for details) and the difference in the index is solely attributed to the different sample period and edition of the database.

[7] RZ calculated index on 1980–1989 sample. Compustat North America is a database of U.S. and Canadian publicly traded firms. It provides detail information on income statement, balance sheet, statement of cash flows, and other data items.

In addition to time and country specific effects, I also include lagged growth of real GDP per capita in order to control for overall business climate in the country. These data were taken from Penn World Tables, retrieved from Wharton Research Data Services.

4 Econometric Analysis

4.1 Estimation procedures

The total sample size of my dataset (more than two million observation) as well as a graphical inspection of the real sales growth discussed in the section above dictates the choice of estimation procedure robust to the possible large number of outliers. Standard OLS procedure gives so much weight to large deviations from the regression that the results might be very sensitive to small numbers of errant points. Therefore, I chose to use the two estimation methods alternative to OLS.

The first procedure, the Least Absolute Deviation (LAD) estimator estimates the median regression. Koenker and Bassett (1982), Huber (1967) and Rogers (1993) suggested a way to estimate such regression.[8] Although the method has a number of advantages over OLS especially in case of presence of outliers or skewed distributions, it is little use in applied econometrics is primarily explained by a substantial simplicity and more firmly

[8]See also Stata (2007) for methods and formulas of the quantile estimation procedure.

determined statistical properties of OLS (Green (2000)).

The second method, which might be characterized as "Heavily Weighted OLS", needs a more detailed explanation.[9] Hamilton (1991), in a Monte Carlo study, finds that this method is about 95% as efficient as OLS.

Estimation procedure begins by fitting the regression, calculating Cook's Distance, $D_i = \frac{\sum(\hat{Y}_j - \hat{Y}_{j(i)})^2}{p*MSE}$, where $\hat{Y}_j$ is the fitted value of the i^{th} observation, $\hat{Y}_{j(i)}$ is the predicted value of the j^{th} observation using a new regression equation found by deleting the i^{th} case and p is the number of parameters in the model. In the next step, all observations for which $D > 1$ are excluded from the sample. Thereafter the procedure performs iteratively: calculates case weights from absolute residuals, and regresses again using these weights. Weights are derived from two functions – Huber weights[10] and then biweights[11] that are used until convergence. Huber procedure downweights the observations whose absolute residual exceeds two median absolute deviations from the median residual ($M = med(|e_i - med(e_i)|)$). From that result biweight procedure also runs until convergence assigning weights according to the distance from M and dropping cases with absolute

[9] Now it is implemented as a *rreg* built-in procedure in Stata software.

[10] Huber weights= $\begin{cases} w_i = 1, \text{ if } |u_i| \leq c_h \\ \frac{c_h}{|u_i|}, \text{ otherwise,} \end{cases}$ where $u_i = \frac{0.6745*e_i}{M}$ and $c_h = 1.345$ by default.

[11] Biweight weights= $\begin{cases} w_i = (1 - (\frac{u_i}{c_b})^2)^2, \; if \; |u_i| \leq c_b \\ 0, \text{ otherwise,} \end{cases}$ where $c_b = 4.685$ by default.

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residuals of seven times the M.[12]

Each of two methods has its own advantages. "Heavily Weighted OLS" models robust mean and removes "heavy" outliers but might be outperformed by quantile regression in case of nonsymmetrical distribution. Therefore, I estimate the model with the former procedure and check whether there are substantive differences with the latter one.

4.2 Changes in banks' capital and firms' growth

I analyze the effect of translating the bank capital shock into credit supply shock described in subsection 2.2 by estimating the following equation:

$$s_{kijt} = \beta_1 * (change\ in\ TCR_{it}) + \beta_2 * EFD_j + \beta_3 * EFD_j * (change\ in\ TCR_{it}) + X\beta + u_{kijt}, \tag{11}$$

where subscripts k, i, j, and t denote firm, country, industry, and time respectively. s_{kijt} is the growth rate of firm's k real sales, TCR is the total capital ratio of country i in period t, EFD is the index of external financial dependence of the industry j, discussed in subchapter 3.3, and X is a vector of control variables that includes firm's age, size, listing on the stock exchange dummy, lagged growth of real GDP per capita, time and country specific effects. Following Gertler and Girlchrist (1994), Comin and Philippon

[12]See Stata (2007), volume 3, pp. 208-209 for other details.

(2005) and Larrain (2006) I choose the growth rate of sales as the major indicator of real sector performance.

The interaction of the index of the industry's external financial dependence with the change in bank total capital ratio is the variable of prime interest here. It aims at capturing the effect of changes in banking capital on sectors that differ in their dependence on external finance. I include size dummy and age variable as control variables in the main specification but also make a partition of the sample by size and age. I borrow size classification from the AMADEUS database and divide firms into large, medium and small. If the age of the firm is less or equal to ten then a firm is classified as young while old firm should be at least eleven years old.

Table 3 reports estimates of the basic specification (equation 11). I start with the sample of all firms controlling for age and size (column 1). All variables in basic specification are statistically significant at the 1% level (throughout the paper t-statistics are presented in the parentheses).[13] The coefficient estimates for the variables of prime interest: change in total capital ratio, index of industries' external financial dependence and their interaction have the signs predicted by the model. Thus, an increase in total capital ratio would have negative impact on firms' growth. Positive coefficient estimate for the proxy of external financial dependence implies that firms in industries with higher financial dependence are growing faster compared to firms in other industries. Finally,

[13]The reported t-statistics were calculated using the pseudovalues approach described in Street et al. (1988).

negative coefficient estimate for the interaction of these variables suggests that firms in industries with relatively higher dependence on external finance would experience larger output contraction due to the decrease in bank capital compared to firms in industries whose dependence on external finance is lower. In addition, negative coefficient for firms age predicts that younger firms are growing faster that is also correspondent to current empirical literature.

The next three columns of Table 3 report the results for the same specification but the sample is partitioned by firms' size. I divided firms into three categories – large, medium and small (definitions of big and medium companies are given in subsection 3.1 above). The estimates show that only small and medium firms are affected by changes in bank credit. Neither the coefficient estimate for the change in total capital ratio nor estimate for its interaction with the index of external financial dependence are statistically significant for the large firms. The coefficient estimate for the index of external financial dependence is statistically significant in all three equations but is about three and four times lower for large firms than for medium and small firms respectively. It also indicates that small firms are more financially dependent than medium ones. Another interesting finding is that changes in total capital ratio varies with a financial dependence of the industry only for small firms. The coefficient estimate for the interaction term is statistically significant at the 1% only for small firms.

However, it might be also noted that the overall effect of changes in bank capital

position is bigger in absolute value for medium firms than for small ones. However, if we take into account its interaction with the index of financial dependence the conclusion will not hold hold for industries whose dependence on external finance is above average. My hypothesis is that it is very difficult for a just established small firm to attract bank financing in order to start or finance even a part of a new business. Thus, firms in industries with relatively lower dependency for external finance may rely on own funds or/and borrow from other sources (e.g. relatives, friends, etc.). At the same time, firms in industries that can be characterized as highly financially dependent cannot start and develop business without bank finance. Therefore, a negative shock to bank capital affects much more small firms in industries with higher dependency on external finance and it is reflected in a statistical significance of interaction coefficient discussed above. Medium firms usually do not face such problems. Longer credit and operating history (median age for medium firms is 14 years compared to 9 for small ones) allows them to raise the amount of external funds much closer to a desired amount. Therefore, the effect of changes in bank capital does not vary with an industry for the medium firms. At the same time, less than 1% of medium companies are listed at a stock exchange making bank credit the most important source of external finance to such firms.

In order to test this hypothesis, I partitioned the sample by age. I define firms as young if their age does not exceed ten years; all other firms are classified as old. Table 4 contains the results of this partition. First finding confirms the hypothesis that firms are

more dependent on external finance especially early in their life. The coefficient estimate for the index of external financial dependence is about 3.5 times higher for young firms than for old ones. The second result consistent with the above hypothesis is that changes in bank credit affect primarily old small and medium firms. The variable indicating change in bank credit availability is insignificant for all young firms but is statistically significant at the 1% level of significance for old small and medium firms. Furthermore, the effect is slightly bigger for small firms now compared to Table 3. Finally, changes in bank credit availability varies by industry only for small firms as in the previous table and the overall effect is slightly higher. It indicates that small firms in industries with relatively higher dependence on external finance hurt the most by negative credit supply shock.

In summary, the results suggest that if banks face a loss of capital and conditions are unfavorable for raising a new capital then their decision to cut lending might hurt the real sector. Small and medium firms are affected the most while bank credit is not a prime source of finance for large firms. The effect varies with an industry for only small firms. Small firms in industries with relatively higher external financial dependency will experience the biggest decline in output due to negative shock to bank capital.

4.3 Robustness checks and potential biases

I reestimated all equation reported above using the Least Absolute Deviation procedure. The coefficient estimates and their statistical significance are almost identical to reported in Tables 3 and Table 4. Among other performed robustness checks it is probably worth to mention nonlinear transformation of change in total capital ratio. Obtained estimates also confirm results that small firms in industries with relatively higher dependency on external finance are affected the most by changes in total capital ratio.[14]

I use a lagged growth of GDP per capita as well as include country and time specific effects in each estimated equation to control for an overall economic conditions. However, some concerns about endogeneity of total capital ratio might still remain. As I mentioned capital requirements were first implemented by EU countries in 1989. Thus, I cannot use difference estimator due to the time span of my dataset. However, European Union Enlargement provides an amazing natural experiment. Central and Eastern European countries that joined EU only in 2004 and 2007 might serve as a perfect control group. The estimation of difference-in-difference regression should provide the additional evidence on the impact of changes in banking capital position on the real sector performance and it is the next step in this research.

[14]Details of these results are suppressed to conserve space since both point estimates and their statistical significance are almost identical to those presented in Tables 3 and 4 but are available on request.

5 Conclusion

I find that banks' capital position has an effect on real sector output growth. A reduction in bank credit supply has a negative impact on firms' output and hurts bank dependent sectors the most, in particular small firms with the highest dependency on external finance. These results are in line with theoretical predictions of the Bernanke and Blinder (1988) model and provide additional evidence on the link between financial sector and real economic activity.

One of the major contribution of this paper is the analysis of the connection between financial intermediaries and firm performance using the dataset consisting primarily of small private firms. I use the AMADEUS dataset to analyze the response of firms of different size and age in manufacturing and construction sector to changes in bank capital position. My final sample consists of more than half a million private and public firms in thirteen European countries and includes 1997-2004 period. The total number of observations in estimated equations is more than two million.

The results reveal statistically significant effect of changes in banking capital position on sales of small and medium firms while large firms are not affected since bank credit is not a prime source of finance for them. The effect also varies by industry: small firms in industries with relatively higher external financial dependence will experience the biggest decline in output due to contraction in bank credit supply. Finally, the results suggest that

although small and medium firms depend much more on external finance in their earlier ages, changes in bank capital position affect them more in their late ages. Intuitively, this may indicate that banks are reluctant to provide credit to a large number of young firms in European Union. However, the results show that small firms are vulnerable to changes in bank credit and the effect varies by industries' dependence on external finance regardless of their age.

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Table 1: Variables Definitions

Variable	Data Source	Calculation
Sales Growth	AMADEUS	$\log(\frac{S_{kijt}}{cpi_{jt}}) - \log(\frac{S_{kijt-1}}{cpi_{jt-1}})$, where S denote firm sales in current prices.
Employment Growth	AMADEUS	$\log(E_{ijt}) - \log(E_{ijt-1})$, where E denote the number of people employed.
Change in the TCR	BANKSCOPE	$\frac{TCR_{jt}-TCR_{jt-1}}{100}$, where TCR - total capital ratio, calculated as a median for large banks (banks with total assets above the 1 bn 1995 EURO).
EFD of the Industry	COMPUSTAT North America	$\frac{CE_{kj}-CF_{kjt}}{CE_{kj}}$, where EFD is index of external financial dependence, calculated according to the RZ AER(1998). CE and CF denote capital expenditure and cash flow respectively.
Lagged Growth of real GDP per Capita	Penn Tables	$ln(gdp_{jt-1}) - ln(gdp_{jt-2})$
Quoted Company	AMADEUS	Dummy variable. Takes the value of one if a company listed on a Stock Exchange.
Age	AMADEUS	$\log(age_{kijt} + 1)$
Big Company	AMADEUS	Dummy variable. The variable takes the value of one if the company satisfies at least one of the following size criteria: for the UK, Germany, France and Italy - operating revenue equal to at least 15 million EURO, total assets equal to at least 30 million EURO, number of employees equal to at least 150; for all other countries: operating revenue equal to at least 10 million EURO, total assets equal to at least 20 million EURO, number of employees equal to at least 100.
Medium Company	AMADEUS	Dummy variable. The variable takes the value of one if the company satisfies at least one of the following size criteria: for the UK, Germany, France and Italy - operating revenue equal to at least 1.5 million EURO, total assets equal to at least 3 million EURO, number of employees equal to at least 15; for all other countries: operating revenue equal to at least 1 million EURO, total assets equal to at least 2 million EURO, number of employees equal to at least 10.

Notes: i denotes firm and j, k, t denote country, industry and time respectively, TCR is the the total capital ratio and EFD is the index of external financial dependence of the industry.

Table 2: Descriptive Statistics, all manufacturing and construction firms, data sample 1997-2004

Variable	Obs.	Mean	Var.	Kurt.	Skewn.	Med.
Sales Growth	2,363,355	.060	.304	45.63	.583	.035
Employment Growth	2,117,487	.026	.117	42.37	.368	0
Change in Total Capital Ratio	98	.0006	.0001	8.43	1.39	.0003
External Financial Dependence of the Industry	21	.261	1.330	14.14	3.21	.027
Lagged Growth of real GDP per Capita	112	.025	.0003	5.80	1.23	0.23
Quoted Company	5,380,377	.003	.003	382.48	19.53	0
Age	5,347,805	2.40	.932	2.92	–.188	2.48
Big Company	5,380,377	.070	.065	12.36	3.37	0
Medium Company	5,380,377	.314	.216	1.63	.799	0

Table 3: Change in Total Capital Ratio and Sales Growth

The dependent variable is the growth rate of sales (logarithmic change). The sample is 1997–2004 and consists of only active manufacturing and construction firms. The regression is estimated by "Robust Regression" (see Section 4.1 for details). In regressions, the variables Change in Total Capital Ratio and External Financial Dependence are demeaned. For definitions of the variables used in regressions, see Table 1.

	All firms	Large firms	Medium firms	Small Firms
Change in Total Capital Ratio	–0.101***	–0.034	–0.152***	–0.092**
	(–4.13)	(–0.68)	(–4.28)	(–2.28)
External Financial Dependence	0.003***	0.001**	0.003***	0.004***
	(15.50)	(2.05)	(12.87)	(11.27)
Change in Total Capital Ratio*	–0.027	–0.008	0.011	–0.164***
External Financial Dependence	(–1.10)	(–0.24)	(0.31)	(–3.26)
Lagged growth of real GDP per capita	0.119***	–0.068	0.341***	0.074
	(3.32)	(–1.00)	(6.92)	(1.13)
Quoted company	0.020***	0.007***	–0.014*	
	(7.49)	(3.47)	(–1.75)	
Age	–0.054***	–0.021***	–0.055***	–0.061***
	(–264.48)	(–45.43)	(–172.06)	(–198.99)
Big	0.071***			
	(113.39)			
Medium	0.051***			
	(145.91)			
Country-Specific Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
R Adj sq.	0.048	0.044	0.057	0.044
N	2344595	190094	822540	1331961

Notes: *** , **, and *denote significance at 1%, 5%, and 10% under null that the coefficient is zero.

Table 4: Change in Total Capital Ratio and Sales Growth

The dependent variable is the growth rate of sales (logarithmic change). The sample is 1997–2004 and consists of only active manufacturing and construction firms. The regression is estimated by "Robust Regression" (see Section 4.1 for details). In regressions, the variables Change in Total Capital Ratio and External Financial Dependence are demeaned. For definitions of the variables used in regressions, see Table 1.

	Young				Old			
	All Firms	Large Firms	Medium Firms	Small Firms	All Firms	Large Firms	Medium Firms	Small Firms
Change in TCR	–0.020	0.152	–0.092	–0.007	–0.204***	–0.075	–0.231***	–0.252***
	(–0.45)	(1.10)	(–1.33)	(–0.11)	(–7.54)	(–1.42)	(–5.58)	(–5.42)
EFD	0.005***	–0.001	0.007***	0.006***	0.002***	0.001***	0.002***	0.002***
	(13.01)	(–1.51)	(10.95)	(10.59)	(10.54)	(3.79)	(8.79)	(5.95)
Change in TCR*EFD	–0.123**	–0.106	–0.091	–0.186**	0.008	0.017	0.059	–0.183***
	(–2.39)	(–1.06)	(–1.22)	(–2.16)	(0.32)	(0.48)	(1.54)	(–3.30)
Lagged growth of real GDP per capita	0.358***	–0.056	0.608***	0.335***	0.030	–0.046	0.188***	–0.007
	(5.29)	(–0.29)	(6.10)	(3.17)	(0.78)	(–0.63)	(3.36)	(–0.09)
Quoted company	0.046***	0.042***	0.045**		0.002	0.003	–0.038***	
	(5.79)	(5.87)	(2.41)		(0.91)	(1.44)	(–4.52)	
Age	–0.128***	–0.041***	–0.137***	–0.128***	–0.028***	–0.021***	–0.031***	–0.024***
	(–225.39)	(–16.66)	(–122.12)	(–188.98)	(–69.72)	(–30.09)	(–53.61)	(–33.12)
Big	0.062***				0.061***			
	(40.37)				(98.57)			
Medium	0.069***				0.040***			
	(107.18)				(102.92)			
Country-Specific Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R Adj sq.	0.061	0.040	0.065	0.054	0.032	0.040	0.029	0.021
N	1136452	41973	303518	790961	1208140	148120	519023	540997

Notes: *** , **, and * denote significance at 1%, 5%, and 10% under null that the coefficient is zero.

FIGURE 1: Macroeconomic Impact of Credit Supply Shock in Bernanke and Blinder (1988) model

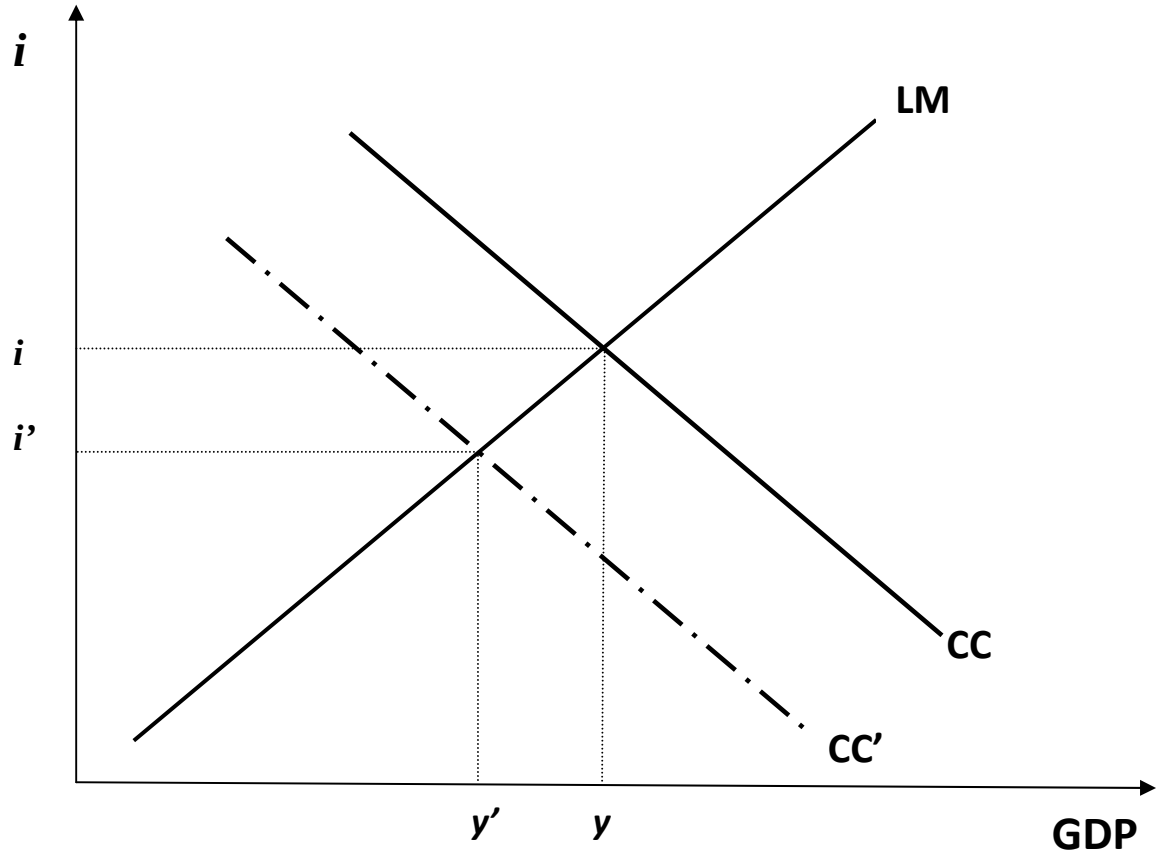

FIGURE 2: Sales Growth

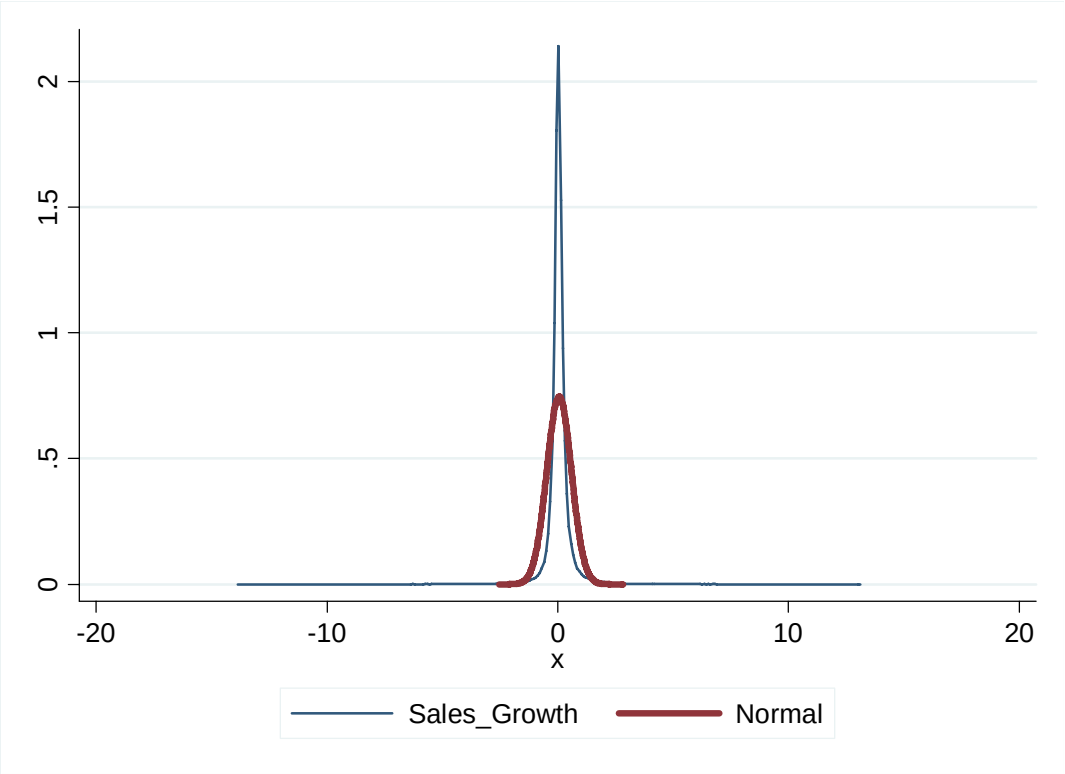

FIGURE 3: Sales Growth, 95% interval

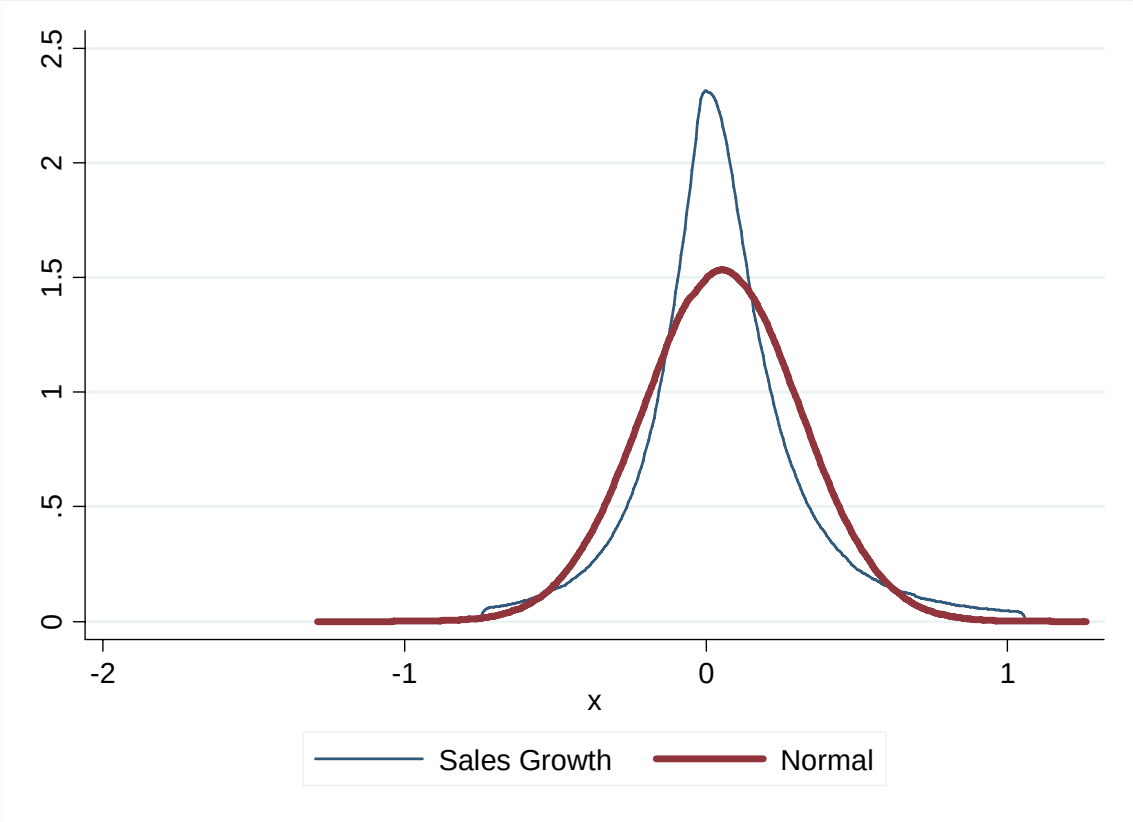

FIGURE 4: Employment Growth

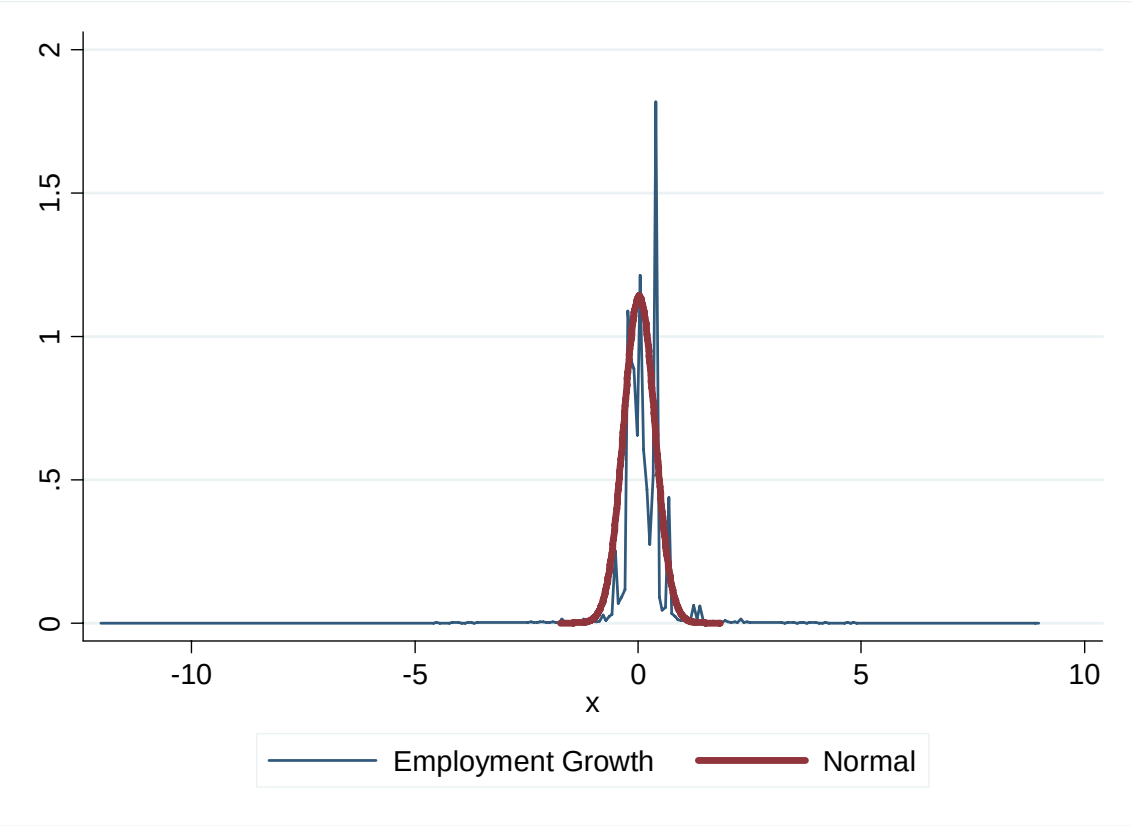

FIGURE 5: Employment Growth, 95% interval