Financial frictions and productivity: Firm-level evidence from Kazakhstan

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FINANCIAL FRICTIONS AND PRODUCTIVITY: FIRM-LEVEL EVIDENCE FROM KAZAKHSTAN

Abstract

This paper studies the effect of financial frictions on firm-level total factor productivity in Kazakhstan using a large data set on medium and large enterprises from 2009 to 2017. We explain the effect of financial frictions on productivity growth and the microeconomic channels through which they may transmit to the real economy. The results demonstrate that productivity growth is vulnerable to debt growth due to the rising financial friction, which is helpful in understanding of reasons why financial crises lead to a persistent decline in economic activity.

Keyword: Total Factor Productivity (TFP); Financial Frictions; Debt Growth

JEL code: D24, G30, O16

1. Introduction

There is a growing interest in potential spillover effects from finance to the real economy. From macro-level empirical analysis, it is well known that a developed financial system significantly facilitates aggregate economic growth in the country (Levine, 1997; Beck et al., 2000; Khan and Senhadji, 2003). However, financial frictions impede firms real activity due to the misallocation of production resources, reduced investments in physical capital[1], and effects on firm-level employment decisions, please refer to Popov and Rocholl (2015), Siemer (2019), Falato and Liang (2016). Asymmetric information, credit constraints, and liquidity risks are factors that amplify the role of financial frictions in shaping productivity by decreasing the ability of firms to allocate investment opportunities toward their most efficient use. For example, Aghion et al. (2010) show that under tight credit constraints firms may detour long-term productivity-boosting investments in the expectation of a higher liquidity risk. Confirming this, Campello and Hackbarth (2012) also believe that the investment decisions of firms experiencing financial difficulties increase the tangibility of firms' assets in order to benefit from the resulting increase in debt potential. The intuition underlying these theoretical papers suggests that productivity is inhibited by financial frictions through restraining investments in innovations, intangible assets, and new technologies.

Given these motives, this paper aims at analyzing the influence of financial frictions on productivity growth and the microeconomic channels through which they can be transmitted to the real economy. To this extent, we exploit firm-level panel data on a large sample of medium- and big-size Kazakhstani firms obtained from the Bureau of National statistics of the Agency for Strategic planning and reforms of the Republic of Kazakhstan. The uniqueness of the dataset lies in the inclusion of data on labor, various financial and balance indicators, as well as in tracking them in all regions of the country and seventeen broad sectors of the economy during the period 2009-2017.

Following Levine and Warusawitharana (2019), we analyze the impact of financial frictions, lagged productivity growth, debt growth, access to external and internal financing, and various control variables on firm-level total factor productivity (TFP). Debt growth is introduced as a measure of firm financing. Financial frictions are presented through various proxies, including industry-adjusted interest payment burden, firm liabilities, and fixed assets to sales as a measure of an external finance dependency, and cash holdings and receivables as indicators of internal resource capacity. We also include interactive terms between financial frictions and debt growth. Sector and location dummies are used to control the heterogeneity of firms, and time fixed-effects to account for the business cycle. The empirical approach allows us to control endogeneity issues using a two-step estimation approach. First, we estimate firm-level TFP using the GMM method proposed by Wooldridge (2009) that resolves simultaneity and selection biases when estimating the Cobb-Douglas production function. In the second stage, we adopt the Arellano and Bond (1991) approach for the dynamic panel data due to the presence of lagged dependent variable.

We demonstrate that productivity growth is vulnerable to debt growth due to the rising financial frictions, supporting the findings of Levine and Warusawitharana (2019). This implies that financial frictions constrain the firm-level productivity growth in Kazakhstan. Since productivity is one of

[1] There is a large portion of the literature on the analysis of the impact of the financial friction on investments in physical capital, see Fazzari et al. (1987), Whited and Wu (2006), Almeida and Campello (2007), Chava and Roberts (2008), and Campello and Chen (2010).

the main drivers of output growth, these findings are important for policy implications to address a number of issues. First, it is known that financial crises have a persistent and negative effect on production (Cerra and Saxena, 2008, Reinhart and Rogoff, 2009a, and Reinhart and Rogoff, 2009b). However, traditional models report a quick rebound following an economic downturn (Hall, 2016). The relationship between financial frictions and productivity growth may help to explain this negative persistence since lower TFP growth not only affects production but also indirectly influences employment and investment activities, exacerbating the impact of financial downturns. Second, a bunch of literature shows the impact of financial sector development on a country's growth (King and Levine, 1993). But how finance affects growth is still uncertain. This article attempts to explain the complementary channel through which finance can influence a country's economic development.

These findings contribute to the understanding of the relationship between finance and growth. Our work complements the findings in the literature on developing countries by analyzing how financial frictions are transmitted through the microeconomic channels to the firm-level productivity in Kazakhstan. The results are vital in understanding that the developed financial system, access to bank loans, and trade credit are important factors that drive the economic development in the country.

The paper is organized as follows. Section 2 presents an overview of the literature. Section 3 details the empirical strategy, discusses the methodology, and proceeds to the data description in Section 4. Section 5 presents the results and Section 6 concludes.

2. Literature review

The effect of financial development on economic growth is an important topic that has been studied for several decades. Rajan and Zingales (1998) show that the financial sector development positively influences the rate of economic growth. Particularly, they demonstrate that this is partly due to the lowering the cost of external finance to financially dependent firms. In the context of financial constraints, the authors suggest that financial market imperfections have an influence on investments and growth. Financial constraints deter the decisions to invest in R&D (Bond et al., 2005 and Mancusi et al., 2010). Campello et al. (2010) find that firms with a higher degree of financial constraint targeted deeper reductions in tech and capital spending, and employment during the global financial crisis of 2008. This is also confirmed theoretically by Aghion et al. (2010) and empirically by Aghion et al. (2012), who find that firms with limited credit tend to cut R&D and long-term illiquid investment during a recession based on data from French firms.

Recent theoretical models by Garcia-Macia (2017) and Anzoategui et al. (2019) suggest that declining investment in intangible assets reduces productivity growth. At the same time, OECD [2] confirms that sustainable investment in R&D is one of the channels through which financing can be linked to productivity. Analyzing 11,000 multinational firms, they find that firms with higher productivity growth show sustained growth in investment in R&D, which is important for improving firm productivity. Moreover, Madsen and Ang (2016) examine knowledge production, savings, investment, and education as four potential channels for testing the impact of financial sector development. Consistent

[2] OECD (2016), "Corporate finance and productivity", in OECD Business and Finance Outlook 2016, OECD Publishing, Paris, https://doi.org/10.1787/9789264257573-7-en.

with the previous findings, they suggest that all four channels are positively associated with financial development, which drives long-run productivity growth.

From the macroeconomic perspective, empirical papers on business cycles and productivity with the incorporation of financial-market imperfections suggest that distortions in the credit market can exacerbate resource misallocation. Barlevy (2003) analyzes a general equilibrium model and finds that the presence of credit market frictions can impede the reallocation of resources during recessions, directing them from more productive to less efficient production schemes. However, Osotimehin and Pappadà (2017) present a calibrated model to analyze firm dynamics in the presence of credit frictions and firm exit and entry during recessions. They find that, without financial frictions, productivity and financial crisis shocks lead to the increased exit of less productive firms, while under financial friction, on the contrary, more productive firms become more sensitive to the effects of financial friction.

Some closely related papers investigate the impact of financial conditions on productivity: Levine and Zervos (1998) show that stock market liquidity and banking development are positively associated with productivity growth and capital accumulation; Beck et al. (2000) report that the development of financial intermediaries contributes to economic growth mainly by fuelling higher total factor productivity; Buera et al. (2011) show that financial frictions significantly adds to labor productivity and aggregate TFP variations and economic development gaps across countries; Hsu et al. (2014) demonstrate that better developed equity markets lead to a higher innovation level in countries at the firm-level; Krishnan et al. (2015) suggest that greater access to financing and bank deregulation increase TFP of US manufacturing firms; and Cole et al. (2016) provide another empirical confirmation of the productivity-enhancing effect from efficient interaction of advanced technology adoption and external financing contracts.

As we can see vast literature highlights the importance of the influence of financial frictions on firm-level productivity. Gatti and Love (2008) find that firms limited in credit financing have a lower productivity growth. Krishnan et al. (2015) also show that productivity of small and financially restricted firms is positively associated with increased access to bank credits based on a natural experiment of manufacturing firms. Chemmanur et al. (2011) report that the productivity of firms that received venture capital is higher than that of non-venture capital firms. Ferrando and Ruggieri (2018) provide evidence of a negative relationship between financial frictions and TFP in the analysis of Euro area countries in 1995-2011. They also show that this financial pressure is amplified for small, young, and private firms. Caggese (2019) believes that financial tensions matter because they create barriers to market entry and negatively impact productivity growth over the life cycle of Italian firms. Compared to these studies, we test a novel method proposed by Levine and Warusawitharana (2019) and expand it by incorporating different measures of financial frictions. Our contribution is also in the analysis of microeconomic channels of economic downturns to the output growth through the effect of financial frictions on firm-level TFP.

This paper also aims to show the potential reason why the economy remains depressed and is slowly recovering from the financial crisis. Bassetto et al. (2015) and Clementi and Palazzo (2016) suggest that increased financing costs for businesses and reduced market entry are the factors that may explain the persistent decline in output. Petrosky-Nadeau and Wasmer (2015) show that the persistence of the labor market depends on frictions in the goods market. And the recent paper of Duval et al. (2020) examined the role of financial frictions for productivity growth using cross-country firm-level data. They find that financial frictions induced by credit tightening conditions cause a higher persistent productivity slowdown for firms with weaker pre-crisis conditions. Compared with these previous studies, we investigate how the impact of financial friction on the TFP slowdown may explain the negative resilience of output growth following financial crises.

3. Model

This section describes the model and theoretical explanation from the literature that generates a hypothesis about a stronger connection between finance and productivity growth caused by the increase in financial frictions under general assumptions about innovations and financial frictions (Levine and Warusawitharana, 2019).

3.1. Setup

The model is based on a well-known investment model with a classical Cobb-Douglas specification. Capital (K) and labor (L) are the factors of production used by firms to produce output (Y):

$$Y = e^z K^\alpha L^{1-\alpha} \tag{3.1}$$

where z is the log productivity of a firm, α is a capital share, and $1-\alpha$ is a labor share, respectively. The output of a firm is normalized to one. The wage rate of firms is fixed at the rate of w. The cash flow of the firm is given by

$$\max_L \ \Pi = Y - wL \tag{3.2}$$

The rate at which the capital stock depreciates is σ. Firms are assumed to carry a quadratic adjustment cost of investment, $\lambda \frac{I^2}{2K}$, to make sure that they are well-defined.

3.2. Productivity-boosting financing

A large literature reports that investments in R&D, information technologies, innovation, and organizational improvements drive the efficiency and productivity of firms; they contribute to more efficient services, production, and better workplace organization (Eisfeldt and Papanikolaou, 2013, Hall, 2011, Aghion et al., 2009, Yaşar and Paul, 2012). Firms can invest in such research and innovative projects to raise productivity, z. These expenditures on innovations are denoted as S, and some of the outcomes from them are assumed to be stochastic (see Levine and Warusawitharana, 2019). The firm gets a productivity increase denoted by the function $g(S/K, \epsilon)$, where the productivity is affected by innovation expenditures normalized by the firm size and exogenous variable ϵ (i.i.d.). Large firms may spend more to obtain a similar level of productivity, therefore, scaling by K captures it. Log-productivity in the next period is $z^{'}$, a random variable looks as follows:

$$z^{'} = z + g(S/K, \epsilon) \tag{3.3}$$

Productivity function $g(S/K, \epsilon)$ is assumed to satisfy Inada conditions with respect to the first term, S/K. The stochastic function from innovative projects expenditures is strictly increasing and concave in its first term:

$$\frac{\partial g(S/K,\epsilon)}{\partial S} > 0, \frac{\partial^2 g(S/K,\epsilon)}{\partial S^2} > 0, \tag{3.4}$$

3.3. Financing

Firms use their cash flows to invest in physical capital and innovation, as well as external funding to finance the remainder. Financial frictions are addressed by introducing an additional cost, ϕ, for each unit of external funding. For simplicity of the model, firms only make one financing decision. The model is needed to understand the reaction of firms' productivity growth to external funding through the changes in financial frictions. The next equation shows the amount of external financing utilized by a firm:

$$F = I + \lambda \frac{I^2}{2K} + S - \Pi \tag{3.5}$$

where F is the external financing, I is investments, $\lambda \frac{I^2}{2K}$ is a cost of investments, S is expenditures on innovative projects, and Π is a firm's cash flow. An increase in spending on innovation entails the need for additional funding. Let $V(K, z)$ denote the value of a firm, Levine and Warusawitharana (2019) show that it is a solution of the Bellman equation:

$$V(K, z) = \max_{I,K',S} -F(1 + \phi \mathcal{I}(F > 0)) + \beta E[V(K', z')] \tag{3.6}$$

$$K' = K(1 - \sigma) + I \tag{3.7}$$

where $\mathcal{I}(F > 0)$ takes value one if a firm gets external financing, β is a discount rate of the firm. The excess cash flows of the firms are returned to shareholders in the form of dividends. The following limitation is established in the literature whole including innovation investments and their transition to productivity (z):[3]

$$\frac{\partial^2}{\partial S^2} E[V(K', z')] < 0 \tag{3.8}$$

The existence of financial frictions shows that there can be options when firms do not pay dividends or do not receive external financing, and their investments in capital and innovation are shaped by the budget constraint. However, for other firms where investments are determined by first-order conditions, the optimal spending on innovation is given by the following expression:

$$1 + \phi \mathcal{I}(F > 0) = \beta \frac{\partial}{\partial S} E[V(K', z')] \tag{3.9}$$

where the left side $(1 + \phi \mathcal{I}(F > 0))$ is the marginal cost, the right side is the marginal benefit of such expenditures. The standard Inada conditions of the productivity function $(g(S/K, \epsilon))$ and the given above restriction are the conditions that help to find an interior solution to the optimal spending on innovations. This equation 3.9 shows how financial frictions could influence the optimal innovative project spending by controlling the cost of funds.

3.4. Model implications and hypothesis

The model stated above provides several implications that were tested in the literature. Brown et al. (2009) find that the availability of external finance relaxed the financial frictions and contributed

[3] This equation comes as the second-order condition for optimality of the expenditure on innovative projects.

to increased spending in innovations and R&D booms. Further, Cornaggia et al. (2015) show that banking competition increases spending on innovation projects among private firms. One of the main model implications is the rise in innovations due to the reduction of financial frictions. Following the Levine and Warusawitharana (2019), we analyze the responsiveness of productivity growth to the use of external finance in the presence of financial constraints. Particularly, we test the following hypothesis for Kazakhstan: *A rise in financial frictions empowers the link between financing and productivity growth.*[4]

$$\frac{\partial}{\partial \phi} \frac{\partial g(S/K, \epsilon)}{\partial F} > 0 \tag{3.10}$$

The rationale behind this is that financing tensions increase the cost of funds for financially constrained and dependent firms. This increase in costs hampers the spending on innovative projects. The decreasing expected returns on innovation spending means that productivity gains are greatly sensitive to expenditures on innovation when they are small. Thus, as financial problems escalate, the sensitivity of productivity growth to financing increases.

The model shows that when financial frictions are relatively small, firms receive external financing and invest more in innovative projects, resulting in higher productivity. However, when financial frictions are high, firms receive less external funding, which is associated with lower productivity growth.

The empirical strategy and analysis of the model using firm-level data on Kazakhstan are described and examined in the next Sections 4 and 5.

4. Data and Empirical strategy

4.1. The data

The data (1-PF and 1-T) are obtained from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan[5]. The 1-PF data-set is called "Report on the financial and economic activities of the enterprise" and is collected annually from firms with more than 50 employees from 2009 to 2014 and from firms with more than 100 employees since 2015 after changing the data collection methodology. It includes all medium and large firms except educational and medical organizations, banks, public associations, and insurance companies. The annual data of the form 1-T named "Report on Labor" consists of all observations for all legal entities and their separate divisions, except for the small enterprises reporting the 2-MP statistical form. This data-set is broader than 1-PF. We merge two data sets 1-T and 1-PF and limit the entire sample to firms with more than 100 employees from 2009 to 2017 to analyze the panel data. The data covers variables such as location, industries, and various financial indicators. It consists of about 5,873 firms observed between 2009 and 2017, for a total of 29,490 observations.

Table 1 shows the location and industrial composition of the data. The geographical composition of the data is presented in panel A, showing the main 14 oblasts and 2 republican-level cities, Almaty and Nur-Sultan. It demonstrates that the largest concentration of firms is located in Almaty (20%),

[4] To see the proof, refer to Section A of Supplementary Materials of Levine and Warusawitharana (2019).

[5] Before 2020, the Bureau of National Statistics operated as Statistics Committee under the Ministry of National Economy

then about 8.4% in Nur-Sultan and 7.8% in the East Kazakhstan region. The industrial variation in our data is provided via a 2-digit classification and distinguishes 17 sectors. Manufacturing (19.5%), Construction (14.6%), Agriculture (11.7%), and Retail and Wholesale trade (10.5%) are the main sectors, which account for more than half of the observations.

Table 1: Data structure

Panel A: Location composition			Panel B: Sector composition		
Regions	Freq.	Percent.	Sector	Freq.	Percent.
Aktobe region	1,332	4.5	Accommodation and Food Services	759	2.6
Almaty region	1,649	5.6	Administration and Support Services	1,784	6.0
Atyrau region	1,450	4.9	Art, Entertainment and Recreation	1,266	4.3
East Kazakhstan region	2,311	7.8	Construction	4,305	14.6
Kyzylorda region	1,025	3.5	Finance and Insurance	107	0.4
Mangystau region	1,316	4.5	Information and Communication	653	2.2
North Kazakhstan region	1,529	5.2	Other Services	111	0.4
Pavlodar region	1,289	4.4	Professional, Sci. and Tech. Services	1,930	6.5
South Kazakhstan region	1,900	6.4	Real Estate	592	2.0
West Kazakhstan region	1,138	3.9	Transportation and Warehouse	2.007	6.8
Akmola region	1,607	5.4	Agriculture	3,455	11.7
Almaty city	5,704	19.3	Automobile	138	0.5
Nur-Sultan city	2,480	8.4	Manufacture	5,736	19.5
Karagandy region	2,176	7.4	Mining	1,206	4.1
Kostanay region	1,905	6.5	Oil and Gas	277	0.9
Zhambyl region	679	2.3	Utilities	2,070	7.0
			Retail and Wholesale Trade	3,094	10.5
Total	29,490	100	Total	29, 490	100

TThe uniqueness of the data is in the inclusion of all variables needed to calculate firm-level productivity and various measures of financial friction. The data set contains information about wages, workers, hours worked, output, fixed assets, investment, raw materials, revenue, and many other variables of firm performance. This helps to construct a robust measure of total factor productivity for each firm. Balance sheet variables such as short-term and long-term debt, interest payment expenses, liabilities, accounts payable, and receivable, allow for building financing indicators.

4.2. Measurement of TFP

We use Cobb-Douglas production function at the firm-level that takes the form:

$$\log y_{it} = c + \alpha \log k_{it} + \beta \log l_{it} + \epsilon_{it} \tag{4.1}$$

where subscripts i and t denote firm and year respectively: y_{it} is output, k_{it} is the capital stock, l_{it} is labor, c is a constant term. The total factor productivity (TFP) is estimated as a residual, ϵ_{it}, from the equation 4.1. We allow capital and labor shares to be estimated by the model and do not impose a constant returns-to-scale restriction. The capital is measured as a firm's fixed assets and labor is measured as hours worked. For the robustness check, we use different measures of labor such as wage and the number of workers, and also apply other approaches to TFP estimation.

Unobserved heterogeneity and simultaneity bias are the main challenges in assessing total factor productivity. The unobserved heterogeneity can increase productivity. Whereas the simultaneity bias arises when an economic shock in a particular area or industry affects the performance of other firms. Several methodologies have been designed specifically to address the problem of simultaneity and selection bias in estimating the capital and labor shares via regression analysis. The simultaneity arises due to the correlation between inputs (capital and labor) with unobservable productivity shocks. Firms choose inputs knowing the level of productivity, which introduces bias in the estimates of OLS parameters. There are numerous approaches to addressing this issue: instrumental variable (IV), fixed-effects approach, control functions (Olley and Pakes, 1996; Levinsohn and Petrin, 2003), and generalized methods of moments (GMM). Input prices are candidates for the role of instruments in IV estimation. However, finding an appropriate instrument for capital is the main problem of this method. Regarding the fixed-effects model, which controls for unobservable heterogeneity across firms, it requires the productivity shock to be fixed over time, and a strict endogeneity of inputs conditional on firms' heterogeneity (Wooldridge, 2005), which does not hold in theory. Control functions method is a semi-parametric method introduced by Olley and Pakes (1996) (Levinsohn and Petrin (2003)) where investments (intermediate inputs) are introduced through semi-parametric function to control for unobservable productivity shocks. They develop a two-step estimation procedure to resolve the pathologies of simultaneity and selection bias present in OLS. However, Wooldridge (2009) proposed a new estimation technique using a GMM framework to modify the control functions method. His approach has several advantages over the two-step approach. First, it addresses an identification problem highlighted by Ackerberg et al. (2006) who finds that the assumptions of the previous approach hold if there is some variation in the data. If not, labor and the non-parametric term suffer from collinearity because firms choose the variable input at some point in time depending on their capital and productivity. Second, it accounts for heteroskedasticity and serial correlation by obtaining robust standard errors.

We estimate production function using Wooldridge (2009) methodology at the firm-level. The log growth rate of TFP is used as a dependent variable in the following analysis, which is calculated as a difference of a residuals, $\Delta TFP_{i,t+1} \equiv TFP_{i,t+1} - TFP_{i,t}$.

4.3. Estimation approach

To test the hypothesis that the sensitivity of future productivity growth to debt growth rises as financial frictions increase, we use the following regression equation:

$$\Delta TFP_{i,t+1} = \beta_1 \Delta TFP_{i,t} + \beta_2 \Delta TFP_{i,t-1} + \beta_3 \Delta Debt_{i,t} + \gamma Financial\_frictions_{i,t} \quad (4.2)$$

$$+ \lambda Financial\_frictions_{i,t} * \Delta Debt_{i,t} + \sigma X_{i,t} + a_i + b_t + z_i + \epsilon_{i,t+1} \quad (4.3)$$

where $\Delta TFP_{i,t+1}$ is the productivity growth in real terms from year t to $t+1$; $\Delta Debt_{i,t}$ is the log difference of firm's debt from $t-1$ to t; $X_{i,t}$ denotes control variables such as log of assets representing the size of firm, sales growth, and physical investments at time t; a_i, b_t, z_i denote location, time, and industry fixed-effects, respectively, to take into account firm-level environmental unobserved characteristics. Also, we employ robust standard errors clustered by location-industry-year to control for possible intertemporal correlation across firms in each industry, each location and each year.

The presence of lagged dependent variable may cause a biasedness of estimates (Holtz-Eakin et al., 1988). We apply the Arellano and Bond (1991) approach for the dynamic panel data to capture the endogeneity problem and address individual effects. The lagged values of the first difference are used as instrumental variables. We employ the GMM approach for the system of equations. The instruments of the GMM method help to mitigate simultaneity and endogeneity concerns.

The first-differencing technique helps us to remove any firm fixed effect. This implies that we control for firm-specific unobserved heterogeneity and focus only on a within-firm variation that mitigates omitted variable bias.

4.4. Variables and summary statistics

We use various indicators of financial frictions at the firm level. The ability to obtain external and internal financing helps to show the financing issues outside and inside of firms. External financing is taken into account via debt growth, external finance dependency, and liabilities that help us to capture other financing sources such as accounts payable [6], leasing finance, tax liabilities, and informal finance[7]. The debt growth is measured by the growth of bank loans. The interest payments ratio captures the price of the debt. A firm with high-interest expenses is likely to have a higher marginal cost of borrowing, which inhibits further debt financing.

Table 2: Variables definitions

Variable	Definition
Debt	Log(Short-term bank loans + Long-term bank loans)
Liabilities	(Liabilities + Accounts payable - Bank loans)/Total assets
Extern. financial dependency	Fixed-assets/Sales
Accounts receivable	Accounts receivables/Total assets
Cash holdings	(Cash + Bank deposits + Other current assets)/ Total assets
SizeLA	log (Total assets)
Investments	log (Investments)
Interest expense ratio	Interest payments on loans/Liabilities
Sales growth	Compound annual sales growth rate
Output	Log(Output)
Capital	Log(Fixed assets)
Labor	Log(Hours worked)

Monetary variables normalized to 2009 tenge. Financial friction variables are industry-adjusted.

We measure the ability of firms to generate internal funds using *Cash holdings* and *Accounts receivable*. Cash-rich companies that can more easily access capital for reinvestment may have less

[6] Accounts payable is also a major source of external financing together with bank loans since almost 90% of big firms and 70% of small and medium enterprises (SMEs) use trade credit in Kazakhstan (Adilkhanova et al., 2021).

[7] According to the given data, we have the only sum of the variables.

need to raise external funding to invest in innovation. Similarly, firms with a high amount of accounts receivable are prone to be more resilient to the constraints of the financial system. Being able to generate internal funds, we expect both cash-rich and liquid firms to suffer less from financial frictions.

Overall, we use three proxies for financial frictions: liabilities, cash holdings, accounts receivable, external finance dependency, and interest expense ratio are financial friction proxies. These firm-level variables give a good advantage in providing rich cross-sectional and firm-level variation but, at the same time, they may cause endogenous choice biases. Therefore, we take all these variables relative to their industry median to mitigate heterogeneity in firms across industries. To control for the simultaneity bias, we use the lag of financial friction variables, and also include control variables to account for observable heterogeneity. A list of the variables of interest along with their definitions can be found in Table 2.

Table 3 reports summary statistics of chosen variables. The data set is limited to around 12000 observations for those firms that are using bank loans. All monetary variables are adjusted for inflation. The average TFP growth is a bit negative. This may reflect the country's TFP growth over the period after the 2008 Global financial crisis when the economy faced a harsh downturn. Debt growth demonstrates a similar tendency as productivity growth.

Table 3: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
TFP growth	-0.034	0.79	-7.57	7.94	10263
Debt growth	-0.040	1.00	-10.82	13.81	8782
Liabilities	2.561	13.78	0	1379.33	12196
Extern. financial dependency	35.467	139.78	0	122.35	12138
Accounts receivable	1.663	3.35	0	144.85	12016
Cash holdings	2.161	4.85	0	109.37	12122
SizeLA	14.235	1.720	8.04	22.42	12196
Investments	10.370	3.70	-0.60	22.32	3516
Interest expense ratio	3.494	5.40	0	15.29	8902
Sales growth	2.501	21.1	-0.99	95.26	10295
Output	13.662	1.586	5.30	20.41	12196
Capital	12.787	2.00	3.42	20.52	12196
Labor	12.733	1.03	4.11	17.98	12183

5. Results

5.1. Baseline results

In this section, we explore how finance affects productivity growth at the firm level in Kazakhstan. The outlined assumption in Section 3 suggests that firms with access to external funding tend to invest in innovative projects that increase productivity. To investigate this causal relationship, we use the regression equation outlined earlier, but without interaction terms of financial frictions.

The regression results are reported in Table 4. They demonstrate that the debt growth of firms has a positive and significant effect on future productivity growth. The results show the persistence of TFP. A 10% increase in TFP shows a subsequent decrease in TFP to 2.62% next period after the crisis. Thus, much of the initial increase in TFP remains.

The coefficients of control variables present that larger firms have lower TFP growth, while investments have a positive effect on future TFP growth. There are two potential reasons: first, a firm's investment decisions are made in expectation of future productivity gains, or second, it partly captures investments in technology that drives TFP.

Table 4: Regression results without financial frictions

	$\Delta TFP_{i,t+1}$
$\Delta TFP_{i,t}$	-0.262**
	(0.14)
$\Delta TFP_{i,t-1}$	-0.080
	(0.06)
SizeLA$_{i,t}$	-0.210*
	(0.11)
Sales growth$_{i,t}$	-0.038
	(0.02)
Investments$_{i,t}$	0.007**
	(0.02)
Debt growth$_{i,t}$	0.022**
	(0.02)

Standard errors in parentheses clustered at the location-industry-year level.
Year, industry, and location fixed-effects are included but not reported.
$^{*}p < 0.20$, $^{**}\ p < 0.10$, $^{***}p < 0.05$

5.2. Liabilities

The first measure of financial frictions is a firm's liability relative to its industry mean, including accounts payable and excluding bank loans. Firms with higher leverage face a higher cost of additional debt financing. The choice of this variable also motivated by the theoretical model of Kiyotaki and Moore (1997), which states that firms face higher borrowing costs of funds as they get closer to their loan limit. Financial frictions are increasing in liabilities, the more a firm is in debt, the higher financial friction it has.

Table 5: Industry-adjusted liabilities

	$\Delta TFP_{i,t+1}$
$\Delta TFP_{i,t}$	-0.209*
	(0.12)
$\Delta TFP_{i,t-1}$	-0.083
	(0.06)
SizeLA$_{i,t}$	-0.192*
	(0.10)
Sales growth$_{i,t}$	-0.043*
	(0.02)
Investments$_{i,t}$	0.016**
	(0.02)
Debt growth$_{i,t}$	0.067*
	(0.04)
Adj. liabilities$_{i,t-1}$	0.071**
	(0.03)
Debt growth$_{i,t}$*Adj. liabilities$_{i,t-1}$	0.190*
	(0.01)

Standard errors in parentheses clustered at the location-industry-year level.
Year, industry, and location fixed-effects are included but not reported.
$^{*}p < 0.20$, $^{**}\ p < 0.10$, $^{***}p < 0.05$

Table 5 below demonstrates the regression results of the model with financial frictions and its interaction with debt growth. The results show a statistically significant relationship between the interaction of firm-level debt growth and industry-adjusted liabilities in Kazakhstan. This implies that the elasticity between future productivity growth and debt growth is increasing in the degree of financial frictions, and confirms that firms with a higher degree of debt face higher financial frictions.

However, we find a positive coefficient of liabilities. Levine and Warusawitharana (2019) provide a possible explanation for this is that lagged liabilities could capture the effect of longer lags in the returns of debt-financed innovations, with firms that had higher debt growth before t-1, showing both higher liabilities and higher productivity growth from the period t to t+1. This reflects that past borrowing activities are informative for future TFP growth as well.

5.3. Internal funds

The ability of firms to generate internal funds is associated with a lower probability of default. We use cash holdings and accounts receivable as a measure of financial tensions. A firm with higher internal liquidity funds could use less external financing for innovative projects, or also would be more stable among other firms in the debt market. Due to the heterogeneity across industries, we use variables of internal funds relative to their industry median, as in the case of liabilities. Higher internal funds weaken the impact of financial friction, the hypothesis stated earlier would show a negative coefficient on the interaction term.

Table 6: Industry-adjusted internal funds

	$\Delta TFP_{i,t+1}$
$\Delta TFP_{i,t}$	-0.203*
	(0.12)
$\Delta TFP_{i,t-1}$	-0.057
	(0.06)
SizeLA$_{i,t}$	-0.236
	(0.15)
Sales growth$_{i,t}$	-0.055**
	(0.02)
Investments$_{i,t}$	0.010
	(0.02)
Debt growth$_{i,t}$	0.087**
	(0.04)
Adj. cash holdings$_{i,t-1}$	0.045**
	(0.02)
Debt growth$_{i,t}$*Adj. cash holdings$_{i,t-1}$	-0.017
	(0.01)
Adj. accounts receivable$_{i,t-1}$	0.145*
	(0.08)
Debt growth$_{i,t}$*ADJ. acc. receivable$_{i,t-1}$	-0.051**
	(0.02)

Standard errors in parentheses clustered at the location-industry-year level.
Year, industry, and location fixed-effects are included but not reported.
*$p < 0.20$, ** $p < 0.10$, ***$p < 0.05$

The obtained results in Table 6 demonstrate that the coefficient on interaction terms with accounts receivable is negative and statistically significant, implying that the sensitivity of productivity growth to debt growth is lower as firms' liquid funds raise. The coefficients of industry-adjusted cash holdings and accounts receivable are positive and statistically significant. It shows that firms with higher amounts of cash and receivables have higher future growth. Such firms' liquidity lowers financial frictions in comparison with cash-constrained firms. These firms are more prone to obtain external financing and invest available finance in innovative projects that are associated with greater growth.

5.4. External financing dependency

We next use the ratio of fixed assets to sales relative to the industry mean as a measure of financial friction. It reflects the firms' industry external finance dependency. Firms in some industries can be more dependent and reliant on external financing, and, therefore, they would be more vulnerable to higher financial frictions in the market rather than firms operating in less financially dependent industries (Rajan and Zingales, 1998).

Table 7 reports the positive and statistically significant coefficients but economically smaller than other measures of financial frictions. According to the results, the sensitivity of future productivity growth relative to debt growth is increasing as external financing dependency rises. These findings confirm the hypothesis that firms in the industries which have external financing dependency to a greater extent face higher financial frictions.

Table 7: Industry-adjusted external financing dependency

	$\Delta TFP_{i,t+1}$
$\Delta TFP_{i,t}$	-0.293***
	(0.11)
$\Delta TFP_{i,t-1}$	-0.093*
	(0.05)
SizeLA$_{i,t}$	-0.198*
	(0.11)
Sales growth$_{i,t}$	-0.033
	(0.02)
Investments$_{i,t}$	0.005*
	(0.02)
Debt growth$_{i,t}$	-0.034*
	(0.03)
Adj. ext. fin. dependency$_{i,t-1}$	0.001
	(0.00)
Debt growth$_{i,t}$*Adj. ext. fin. dependency$_{i,t-1}$	0.009*
	(0.01)

Standard errors in parentheses clustered at the location-industry-year level.
Year, industry, and location fixed-effects are included but not reported.
$*p < 0.20$, $**\ p < 0.10$, $***p < 0.05$

5.5. Interest expense

In this section, we estimate the impact of the interest expense ratio on future TFP growth. We calculate the interest expense ratio as a ratio of loan interest payments to liabilities. As for other financial frictions, we take it relative to the industry median to mitigate the heterogeneity bias in the estimation coefficients.

Interest expense ratio is an important variable as it reflects the cost of borrowing and the extent of the current bank debts. Firms with greater interest expenses tend to face a higher cost of borrowing for further loans. Table 8 exhibits the results of regression using the industry-adjusted interest expense ratio as a measure of financial frictions.

The findings show the significant positive coefficient of the interaction term between debt growth and industry-adjusted interest expense ratio. This indicates that the sensitivity of future TFP growth relative to the lagged debt growth is rising with the interest expenses. The coefficient is not only positive but also economically significant, validating the outlined hypothesis. In contrast to the other financial friction measures, the interest expense ratio harms future productivity. This suggests that firms facing a higher cost of borrowing are prone to meet lower future growth.

Table 8: Industry-adjusted interest expense ratio

	$\Delta TFP_{i,t+1}$
$\Delta TFP_{i,t}$	-0.299**
	(0.15)
$\Delta TFP_{i,t-1}$	-0.098
	(0.07)
SizeLA$_{i,t}$	-0.238*
	(0.13)
Sales growth$_{i,t}$	-0.038
	(0.03)
Investments$_{i,t}$	-0.031
	(0.03)
Debt growth$_{i,t}$	0.002*
	(0.02)
Adj. interest exp. ratio$_{i,t-1}$	-0.009**
	(0.00)
Debt growth$_{i,t}$*Adj. interest exp. ratio$_{i,t-1}$	0.103*
	(0.00)

Standard errors in parentheses clustered at the location-industry-year level.
Year, industry, and location fixed-effects are included but not reported.
$^{*}p < 0.20$, $^{**}\ p < 0.10$, $^{***}p < 0.05$

6. Conclusion

The global financial crisis has demonstrated that problems in a country's financial system can significantly influence economic growth. When financial markets are underdeveloped, firms may not have sufficient access to external financing to reach their optimal size. Consequently, firms are faced with a misallocation of resources, resulting in low productivity gains. In this paper, we analyze the effect of financial frictions on productivity growth and the microeconomic channels through which they may transmit to the real economy. We show that in a setting where firms can invest in innovative projects, the connection between financing and productivity growth strengthens as the severity of financial frictions increases. Using firm-level panel data on a large sample of medium- and big-size Kazakhstani firms, we find strong empirical support for this hypothesis.

The results demonstrate that productivity growth is vulnerable to debt growth due to the rising financial frictions, supporting the findings of Levine and Warusawitharana (2019). This implies that financial frictions constrain the firm-level productivity growth in Kazakhstan. Since productivity is one of the main drivers of output growth, these findings are important for policy implications to address several issues. First, it is known that financial crises have a persistent and negative effect on production. However, traditional models report a quick rebound following an economic downturn. The relationship between financial frictions and productivity growth may help to explain this negative persistence since lower TFP growth not only affects production but also indirectly influences employment and investment activities, exacerbating the impact of financial downturns. Second, a bunch of literature shows the impact of financial sector development on a country's growth but how finance affects growth is still uncertain. These findings contribute to the understanding of the relationship between finance and growth.

The results show the persistence of TFP. A 10% increase in TFP shows a subsequent decrease in TFP to 2.62% next periods after crises. Liquid firms have less financial distress; they are more prone to obtain external financing for investing rather than cash constraint firms. They can invest available finance in innovative projects associated with greater growth. In contrast, firms with limited access to external financing are cutting back on their investment in innovation projects. This is one of the channels for how financial tensions are holding back productivity growth. The second channel is the influence of the high-interest expense ratio on future TFP growth. The interest expense ratio reflects the cost of borrowing and the extent of the current bank debts. When firms face a higher cost of borrowing are prone to meet lower future growth. The high amount of liabilities is a third channel by which finance is negatively transmitted to TFP. The firms' future productivity becomes more vulnerable to debt growth.

Overall, our findings suggest that financial frictions harmfully affect investments, resulting in low future productivity growth. They restrain firms from accessing additional finance and investing in innovative projects. Since lower productivity growth leads to lower output growth, ceteris paribus, our results may help to understand why financial crises lead to a permanent decline in economic activity. Therefore, the improvement of the financial state of firms and the development of the financial system in the country will reduce these frictions, which hinder a quick recovery from crises.

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