Financial Development, Dependence on External Finance and Firm–Level Volatility in Manufacturing and Construction Sectors *

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April, 2009

Abstract

Theoretical and empirical literature so far have failed to establish a robust link between the financial development and output volatility at the firm level. In this paper I test the theoretical predictions of a general equilibrium model of financial development, risk–taking, risk–diversification and firm–level volatility. I find a significant positive effect of financial development on firm–level volatility confirming the relationship predicted by the model. This finding stands in sharp contrast to a number of recent studies reporting a negative relationship between the financial development and the volatility at the firm level. Furthermore, the effect is stronger for firms in industries that are relatively more dependent on external finance. These results imply that firms requiring more external funds due to technological characteristics of the industry would choose higher risk–taking strategies in countries that are more financially developed. The results are very robust to the choice of different estimation methods which control for potential outliers and alternative measures of financial development.

KEYWORDS: Firm Volatility, Financial Development, External Finance

JEL CLASSIFICATIONS: E32, D21, E44, L25

*I am very grateful to Bent Sørensen for his extensive comments and encouragement. All errors are my own.

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1 Introduction

Despite a well documented decrease in the aggregate volatility of output over the last thirty years in major developed countries, often known as the Great Moderation, there is still no certainty over the causes of this decline. Aggregate volatility could decline due to either a decrease in the volatility at the firm level, or the lower correlation of output growth rates between firms, or just an increase in a number of firms in the economy. Therefore, understanding volatility pattern at the firm level would be very informative for explaining the Great Moderation.

A tremendous pace of financial development over the last thirty years could serve as a potential explanation. However, both the theoretical and empirical literature so far have failed to establish a robust link between the financial development and output volatility at the firm level. Acemoglu (2006) develops a model predicting that financial development leads to an increase in the number of smaller firms adopting higher risk–taking strategies. Thus, financial development results in higher firm–level volatility but aggregate volatility declines due to averaging over a bigger number of firms and decreasing correlation across firms (i.e., increasing diversification). Thesmar and Thoenig (2009) model predicts an opposite trends for the volatility of private and public companies with an increase in the level of financial development. In contrast, Koren and Tenreyro (2007) proposes a model where the financial development might be associated with a decline of both aggregate and firm–level volatility. Finally, higher financial development in the Holmstrom and Tirole (1997) model might either smooth or amplify shocks at the firm level depending on the nature of the shock.

Empirical evidence on the link between the financial development and firm–level volatility is still rather limited and contains controversial results. Black and Strahan (2002) and Cetorelli and Strahan (2006) document that financial innovations lead to an

increase in the number of firms and decrease in the average size of the firm that is in line with Acemoglu (2006) model. Comin and Philippon (2005) show that the financial development and access to external finance might be the possible sources of an increase in firm volatility. On the contrary, Thesmar and Thoenig (2009) document the opposite trends for private and listed companies as consequences of financial development. Larrain (2006) reports a negative effect of financial development on both firm–level and industrial volatility. Correa and Suarez (2008) find the negative impact of the U.S. banking deregulation on firm volatility.

In this paper, I test the theoretical predictions of a Acemoglu (2006) general equilibrium model of financial development, risk–taking, risk–diversification and firm–level volatility. As was mentioned above, the model predicts a higher level of risk–taking and risk–diversification associated with higher level of financial development and consequently higher firm–level volatility but lower aggregate volatility. I examine whether the effect of financial development on firm volatility increases with industry's dependence on external finance. Some industries depend on external finance more than others due to technological reasons. 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. Thus, I expect that firms in industries with greater dependence on external finance adopt the higher risk–taking strategies and the effect increases with higher level of financial development of the country.

The effect on financial development on firm–level volatility is studied using a very large AMADEUS dataset containing information on both private and public companies. Most of the available empirical papers on the effect of financial development on volatility are based on datasets containing industry or firm data on publicly traded companies. On the contrary, the 2005 vintage of the AMADEUS dataset has a sample of 7,342,095 firms from which only 10,139 or 0.13% are listed at a stock exchange. Although the dataset

contains the information for 41 countries I restrict my sample to 24 countries representing old and new EU members. The firm volatility is defined as the standard deviation of firms' growth of real sales or employment over 2000-2005 years. Manufacturing and construction firms are not removed from the sample unless they contain observations on either sales or employment for all six years.[1] After imposing a number of other restrictions in the process of sample selection,[2] I have a sample of about 100,000 firms in manufacturing and construction sector. Employing the dataset of this size allows me to differentiate the impact of financial development on firm volatility by firms' size including self–employed businesses.[3] It is another novel and contribution of this paper to the empirical literature on the connection between financial and real sectors.

I find a significant positive effect of financial development on firm–level volatility confirming the relationship predicted by Acemoglu (2006). This finding stands in sharp contrasts to Larrain (2006) reporting a negative relationship between volatility and bank credit in the country, usually associated with a higher level of financial development. It should be pointed out that the effect is stronger for firms in industries that are relatively more dependent on external finance. These results imply that firms requiring more external funds due to technological characteristics of the industry would chose higher risk–taking strategies in countries that are more financially developed. The estimated coefficients for other firm–level variables: firm size and age, have negative signs that corresponds to current literature.

Following Davis et al. (2006) and Thesmar and Thoenig (2009), I also partitioned my sample into private and public companies in order to check whether financial development affects them differently. The results indicate that neither financial development nor its interaction with external financial dependence of the industry affect the volatility of the

[1]Due to short nature of the available data I estimated only cross–sectional regressions.
[2]For sample selection see section 4.
[3]For example, the 2005 vintage contains information on 698,807 firms with just one employee.

companies listed at the stock exchange. Public companies have much better access to capital market than private firms and may substitute the bank credit by issuing different forms of equity, public debt or commercial paper. Therefore, the effect of financial development on their volatility does not appear to be statistically significant. Results suggest that size and age are the most important determinants of the volatility of the public companies. On the contrary, financial development, external financial dependence and their interaction are significant for private firms at the 1% level of statistical significance.

In order to control for possible endogeneity of financial development, I also estimated the same specifications for the whole sample, public and private companies by Instrumental Variable (IV) regressions using the law of origin and institutional development as a set of instruments. The law of origin is a list of dummy variables from La Porta et al. (1998) and an additional dummy variable for post–socialist countries. The institutional development is captured by the six World Bank indicators. Neither coefficients nor their significance are affected compared to OLS estimation. All variables remain significant at 1% level and hold their signs.

Following my analysis in the Dodonov (2009) I also divide firms into three categories – big, medium and small.[4] As was discussed in Dodonov (2009) the dependence on external finance is not a big factor for the large firms compared to the small ones. Therefore, neither the estimated coefficient of this variable nor its interaction with financial development are statistically significant for large firms. On the contrary, the coefficient estimates are positive and significant for medium and small firms indicating that financial development has a positive impact on their volatility and that the effect varies with industries dependence on external finance. However, the magnitude of the impacts of both financial development and the external financial dependence of the industry is more intriguing, especially accounting for a fact that all of these companies are private and are not listed

[4]For the definitions of big and medium companies see section 3.1 or Table 1 in Dodonov (2009).

at a stock exchange. Estimated coefficients suggest that the impacts of external finance dependence and financial development on firm volatility are, on average, about two and half and three times bigger respectively for small firms. Thus, an increase in a ratio of market capitalization of the listed companies to GDP by 1% would result in an increase of volatility of medium and small companies by about 1% and 3% respectively.

Finally, current literature suggest that age is one of the most important characteristics of firm volatility since younger firms experience higher volatility than an old, well established businesses. Therefore, I also partitioned a sample by age. 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. Evaluating the effects of financial development, external financial dependence and their interaction on firm volatility at their means, I find that an increase in the financial development by 1% would result in an about 1.4 times higher volatility of young firms compared to the old ones. At the same time, volatility of older firms varies a bit more with industry's dependence on external finance.

The results are very robust to the choice of different estimation methods controlling for potential outliers and alternative measures of financial development. I reestimated the model by Least Absolute Deviation (LAD) and "Heavily Weighted OLS" (Robust) estimators that are robust to the possible large number of outliers.[5] Neither significance nor signs of the estimated coefficients have changed. Therefore, potential presence of outliers is not likely to have an impact on the reported results. My second robustness check is exploiting qualitative financial market index for advanced economies from IMF (2008) as another measure of financial development. However, it is available only for thirteen "old" members of the European Union that have well developed financial markets. I estimated the model by OLS, IV, and "Robust" estimators using this index as a second measure of financial development. Coefficient estimates of external financial dependence,

[5]For the detailed description of both methods see section 4.1 in the Dodonov (2009).

financial development and their interaction are again significant at 1% level of statistical significance and hold positive signs.

The paper is organized as follows. Section 2 provides a background of the effect of financial development on firm–level volatility. Section 3 presents an Acemoglu (2006) general equilibrium model of financial development, risk–taking, risk–diversification and firm–level volatility. Section 4 describes my sample selection. Section 5 presents the empirical strategy and discusses the results. Section 6 concludes.

2 Background

There is a well documented decline in aggregate volatility for major developed countries over the last thirty years, often known as the Great Moderation (See Figure 1).[6] However, there is still an uncertainty over the causes of this decline. As pointed out in Acemoglu (2006), there are three possible explanations for a decline in aggregate volatility. First, most obvious, it stems from a reduction of volatility at a firm level. Second, it could decrease due to increased diversification of the economy (bigger number of firms). Finally, aggregate volatility may go down due to the decreased co–movement at the firm level. The easiest way to see it is to look on the definition of aggregate volatility:

$$VAR\left(\sum_{i}^{n}\alpha_i y_i\right) = \sum_{i}^{n}\alpha_i^2\, VAR(y_i) + 2\sum_{j>i}^{n}\alpha_i\alpha_j\, Cov(y_i, y_j) \tag{1}$$

where $y = \sum_{i}^{n}\alpha_i y_i$ is the growth rate of aggregate output, y_i is the growth rate of firm i and α_i is the share of firm i in the total output. This equation shows that aggregate volatility might decrease from either lower volatility at the firm level $VAR(y_i)$, or bigger

[6]For example, see Kim and Nelson (1999), McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), Stock and Watson (2006) and Comin and Philippon (2005).

number of firms in the economy n, or lower covariance between firms i and j. Hence, it possible to conclude that the Great Moderation could be a consequence of any of these factors.

Unfortunately, the empirical evidence is mixed. There is a number of papers arguing that a decline in aggregate volatility is attributed to a similar decline in volatility at the firm level. On the contrary, there are recent empirical findings documenting the increasing trend in firm–level volatility and explaining the Great Moderation by decreasing co–movement between different firms and sectors. Hence, understanding firm–level volatility would be very challenging for understanding the recent decline in aggregate volatility.

Using the newly developed Longitudinal Business Database that contains annual information on employment for all U.S. businesses, Davis et al. (2006) report that firm–level volatility has declined by more than 40% since 1982. Their results reveal a sharp decrease in firm volatility among private firms but also reveal an increase in volatility among publicly traded companies. However, the overall impact on aggregate volatility of the former considerably outweighs the impact of the latter. These findings were recently confirmed by Thesmar and Thoenig (2009) on the French census data who also document the same opposite trends for private and listed companies. In order to explain these patterns in firm–level volatility, they construct a model with the risk–taking as a choice variable at the firm level and show that an increase in stock market participation or integration into the international capital markets might be an explanation for this evolution of firm–level volatility.

At the same time Comin and Philippon (2005) explain the decline in aggregate volatility by a decrease in correlation of growth rates across sectors. They argue that correlation has decreased more in sectors with a highest increase in firm–level volatility. Among other important findings of this paper are the increasing pattern of firm–level volatility, absence of correlation between firm–level volatility and income per–capita in the country, and a

positive effect of deregulation on firm volatility. Comin and Philippon (2005) suggest that R&D intensity may be the major explanation for an increase in firm–level volatility and a decrease in correlation between sectors. They also mention financial development and access to external finance as a possible sources of an increase in firm volatility. Comin and Mulani (2007) and Comin and Mulani (2006) also record an increase in firm–level volatility for publicly traded companies. The former explains it by an increase in R&D intensity while the latter suggests embodied and disembodied innovations as a major explanation for firm level and aggregate volatility respectively.

The empirical evidence of the effect of financial sector on volatility on the real one is rather limited. Using the average private credit by deposit money banks over GDP as a proxy for financial development of the country, Larrain (2006) reports a negative effect of financial development on both firm–level and industrial volatility. His firm–level analysis is based on dataset containing information only on listed companies. These findings contradict Comin and Philippon (2005) mentioned above and the theoretical prediction on the link between financial development and firm level predicted by Acemoglu (2006), described in the next section. Li et al. (2004) show that capital market openness has a positive impact on a firm volatility in emerging markets. Correa and Suarez (2008) explore the impact of U.S. banking deregulation on firm volatility in manufacturing sector. As most of other available studies of firm volatility they use a COMPUSTAT database that contain information on only listed U.S. companies. The results suggest that firm volatility has declined after interstate banking deregulation and the effect is stronger for firms with higher dependency on bank finance.

3 Model

The empirical framework of this paper is based on a general equilibrium model of financial development, risk–taking, risk–diversification, firm–level, and aggregate volatility developed in Acemoglu (2006) as a modification of general equilibrium model from Acemoglu and Zilibotti (1997). I am presenting only short description of the model in this paper, skipping all details and derivations.

Suppose firm j covers the interval of length ϵ at the unit interval [0,1] and utilizes the following technology of production:

$$\begin{aligned} y_t^j &= r\phi_t^j + \theta_t^j \frac{R}{\epsilon}(\epsilon F_t^j) \\ &= r\phi_t^j + \theta_t^j R F_t^j, \end{aligned} \tag{2}$$

where $\epsilon F_t^j + \phi_t^j$ is the total amount invested in a firm, ϕ_t^j and ϵF_t^j invested in safe and risky activities with rate of returns r and $\frac{R}{\epsilon}$ respectively, with $R > r$. The variable θ_t^j is defined such that $\theta_t^j = 1$ if its realization falls in the ϵ interval controlled by this firm. Thus, the higher ϵF_t^j compared to ϕ_t^j in this specification, the higher is the risk–taking by the firm.

All active firms are constrained by available technology and minimum size requirements. A latter implies that a minimum investment in risky assets of firm j must exceed an amount *M(j)*:

$$M(j) = max \left\{ \ 0, \tfrac{D}{1-\gamma}(j-\gamma) \ \right\},$$

where firms are ranked in increasing minimum size and γ are the sectors that do not have minimum size requirements while the former states that only firms with $j \leq \bar{n_t}$ can be active.

Acemoglu (2006) also assumes that a representative consumer has a logarithmic preferences and the total amount K_t can be invested in period t. The equilibrium is defined as an allocation such that prices clear all markets, and the set of active firms is determined by free entry.

Given the set of active firms J_t, the equilibrium is competitive and will be a solution to the following problem:

$$\max_{\{\phi_t^j\}_{0\leq j\leq 1}\{F_t^j\}_{0\leq j\leq 1}} \int_0^1 log(c_t^j)dj \tag{3}$$

subject to:

$$\int_0^1 \phi_t^j dj + \int_0^1 F_t^j dj = K_t \tag{4}$$

$$c_t^j = r\int_0^1 \phi_t^j dj + RF_t^j \tag{5}$$

$$\phi_t^j = F_t^j = 0 \quad \forall j \notin J_t. \tag{6}$$

Equation (4) imposes constraints on total investments to be equal to total resources; equation (5) makes consumption in state j to be equal to a sum of return on safe assets and investments in the firm paying out in state j; while equation (6) says that there are no investments in inactive firms.

Solving this problem for the set of active firms $j \in [0, n_t]$ yields the following solution

for the equilibrium:

$$\phi(K_t, n_t) \equiv \int_0^1 \phi_t^j dj = \frac{(1-n_t)R}{R-rn_t} K_t \tag{7}$$

$$F_t^j = \begin{cases} F(K_t, n_t) \equiv \frac{R-r}{R-rn_t} K_t & \text{if } \forall j \leq n_t \\ 0 & \text{if } \forall j > n_t \end{cases} \tag{8}$$

It should be noticed that safe investment, $\phi(K_t, n_t)$, and risky investment $F(K_t, n_t)$ are a decreasing and an increasing functions of n_t respectively. A higher n_t leads to higher diversification, consequently making investments in risky activities less costly.

Free entry conditions implies that the equilibrium number of firms in given by: $n_t = \min\{n^*(K_t), \bar{n_t}\}$. Equilibrium $n^*(K_t)$ is determined by
$F(K_t, n^*(K_t)) = M(K_t, n^*(K_t))$ while available technology dictates that number of firms at the market cannot exceed $\bar{n_t}$.

In order to determine the effect of financial development on firm–level volatility Acemoglu (2006) assumes endogenous participation in the economy. Let τ denotes a transaction costs associated with an investing in firms, a unit measure of consumers have capital k, outside option w_i is distributed according to the cumulative density function G and consumer maximizes $U(\bar{n_t}, K_t)$. Consumer i makes an investment only if $w_i \leq U(\bar{n_t}, K_t) - \tau$. Then the equilibrium investment in firms is given by:

$$K_t = G(U(\bar{n_t}, K_t) - \tau)k \tag{9}$$

According to this model, an increase in $\bar{n_t}$ induced by technological progress would result in larger K_t. In addition, financial development induced by a decline in τ leads to higher

risk–taking by firms, and, hence, an increase in firm–level volatility. It should be also noticed that a merging of two firms would result in lower firm–level volatility. Thus, firm–level volatility is increasing only if economic expansion is undertaken by new firms.

Altogether, the model contains several important theoretical predictions. First, there should be a positive correlation between economic development and firm–level volatility. Second, financial development results in higher risk–taking by firms and, consequently, higher firm–level volatility. Finally, merging and acquisitions have a negative effect on firm–level volatility while expansion undertaken by new affects it positively.

4 Data

4.1 Firm–level data

In my analysis, I use annual firm data on the firm, industry and country level.[7] The firm–level data are obtained from AMADEUS database and my sample is limited to 2000–2005 years. I calculate a dependent variable, firm–level volatility, as a standard deviation of real sales and/or employment over this period. Firms are not removed from the sample unless they contain observations on either sales or employment for all six years. This restriction is dictated by the unbalanced panel in the AMADEUS dataset because previous years contain relatively few number observations.

A detailed description of the AMADEUS database is provided in Dodonov (2009). I only describe sample selection for the empirical analysis of this paper. First I delete from the sample all firms that report only consolidated statements in order to avoid double–

[7]The sample contains observations from 24 EU member countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Romania, Slovenia, Slovak Republic, Sweden, Spain and the U.K.

counting subsidiaries firms. This restriction results in a sample of 19,005,478 observations over 2000–2005 period. Then I restrict my sample to only active firms and I drop all self-employed businesses (firm with only one employee). I further limit my sample to only construction and manufacturing firms (US SIC codes 1500-1799 and 2000-3999 respectively). These restrictions leave me with 4,114,983 observations on manufacturing and construction firms. After that I calculate the growth rates of real sales and employment and drop all firms with annual absolute growth rate above 500%. Imposing restrictions on a firm to have observations on employment or sales for all years covered by the sample and calculating firm-level volatility, I have a sample that includes 90,499 observations on firm–level volatility. I calculate all variables measured at the firm level as follows:

$Firm-level\,volatility$ is a standard deviation of firms' growth of real sales or employment. Firms growth of real sales and employment are calculated as a hundred multiplied by the logarithmic change of real sales and logarithmic change of employment respectively. I use the standard deviation of real sales growth as a dependent variable in my empirical analysis and employ the standard deviation of employment for robustness check.[8]

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

Age is defined as $\log(age+1)$, where *age* is equal to current year minus the year of company's incorporation.

Size is calculated as a real total asset of the firm.

Bigcompany 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

[8]See Dodonov (2009), Section Data for a detailed description of a distribution of firms' growth rate of employment and associated problems.

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.[9]

Medium company 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.

4.2 Industry and country–level data

I use the same index of external financial dependence as in the Dodonov (2009) to capture the industry's dependence of external finance. 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.[10] As was mentioned before, the index of external financial dependence for U.S. industries, should serve as a very good proxy for external finance dependency of foreign firms in the same industries. This methodology gained a widespread recognition since the index should be exogenous in a regression analysis that does not contain U.S. industries.

I employ the average market capitalization of listed companies as percent of GDP for 2000–2005 years from World Bank (WB) Development Indicators database as a first proxy for the level of financial development in the particular country. As a second measure of

[9]The classification of companies into big, medium and small was taken from the AMADEUS database.
[10]I use 1990–2005 sample while RZ employ 1980–1989 sample.

financial development, I also use qualitative financial market index for advanced economies from IMF (2008). It is constructed as an average of three subindices that are in turn obtained as an average of other subindices capturing different aspects of development of financial market in a particular countries. Using this qualitative index as a measure of financial development has a number of shortcomings. First, it is available only for advanced economies (thirteen "old" EU members in my sample). These economies have well developed financial markets and the index does not show a big variation for the most countries. Second, I was able to retrieve it only for 1995 and 2004 and take the average of these two years. Therefore, I decide to use this index only to check the robustness of my empirical findings.

There is a broad consensus in current literature that all available measures of financial development might be a subject of endogeneity bias. Therefore, I also use the law of origin and the number of indicators of prevailing institutions in particular country to instrument the level of financial development. I compute the index of institutional development as an average of six World Bank indices: Control of Corruption, Rule of Law, Regulatory Quality, Government Effectiveness, Political Stability & Absence of Violence/Terrorism, Voice and Accountability as well as use all of these indicators as instruments in the IV regression.

I also include natural logarithm of an average GDP per capita in order to control for overall level of economic development in the country. These data were taken from Penn World Tables, retrieved from Wharton Research Data Services.

5 Econometric Analysis

5.1 Results

I test the model of financial development and firm–level volatility by estimating the following equation:

$$\begin{aligned} Volatility_{ikj} = \beta_1 * FD_k + \beta_2 * EFD_j + \beta_3 * FD_k * EFD_j + \\ + Controls * \beta + \varepsilon_{ikt}, \end{aligned} \tag{10}$$

where subscripts i, k, and j denote firm, country, and industry respectively. $Volatility_{ikj}$ is the standard deviation of real sales growth or employment growth of the firm i, FD_k is the financial development of country k, measured as an average ratio of market capitalization of listed companies to GDP or IMF qualitative indicator, EFD_j is an index of external financial dependence of the industry j. Controls include firm's size, age, dummy variable indicating whether the company is listed at a stock exchange and the logarithm of real per capita GDP. Due to short nature of the available data I estimated only cross–sectional regressions.

Table 2 reports the OLS estimates of equation (10). All variables in the basic specification except quoted dummy are statistically significant at 1%.[11] The coefficient estimates for the variables capturing the financial development of the country, the industry's dependence on external finance and their interaction have positive signs that corresponds to the predictions of the Acemoglu (2006). Hence, financial development of the country leads to higher risk–taking and higher volatility of output growth at the firm level. This finding stands in sharp contrast to Larrain (2006) reporting a negative relationship between volatility and bank credit in the country, usually associated with a higher level of financial

[11] Constant is omitted from reported results. Through the paper t–statistics are presented in parentheses.

development. It should be pointed out that the effect is stronger for firms in industries that are relatively more dependent on external finance. These results imply that firms requiring more external funds due to technological characteristics of the industry would choose higher risk–taking strategies in countries that are more financially developed. The estimated coefficients for other firm–level variables, firm size and age, have negative signs that corresponds to current literature. Thus, larger and/or older firms have lower volatility. Finally, results suggest that the level of economic development also reduce volatility at the firm level. It might indicate that increase in risk–taking by firms is mainly associated with higher level of financial development rather than economic one. Larrain (2006) reports the same link while Comin and Philippon (2005) could not detect any relationship between the two.

Davis et al. (2006) and Thesmar and Thoenig (2009) documented an opposite trend in firm–level volatility of publicly listed and private firms. I also partitioned my sample into private and public companies in order to check whether financial development affects them differently. The OLS estimation of the equation (10) for all firms, listed and private firms is presented in Table 3 (Columns 1-3 respectively). Results indicate that financial development has no impact on the volatility of the companies listed at the stock exchange (Column 2). Public companies have much better access to capital market than private firms and may substitute the bank credit by issuing different forms of equity, public debt or commercial paper. Therefore, the effect of financial development on their volatility does not appear to be statistically significant. Not surprisingly, neither its interaction with the external financial dependence variable nor external financial dependence by itself are statistically significant as well. Results suggest that size and age are the most important determinants of the volatility of the public companies. On the contrary, financial development, external financial dependence and their interaction are significant for private firms at the 1% level of statistical significance (Column 3) and their impact on volatility is bigger compared to the estimates from basic specification (Column 1).

In order to control for possible endogeneity of financial development, I also estimated the same specifications for the whole sample, public and private companies by Instrumental Variable (IV) regressions using the law of origin and institutional development as a set of instruments. The law of origin is a list of dummy variables from La Porta et al. (1998) and an additional dummy variable for post–socialist countries. The institutional development is captured by the six World Bank indicators described in the previous section. Both instrumented variable and the list of instruments are varying only at country level, hence, it would be more informative to evaluate the choice of instruments at the country level as well. The first stage regression is presented in Table 4. I decided to use all six institutional indices due to a bit higher explanatory power of the second regression. The IV estimates are reported in Table 5. Neither coefficients nor their significance are affected compared to OLS estimation. All variables remain significant at 1% level and hold their signs.

Beck et al. (2005) 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. Following my analysis in the Dodonov (2009) I divide firms into three categories — big, medium and small. The OLS and IV estimations of the equation (10) of the partitioned sample are reported in Table 6. The difference in OLS and IV estimates is barely seen, therefore, I describe only differences in statistical significance and magnitude of the estimated coefficients. As was discussed in Dodonov (2009) the dependence on external finance is not a big factor for the large firms compared to the small ones. Therefore, neither the estimated coefficient of this variable nor its interaction with financial development are statistically significant for large firms. On the contrary, the coefficient estimates are positive and significant at 1% and 5% level for medium firms and at 1% for small firms indicating that financial development has a positive impact on their volatility and that the effect varies with industries dependence on external finance. However, the magnitude of the impacts of both financial development and the external financial dependence of the

industry is more intriguing, especially accounting for a fact that all of these companies are private and are not listed at a stock exchange. Estimated coefficients suggest that the impacts of external financial dependence and financial development on volatility are, on average, about two and half and three times bigger respectively for small firms. Thus, an increase in a ratio of market capitalization of the listed companies to GDP by 1% would result in an increase of volatility of medium and small companies by about 1% and 3% respectively.[12]

Finally, current literature suggests that age is one of the most important characteristics of firms' volatility and younger firms experience higher volatility than an old, well established businesses. Therefore, I also partitioned a sample by age. 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 7 reports the OLS and IV estimates of equation (10). First, it should be noticed that OLS and IV estimates are very close to each other.[13] Second, the coefficient estimate of the external financial dependence is more than two times bigger for the young firms than for the old ones. However, the estimated effect of financial development is bigger for the old firms. In addition, its interaction with external financial dependence is statistically significant at 1% for old firms and only at 10% for the young ones. Evaluating the effects of these variable on firm volatility at their means, I find that an increase in the financial development by 1% would result in an about 1.4 times higher volatility of young firms compared to the old ones.

5.2 Robustness Check

My first concern with the robustness of the empirical findings is related to possible presence of outliers. A sample selection, described in the previous section, enables me to get

[12]The effects are evaluated at variables means.

[13]IV estimates are a bit larger in absolute value but standard errors are a bit larger as well.

rid of the most severe of them, however, some outliers could still be present due to the very large sample size. Therefore, I reestimated the equation (10) by Least Absolute Deviation (LAD) and "Heavily Weighted OLS" (Robust) estimators described in the section 4.1 of the Dodonov (2009). The results are shown in Table 8. Neither significance nor signs of the estimated coefficients have changed. Therefore, potential presence of outliers is not likely to have an impact on the results reported in the previous subsection. However, it should be noted that the magnitude of the coefficient estimate of the external financial dependence is about twofold and threefold smaller in LAD and "Robust" regressions respectively compared to OLS or IV estimations.

My second robustness check is exploiting qualitative financial market index for advanced economies from IMF (2008), described in the previous section, as another measure of financial development. As was mentioned before it is available only for thirteen "old" members of the European Union that have well developed financial markets. I estimated the basic specification (equation (10)) by OLS, IV, and "Robust" estimators using this index as a second measure of financial development. Table 9 reports a first stage of the IV estimation while the results are presented in Table 10. Coefficient estimates of external financial dependence, financial development and their interaction are again positive and significant at 1% level. It probably should be mentioned that coefficient estimate for firms size is statistically significant at 1% only in regression estimated by "Robust" estimator. Quantitative impact of financial development on firm volatility should be interpreted with caution since financial development is captured by the qualitative indicator. Greece has a lowest level of financial development in this sample. Point estimates suggest that an increase in financial development to the median level (correspondent to Belgium in the sample) would result in an increase in firm level volatility by about 8%. At the same time an increase in financial development of Belgium to the UK level, that has the highest index, would cause firm volatility to by 16%.

6 Conclusion

Theoretical and empirical literature so far failed to establish a robust link between the financial development and output volatility at the firm level. In this paper I test the theoretical predictions of a Acemoglu (2006) general equilibrium model of financial development, risk–taking, risk–diversification and firm–level volatility. I also examine whether the effect of financial development on firm volatility increases with industry's dependence on external finance. I argue that firms in industries with greater dependence on external finance adopt a higher risk–taking strategies and the effect increases with higher level of financial development of the country. The effect on financial development on firm–level volatility is studied using a very large AMADEUS dataset containing information on more than 1.5 million private and public companies in manufacturing and construction sector.[14]

I find a significant positive effect of financial development on firm–level volatility confirming the relationship predicted by Acemoglu (2006). This finding stands in sharp contrast to a number of previous findings reporting a negative relationship between the financial development and the volatility at the firm level. It should be pointed out that the effect is stronger for firms in industries that are relatively more dependent on external finance. These results imply that firms requiring more external funds due to technological characteristics of the industry would chose higher risk–taking strategies in countries that are more financially developed. The estimated coefficients for other firm–level variables, firm size and age, have negative signs that corresponds to current literature.

The results are very robust to the choice of different estimation methods controlling for potential outliers and alternative measures of financial development. I reestimated the model by Least Absolute Deviation (LAD) and "Heavily Weighted OLS" (Robust) estimators that are robust to the possible large number of outliers and find that neither

[14]My final sample includes about 100,000 firms.

significance nor signs of the estimated coefficients have changed. I also use a qualitative financial market index as another measure of financial development in the country. Coefficient estimates of external financial dependence, financial development and their interaction are again significant at 1% level of statistical significance and hold positive signs.

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FIGURE 1: Variance of Quarterly GDP Growth Rate (five–year moving variance)

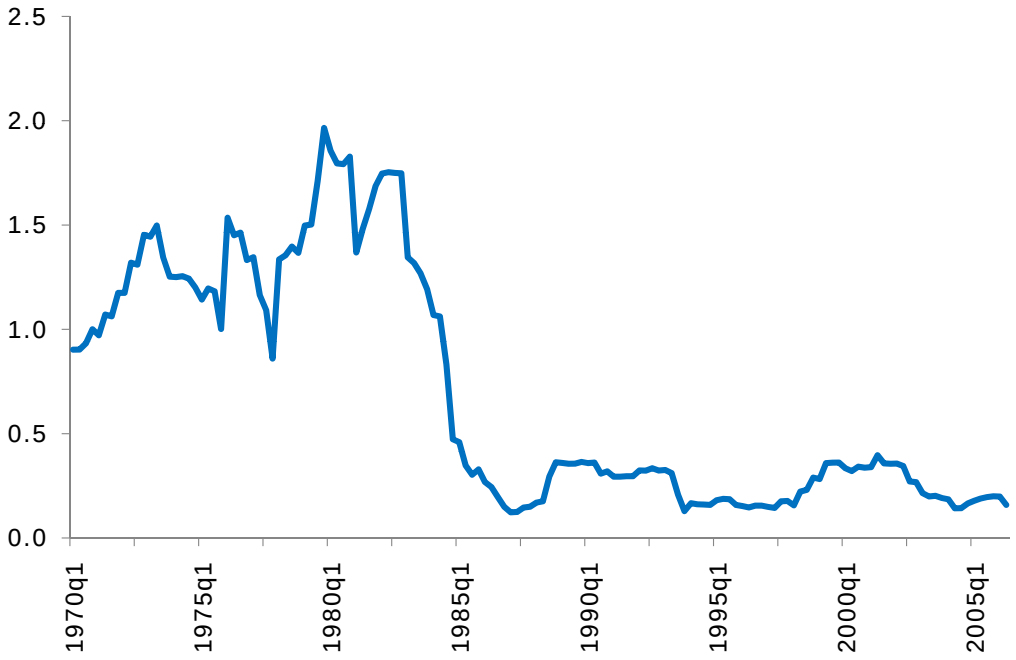

Table 1: Descriptive Statistics, all manufacturing and construction firms

Variable	Obs.	Mean	Std.	Min	Max
Volatility of Real Sales Growth	90,499	23.10	18.45	.25	151.01
Volatility of Employment Growth	90,499	18.25	15.60	0	163.72
Size	90,499	8.35	2.06	1.21	20.44
Quoted Company	90,499	.006	.075	0	1
Log of Age	89,093	2.79	.65	1.04	6.83
External Financial Dependence of the Industry	23	.26	1.15	-1.01	5.04
Financial Development (Market Capitalization as % of GDP)	24	51.43	39.76	8.22	141.93
Financial Development of the Country (IMF's index of Financial Markets)	13	.39	.07	.295	.53
Log of real GDP per Capita	24	9.72	.48	8.65	10.23
Institutional Development	24	1.10	.52	–.02	1.91
Voice &Accountability	24	1.17	.33	.39	1.65
Political Stability & Absence of Violence	24	.86	.33	.16	1.55
Government Effectiveness	24	1.22	.67	–.19	2.13
Regulatory Quality	24	1.19	.45	.017	1.85
Rule of Law	24	1.06	.64	–.21	1.88
Control of Corruption	24	1.12	.83	–.29	2.41

Table 2: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. OLS regression. Financial Development is captured by market capitalization of the listed companies as a share of GDP.

External Financial Dependence	0.137**	0.009	0.056	0.211***	0.215***	0.162***	0.492***
	(2.19)	(0.14)	(0.91)	(3.47)	(3.54)	(2.66)	(8.31)
Financial Development		–0.146***	–0.146***	–0.122***	–0.122***	–0.113***	0.097***
		(–74.68)	(–74.25)	(–62.49)	(–62.44)	(–51.75)	(30.05)
Financial Development*			0.018***	0.016***	0.016***	0.016***	0.015***
External Financial Dependence			(8.67)	(7.57)	(7.56)	(7.43)	(6.96)
Age				–5.642***	–5.624***	–5.779***	–3.458***
				(–62.68)	(–62.36)	(–63.21)	(–37.28)
Quoted					–2.159***	–3.034***	–1.176
					(–2.64)	(–3.67)	(–1.40)
Size						0.326***	–0.096***
						(10.19)	(–2.97)
Real GDP per Capita							–16.115***
							(–71.12)
R Adj sq.	0.000	0.075	0.076	0.115	0.115	0.116	0.173
N	90499	90499	90499	89093	89093	89093	89093

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

Table 3: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. OLS regression. Financial Development is captured by market capitalization of the listed companies as a share of GDP.

	All firms	Listed firms	Private firms
External Financial Dependence	0.492***	–0.576	0.505***
	(8.31)	(–1.21)	(8.45)
Financial Development	0.097***	0.070	0.098***
	(30.05)	(1.17)	(30.20)
Financial Development*	0.015***	–0.013	0.015***
External Financial Dependence	(6.96)	(–0.96)	(6.73)
Real GDP per Capita	–16.115***	–3.636	–16.194***
	(–71.12)	(–1.25)	(–71.22)
Age	–3.458***	–2.890***	–3.468***
	(–37.28)	(–2.94)	(–37.29)
Size	–0.096***	–0.687*	–0.091***
	(–2.97)	(–1.79)	(–2.83)
Quoted	–1.176		
	(–1.40)		
R Adj sq.	0.173	0.026	0.174
N	89093	483	88610

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

Table 4: First Stage

The dependent variable is Financial Development, captured by market capitalization of the listed companies as a share of GDP.

British Law of Origin	61.339*	–0.502
	(1.87)	(–0.02)
Scandinavian Law of Origin	42.065*	–5.352
	(2.09)	(–0.19)
German Law of Origin	–7.781	–75.339***
	(–0.52)	(–3.22)
Spanish Law of Origin	40.917***	11.193
	(3.16)	(0.74)
Institutional Development	56.039**	
	(2.77)	
Log of Real GDP per Capita	–30.193	–30.084
	(–1.23)	(–1.25)
Voice &Accountability		–86.451*
		(–1.95)
Political Stability & Absence of Violence		–32.279
		(–1.10)
Government Effectiveness		–36.906
		(–1.01)
Regulatory Quality		32.676*
		(1.79)
Rule of Law		53.720
		(1.25)
Control of Corruption		75.801**
		(2.72)
R Adj sq.	0.712	0.779
N	24	24

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

Table 5: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. IV regression. Financial Development is captured by market capitalization of the listed companies as a share of GDP. Instrumented variables: Financial Development, Financial Development*External Financial Dependence. Instruments: Law of origin and six indicators of World Bank of institutional development

	All firms	Listed firms	Private firms
External Financial Dependence	0.493***	–0.481	0.506***
	(8.31)	(–0.95)	(8.46)
Financial Development	0.098***	0.066	0.099***
	(30.19)	(1.09)	(30.35)
Financial Development*	0.015***	–0.005	0.015***
External Financial Dependence	(6.86)	(–0.36)	(6.77)
Real GDP per Capita	–16.146***	–3.595	–16.225***
	(–71.17)	(–1.22)	(–71.28)
Age	–3.456***	–2.884***	–3.466***
	(–37.26)	(–2.93)	(–37.27)
Size	–0.095***	–0.679*	–0.091***
	(–2.95)	(–1.77)	(–2.81)
Quoted	–1.173		
	(–1.39)		
R Adj sq.	0.173	0.026	0.174
N	89093	483	88610

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

Table 6: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. Large, Medium and Small Firms. OLS and IV regressions. Financial Development is captured by market capitalization of the listed companies as a share of GDP.

	OLS			IV		
	Large Firms	Medium Firms	Small Firms	Large Firms	Medium Firms	Small Firms
External Financial Dependence	0.022	0.676***	1.314***	0.024	0.677***	1.314***
	(0.25)	(7.40)	(8.11)	(0.28)	(7.41)	(8.11)
Financial Development	0.042***	0.056***	0.165***	0.045***	0.057***	0.165***
	(5.51)	(12.24)	(20.46)	(5.84)	(12.39)	(20.46)
Financial Development*	0.003	0.008**	0.025***	0.005	0.008**	0.025***
External Financial Dependence	(0.96)	(2.36)	(5.84)	(1.43)	(2.38)	(5.84)
Real GDP per Capita	–6.888***	–12.134***	–23.144***	–7.060***	–12.173***	–23.144***
	(–14.91)	(–39.51)	(–48.21)	(–15.13)	(–39.62)	(–48.21)
Age	–2.681***	–3.602***	–3.240***	–2.689***	–3.599***	–3.240***
	(–14.03)	(–25.63)	(–19.84)	(–14.10)	(–25.61)	(–19.84)
Quoted	0.427			0.445		
	(0.52)			(0.54)		
R Adj sq.	0.047	0.146	0.245	0.047	0.146	0.245
N	16170	38289	34634	16170	38289	34634

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

Table 7: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. "Young" vs. "Old" firms. OLS and IV regressions. Financial Development is captured by market capitalization of the listed companies as a share of GDP.

	Old Firms		Young Firms	
	OLS	IV	OLS	IV
External Financial Dependence	0.367***	0.382***	0.844***	0.839***
	(5.81)	(6.03)	(5.40)	(5.36)
Financial Development	0.089***	0.107***	0.137***	0.158***
	(25.30)	(28.71)	(16.33)	(18.12)
Financial Development*	0.019***	0.022***	0.008*	0.006
External Financial Dependence	(7.85)	(7.90)	(1.77)	(1.31)
Real GDP per Capita	–14.629***	–15.589***	–20.209***	–21.229***
	(–53.71)	(–55.81)	(–41.54)	(–42.53)
Age	–2.796***	–2.731***	–9.843***	–9.849***
	(–22.44)	(–21.83)	(–20.19)	(–20.20)
Size	–0.028	–0.010	–0.311***	–0.289***
	(–0.77)	(–0.26)	(–4.64)	(–4.33)
Quoted	–1.970**	–1.884**	5.254*	5.560**
	(–2.29)	(–2.19)	(1.85)	(1.96)
R Adj sq.	0.118	0.117	0.192	0.192
N	66194	66194	22924	22924

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

Table 8: Robustness Check: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. Least Absolute Deviation (LAD) and "Heavily Weighted OLS" ("Robust") regressions. Financial Development is captured by market capitalization of the listed companies as a share of GDP.

	LAD	"Robust"
External Financial Dependence	0.238***	0.143***
	(4.66)	(3.25)
Financial Development	0.104***	0.097***
	(38.02)	(41.24)
Financial Development*	0.017***	0.012***
External Financial Dependence	(10.36)	(8.87)
Real GDP per Capita	–16.273***	–14.045***
	(–95.08)	(–95.39)
Age	–2.983***	–2.693***
	(–37.72)	(–39.59)
Size	–0.310***	–0.249***
	(–11.88)	(–11.13)
Quoted	–0.782	–0.997*
	(–1.22)	(–1.80)
R Adj sq.		0.211
N	89093	89093

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

Table 9: First Stage

The dependent variable is Financial Development, captured by IMF's qualitative financial market index for advanced economies.

Scandinavian Law of Origin	–0.143***	–0.010
	(–5.90)	(–0.19)
German Law of Origin	–0.209***	–0.155**
	(–6.67)	(–8.75)
Spanish Law of Origin	–0.092**	0.050
	(–2.59)	(1.08)
Institutional Development	0.085	
	(1.37)	
Log of Real GDP per Capita	0.158**	0.186**
	(2.46)	(4.34)
Voice &Accountability		0.155
		(1.59)
Political Stability & Absence of Violence		–0.211
		(–2.88)
Government Effectiveness		–0.296
		(–2.82)
Regulatory Quality		0.204
		(2.89)
Rule of Law		0.354
		(1.39)
Control of Corruption		–0.013
		(–0.11)
R Adj sq.	0.697	0.872
N	13	13

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

Table 10: Robustness Check: Financial Development, External Financial Dependence and Firm–Level Volatility

The dependent variable is the standard deviation of real sales growth. Financial Development is captured by IMF's qualitative financial market index for advanced economies.

	OLS	"Robust"	IV
External Financial Dependence	0.491***	0.165***	0.488***
	(7.78)	(3.87)	(7.74)
Financial Development	113.989***	98.275***	113.926***
	(30.26)	(41.19)	(30.23)
Financial Development*	8.657**	9.206***	9.544***
External Financial Dependence	(2.45)	(5.32)	(2.75)
Real GDP per Capita	–26.295***	–15.853***	–26.285***
	(–15.44)	(–14.54)	(–15.43)
Age	–3.239***	–2.346***	–3.239***
	(–32.73)	(–36.82)	(–32.74)
Size	0.051	–0.386***	0.051
	(1.28)	(–15.27)	(1.28)
Quoted	3.268***	1.790***	3.268***
	(2.84)	(2.96)	(2.84)
R Adj sq.	0.037	0.057	0.037
N	68693	68693	68693

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