Financial constraints and productivity growth: firm-level evidence from a large emerging economy

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Financial constraints and productivity growth: firm-level evidence from a large emerging economy

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Abstract

We study whether the linkage between financing and productivity growth strengthens as the severity of financial constraints increases by using firm-level administrative data from a large emerging economy. We also explore whether upstream firms' financial constraints play a role in the linkage between finance and productivity. Using a combination of administrative databases of tax registry and firm-to-firm trade data of 896,317 Turkish firms from 2007 to 2018, employing various robustness tests and controlling for reverse causality, we find strong evidence that firms facing higher financial constraints exhibit a higher sensitivity of total factor productivity (TFP) growth to debt growth. Moreover, we show that a rise in upstream firms' financial constraint level also leads to increased sensitivity of TFP growth to debt growth. Our results reveal important channels through which financial constraints could hinder productivity growth in Turkey.

JEL Codes: D24, G30, O16

Keywords: TFP growth, Financial constraints, Debt growth

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Non-technical Summary

A vast majority of the existing theoretical and empirical literature notes that financial systems may foster long-term economic growth at the country level by improving capital allocation efficiency and encouraging savings. A growing literature recognizes that not the factor accumulation but total factor productivity (TFP) explains the cross-country differences in the level of growth of gross domestic product (GDP). Moreover, the capital market imperfections may prevent firms with a low level of internal funds - or financially constrained firms - from investing in productivity-enhancing activities given the fact that in most countries, especially in developing and under-developed countries, access to credit is based on collateral, and large firms disproportionately own the assets. Therefore, improving capital allocation efficiency and relaxing the funding constraints for financially constrained firms are crucial to enhance productivity. However, the empirical evidence on the link between financial constraints and productivity growth at the microeconomic level is mixed and not well understood.

In this paper, we study the effect of financial constraints on productivity growth. Specifically, we estimate whether the linkage between financing and productivity growth strengthens as the severity of financial constraints increases in a large emerging economy, Turkey. We also study the role of upstream firms' financial constraint level in the finance-productivity linkage. The empirical analyses are based on the matched administrative balance sheet and firm-to-firm trade databases covering the universe of firms operating in Turkey between 2007 and 2018. We start with calculating firm-level TFP based on a Cobb-Douglas specification. We then construct four variables for measuring each firm's financial constraint level, including tangible assets to total assets ratio, leverage ratio, cash holding ratio, and interest expense ratio of firms.

Employing various robustness tests and controlling for reverse causality, we find a significant positive relation between debt growth and future total factor productivity growth in Turkey. We also find strong evidence that an increase in financial constraints leads to a rise in the sensitivity of productivity growth in terms of value-added generated. In other words, our results show that firms having higher financial constraints experience a higher sensitivity of productivity to debt growth. Moreover, we show that an increase in a firm's suppliers' financial constraints leads to a rise in productivity growth's sensitivity to debt growth. The evidence we present in this study reassures the importance of effective resource allocation through the financial system in a developing country.

1 Introduction

Do financial constraints affect productivity growth? A vast majority of the existing theoretical and empirical literature notes that financial systems may foster long-term economic growth at the country level by improving capital allocation efficiency and encouraging savings.[1] At the firm level, finance may influence firms' investments in production factors such as fixed capital (Fazzari et al., 1988; Chava and Roberts, 2008) and employment (Nickell and Nicolitsas, 1999; Falato and Liang, 2016; Atabek and Aldan, 2020). However, a growing literature recognizes that not the factor accumulation but TFP explains the cross-country differences in the level of growth of gross domestic product (GDP) (e.g., Kydland and Prescott, 1982; Hall and Jones, 1999; Easterly and Levine, 2001, among many others). Given that TFP differences are crucial to understanding GDP differences across countries and over time, we still lack empirical evidence on the channels through which financial constraints may affect firm-level TFP growth.

If the financial system can utilize funds more efficiently and productively, financially constrained firms may invest in productivity-enhancing strategies (Ayyagari et al., 2010) where innovation-based productivity growth requires costly investments. Moreover, firms that innovate generally have lower access to credit as they mostly hold R&D related intangible assets, and it is more difficult to use them as collateral.[2] When firms face difficulties in finding external finance, they have to rely on internal funds for investments. In other words, the capital market imperfections and lending constraints that limit access to finance can influence firms' decisions on investments. These imperfections may prevent firms with a low level of internal funds-or financially constrained firms- from investing in productivity-enhancing activities. Even if there is a development in the financial sector's size and liquidity, this does not necessarily improve access to finance of constrained firms because of the lack of democratized access to financial products. Similarly, as credit is mostly concentrated among large firms, especially in developing countries, a large amount of credit does not always correspond to more access to finance. The concentration of credits towards large firms reduces funds for the other firms, interrupting their investment decisions. Moreover, in most countries, especially in developing and under-developed countries, access to credit is based on collateral, and large firms disproportionately own the assets (financial or non-

[1] Levine (2005) presented a survey of theories on the finance-growth nexus and lists the possible channels through which finance may influence economic growth.

[2] On the other hand, financially constraint firms might invest less in R&D activities because of liquidity risk (Aghion et al., 2010).

financial).[3] Therefore, improving capital allocation efficiency and relaxing the funding constraints for financially constrained firms are crucial to enhance productivity.

In this paper, we study the effect of financial constraints on productivity growth. Specifically, we estimate whether the linkage between financing and productivity growth strengthens as the severity of financial constraints increases in a large emerging economy, Turkey. We also study the role of upstream firms' financial constraint level in the finance-productivity linkage. Although Turkey had experienced an era of strong economic growth after adopting financial and fiscal reforms following the 2000-2001 crisis, the contribution of productivity has been on a declining path in recent years.[4] Moreover, despite being characterized by a bank-based financial system, the Turkish credit sector is highly concentrated[5] and the concentration rate is highly dependent on global monetary conditions. These make Turkey an ideal laboratory to study the impact of financial constraints on productivity growth over a period that contains both easing and tightening global monetary conditions.

The empirical analyses are based on the matched administrative balance sheet and firm-to-firm trade databases covering the universe of firms operating in Turkey between 2007 and 2018. The firm-level data used in this study are from the confidential financial reports of the universe of firms in Turkey that are to report balance sheet information annually. The financial reports' data, provided by the Ministry of Treasury and Finance, contain the balance sheet, the income statement, and the firm-to-firm trade data. The transaction-level data provides novel supplier network information at the firm level to a great extent. We start with calculating firm-level TFP following Levinsohn and Petrin (2003) based on a Cobb-Douglas specification. We estimate separate production functions at two-digit NACE sectors. We then construct four variables for measuring each firm's financial constraint level, including tangible assets to total assets ratio, leverage ratio, cash holding ratio, and interest expense ratio of firms. We finally use administrative domestic firm-to-firm trade data for investigating the role of network effects by controlling for the financial

[3] According to the latest data provided by the World Bank's Enterprise Surveys, the collateral value needed for a loan as a percentage of the loan amount is 88.1, 176.6, and 174.5 in high-income OECD countries, the Europe & Central Asia region and Turkey, respectively. Moreover, the same survey reports that while the percentage of firms identifying access to finance as their biggest obstacle is 9.1 in high-income OECD countries, it is about 15.9 percent for the Europe & Central Asia region, and it is about 26.5 percent for the non-financial Turkish firms. See www.enterprisesurveys.org for the detailed description of the surveys.

[4] The weak productivity growth has been partly offset by higher labor force participation and employment in Turkey.

[5] The study of Akcigit et al. (2020) estimated a Herfindahl-Hirschman Index of total credit distribution for the manufacturing sector in Turkey and showed that credit concentration was high compared to the peers, and it started to increase following the Fed tapering.

constraint of suppliers. Specifically, we calculate the weighted measures for the supplier firms' financial constraints using the firm-to-firm trade value between the producer and the supplier. Methodologically, we regress firm-level productivity growth, namely TFP growth, on lagged TFP growth, debt growth, a measure of financial constraint, an interaction of financial constraints with debt growth, a measure of suppliers' financial constraints, an interaction of suppliers' financial constraints with firm's debt growth, and several firm-level control variables.

Using a large set of firm-level administrative data, employing various robustness tests, and controlling for reverse causality, we find a significant positive relation between debt growth and future total factor productivity growth in Turkey. We also find strong evidence that an increase in financial constraints leads to a rise in the sensitivity of productivity growth in terms of value-added generated. In other words, our results show that firms having higher financial constraints experience a higher sensitivity of productivity to debt growth. Moreover, we show that an increase in a firm's suppliers' financial constraints leads to a rise in productivity growth's sensitivity to debt growth. Our results would demonstrate important channels through which financial constraints could hinder productivity growth, hence Turkey's economic growth.

Although the existing literature on the link between finance and growth argues that lower financial constraints should contribute to improved economic outcomes, especially by the mobilization of savings aimed at financing investment (see King and Levine, 1993; Rajan and Zingales, 1998; Demirguc-Kunt and Levine, 2008, among many others), the empirical evidence on the link between financial constraints and productivity growth at the microeconomic level is mixed and not well understood. One line of researches reports a non-significant impact of financial constraints on productivity (e.g., Moreno-Badia and Slootmaekers, 2009; Mwangi, 2014; Cao and Leung, 2020) or negative impact (e.g., Nucci et al., 2005; Nunes et al., 2007). A large body of these studies mostly relies on sectoral or survey-based datasets. Another line of studies finds significant positive estimates for the effect of financial constraints on firm innovation and productivity growth (e.g., Gatti and Love, 2008; Chen and Guariglia, 2013; Ferrando and Ruggieri, 2015; Aghion et al., 2019; Levine and Warusawitharana, 2020).[6] Our paper contributes to this line of researches yet differs from the existing literature in several dimensions.

[6] Using the World Bank's survey data for Bulgaria, Gatti and Love (2008) showed that firms having higher financial constraints had lower productivity growth. Chen and Guariglia (2013) found that cash flow and productivity are positively and significantly correlated in China. Moreover, Ferrando and Ruggieri (2015) showed that financial constraints and productivity are negatively and significantly correlated in Euro area countries. Using French

First, our data on domestic firm-to-firm trade allows us to explore whether upstream firms' financial constraints play a role in the linkage between finance and productivity.[7] This important question has not been answered so far to our best knowledge. When suppliers of a firm become financially constrained, it is difficult to get trade credit from these suppliers, directly affecting the firm's investment decision. Similarly, when suppliers of a firm are financially strong (unconstrained), it is highly probable for the firm to obtain long-term financing from these unconstrained suppliers.[8] Therefore, it is crucial to explore whether financial constraints of firms' suppliers matter for the sensitivity of productivity growth to debt growth. Our study contributes to the literature by being the first to explore how firm-to-firm trade plays a role in determining the impact of financial constraints on TFP growth. Second, existing studies mostly rely on commonly used data of large firms or specific sectors, while our paper covers the universe of firms operating in Turkey across all sectors and size groups, which enables us to control for the sector and size fixed effects. This is crucial for analyzing the finance-productivity growth linkage since small and medium-sized firms are more likely to be financially constrained than large firms.[9] Third, we look at the linkage between financial constraints and total factor productivity in a large emerging economy, though the finance-productivity linkage has been a major concern of economists in the context of developed countries mostly due to the data availability. Fourth, we contribute to the literature on measuring financial constraints. Since whether a firm is financially constrained is not directly observable in the data, how the financial constraint is measured is crucial. We construct four measures of firm-level financial constraints in an emerging economy context.[10] Fifth, our study is the first study that examines the finance-productivity linkage using the universe of firms

manufacturing firm-level dataset, Aghion et al. (2019) found that incumbent firms with easier access to credit experience higher productivity growth and lower exit rates. Similarly, Levine and Warusawitharana (2020) found that financial frictions and the sensitivity of productivity growth to debt growth are positively and significantly associated for private European firms.

[7] Studies such as Acemoglu et al. (2016) and Bernard et al. (2017) showed that the economic outcomes of a firm are very likely to be affected by its supply network. Moreover, when a firm experiences financial distress, it is likely that its suppliers and customers will be affected because of the spillover (see Hertzel et al., 2008).

[8] Trade debt generally constitutes the largest component of firms' total debt in Turkey. The average ratio of trade debt to total debt is about 0.4 for the 2007-2018 period (see Section 3 for the details).

[9] See, for example, Fazzari et al. (1988) and Gilchrist and Himmelberg (1995).

[10] There are several measures of financial constraints such as the investment cash-flow sensitivity measure of Fazzari et al. (1988), the Kaplan and Zingales (KZ) index, the cash flow sensitivity of cash index of Almedia et al. (2004), the size-age (SA) index of Hadlock and Pierce (2010), among many others.

operating in Turkey.[11] Finally, our productivity estimations consider the endogeneity of the variables by using a Generalized Method of Moments (GMM) estimator where most of the studies in the related literature use fixed or random effects estimators.

The remainder of the paper is as follows. Section 2 describes the empirical methodology used to calculate financial constraint measures and estimate their effects on TFP growth. Section 3 presents the data and descriptive information. Section 4 summarizes the empirical findings and discusses several robustness tests. Section 5 concludes.

2 Empirical methodology

2.1 Constructing financial constraints measures

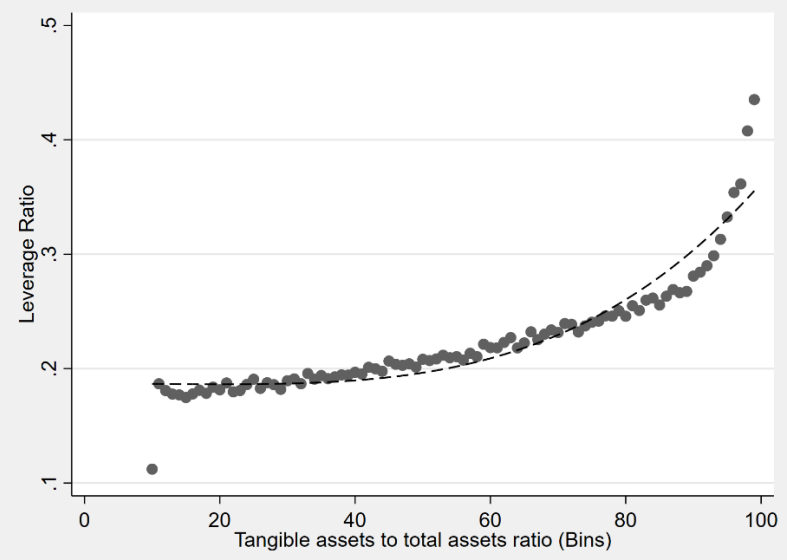
We use several indicators to proxy for financial constraint at the firm level, following the literature's widely accepted methodologies. Our baseline proxy variable for the firm-level financial constraint is tangible fixed assets to total assets ratio, namely the tangibility ratio. Financial markets and intermediaries do not perfectly operate in developing countries due to information asymmetries between debtors and creditor banks. Thus, most commercial loans are collateral-based, making the stock of fixed assets a key factor in accessing the bank loans. As a result, a higher tangible fixed asset to total asset ratio implies a higher capacity to provide collateral against banks meaning that the firm is less financially constrained. The tangibility ratio is calculated as (land + buildings + motor vehicles)/total assets, which denotes the availability of tangible assets for collateral needs.

As visual evidence for the role of collateral in access to finance, we plot the financial leverage ratio against the tangibility ratio in Figure 1 using the firm-level data employed in our regression analysis. The horizontal axis in Figure 1 presents the bins of tangibility ratios when firms are ordered from low tangibility ratio to high tangibility ratio in percentiles, where the vertical axis shows the median level of financial leverage ratio at each bin. There is a strong non-linear positive relationship between the two variables, implying that access to finance increases at an increasing rate in the level of tangible assets to total assets ratio. While the median financial leverage ratio of firms in the 20th percentile is around 18%, the same ratio in the 99th percentile is around 43%. Figure 1 also sheds light on why the construction sector, which has relatively higher

[11] Atabek and Aldan (2020) showed that financial constraints inhibit employment growth in Turkey using firm-level data. However, their sample is not fully representative, where the average firm size in their sample is much larger than the national average.

tangible assets than the other sectors, usually gets a bigger share during Turkey's credit expansion cycles.

Figure 1: Correlation between tangibility and access to finance



Source: Authors' calculations. The tangible assets to total assets ratio is divided into bins.

Because access to bank loans is harder for firms with a relatively lower tangibility ratio, we expect the interaction of lagged tangibility ratio with debt growth to be negatively related to future productivity growth, implying that return to the bank loan is greater for financially constrained firms. We test the robustness of our estimates for several other proxy variables for financial constraint, including lagged financial leverage, cash holdings to total asset ratio, and implicit interest rate, following the previous literature.

The second proxy variable we use for the financial constraint is the financial leverage ratio. A higher financial leverage ratio will imply a more financially constrained firm based on the assumption that firms with higher leverage would have higher costs of additional debt (Kaplan and Zingales, 1997; Hennessy and Whited, 2007; Levine and Warusawitharana, 2020). The financial leverage ratio is calculated as (short term financial debt + long term financial debt)/total assets, which measures how far a firm is from its borrowing limit. We expect the interaction of financial leverage ratio with debt growth to be positively related to future productivity growth.

The third proxy variable for the financial constraint is the cash holding ratio, which measures internal financing sufficiency. Firms with higher cash holdings could require less external financing to invest in productivity-enhancing activities (Li et al., 2018; Chen and Guariglia, 2013;

Levine and Warusawitharana, 2020). It is measured as the ratio of cash and cash equivalents to total assets. The expected sign for the estimated coefficient of interaction term of cash holding ratio with debt growth is negative.

Our last proxy variable for the financial constraint is the implicit interest rate, which captures the cost of debt finance (Levine and Warusawitharana, 2020). It is measured as the ratio of total interest expense to lagged financial debt, where a higher ratio implies a higher level of financial constraint. We expect a significant positive relationship between the interaction of implicit interest rate with debt growth and future productivity growth.

Figures 2a-2d show the kernel density of the four variables we used as a proxy for the level of financial constraint.

Figure 2: Financial constraint variables

Figure 2a: Tangibility ratio

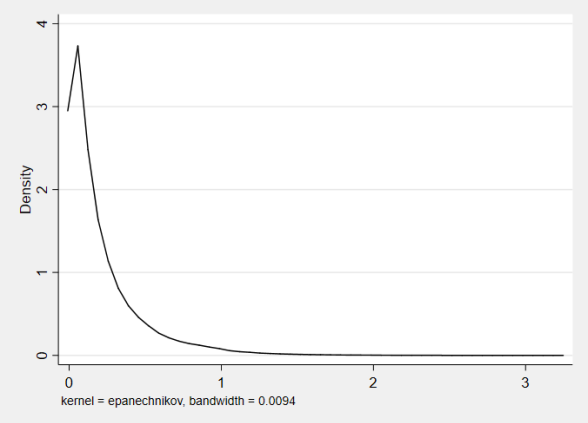


Figure 2b: Financial leverage ratio

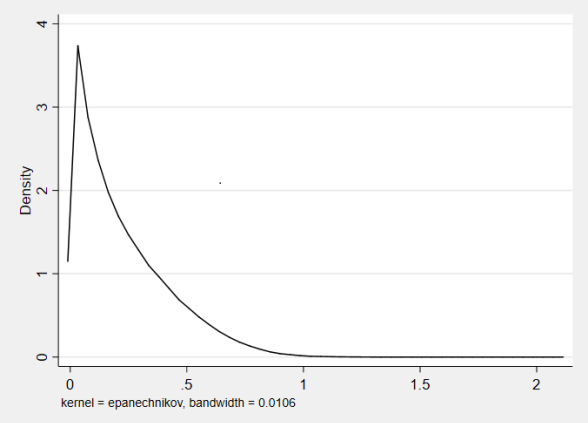


Figure 2c: Cash ratio

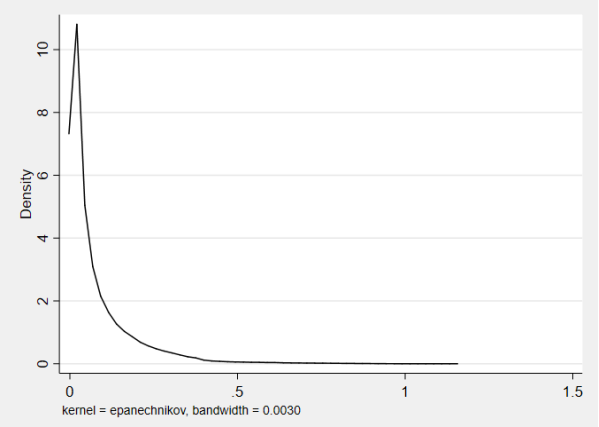
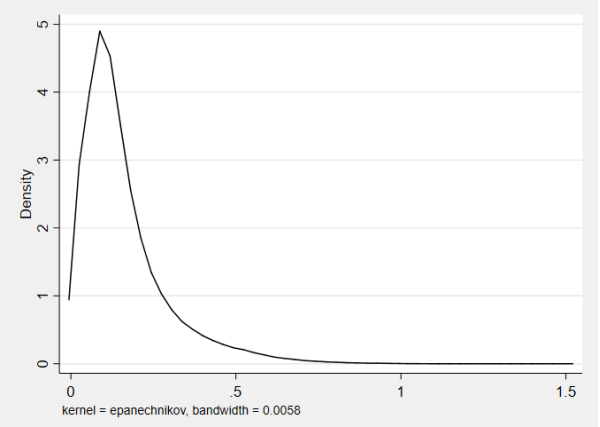


Figure 2d: Implicit interest rate



Notes: The figure plots the kernel density estimates of the financial constraint variables.

2.2 Econometric methodology

2.2.1 Estimating firm-level total factor productivity

We first generate a firm-level total factor productivity measure following Levinsohn and Petrin (2003) based on a Cobb-Douglas specification. We estimate separate production functions at two-digit NACE sectors as in the equation below in log form to retrieve the output elasticities of capital and labor.

$$lnrevenue_{i,t} = \beta_0 + \beta_1 lnk_{i,t} + \beta_2 lnl_{i,t} + \varphi W_{i,t-1} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

where $lnrevenue_{i,t}$ is the natural logarithm of real net sales of firm i at time t, $lnk_{i,t}$ and $lnl_{i,t}$ are firm i's fixed assets and labor size in logarithms at time t, $W_{i,t-1}$ is a vector of exogenous control variables including first, second, and third-order polynomials of capital and labor at time t-1, and γ_t represents the set of year dummies.

Equation (1) is estimated using one-step GMM using lagged values of labor as instruments for its contemporaneous values following Wooldridge (2009). The output elasticities obtained from equation (1) at the two-digit sector level are then employed in the log-transformed Cobb-Douglas function to retrieve the firm-level total productivity values as in equation (2).

$$lnTFP_{i,t} = lnrevenue_{i,t} - \beta_1 lnk_{i,t} - \beta_2 lnl_{i,t} \quad (2)$$

2.2.2 Estimating the effects of financial constraints on productivity growth

We follow the previous literature, mainly Levine and Warusawitharana (2020), to estimate the heterogeneous impact of access to finance on firm-level total factor productivity under financial constraint. As an improvement to the existing models, we further investigate the role of network effects by controlling for suppliers' financial constraints. The equation below is the baseline specification we use in our regressions:

$$\Delta lnTFP_{i,t+1} = \gamma_1 \Delta lnD_{i,t} + \gamma_2 FC_{i,t-1} + \gamma_3 FC_{i,t-1} * \Delta lnD_{i,t} + \gamma_4 FCsup_{i,t-1} + \gamma_5 FCsup_{i,t-1} * \Delta lnD_{i,t} + \delta X_{i,t} + f_{s,j,t} + \varepsilon_{i,t} \quad (3)$$

where $\Delta lnTFP_{i,t+1}$ denotes real total factor productivity growth from year t to t+1; $\Delta lnD_{i,t}$ denotes the real financial debt growth from year t-1 to t; $FC_{i,t-1}$ is a measure of how firm i at time t-1 was financially constraint, including tangible fixed assets to total assets ratio, lagged financial leverage, cash holdings to total asset ratio and implicit interest rate. The variable $FCsup_{i,t-1}$ represents the

average of firm i's suppliers' level of financial constraint calculated from the novel transaction-level firm-to-firm trade data and weighted by the supplier share in the total supply of firm i.[12] $X_{i,t}$ is a vector of several other control variables, including the lagged dependent variable, the natural logarithm of lagged firm size, lag of sales growth, and lag of physical investment rate. Finally, $f_{s,j,t}$ are a full set of size by sector dummies interacted with time dummies to capture any sector by size macro-economic shocks in a given year. Thus, we are only interested in the variation of the key variables within a sector-size cell. First differencing at the firm level sweeps out the firm-level fixed effects, which reduces the concern of an omitted variable bias. We control for dynamic effects by including the lag dependent variable among the control variables.

All independent variables are first lagged to address any reverse-causality and simultaneity bias issues between the dependent and control variables. We further ensure the exogeneity between the debt growth and the financial constraint measure by taking the two lags of the second.

γ_3 and γ_5 are the key coefficients in equation (3) and show whether financial debt growth generates higher productivity growth for financially constrained firms and firms with financially constrained suppliers, respectively. We expect the access to finance to play a more significant role for financially constrained firms, hence the coefficient γ_3 to be statistically significant and positive/negative depending on the proxy variable used for financial constraint. We also expect the coefficient γ_5 to be statistically significant since the trade credits through suppliers is an important finance channel for firms. A firm with financially constrained suppliers will face further pressure in terms of access to finance.

3 Data

The firm-level data used in this study are from the confidential financial reports of the universe of firms in Turkey that are to report balance sheet information annually. The financial reports' data, provided by the Ministry of Treasury and Finance, contain the balance sheet, the income statement, and the firm-to-firm trade data that include all transactions exceeding 5,000 Turkish Lira (which on average corresponds to about 2,200 US dollars based on average exchange rate over the 2007-2018 period). The data covers the period between 2007 and 2018.

[12] $FCsup_{i,t} = \sum_j \frac{Supply_{i,j,t}}{Supply_{i,t}} FC_{j,t}$, where $Supply_{i,j}$ is firm i's total purchases from firm j in year t and $Supply_{i,t}$ is the total purchases of firm i in year t.

We apply several data cleaning procedures since the administrative data may include significant outliers that may cause attenuation bias in our results due to measurement errors. Our raw data set includes 7,254,758 firm-year observations for the period 2007-2018. First, we restrict our sample to firms with at least one registered employee and positive net sales and total assets to make sure the very small firms do not drive the estimation results. Doing so, we drop 1,388,346 observations. Second, we replace negative values that are impossible to exist due to accounting rules such as negative debt or cash with missing. Third, we drop observations of a firm at time t and t-1 if a firm's employment experiences a substantially large growth or decline from year t to t-1.[13] Only 5,261 observations are dropped due to the third procedure. Fourth, we replaced outliers in growth and ratio variables that are derived from the raw data, such as debt growth and investment ratio with missing. For the fourth cleaning procedure, we apply a standard approach based on the deviations from the median. Values that are more than three inter-quartile range away from the variable's median value are replaced with missing.[14]

The resulting sample is composed of 896,317 firm and 5,022,010 firm-year observations. However, many firms in the data set have no financial debt. Therefore, the debt growth variable is missing for 3,430,242 observations. We further lose some observations due to lagged terms in our baseline model. The final sample used in the estimation of baseline specification consists of 331,654 firms and 1,336,239 firm-year observations. Since the sample is not balanced, some firms may drop and reappear in following years. The sectoral composition of the final sample is as follows; agriculture 1%, industry 25%, construction 11%, and services 63%.

Table 1 reports the summary statistics of the variables used in our baseline specification. The average number of employees in the sample is around 36.7, year-on-year TFP growth, sales growth, and debt growth are -0.034, 0.042, and -0.018, respectively. As explained earlier, we use four alternative variables as a proxy for the level of financial constraint at the firm level, namely tangible assets to total assets ratio, financial leverage, cash ratio, and implicit interest rate.

The last four rows of Table 1 present the weighted financial constraint of suppliers that are calculated using the novel firm-to-firm trade data that covers all transactions above 5,000 Turkish

[13] Formally, we drop observations if the following two conditions are met: $(l/l_{t-1} - 1)\ x\ l_{t-1}^3 > 75$ or $(l_{t-1}/l - 1)\ x\ l^3 > 75$, where l is the number of employment.

[14] We apply the fourth cleaning procedure for the following variables; debt growth (84,577), investment ratio (344,162), sales growth (272,561), financial leverage (28,967), cash ratio (418,378), implicit interest rate (150,775), and tangibility ratio (110,985) variables. The number of observations that are replaced with a missing value are presented in the parentheses for each variable.

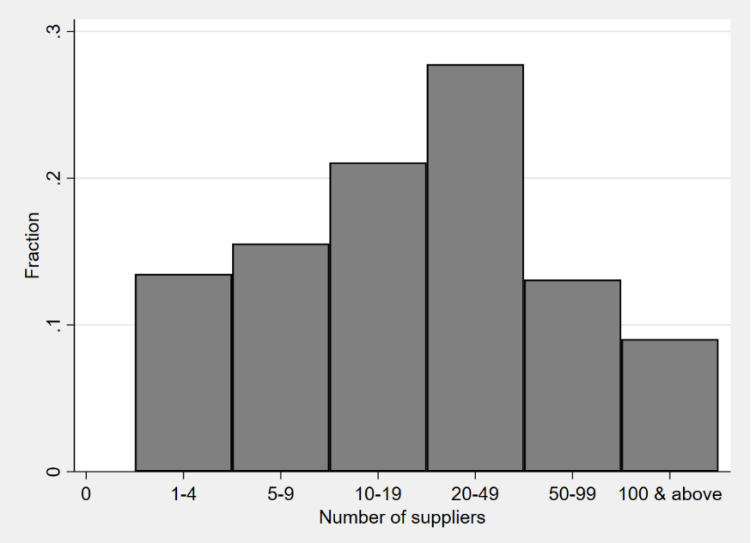
Lira. Figure 3 shows the number of firm's suppliers in our sample for the year 2017. The firm-to-firm trade data shows that the majority of firms trade with more than ten suppliers, and some firms trade with more than 100 suppliers. Having many suppliers is important for the supply chain, implying that firms are economically linked to each other; however, these economic linkages become more binding when up- and/or downstream firms experience financial distress.

Table 1: Summary statistics

Variable names	Mean	p10	p50	p90	S.D.	N
Real Sales (Ln)	14.960	12.742	14.893	17.215	1.751	1351602
Employment (Ln)	2.234	0.000	2.197	4.060	1.453	1351602
Fixed assets (Ln)	13.467	11.293	13.331	15.904	1.923	1343236
TFP growth	-0.034	-0.634	-0.004	0.519	0.643	1351602
Debt growth	-0.018	-1.072	-0.065	1.103	0.916	1351602
Sales growth	0.042	-0.519	0.038	0.596	0.560	1351602
Investment ratio	0.122	-0.112	0.040	0.504	0.312	1351602
Tangible fixed assets to total assets ratio (FC-1)	0.220	0.020	0.163	0.508	0.197	1336325
Financial leverage (FC-2)	0.069	0.003	0.027	0.193	0.105	1292719
Cash ratio (FC-3)	0.157	0.031	0.123	0.328	0.133	773963
Implicit interest rate (FC-4)	0.213	0.006	0.124	0.533	0.262	1319894
Tangible fixed assets to total assets ratio (supplier)	0.203	0.042	0.187	0.379	0.131	1196026
Financial leverage (supplier)	0.063	0.017	0.052	0.123	0.048	1175698
Cash ratio (supplier)	0.151	0.071	0.135	0.250	0.079	1134918
Implicit interest rate (supplier)	0.140	0.036	0.116	0.265	0.109	1180965

Notes: Ln stands for natural logarithm.

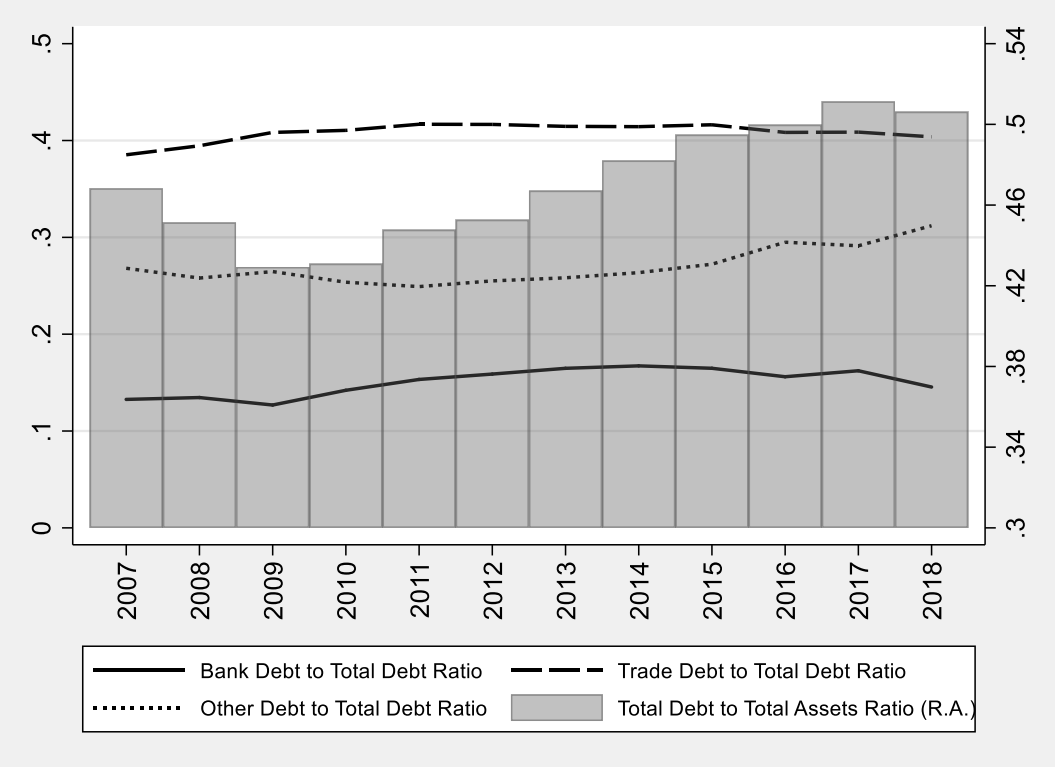
Figure 3: Number of suppliers



Source: Authors' calculations.

In addition, Figure 4 shows that Turkish firms mostly finance their operations via alternative methods other than bank finance. The largest debt component is the trade debt, where the average ratio of trade debt to total debt is about 40% during the sample period, indicating the importance of suppliers in firms' decisions such as investment and growth. Considering Figure 3 and Figure 4 together, it is natural to think that the financial constraint level of firms' suppliers should also matter for the sensitivity of productivity growth to debt growth.

Figure 4: Leverage decomposition



Source: Authors' calculations.
Notes: The figure presents the mean leverage ratio for the universe of Turkish firms. Total debt includes bank debt, trade debt, financial debt, and other debts.

4 Empirical results

4.1 Main results

Table 2 reports the main results from equation (3). We start with a baseline specification in column (1) that estimates the impact of lagged debt growth on TFP growth, ignoring the roles of financial constraint and its interaction with debt growth, i.e., setting $\gamma_2 = \gamma_3 = 0$. In column (2),

we add financial constraint and its interaction with lagged debt growth, which is the key variable of interest in this study. From column (3) to the right, each column adds additional control variables to the baseline model presented in column (2). The last column presents the results of our preferred specification, as described in equation (3).

Table 2: Financial constraint and TFP growth (Main results)

	Dependent variable: Change in Ln Productivity (from year t to t+1) **Financial Constraint (FC) Indicator:** Tangible fixed assets to total assets ratio						
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Debt growth	0.0265***	0.0295***	0.0262***	0.0256***	0.0254***	0.0250***	0.0210***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FC indicator (t-1)		0.1008***	0.0971***	0.0980***	0.0973***	0.1000***	0.0884***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Debt growth * FC indicator (t-1)		-0.0101***	-0.0132***	-0.0126***	-0.0116***	-0.0112***	-0.0086***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Real sales growth	-0.1891***	-0.2082***	-0.2150***	-0.2179***	-0.2188***	-0.2204***	0.0604***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Investment ratio	0.1195***	0.1301***	0.1147***	0.1129***	0.1133***	0.1114***	0.0817***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ln employment			0.0465***	0.0893***	0.0897***	0.0910***	0.0601***
			(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Lagged dependent variable							-0.3200***
							(0.003)
Constant	-0.0408***	-0.0667***	-0.1698***	-0.2674***	-0.2681***	-0.2714***	-0.2003***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Sector FE	+	+	+	+			
Year FE	+	+	+	+			
Size FE				+	+		
Sector x Year FE					+		
Sector x Year x Size FE						+	+
Observations	1,351,602	1,319,894	1,319,894	1,319,894	1,319,894	1,319,807	1,319,807
R-squared	0.036	0.042	0.051	0.055	0.058	0.062	0.079

Notes: The data covers the universe of all firms in Turkey that are to report financial statements on an annual basis and are made available to the CBRT by Turkstat. The sample is restricted to firms with at least one registered employee. The dependent variable in all models is the change in the natural logarithm of total factor productivity from year t to t+1. Sector refers to two-digit NACE codes. Size refers to four size groups in terms of the registered employee as follows; 1-9, 10-49, 50-249, and 250+. Standard errors are clustered at the firm level in all regressions and reported in parenthesis. Ln stands for natural logarithm. *** p<0.01, ** p<0.05, * p<0.1

In Table (2), financial constraint is measured in terms of tangibility ratio defined as tangible fixed assets to total assets ratio. A higher tangibility ratio implies a lower financial constraint; therefore, we expect the coefficient of interest, the interaction term between debt growth and tangibility ratio, to be negative, suggesting that access to credit results in higher productivity growth for financially constrained firms. Indeed, the key coefficient is negative and statistically significant for each specification we report in Table 2, indicating that the marginal effect of debt

growth on future TFP growth varies by the level of financial constraint. The effect size slightly declines when we control for the lagged dependent variable that takes care of the base effect (column 7). Moreover, the tangibility ratio's statistically significant and positive coefficient indicates that our proxy captures firms' financial constraint levels. Besides, the lagged dependent variable's estimated coefficient implies that a 10% increase in TFP will decrease the subsequent TFP by 3.2%, indicating the persistence of TFP. Furthermore, the coefficient estimates for the control variables suggest that firms with higher investment ratios have higher TFP growth in the next period. Similarly, the estimated coefficient of employment implies that large firms have higher future TFP growth.

Table 3: Financial constraint and TFP growth (Alternative financial constraint measures)

Dependent variable: Change in Ln Productivity (from year t to t+1)				
Variables	(1) **FC indicator:** Tangible fixed assets to total assets ratio	(2) **FC indicator:** Financial leverage	(3) **FC indicator:** Cash ratio	(4) **FC indicator:** Implicit interest rate
Debt growth	0.0210***	0.0084***	0.0239***	0.0209***
	(0.001)	(0.001)	(0.001)	(0.001)
FC indicator (t-1)	0.0884***	0.0273***	-0.0124**	-0.0687***
	(0.002)	(0.003)	(0.005)	(0.005)
Debt growth * FC indicator (t-1)	-0.0086***	0.0926***	-0.0559***	0.0112**
	(0.002)	(0.004)	(0.005)	(0.006)
Real sales growth	0.0604***	0.0610***	0.0632***	0.0652***
	(0.003)	(0.003)	(0.003)	(0.004)
Investment ratio	0.0817***	0.0734***	0.0782***	0.0744***
	(0.002)	(0.002)	(0.002)	(0.003)
Ln employment	-0.3200***	-0.3205***	-0.3221***	-0.3398***
	(0.003)	(0.003)	(0.003)	(0.004)
Lagged dependent variable	0.0601***	0.0587***	0.0592***	0.0589***
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.2003***	-0.1801***	-0.1771***	-0.1695***
	(0.002)	(0.002)	(0.002)	(0.003)
Observations	1,319,807	1,336,239	1,292,632	773,876
R-squared	0.079	0.079	0.078	0.079

Notes: The data cover the universe of all firms in Turkey that are to report financial statements on an annual basis and are made available to the CBRT by Turkstat. The sample is restricted to firms with at least one registered employee. The dependent variable in all models is the change in the natural logarithm of total factor productivity from year t to t+1. Column (1) is the replication of the specification in column (6) of Table 2. Columns (2) - (4) replicate the same specification with alternative proxies for financial constraint (FC). All models control for Sector x Year x Size fixed effects. Sector refers to two-digit NACE codes. Size refers to four size groups in terms of the registered employee as follows; 1-9, 10-49, 50-249, and 250+. Standard errors are clustered at the firm level in all regressions and reported in parenthesis. Ln stands for natural logarithm. *** p<0.01, ** p<0.05, * p<0.1.

Table 3 replicates the preferred specification in Table (2) for alternative definitions of financial constraints, including tangibility ratio, financial leverage, cash ratio, and implicit interest rate. The coefficient of interest takes the expected sign and statistically significant for each

definition of the financial constraint. The interaction term takes positive values when we define the financial constraint with financial leverage and implicit interest rate since the higher these two indicators, the higher the level of financial constraint. Moreover, the estimated coefficient of the interaction between debt growth and cash ratio is negative and statistically significant at a 1% significance level. As regards the control variables, we obtain similar results with Table 2.

In contrast to the financial leverage proxy for financial constraint, the direct effect of the implicit interest rate on future TFP growth is negative, suggesting that firms with a higher cost of debt are more likely to experience lower TFP growth in the next period. In economic magnitudes, the impact of financial leverage on the sensitivity of TFP growth to debt growth is significantly larger than the corresponding results using the tangibility, cash ratio, and implicit interest rate. In short, the results of Table 3 and Table 4 reveal that the returns to additional investment in productivity-enhancing activities are higher for financially constrained firms.

4.2 Robustness checks

We start with noting that our main specification is already robust to controlling for several fixed effects, NACE Rev. 2 Classification level sector-time-size fixed effects. These fixed effects are particularly important to account for various sector and size-specific time-varying shifts. In Table 4, we carry out various robustness tests for each financial constraint measure to further strengthen our results.

In panel (A), we replace the time-variant financial constraint measure with a time-invariant measure representing the average value during the observation period to test if our results are solely driven by within-firm variation in financial constraint measure. All results survive, but the one for the implicit interest rate.

Next, in panel (B), we define the financial constraint as a dummy variable that takes value 1 if a firm's financial constraint measure is above the sector median and value 0 otherwise. This adjustment helps us to control for firm heterogeneity across sectors. The dummy financial constraint measure is calculated using firm-level average during the observation period, hence time-invariant as in panel (A). The interaction term for all alternative definitions of financial constraint is positive and statistically significant, confirming our results for the financial leverage and implicit interest rate proxies for financial constraint.

Table 4: Robustness tests

Dependent variable: Change in Ln Productivity (from year t to t+1)				
	(1)	(2)	(3)	(4)
	FC indicator: Tangible fixed assets to total assets ratio	**FC indicator:** Financial leverage	**FC indicator:** Cash ratio	**FC indicator:** Implicit interest rate
PANEL A: Time invariant FC indicator:				
Debt growth	0.0210***	0.0043***	0.0269***	0.0221***
	(0.001)	(0.001)	(0.001)	(0.001)
Debt growth * FC indicator	-0.0105***	0.1083***	-0.0944***	-0.0167**
	(0.002)	(0.005)	(0.006)	(0.007)
Observations	1,344,612	1,346,729	1,344,756	1,230,394
PANEL B: Dummy FC indicator:				
Debt growth	0.0174***	0.0112***	0.0143***	0.0190***
	(0.001)	(0.001)	(0.001)	(0.001)
Debt growth * FC indicator (dummy)	0.0100***	0.0129***	0.0144***	0.0042***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	1,344,612	1,346,729	1,344,756	1,230,394
PANEL C: Restricted sample: (Employment>=5):				
Debt growth	0.0204***	0.0079***	0.0239***	0.0212***
	(0.001)	(0.001)	(0.001)	(0.001)
FC indicator (t-1)	0.0597***	0.0123***	-0.0265***	-0.0611***
	(0.003)	(0.003)	(0.006)	(0.006)
Debt growth * FC indicator (t-1)	-0.0050*	0.1016***	-0.0539***	0.0108*
	(0.003)	(0.005)	(0.006)	(0.006)
Observations	902,133	912,002	886,113	571,161

Notes: The data cover the universe of all firms in Turkey that are to report financial reports on an annual basis and are made available to the CBRT by Turkstat. The sample is restricted to firms with at least one registered employee (except the specification in panel C). The dependent variable in all models is the change in the natural logarithm of total factor productivity from year t to t+1. Column (1) is the replication of the specification in column (6) of the Table 2. Columns (2) - (4) replicate the same specification with alternative proxies for financial constraint (FC). All models control for Sector x Year x Size fixed effects. Sector refers to two-digit NACE codes. Size refers to four size groups in terms of the registered employee as follows; 1-9, 10-49, 50-249, and 250+. Standard errors are clustered at the firm level in all regressions and reported in parenthesis. Ln stands for natural logarithm. *** p<0.01, ** p<0.05, * p<0.1.

Finally, in panel (C), we replicate the baseline specification for a restricted sample that excludes micro firms with less than five registered employees to check if the results are being driven by very small firms, financial reports of which may be more volatile over time and less dependable relative to larger firms. Even though the sample size drops by about 40% due to firm size restriction, all results survive.

4.3 Network effects

A financial constraint measure based on a firm's financial indicators does not fully account for the entire general equilibrium effects on firm performance by itself since financial shocks propagate across firms and industries through trade linkages (Acemoglu, 2016). A firm in good shape in terms of tangible assets or financial debt may still face difficulty accessing the capital

needed for production if its suppliers are financially constrained. Garcia and Martinez (2010) investigated the determinants of trade credits as an alternative source of finance for European SMEs. They found that firms with greater capacity to access resources from the financial sector, and less costly, grant higher trade credit to their customers. Using a sample of French SMEs, Psillaki and Eleftheriou (2015) showed that trade credit for small firms during periods of constrained money acts as a complement to bank credit. From this point of view, we may expect a strong relationship between the financing through trade credit and the financial condition of suppliers of a firm. A firm with financially constrained suppliers may have difficulty in accessing trade credit as an alternative source to conventional bank credit relative to a firm working with stronger suppliers in terms of financial conditions.

Having the universe of firm-to-firm trade data in Turkey, we can picture the entire supply chain at the firm level. Using intra-firm trade volume as a weight, we generate a proxy variable for measuring a firm's suppliers' financial constraint level. Then, we interact debt growth with the weighted mean of suppliers' financial constraint in addition to the firm's own financial constraint. This interaction term's coefficient will allow us to explore if productivity gains from access to additional bank credit are higher when supplier firms are financially constrained, an empirical questioned that is not discovered in the literature so far.

Table 5 reports the results for network effects in comparison with the baseline results in Table 4. We find significant evidence for the propagation of financial constraints through supply networks in two of our financial constraint measures, financial leverage, and cash ratio. The significant and positive (negative) coefficient for the interaction term between the firm's debt growth and financial constraint of its suppliers in column 4 (6) implies that firms working with more financially constrained firms experience higher productivity growth in response to debt growth relative to the firms working with less constrained firms. In economic magnitudes, the impact of the suppliers' cash ratio on the sensitivity of TFP growth to debt growth is the largest among the other financial constraint measures. Moreover, Table 5 shows that our baseline results presented in Tables 3 and 4 are robust even after controlling for the network effects.

Furthermore, the results presented in column 6 of Table 5 show that firms with financially unconstrained suppliers (higher cash ratio) have higher TFP growth in the next period. This could be because financially unconstrained suppliers may provide financing through trade credit to their customers.

Table 5: Network effects

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FC indicator: Tangible fixed assets to total assets ratio		**FC indicator:** Financial leverage		**FC indicator:** Cash ratio		**FC indicator:** Implicit interest rate	
Debt growth	0.0210***	0.0215***	0.0084***	0.0066***	0.0239***	0.0285***	0.0209***	0.0201***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
FC indicator (t-1)	0.0884***	0.0698***	0.0273***	0.0317***	-0.0124**	-0.0296***	-0.0687***	-0.0646***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)
Debt growth * FC indicator (t-1)	-0.0086***	-0.0093***	0.0926***	0.1029***	-0.0559***	-0.0550***	0.0112**	0.0094
	(0.002)	(0.003)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
Suppliers' FC indicator (t-1)		0.0802***		0.0102**		0.1505***		-0.0254***
		(0.006)		(0.004)		(0.012)		(0.010)
Debt growth * Suppliers' FC indicator (t-1)		0.0082		0.0114**		-0.0492***		0.0169
		(0.006)		(0.005)		(0.013)		(0.011)
Observations	1,319,807	1,158,533	1,336,239	1,187,257	1,292,632	1,130,549	773,876	722,352
R-squared	0.079	0.079	0.079	0.078	0.078	0.078	0.079	0.081

Notes: The data cover the universe of all firms in Turkey that are to report financial reports on an annual basis and are made available to the CBRT by Turkstat. The sample is restricted to firms with at least one registered employee. The dependent variable in all models is the change in the natural logarithm of total factor productivity from year t to t+1. Column (1) is the replication of the specification in column (6) of the Table 2. The second column in each financial constraint (FC) definition presents the results of a regression in which the suppliers' financial constraint and its interaction with the debt growth are controlled. All models control for Sector x Year x Size fixed effects, real sales growth, investment ratio, Ln employment, lagged dependent variable. Sector refers to two-digit NACE codes. Size refers to four size groups in terms of the registered employee as follows; 1-9, 10-49, 50-249, and 250+. Standard errors are clustered at the firm level in all regressions and reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

5 Conclusion

We use a panel of 896,317 Turkish firms (total of 1,336,239 firm-year observations) for the 2007-2018 period to study the impact of financial constraints on firm productivity growth. We estimate a firm-level TFP growth and then used it as a dependent variable in our regressions. We find that Turkish firms' productivity growth is significantly and negatively affected by the level of financial constraints. We also show that firms having higher financial constraints have a higher sensitivity of productivity growth to debt growth. Moreover, our results indicate that the suppliers' financial constraint levels are also critical for firms' productivity growth.

The evidence we present in this study reassures the importance of effective resource allocation through the financial system in a developing country. Without public policy intervention, financial resources are more likely to flow to firms in better shape in terms of collateral and assets. This is because banks prioritize the current financial outlook of a firm rather than its expected returns in the long term when evaluating its ability to repay. However, we show that firms under financial constraints are more likely to increase their productivity if they can access financial resources. Thus, if the limited resources can be allocated towards the financially constrained firms with higher productivity growth potential, aggregate productivity gain from financial borrowing in an economy will be higher. Thus, indirect government policies encouraging private banks to give loans to small businesses and startups through credit guaranteed funds and direct positive discrimination by government banks and financial institutions will accelerate the flow of financial resources towards business with higher potential productivity growth.

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(Aylin Aslan, Ahmet Şensoy, Levent Akdeniz Working Paper No. 21/16, July 2021)