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### Article

# The role of institutions in the corporate debt-productivity relationship: Evidence from listed firms in China

Journal of Applied Economics

**Provided in Cooperation with:** University of CEMA, Buenos Aires

*Suggested Citation:* Li, Chengchun; Lu, Huanhuan; Wu, Min; Teng, Da (2023) : The role of institutions in the corporate debt-productivity relationship: Evidence from listed firms in China, Journal of Applied Economics, ISSN 1667-6726, Taylor & Francis, Abingdon, Vol. 26, Iss. 1, pp. 1-24, https://doi.org/10.1080/15140326.2023.2207325

This Version is available at: https://hdl.handle.net/10419/314224

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**Journal of Applied Economics** 

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/recs20

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To cite this article: Chengchun Li, Huanhuan Lu, Min Wu & Da Teng (2023) The role of instituions in the corporate debt-productivity relationship: evidence from listed firms in China, Journal of Applied Economics, 26:1, 2207325, DOI: 10.1080/15140326.2023.2207325

To link to this article: https://doi.org/10.1080/15140326.2023.2207325

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Published online: 04 May 2023.

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## The role of instituions in the corporate debt-productivity relationship: evidence from listed firms in China

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#### ABSTRACT

This paper examines the relationship between corporate debt and firm productivity. We add to the existing literature by investigating the contingency effect of institutional quality in the corporate debtproductivity nexus. Using data for 2,084 Chinese listed firms, we find that corporate debt and political institutional quality have significant and negative impacts on productivity while legal institutional quality is significantly and positively associated with productivity. Also, our results reveal that both financial and fintechsupporting institutional factors exert negative contingency effects in the corporate debt-productivity relationship. Our findings provide a reasonable guideline for emerging market countries aiming to address the corporate debt overhang problem or seeking factors to boost firm productivity growth.

#### **ARTICLE HISTORY**

Received 19 June 2022 Accepted 22 April 2023

#### **KEYWORDS**

corporate debt; institutional quality; firm productivity; debt overhang

#### 1. Introduction

It is generally believed that firms in emerging market economies heavily rely on debt instruments. Corporate borrowing as the main financing method for firms in emerging markets has prevailed since the early 1990s (Cortina et al., 2018). For instance, the main sources of finance available to firms in China, one of the largest emerging market economies, have largely been dependent on credit and debt funds. The overall capital structure of the financial market is unbalanced. According to statistical data from the National Bureau of Statistics of China, by October 2018, the domestic capital obtained by equity financing accounted for 3.52% of the total amount of funds obtained from the financial system, while the domestic capital obtained by debt financing accounted for 96.48% of the total amount, with a debt financing to equity financing ratio of about 27:1. Compared with developed countries, China's debt financing ratio is extremely high. High leverage is a general cause of macro-level financial vulnerability, which is reflected as debt overhang in the real sectors or excessive credit expansion in the financial sector. The rapid growth of indebtedness in emerging market economies due to high levels of corporate debt borrowing has raised academic concerns, as such a problem may lead

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to financial crises (Schularick & Taylor, 2012). The recent outbreak of major credit crises in China's property sector triggered by a series of default events among large property developers, such as China Fortune Land Development and China Evergrande Group, reflect the danger of excessive corporate indebtedness (Huld, 2022). When there is a financial crisis, firm productivity will be negatively affected and such an impact is longlasting and persistent (Duval et al., 2020; Hasan & Manfredonia, 2022; Huber, 2018). Therefore, it is important to investigate the effect of corporate debt on firm productivity.

Firm productivity reflects the overall efficiency of a firm's input of various resource elements such as manpower, material resources, and financial resources into the production and operation process (Duran et al., 2015). The improvement of productivity is essential for the long-term sustainable development of firms which can increase firm financial performance and competitive advantages at the micro-level and such an improvement also can effectively enhance macro-level economic growth (Heil, 2018; Moschella et al., 2019). In addition, the determinants of productivity have been investigated in previous studies (e.g., C. Li & Tanna, 2019; Teng et al., 2022), but there is still no consensus on the effect of corporate debt on productivity. Existing literature suggests a strong positive correlation between corporate debt and firm productivity growth (Jensen, 1986; Levine & Warusawitharana, 2021; Margaritis & Psillaki, 2010). However, excessive levels of firm indebtedness are proven to be detrimental to productivity growth (Anderson & Raissi, 2022; Berk et al., 2010; Titman, 1984). In this study, we re-access the relationship between corporate debt and productivity and account for the influence of institutional quality in such a relationship. In addition, with regard to the effect of institutional quality on firm productivity, previous studies generally suggest that sound institutional settings have a positive effect on firm productivity (Borghi et al., 2016; Lasagni et al., 2015; Shinkle & McCann, 2014) while neglecting the potential contingent role of institutions in the corporate debt-productivity nexus.

Regarding the role of institutional quality in the relationship between corporate debt and firm productivity. Previous studies (e.g., Fan et al., 2012) point out that poor legal institutional quality reduces the level of external equity financing of firms while sound formal institutional quality alleviates the problem of information asymmetry and diversifies firm risks. Therefore, institutions can affect the preferences of capital suppliers which determine the capital structure choices of firms. More specifically, if local institutional settings are in favour of debt contracts or banking sector development, firms are likely to rely on debt financing which can cause the excessive indebtedness problem, which can reduce firm productivity due to the high pressure of debt repayment and the increase of insolvency risk. However, the negative impact of corporate excessive debt can be alleviated by proper institutional factors related to the quality of government and government supervision. Adequate regulation and supervision of financial markets by the government can effectively reduce the financial risk of firms and avoid the occurrence of financial crises (Mishkin, 1999). Hence, we argue that institutions can exert an indirect effect on the relationship between corporate debt and productivity.

The contribution of our research to the existing literature is twofold. First, we highlight the contingency effect of institutional quality in the relationship between corporate debt and firm productivity at the micro-level, while prior studies mainly provide country-level analysis on the debt-institution-productivity nexus. Second, we use disaggregated institutional measures on a province-year basis rather than country-level aggregated proxies to capture the effects of local institutions among different provinces within an emerging market economy (i.e., China). We include the different dimensions of provincial institutions covering the aspects of political, legal and financial institutional factors. Also, given the increasing trend of fintech adoption in emerging market economies, we create an index to measure the fintech-supporting institutional quality using text mining techniques and word frequency analysis quality to distinguish the effect of the fintech-supporting institution from the institutional settings for promoting traditional financial market development.

Using data for 2,084 Chinese firms listed on the Shanghai Stock Exchange and Shenzhen Stock Exchange over the period 2010–2019, we find a robust and negative association between corporate debt and productivity. Also, our empirical results reveal that legal institution has a significant and positive effect on productivity while there are negative contingent effects of both financial and fintech-supporting institutions on the corporate debt-productivity nexus. Our results provide a reasonable guideline for emerging market countries aiming to tackle the corporate debt overhang problem or seeking factors to stimulate firm productivity growth.

The remainder of the paper is organized as follows. Section 2 synthesizes the related literature. Section 3 discusses the data and variables of the empirical method. Section 4 presents the empirical results and Section 5 concludes.

#### 2. Related literature

#### 2.1. Corporate debt and productivity

The pioneering studies can trace back to Modigliani and Miller's (1958) theory which demonstrates that capital structure is not associated with the value of a firm under a set of strict assumptions (e.g., no taxes, no transaction costs, perfect capital market). The modified theory by Modigliani and Miller (1963) relaxes some of the assumptions of their original model and suggests that firms can effectively benefit from debt financing, as the interest expenses of debts have a tax-shield effect and thus increase firm value. From the capital demand side, firms have information asymmetry between their internal executives and external investors, which will result in the costs of external financing being much higher than the financing costs under perfect capital market conditions (Myers, 1977). However, among external financing, compared with equity financing, debt financing has a shield effect along with a lower level of issuance costs. Also, debt financing will not dilute the control rights of the firm. Therefore, debt financing is superior to equity financing. When choosing the types of financing, firms will give priority to using the internal surplus, followed by debt financing, and finally relying on equity financing (Myers & Majluf, 1984).

Through external financing, firms can increase investment in innovation and research and development activities, thereby boosting productivity (Dabla-Norris et al., 2012). Also, corporate indebtedness level is an important factor affecting firm productivity. Despite the above, the theoretical link between corporate debt and firm productivity remains a controversial issue. Several previous studies suggest that firm indebtedness increases productivity. For instance, Nunes et al. (2007) point out that an appropriate proportion of indebtedness can bring an incentive effect to firm managers for increasing efficiency and thus improving productivity. Carlstrom and Fuerst (1997) suggest that debt financing can increase entrepreneurial net worth by reducing agency costs of investment. The repayment pressure of debts urges firms to choose profitable projects in the operation process, which will consequently increase productivity growth (Jensen, 1986; Margaritis & Psillaki, 2010). In addition, the financial and bankruptcy risks due to a high level of firm indebtedness can force firms actively improve their productivity to ensure the repayment of principal and interest and such an enhancing effect of productivity becomes more powerful when there is an increasing financing cost associated with a high level of financial leverage (Gomis & Khatiwada, 2017; Levine & Warusawitharana, 2021).

However, according to the trade-off theory (Kraus & Litzenberger, 1973), a high level of firm indebtedness may trigger a few problems, which can negatively affect the productivity and market value of the firm. For example, high indebtedness levels increase financial distress, which therefore may lead to the issue of moral hazard - firm decisionmakers may choose projects with high returns associated with high uncertainties for repaying the debt interests (Reichlin & Siconolfi, 2004). In such a case, firm raises the possibility of default and bankruptcy risk. As a consequence, excessive debt in turn results in a higher level of debt financing cost (Kiyotaki & Moore, 1997; Van Binsbergen et al., 2010). Also, firms are likely to fall into financial difficulties, if they heavily rely on debt financing (Kahle & Stulz, 2013), which will lead to firms making short-sighted or present-bias decisions while neglecting long-term development. For example, firms may prefer to invest in projects with low costs and quick returns, which reduces the utilization rate of firm capital and inhibits the growth of firm productivity (Crouzet, 2018; Martín-Cruz et al., 2012). In addition, an excessive level of firm indebtedness can reduce the input of human capital and employee benefits, which harms the firm's competitiveness, resulting in being not conducive to the improvement of firm productivity in the future (Bae et al., 2011).

The empirical side of the corporate debt-productivity literature is also mixed. For example, Gomis and Khatiwada (2017) use firm-level data for over 100 countries covering the period from 1986 to 2014 and found that firm leverage has a positive and significant effect on productivity. Giang et al. (2019) use data from small and medium-sized manufacturing firms in Vietnam and their empirical results show that using bank loans as the external financing method can significantly improve firms' total factor productivity (TFP). Using firm-level data for manufacturing firms in India, Girma and Vencappa (2015) found that bank loans amongst various external financing channels exert the greatest effect to enhance firm productivity.

A number of empirical studies have provided supportive evidence for the negative correlation between firm indebtedness and productivity. For instance, Anderson and Raissi (2022) examine whether the TFP growth varies with the level of corporate debt. Using the data for 6,282 Italian firms from 1999 to 2015, they found that corporate debt accumulation has a significant and negative impact on firm TFP growth. Using data for 15 major emerging markets, Converse (2018) finds that when debt and investment project maturities do not match, debt financing will exert a negative impact on productivity by inhibiting investment. Arulraj and Annamalai (2020) test the relationship between financing sources and firm productivity for 8,062 small enterprises in India and their empirical evidence suggests that debt financing hinders firm productivity

growth. Amongst the abovementioned studies investigating the role of firm indebtedness in affecting firm productivity, the evidence seems to suggest that, in emerging economies, debt financing has no significant enhancing effect on productivity and an excessive level of firm leverage has a significant inhibiting effect.

#### 2.2. Institutions and firm productivity

Firms are organizations in a social framework, and their behaviours need to comply with the constraints of institutional quality. The institutional setting is a key external factor affecting firm productivity (North, 1990). Sound institutional arrangements can provide conditions to establish a well-functioning human capital market and increase the return to education, thus improving human capital accumulation (Dias & Tebaldi, 2012). Such an improvement in human capital can positively influence firm productivity (Backman, 2014). According to the institution-based view (Peng & Khoury, 2008), institutions can be divided into formal and informal types, which can directly or indirectly affect firm productivity (Ostapenko, 2015). Shu et al. (2019) point out that formal institutions are critical to firms in transition economies. The influences of formal institutions are mainly through government and legal support with favourable policies and laws (e.g., tax credits and government subsidies), government supervision, property rights protection and market-oriented financial regulation to stimulate R&D investment and therefore increase firm productivity (Belloc, 2012; Xu et al., 2021).<sup>1</sup> With the support of formal institutions, firms can increase their ability and motivation to meet strategic goals and remedy the adverse effects of institutional voids, which can effectively direct business operations (Shu et al., 2019). Compared with the imperfect formal institutional environment, mature institutional settings along with proper incentive mechanisms are more likely to stimulate the innovation potential of firms (Shinkle & McCann, 2014). As a consequence, mature institutional settings will enable firms to improve the efficiency of resource usage and productivity growth. In contrast, if firms face poor formal institutional settings (e.g., lack of fairness of the law), such an institutional environment will increase firms' uncertainty in the process of operation with the possibility of generating a higher level of costs, which is not conducive to the improvement of firms' overall productivity (McCaffrey, 2018).

A large number of empirical studies have confirmed that institutions are important to firm productivity. Ganau and Rodríguez-pose (2019) use a large sample consisting of 30,801 European firms in the manufacturing sector over the period from 2009 to 2014 and find that government effectiveness has a positive and significant influence on the level of firm productivity. Using data covering 336 firms in 16 EU countries, Borghi et al. (2016) report that the quality of government is positively correlated with firm

<sup>&</sup>lt;sup>1</sup>Plenty of studies have investigated the relationship between formal institutions and firm productivity. For example, Moser (2005) stresses that good intelligent property rights (IPR) protection system to increase the costs of copying or stealing enterprise's innovation by competitors. Also, proper government rules and regulations can motivate firms to carry out innovative activities, to some extent, which has the similar function to the legal institutions that can a protect the legitimate rights and interests of firms and reduce the possibility of innovation achievements being imitated (Berggren & Bjørnskov, 2022; Usman et al., 2021). In addition, the institutions for supporting fintech development benefit the fintech industry which have an ehancing effect on macro-level productivity growth (Heil, 2018). Also such institutions provides more convenient, intelligent and personalized service to meet firms' preferred requirements and reduce the cost of capital, which consenquently can improve firm productivity (Gomber et al., 2017).

productivity. Focussing on newly listed firms in China, Teng et al. (2022) present empirical evidence that better market-supporting institutions (including the effects of government intervention, corporate tax burden and government capability of resource allocation) can significantly and positively increase firm productivity.

#### 2.3. The influence of institutions in the corporate debt-productivity nexus

Previous studies have mainly focused on the macro-level analysis of the role of institutional quality in influencing the finance-productivity relation. The macro-level debt overhang can be mitigated by good institutional arrangement and then debt can boost economic growth and productivity (Jalles, 2011; Qayyum et al., 2014). Recent literature (e.g., Cevik & Miryugin, 2022; Jordà et al., 2022) suggests that excessive corporate debt is associated with macro-level debt overhang problem and corporate leverage is highly vulnerable to influence both firm-level profitability and cash flow and aggregate-level economic growth. There have been firm-level studies focussing on the role of institutions in the finance-productivity relationship (Moretti, 2014).<sup>2</sup> However, attempts to explicitly characterize the institutions-corporate debt-productivity nexus have not been previously reported in the literature. In an attempt to identify possible mechanisms through which institutional quality could play a contingency role in the relationship between capital structure (or corporate debt) and firm productivity, we draw – as our starting point – from two arguments that have been presented in the literature

First, institutions can exert influences on the suppliers of capital and therefore affect the capital structure choices of firms. For example, as highlighted by Fan et al. (2012), poorer legal institutional quality such as weaker legal systems and law enforcement is generally associated with less external equity. Sound formal institutional settings are conducive to optimizing the investment decisions of capital suppliers by alleviating the problem of information asymmetry and diversifying the risks of various investment projects (H. Wang et al., 2019). Therefore, firms' capital structure choices are likely to be determined by the preferences of capital suppliers which are influenced by the institutional environment. When the institutions are in favour of debt contracts or banking-sector development, firms tend to use more debt and cause the issue of excessive indebtedness, which can consequently affect firm productivity.

On the other hand, institutions such as the quality of government and government supervision are essential to the demand side of the capital. The adequate prudential supervision of the financial system by the government reduces the financial risk of firms and government intervention can effectively prevent financial crises (Mishkin, 1999). The potential negative impact of corporate excessive debt therefore can be alleviated by government supervision. In view of the contingency of institutional settings, it seems opportune to examine the relative roles of institutions in affecting the corporate debt-productivity relationship using empirical analysis.

<sup>&</sup>lt;sup>2</sup>Using data for a large sample of 73,500 firms in Italia over the period 2000–2007, Moretti (2014) finds that positive and significant effects of financial depth on productivity become stronger when the level of socio-institutional quality is high.

#### 3. Methodology

#### 3.1. Data sources and sample

We use data for Chinese firms listed on the Shanghai Stock Exchange or Shenzhen Stock Exchange over the period 2010–2019. The primary data source is the China Stock Market and Accounting Research (CSMAR) database. The relevant data of the institutions are primarily drawn from the database of the Marketization Index of China's Provinces: NERI Report developed by X. Wang et al. (2021). The data of the province-level and country-level variables are collected from the database of the National Bureau of Statistics of China. Following standard practice in previous studies (e.g., Hoberg & Phillips, 2010), our sample does not include data for firms in the financial industry. We winsorize all the continuous variables at 1% and 99% levels to eliminate the influence of outliers. After excluding all the missing values of each variable, the final sample consists of data for 2,084 firms with 8,987 firm-year observations.

#### 3.2. Dependent variable

The dependent variable in our regression is measured by firm-level TFP, which captures the output capacity depending on the input factors (i.e., capital and labour) in the process of production, reflecting the overall efficiency with which inputs are converted to final output (Girma & Vencappa, 2015). Following previous studies (e.g., Castellani et al., 2020; Teng et al., 2022), the value of TFP is estimated by Levinsohn and Petrin's (2003) approach which can effectively tackle the endogeneity problem (of input factors and unobserved productivity are simultaneously correlated) using intermediate input as a proxy variable.

#### 3.3. Main explanatory variables

We use the debt-to-equity ratio to capture the effect of corporate debt (Ahmad et al., 2013). Specifically, such a ratio is measured by the sum of short-term and long-term borrowings plus the amount of corporate bonds issued divided by the sum of equity and capital reserve.

Institutional quality is a set of external factors that can affect corporate behaviour. The degree of soundness of the institutional environment and the governance exert an essential impact on the operating efficiency and productivity of firms (H. Li & Zhou, 2005; Teng & Li, 2020). In contrast to early studies focussing on country-level institutional measures, following Teng and Li (2020) and Teng et al. (2022), we highlight the importance of formal institutions at the subnational provincial level. We include four types of provincial institutional factors, namely, political, legal, financial, and fintech-supporting institutions. The data of the former three are drawn from the Marketization Index of China's Provinces: National Economic Research Institute (NERI) Report which provides biennial records for various types of institutions in 29 provinces (except Tibet and Qinghai province) of mainland China. Such a report uses official economic data and questionnaires information obtained from over 4,000 firms in China to construct the institutional indices. Each institutional index has two or three sub-dimensional measures. The overall score of each institutional index is computed based on the weighted

values of the sub-dimensions using unique index construction methods (X. Wang et al., 2021). The index of political institution captures the freedom in the functioning of government and the relationship between the government and the local market (i.e., government intervention). Legal institutional index measures the levels of legal protection and development of legal system. Financial institutional index reflects the quality of institutional settings which support the development of traditional financial markets.<sup>3</sup> In addition, we apply the linear interpolation method to obtain the annual measure of each institution. Higher values of the institutional variables indicate better quality of institutional settings.

Given the importance of the fintech industry to the financial market development and modern society (Muganyi et al., 2022) and the factor that emerging economies, such as China, have been increasingly providing resources through relaxed regulations and government-supported programs to support the fintech industry development (Rodstrom, 2020), we include the effect of the fintech-supporting institution in the empirical estimation. Given that there is no available source for fintech-related data, following Chen et al. (2021), we use text mining techniques and word frequency analysis on the annual government work reports to create a province-year level index (see the Appendix for the steps in constructing the fintech-supporting institutional index). Such an index captures the effect of institutional quality for supporting fintech industry development.

Figure 1 shows the mean value of each institutional index and the changes during 2010–2019. There is an overall downward trend of political institutional quality. The



Figure 1. Institutional quality indices.

<sup>&</sup>lt;sup>3</sup>More details of political, legal and financial institutions are presented in the Appendix.

mean of political institution was around 6.2 in 2010 and dropped below 5.4 in 2019. Such a decrease was due to the massive increases in government expenditure and government size in the western provinces of China (X. Wang et al., 2021). Legal institution and financial institution exhibited steadily increasing trends from 2010 to 2019. Fintech-supporting institution rose slowly during 2009–2014 while there was a rapid boost after 2014.

#### 3.4. Control variables

We include a set of control variables to capture the effects of firm-specific, provincelevel and country-level factors. Among the firm-level characteristics, firm size, reflecting the existing capital accumulation of firms and representing the basis of firms to carry out innovative activities, can affect firm productivity (Garicano et al., 2016). Following Teng et al. (2022), we use the form of the natural logarithm of total assets as the proxy of firm size. Second, the effect of firm age is essential to firm productivity (Dabla-Norris et al., 2012) as firm age is highly correlated to the richness of the resources, the strength of the coordination ability, and the R&D potential. We use the established year to calculate the firm age. Thirdly, the profitability of a firm is expected to be associated with the firm's investment amount in innovation (Haugen & Baker, 1996), which is correlated to its pattern of productivity growth. In this study, profitability is measured by the ratio of net income to total assets (ROA). Fourth, we consider the influence of the degree of ownership concentration proxied by the largest shareholder's ownership. Firms can improve decision-making efficiency and therefore influence firm performance through centralised management (Lin, 2018). Fifth, we add the variable of top managers' shareholding which captures the effect of equity incentives on top managers for focusing on the progress of innovative projects and improving firm productivity (S. Li & Fang, 2020). Sixth, firm directors play supervisory and leading roles in firm innovation activities (Blibech & Berraies, 2018). We control for the effect of board size, measured by the number of board members. Seventh, R&D intensity is proven to be associated with productivity in prior studies (De Vita et al., 2021; Wakelin, 2001). We use the natural logarithm of R&D expenditure to measure the effect of R&D intensity. Eighth, the market value of a firm is expected to positively affect productivity. We use Tobin Q, the ratio of firm market value to total assets, to measure such an effect (Fu et al., 2016). Finally, we control for the effect of industry-specific factors and year-fixed effects using dummy variables.

Among the province-level characteristics, we emphasise the importance of economic growth and population size, also widely used in previous studies (e.g., De Vita et al., 2021), which are measured by province-level GDP per capita and total provincial population, respectively. In addition, we include the effects of regional human capital and R&D expenditure measured by the total provincial government expenditure on education and the total expenditure of enterprises' R&D in each province. We control for the effect of international trade in each province measured by the province-level volume of imports and exports. All the above province-level factors are presented in natural logarithms to alleviate potential concerns of heteroscedasticity and non-stationarity.

Table 1	Summary	statistic.
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Variable	Mean	Std. Dev.	Min	Max
TFP (In)	3.7905	0.4138	2.23814	6.0643
Corporate debt	0.8481	1.1973	0	8.2382
Legal institution	9.4815	4.6142	1.25	16.94
Political institution	6.9889	1.3220	2.24	9.01
Financial institution	6.7336	2.6922	0.53	13.67
Fintech-supporting institution	0.3129	0.2799	0.02	0.86
Firm size (billion CNY)	16.2236	44.1829	0.4274	317.203
Profitability	0.0401	0.0489	-0.1458	0.1864
Top managers' shareholding (%)	13.9267	20.3215	0	67.2646
Board size	8.7688	1.7051	5	15
Largest shareholder's ownership (%)	35.3429	14.8302	8.77	75.25
Firm age	2.6359	0.4147	1.3863	3.3673
Tobin Q	2.2928	1.5089	0.9089	9.5448
R&D expense (billion CNY)	0.2424	1.2818	0	73.839
GDP per capita (provincial level, CNY)	60,535.69	27,391.26	12,882	161,776
Population (provincial level, million CNY)	61.4251	33.1403	3	124.89
International trade (provincial level, billion USD)	346.7849	333.7187	0.5448	1092
Education (provincial level, billion CNY)	144.724	85.3173	6.6229	491.8755
R&D expenditure (provincial level, billion CNY)	59.6695	52.683	0.0164	231.4857
HHI	0.0533	0.1031	0.0056	1
M2 (country level, billion CNY)	81,846.94	23,553.95	45,923.03	141,048
Unemployment (country level, %)	4.0608	0.1108	3.6	4.1

Additionally, we account for common time-variant shocks to all the firms by controlling for year dummies and two country-level variables, namely broad money (M2, measured in natural logarithm) and unemployment rate. Following Javorcik (2004), we control for the effects of industry-level concentration measured by the Herfindahl-Hirshmann Index (HHI) and add the industry-specific dummy variables.

Table 1 reports the summary statistics of each variable, suggesting that most of the observations in the sample have reasonable values (i.e., no outliers). Table 2 provides the pairwise correlation coefficients and indicates that there are no serious multicollinearity problems among the explanatory variables.

#### 3.5. Model specification

We first estimate the linear relationship between capital structure, institutional factors and TFP using fixed-effects estimation to control for the firm, industry and year heterogeneities. The empirical model is specified as follows:

$$TFP_{ijt} = \boldsymbol{\beta}_1 Debt_{ijt} + \boldsymbol{\beta}_2 Institutions_{jt} + \boldsymbol{\beta}_3 Z_{ijt} + \boldsymbol{\beta}_0 + \boldsymbol{\mu}_i + \boldsymbol{\varepsilon}_{it}$$
(1)

where  $TFP_{ijt}$  refers to the natural logarithmic value of TFP of firm *i* located in province *j* at year *t*; *Debt* denotes the effect of the corporate debt measured by the debt-to-equity ratio; *Institutions* stand for the influences of political, legal, financial and fintech-supporting institutions; *Z* refers to a set of control variables;  $\mu_i$  represents unobserved specific effects;  $\varepsilon_{it}$  is the error term with  $\varepsilon_{it} \sim iid(0, \sigma_{\varepsilon}^2)$ , and the  $\beta$  is the coefficient of each variable.

While the above model specification is for testing the linear relationship, the potential contingent effects of institutions in the capital structure-productivity nexus are captured

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3. Top managers $-0.32^{\text{M}}$ $0.15^{\text{M}}$ 1           3. Top managers $-0.32^{\text{M}}$ $0.15^{\text{M}}$ $1$ $5$ hareholding           4. Anarcholder/s $0.21^{\text{M}}$ $0.01$ $-0.19^{\text{M}}$ $0.3$ $1$ 5. Largest shareholder/s $0.21^{\text{M}}$ $0.08^{\text{M}}$ $-0.12^{\text{M}}$ $0.03^{\text{M}}$ $-0.12^{\text{M}}$ 6. Firm age $0.21^{\text{M}}$ $0.17^{\text{M}}$ $0.03^{\text{M}}$ $-0.04^{\text{M}}$ $1$ 7. Tobin Q $0.23^{\text{M}}$ $0.17^{\text{M}}$ $0.07^{\text{M}}$ $0.03^{\text{M}}$ $0.01^{\text{M}}$ 7. Tobin Q $0.50^{\text{M}}$ $0.17^{\text{M}}$ $0.07^{\text{M}}$ $0.07^{\text{M}}$ $0.01^{\text{M}}$ 9. GDP per capita $0.18^{\text{M}}$ $0.03^{\text{M}}$ $0.07^{\text{M}}$ $0.03^{\text{M}}$ $0.01^{\text{M}}$ 9. GDP per capita $0.18^{\text{M}}$ $0.03^{\text{M}}$ $0.07^{\text{M}}$ $0.03^{\text{M}}$ $0.01^{\text{M}}$ 9. GDP per capita $0.18^{\text{M}}$ $0.03^{\text{M}}$ $0.07^{\text{M}}$ $0.07^{\text{M}}$ $0.01^{\text{M}}$ 10. Poulution $0.18^{\text{M}}$ $0.03^{\text{M}}$ <td< th=""><th>s' -0.32*** 0.15 holder's 0.26*** 0.00 holder's 0.21*** 0.03 0.21*** 0.03 1.1*** 0.03 ta 0.10*** 0.03 ta 0.11*** 0.03 ta 0.11*** 0.03</th><th>***         1           1         -0.19***           ***         -0.12***           ***         -0.33***           ***         0.05****           ***         0.07****           ***         0.07****           ***         0.10****</th><th>1 0.03 -0.16*** -0.16***</th><th>1 -0.10*** -0.14*** 0.07***</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></td<>	s' -0.32*** 0.15 holder's 0.26*** 0.00 holder's 0.21*** 0.03 0.21*** 0.03 1.1*** 0.03 ta 0.10*** 0.03 ta 0.11*** 0.03 ta 0.11*** 0.03	***         1           1         -0.19***           ***         -0.12***           ***         -0.33***           ***         0.05****           ***         0.07****           ***         0.07****           ***         0.10****	1 0.03 -0.16*** -0.16***	1 -0.10*** -0.14*** 0.07***															
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8. R&D expense         0.50***         0.10***         0.07***         0.17***         0.17***         0.17***         0.17***         0.12****         0.12****         0.12****         0.12****         0.12****         0.12****         0.01	ta 0.50*** 0.10 ta 0.18*** 0.03 -0.11*** 0.03		· 0.07*** -0.08***	0.07***	-0.04	-													
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16. Legal institution         0.04***         0.07***         0.16***         -0.03***         -0.04         0.03***         0.16***           17. Political institution         -0.12***         0.10***         0.13***         -0.09***         0.00         -0.06***         0.03***         0.16***           18. Financial institution         0.17***         0.02***         0.05***         0.09****         0.09***         0.20***         0.20***	ient 0.39*** –0.0	*** -0.04***	0.04	-0.02***	0.24*** -	-0.16*** 0	.24*** 0.	31***	0.01	0.06*** (	<b>).26</b> ***	0.13***	0.60***	-					
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19. Fintech-supporting 0.25*** –0.06*** 0.03*** –0.05*** –0.05*** 0.24*** 0.08*** 0.20***	porting 0.25*** –0.0	*** 0.03***	-0.05***	-0.05***	0.24***	0.08*** 0	.20*** 0.	42*** (	).15***	0.30*** (	0.47***	0.33***	0.68***	0.48***	0.25***	0.05***	0.32***	-	
institution																			
20. Corporate debt 0.55*** –0.21*** –0.22*** 0.14*** 0.10*** 0.23*** –0.30*** 0.08*** 21 HUI 0.11*** 0.01 0.11*** 0.01	ebt 0.55*** –0.2 0.11*** 0	*** -0.22***	0.14***	0.10***	0.23*** -	-0.30*** 0	08*** 0.	03*** -	- 0.04*** -	-0.05***	- 0.04	-0.03***	0.13***	0.23***	-0.03***	-0.09***	0.02**	0.10***	1
		CO-0- 10	0.0	0.01	t-0-0	20.02	0.01	9	50.0		+0.0	0.01	r	67.0	70.02	0.01	c0.0	c1.0	c0.0

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by introducing the interaction terms (*Corporate debt\* Legal institution*, *Corporate debt\* Political institution*, *Corporate debt\* Financial institution*, and *Corporate debt\* Fintech-supporting institution*) in the model.

#### 4. Empirical analysis

#### 4.1. Main results

Table 3 reports the empirical results using fixed-effects estimation. Our empirical strategy for testing the relationship between corporate debt, institutions and productivity relies on presenting the base results first with the basic set of control variables in column 1 and including debt-to-equity ratio and four institutional measures to capture the effect of corporate debt and institutions in columns 2–4. Then, we introduce the interaction terms to allow for the contingency effects of institutions in columns 5–8.

The results of Table 3 suggest that corporate debt per se has a negative and significant effect on productivity at the 1% level, revealing that a high level of corporate indebtedness decreases productivity growth and indicating that there is a general issue of corporate debt overhang among listed firms in China. Among institutional variables, legal institution has a positive and weakly significant effect on productivity while political institution exerts a negative and significant impact on the dependent variable. Financial institution and fintech-supporting institution have insignificant influences. These results suggest that improving legal institution such as providing better property rights protection and strengthening legal enforcement can enhance firm productivity. However, a higher level of political institution reflecting less government support or intervention leads to a lower level of firm's productivity, indicating that in order to stimulate TFP growth, firms in China need supports from local Chinese governments – industrial support policies such as special subsidy, tax exemption and government low-interest loans program do increase firm's productivity.

Regarding the interaction terms, Corporate debt\* Legal institution and Corporate debt\* Political institution do not have a significant effect on productivity while both Corporate debt\* Financial institution and Corporate debt\* Fintech-supporting institution are significantly and negatively associated with the dependent variable. The results suggest that both financial institution and the fintech-supporting institution exert negative contingency effects in the relationship between corporate debt and productivity, indicating that the overall firm indebtedness effect on productivity is negative and conditional on the external environment of financial institution and the fintech-supporting institution. To get a sense of the contingency effects of both types of institutional quality, we depict the marginal effects of debt-to-equity ratio in Figure 2<sup>4</sup> This reveals that corporate debt negatively influences firm productivity and such a negative effect can be magnified by higher levels of financial institution and the fintech-supporting institution. In fact, Chinese firms located in provinces

<sup>&</sup>lt;sup>4</sup>Following Berry et al. (2012) and C. Li and Tanna (2019), we use the method of Brambor et al. (2006) to show the magnitude of the estimated effects in Figure 2 which reveals the marginal effects of corporate debt (debt to equity ratio) on TFP (as well as 95% confidence intervals) for different levels of financial institution and fitench-supporting institution. These are based on the estimates reported in columns 7 and 8 of Table 3. The marginal effects are calculated using the derivative,  $dy/dx = \beta_1 + \beta_2 * institutional quality$ , evaluated at all values of institutional quality, with  $\beta_1$  and  $\beta_2$  being the corporate debt estimates of the constitutive and interaction terms respectively.

Table 3. The impact of corporate debt and	institutions or	n productivity.						
	-	2	m	4	'n	9	7	∞
Corporate debt		-0.0070*** (0.0018)		-0.0071*** (0.0018)	-0.0046 (0.0035)	-0.0109 (0.0077)	0.0030 (0.0041)	-0.0037
Legal institution			0.0016	0.0017*	0.0020*	0.0017*	0.0018*	0.0017*
Political institution			-0.0056*	-0.0056*	-0.0056*	-0.0061*	-0.0055*	-0.0057*
Financial institution			(0.0032) 0.0007	(0.0032) 0.0006	(0.0032) 0.0007	(0.0034) 0.0006	(0.0032) 0.0011	(0.0032) 0.0006
Fintech-supporting institution			(0.0014) 0.0035	(0.0014) 0.0042	(0.0014) 0.0040	(0.0014) 0.0044	(0.0015) 0.0042	(0.0014) 0.0115
Corporate debt* Legal institution			(00000)	(0000.0)	(00003) -0.0003 (00000)	(00000)	(00000)	(6/00.0)
Corporate debt* Political institution					(6000.0)	0.0006		
Corporate debt* Financial institution						(100.0)	-0.0015*** (0.0005)	
Corporate debt* Fintech-supporting institution							(000.0)	-0.0077**
Firm size	0.228***	0.2265***	0.225***	0.2262***	0.2260*** (0.0035)	0.2262***	0.2260*** (0.0035)	0.2257*** 0.2257***
Profitability	1.6630***	1.6475***	1.6636***	1.6480***	1.6490***	1.6477***	1.6486***	1.6523***
Top managers' shareholding	().0297) -0.0002	(0.0299) -0.0002	(0.0297) -0.0002	(9920.0) -0.0001	(8620.0) -0.0001	(9620.0) -0.0001	(8620.0) -0.0001	(0.0300) -0.0001
Board size	(0.0002) 0.0198*	(0.0002) 0.0183*	(0.0002) 0.0196*	(0.0002) 0.0181*	(0.0002) 0.0181*	(0.0002) 0.0180*	(0.0002) 0.0182*	(0.0002) 0.0179*
הולושה מונוס מערך הלמצירת אמריביר -	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)	(0.0103)
Largest shareholder s ownership	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Firm age	0.0604***	0.0613***	0.0577***	0.0585***	0.0580***	0.0585***	0.0555***	0.0547***
Tobin O	(0.0156) 0.0056***	(0.0156) 0.0058***	(0.0157) 0.0055***	(0.0157) 0.0057***	(0.0157) 0.0057***	(0.0157) 0.0057***	(0.0158) 0.0056***	(0.0158) 0.0054***
2	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
R&D expense	0.0100*** (0.0014)	0.0097*** (0.0014)	0.0100*** (0.0014)	0.0097*** (0.0014)	0.0097*** (0.0014)	0.0098*** (0.0014)	0.0097*** (0.0014)	0.0098*** (0.0014)
								(Continued)

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Table 3. (Continued).								
	1	2	3	4	5	6	7	8
GDP per capita	0.0374	0.0378	0.0308	0.0317	0.0317	0.0326	0.0384	0.0272
	(0.0311)	(0.0311)	(0.0322)	(0.0322)	(0.0322)	(0.0322)	(0.0323)	(0.0322)
Population	0.0565	0.0529	0.0498	0.0468	0.0460	0.0472	0.0430	0.0455
	(0.0360)	(0.0360)	(0.0367)	(0.0367)	(0.0367)	(0.0367)	(0.0367)	(0.0367)
International trade	-0.0094	-0.0096	-0.0076	-0.0079	-0.0080	-0.0079	-0.0089	-0.0068
	(0.0077)	(0.0077)	(0.0079)	(0.0079)	(0.0079)	(0.0079)	(0.0079)	(0.0079)
Education	0.0133	0.0158	0.0109	0.0127	0.0129	0.0125	0.0129	0.0141
	(0.0229)	(0.0229)	(0.0240)	(0.0240)	(0.0240)	(0.0240)	(0.0240)	(0.0240)
Provincial R&D expenditure	-0.0027	-0.0038	-0.0025	-0.0038	-0.0037	-0.0040	-0.0061	-0.0039
	(0.0119)	(0.0119)	(0.0120)	(0.0120)	(0.0120)	(0.0120)	(0.0120)	(0.0120)
HHI	0.0287	0.0282	0.0280	0.0275	0.0275	0.0273	0.0264	0.0267
	(0.0186)	(0.0186)	(0.0186)	(0.0186)	(0.0186)	(0.0186)	(0.0186)	(0.0186)
M2 (country level)	0.0915***	0.0883***	0.0871***	0.0835***	0.0839***	0.0831***	0.0834***	0.0869***
	(0.0281)	(0.0281)	(0.0283)	(0.0283)	(0.0283)	(0.0283)	(0.0282)	(0.0283)
Unemployment (country level)	-0.1654***	-0.1628***	-0.1639***	-0.1613***	-0.1611***	-0.1608***	-0.1624***	-0.1557***
	(0.0511)	(0.0510)	(0.0513)	(0.0512)	(0.0512)	(0.0512)	(0.0512)	(0.0513)
Constant	-3.7016***	-3.7252***	-3.4677***	-3.4819***	-3.4798***	-3.4797***	-3.4688***	-3.4859***
	(0.3674)	(0.3670)	(0.3843)	(0.3839)	(0.3839)	(0.3839)	(0.3837)	(0.3838)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Z	8987	8987	8987	8987	8987	8987	8987	8987
R2	0.7344	0.7350	0.7346	0.7352	0.7352	0.7352	0.7355	0.7354
The dependent variable is productivity (InTFP). N and parenthesis (below coefficient estimates). ***Sta (p-value<0.1).	d R2 denote numb tistical significance	er of observations e at 1% level (p-'	and goodness of i value<0.01); **Sta	īt, respectively. E: tistical significan	timations are by f ce at 5% level (p	īxed effects with r -value<0.05); *Sta	obust standard er tistical significanc	ors reported in e at 10% level

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Figure 2. Marginal effects of corporate debt on productivity (financial institution and fintechsupporting institution).

with well-established traditional financial and fintech-supporting institutional settings are easier to access bank loans than obtain equity financing. Such institutional settings are more likely to exacerbate the problem of excessive corporate indebtedness, which therefore hinders firm productivity growth.

Additionally, all the firm-specific factors except for managers' shareholding significantly and positively correlate to firm productivity. The results are consistent with findings from previous studies (Becheikh et al., 2006; Magri, 2009). All the province-level variables exert insignificant influences, while country-level factors appear to be more relevant in determining the level of TFP – M2 has a positive and significant effect while unemployment has a negative and significant impact.

#### 4.2. Robustness check

In order to check the consistency of the results, we conduct the robustness tests and report the results in Tables 4 and 5. In Table 5, we re-estimate the relationship between corporate debt, institutions and productivity using generalised least squares (GLS) as an alternative method. Also, we additionally include the effect of firm ownership using a dummy variable coded 0 if the firm is state-owned and 1 otherwise. In column 1 of Table 4, the linear effect of the corporate debt is negatively and significantly associated with productivity, which is in line with the findings in Table 3. Regarding the effects of institutions, legal institution per se exerts a strongly significant and positive effect on firm productivity. Financial institution and fintech-supporting institution have a negative and significant contingency effect, which are consistent with the results shown in Table 3. In addition, state ownership has a positive and significant effect on productivity, revealing that state-owned enterprises (SOEs) tend to have a higher level of productivity than non-SOEs in China. Also, the effects of other control variables remain apart from that GDP per capita and HHI are positively and significantly associated with firm productivity.

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#### Table 4. Robustness check: alternative method.

	1	2	3	4	5
Corporate debt	-0.0042***	-0.0027	-0.0113*	0.0058	-0.0004
	(0.0016)	(0.0031)	(0.0068)	(0.0037)	(0.0021)
Legal institution	0.0022***	0.0023***	0.0022***	0.0022***	0.0022***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Political institution	-0.0016	-0.0016	-0.0026	-0.0015	-0.0016
<b>-</b>	(0.0026)	(0.0026)	(0.0027)	(0.0026)	(0.0026)
Financial institution	-0.0003	-0.0003	-0.0003	0.0012	-0.0003
First shares and in a tractitudine	(0.0011)	(0.0011)	(0.0011)	(0.0012)	(0.0011)
Fintech-supporting institution	0.0067	0.0067	0.0070	0.0064	0.0148^^
Corporate debt* Logal institution	(0.0065)	(0.0065)	(0.0065)	(0.0065)	(0.0071)
Corporate debta Legal Institution		-0.0002			
Corporate debt* Political institution		(0.0003)	0.0011		
corporate debt - Fontical institution			(0.0011)		
Corporate debt* Financial institution			(0.0010)	-0.0015***	
				(0.0005)	
Corporate debt* Fintech-supporting institution				(0.0005)	-0.0085***
					(0.0032)
Firm size	0.2440***	0.2439***	0.2440***	0.2439***	0.2434***
	(0.0025)	(0.0026)	(0.0025)	(0.0025)	(0.0026)
Profitability	1.7064***	1.7068***	1.7062***	1.7062***	1.7115***
	(0.0283)	(0.0283)	(0.0283)	(0.0283)	(0.0283)
Top managers' shareholding	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Board size	0.0193**	0.0193**	0.0193**	0.0194**	0.0193**
	(0.0090)	(0.0090)	(0.0090)	(0.0090)	(0.0090)
Largest shareholder's ownership	0.0008***	0.0008***	0.0008***	0.0008***	0.0008***
_	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Firm age	0.0243***	0.0242***	0.0242***	0.0230***	0.0232***
	(0.0074)	(0.0074)	(0.0074)	(0.0074)	(0.0074)
Tobin Q	0.0054***	0.0054***	0.0054***	0.0053***	0.0051***
202	(0.0010)	(0.0010)	(0.0010)	(0.0010)	(0.0010)
R&D expense	0.0119***	0.0119***	0.0119***	0.0119***	0.0119***
	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)
GDP per capita	(0.0517""	0.0517***	0.0520""	0.054/***	0.0497***
Population	(0.0221)	(0.0221)	(0.0221)	(0.0221)	(0.0221)
ropulation	(0.0207)	(0.0206)	(0.0202	(0.0206)	(0.0248)
International trade	-0.0068	-0.0067	-0.0068	-0.0069	-0.0064
	(0.0053)	(0.0053)	(0.0053)	(0.0053)	(0.0053)
Education	-0.0072	-0.0072	-0.0076	-0.0093	-0.0072
	(0.0196)	(0.0196)	(0.0196)	(0.0196)	(0.0196)
Provincial R&D expenditure	-0.0027	-0.0027	-0.0028	-0.0041	-0.0026
	(0.0080)	(0.0080)	(0.0080)	(0.0080)	(0.0080)
HHI	0.0362**	0.0362**	0.0359**	0.0351*	0.0353**
	(0.0180)	(0.0180)	(0.0180)	(0.0180)	(0.0180)
M2 (country level)	0.0775***	0.0778***	0.0770***	0.0796***	0.0788***
	(0.0236)	(0.0236)	(0.0236)	(0.0236)	(0.0236)
Unemployment (country level)	-0.1600***	-0.1599***	-0.1591***	-0.1609***	-0.1538***
	(0.0514)	(0.0514)	(0.0514)	(0.0514)	(0.0515)
State ownership	0.0363***	0.0364***	0.0364***	0.0368***	0.0368***
	(0.0063)	(0.0063)	(0.0063)	(0.0063)	(0.0063)
Constant	-3.5150***	-3.5182***	-3.5071***	-3.5624***	-3.5012***
	(0.2890)	(0.2890)	(0.2891)	(0.2892)	(0.2889)
	Yes	Yes	Yes	Yes	Yes
industry FE	res	res	res	res	res
או בס	898/ 0.721/	898/ 0.721/	898/ 0.7216	0 7 7 7 0	898/ 07210
ΠZ	0.7310	0.7310	0.7310	0.7320	0.7318

The dependent variable is productivity (InTFP). N and R2 denote number of observations and goodness of fit, respectively. Estimations are by generalised least squares with robust standard errors reported in parenthesis (below coefficient estimates).\*\*\*Statistical significance at 1% level (p-value<0.01); \*\*Statistical significance at 5% level (p-value<0.05); \*Statistical significance at 10% level (p-value<0.1).

		•			
	1	2	3	4	5
Corporate debt	-0.0065***	-0.0036	0.0050	0.0085	0.0002
·	(0.0022)	(0.0044)	(0.0101)	(0.0052)	(0.0029)
Legal institution	0.0030**	0.0033**	0.0030**	0.0031**	0.0031**
-	(0.0014)	(0.0015)	(0.0014)	(0.0014)	(0.0014)
Political institution	-0.0096**	-0.0098**	-0.0080*	-0.0095**	-0.0098**
	(0.0042)	(0.0042)	(0.0044)	(0.0042)	(0.0042)
Financial institution	-0.0005	-0.0006	-0.0006	0.0022	-0.0005
	(0.0018)	(0.0018)	(0.0018)	(0.0020)	(0.0018)
Fintech-supporting institution	0.0030	0.0029	0.0025	0.0032	0.0170*
	(0.0081)	(0.0081)	(0.0081)	(0.0081)	(0.0090)
Corporate debt* Legal institution		-0.0003			
		(0.0004)	0.0017		
Corporate debt* Political Institution			-0.0017		
Compared dabt* Financial institution			(0.0014)	0 0022***	
Corporate dept." Financial institution				-0.0022	
Corporate debt* Eintech supporting institution				(0.0007)	0.0145***
corporate debt inflecti-supporting institution					(0.0042)
Firm size	0 1680***	0 1679***	0 1681***	0 1683***	0.1670***
	(0.0047)	(0.0047)	(0.0047)	(0.0047)	(0.0047)
Profitability	1.8330***	1.8339***	1.8340***	1.8330***	1.8379***
· · ··································	(0.0379)	(0.0379)	(0.0379)	(0.0378)	(0.0378)
Top managers' shareholding	-0.0010***	-0.0010***	-0.0010***	-0.0010***	-0.0009***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Board size	-0.0093	-0.0093	-0.0089	-0.0082	-0.0085
	(0.0136)	(0.0136)	(0.0136)	(0.0136)	(0.0136)
Largest shareholder's ownership	0.0007**	0.0007**	0.0007**	0.0006**	0.0007**
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Firm age	0.0650***	0.0643***	0.0647***	0.0608***	0.0566**
	(0.0225)	(0.0225)	(0.0225)	(0.0225)	(0.0226)
Tobin Q	0.0033**	0.0033**	0.0033**	0.0031**	0.0028**
	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)
R&D expense	0.0188***	0.0188***	0.0188***	0.0187***	0.0188***
	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0018)
GDP per capital	0.1430^^^	0.1425^^^	0.1404^^^	0.1564^^^	0.130/^^^
Deputation	(0.0438)	(0.0438)	(0.0439)	(0.0440)	(0.0439)
Population	(0.0404)	(0.0404)	(0.0404)	(0.0404)	(0.0404)
International trade	(0.0494)	(0.0494) -0.0142	(0.0494)	(0.0494)	(0.0494)
	(0.0105)	(0.0142	(0.0106)	(0.0106)	(0.0106)
Education	-0.0364	-0.0360	-0.0360	-0.0377	-0.0305
	(0.0332)	(0.0332)	(0.0332)	(0.0332)	(0.0332)
Provincial R&D expenditure	-0.0232	-0.0228	-0.0219	-0.0257	-0.0242
·	(0.0166)	(0.0166)	(0.0167)	(0.0166)	(0.0166)
HHI	0.0117	0.0118	0.0125	0.0107	0.0106
	(0.0256)	(0.0256)	(0.0256)	(0.0256)	(0.0256)
M2 (country level)	0.0741*	0.0743*	0.0752*	0.0704	0.0840*
	(0.0431)	(0.0431)	(0.0431)	(0.0430)	(0.0431)
Unemployment (country level)	-0.1537**	-0.1526**	-0.1554**	-0.1519**	-0.1456**
-	(0.0704)	(0.0704)	(0.0704)	(0.0703)	(0.0704)
Constant	-2.8861***	-2.8843***	-2.8974***	-2.8347***	-2.9650***
	(0.5918)	(0.5918)	(0.5918)	(0.5915)	(0.5916)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
N DO	/121	/121	/121	/121	/121
KZ	0.6333	0.6333	0.6334	0.6340	0.6342

Table 5. Robustness check: dealing with endogeneity.

The dependent variable is productivity (InTFP). N and R2 denote number of observations and goodness of fit, respectively. Estimations are by fixed effects with robust standard errors reported in parenthesis (below coefficient estimates). \*\*\*Statistical significance at 1% level (p-value<0.01); \*\*Statistical significance at 5% level (p-value<0.05); \*Statistical significance at 10% level (p-value<0.1).

In Table 5, we use lagged explanatory variables to deal with potential endogeneity.<sup>5</sup> The results, practically the sign and the significance of coefficients of the main explanatory variables, are essentially unchanged.

Now we can conclude that high levels of firm indebtedness reduce productivity growth. Among institutional factors, legal institution is positively associated with productivity. Financial institution and fintech-supporting institution do not have direct impacts on productivity while both can negatively influence the relationship between corporate debt and productivity.

#### 5. Conclusion

This paper investigates the influence of corporate debt on firm productivity and considers the contingency effect of institutions in such a relationship. Prior studies have examined the corporate debt-productivity and institution-productivity linkages while neglecting to test the role of institutions in influencing the relationship between firm indebtedness and productivity using micro-level analysis. Therefore, this paper adds to the existing literature by highlighting the importance of institutional settings to the corporate debt-productivity nexus. We propose that institutional factors, such as legal institution and financial market-related institutions, may influence the preferences of capital suppliers and then affect firms' capital structure choices. Also, government support and supervision may reduce the potential negative impact of corporate debt overhang. Therefore, we suggest that the relationship between corporate debt and firm productivity may be conditional on local institutional quality.

Using data for Chinese-listed frim during the period 2010–2019, we conduct empirical analyses to test the corporate debt-institutions-productivity nexus. Our empirical results reveal that excessive firm indebtedness has a significant and reductive impact on productivity, suggesting that firms need to maintain a reasonable indebtedness level to avoid hindering productivity growth. More importantly, we find that there are negative contingency effects of financial institution and fintech-supporting institution in the corporate debt-productivity link. Such effects suggest that both traditional and fintech-related financial institutional settings benefit the banking sector in China and strengthen the dominant position of debt financing. The prevailing problem of corporate debt overhang hindering firm productivity appears to be difficult to address without institutional and policy reform from the supply side of the capital. Also, we find that, to some extent, better legal institution improves firm productivity while political institution is negatively associated with firm productivity. The policy implication is that well-established legal institutions including the protection of IPRs and patents, and relevant laws and regulations to protect firms' innovation achievements and property rights are essential for boosting firm productivity. In addition, market-support policies released by local governments along with a certain degree of government intervention and supervision can improve the productivity growth of local firms.

A note of caution should be made at this point. The detection of a significant negative effect of firm indebtedness on productivity does not necessarily imply causality or vice versa (see, for example, De Vita et al., 2018). This opens up further avenues for future research specifically

<sup>&</sup>lt;sup>5</sup>Using instrumental variable (IV) estimation is admittedly a more appropriate approach to tackle the endogeneity issue. However, finding proper instruments is generally difficult and we lack adequate firm-level data to create such IVs.

aimed at investigating, by means of panel causality tests, the causal properties of the economic relationship between the variables in question.

#### Acknowledgments

We would wish to thank the editor and the anonymous referees for many helpful comments. Any remaining errors remain solely ours.

#### **Disclosure statement**

No potential conflict of interest was reported by the authors.

#### Funding

This work was supported by the University Research Projects of Philosophy and Social Sciences in Jiangsu Province (Grant no. 2020SJA1210) and the Humanities and Social Sciences Youth Foundation of Ministry of Education in China (Grant no. 22YJCGJW004)

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#### Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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#### Appendix

The institutional indices in the Marketization Index of China's Provinces: National Economic Research Institute (NERI) Report have two or three sub-dimensional measures.

The index of *political institution* has three sub-dimensions namely government allocation of resources, the level of government intervention in the business, and government size. The degree of government allocation of resources is calculated using the data of economic resources controlled by the provincial government. The level of government intervention in the business is assessed using questionaries results about government intervention in the processes of administrative approval, industry access and other business-related activities. Government size is calculated based on the ratio of employment in public administration, social security and social organizations to the total population in the province.

*Legal institution* measures the levels of legal protection and development of legal system. The sub-dimensions of the index of legal institution include the development of legal services, the degree of the legal environment of business and the level of IPR protection. The development of legal services is measured by questionaries results about the quality of industry associations and market intermediaries related to lawyers and accountants. The legal environment of business is assessed using questionaries results about the impartiality and efficiency of local judicial and administrative law enforcement agencies. IPR protection is calculated based on the ratio of the number of patent applications approved to the number of scientific and technological personnel.

*Financial institution* has two sub-dimensions namely the competitiveness of the financial industry and the regulation of credit allocation. The former dimension is calculated using the data of deposits taken by non-state-owned financial institutions. The latter is computed using the comprehensive data of non-state loans issued by financial organisations.

The index of *fintech-supporting institution* is constructed using text mining techniques and word frequency analysis. The steps for establishing such an index are shown as follows:

- (i) Searching keywords (e.g., inclusive finance, big data, fintech, internet finance, blockchain, etc) related to policies and regulations of the fintech industry from annual government work reports for each province in Mainland China covering the period 2010-2019.
- (ii) Counting the frequencies of all the keywords and classifying them on a province-year basis.
- (iii) Converting the discrete data into continuous values and then transforming to the natural logarithmic term (i.e.,  $FINTECH_{it} = ln(1 + wordfrequency)$ , where  $FINTECH_{it}$  is the non-negative and continuous measure of the quality of fintech-supporting institution in province i year t)
- (iv) Calibrating the variable in the range from 0 to 1 with a higher value indicating a better quality of the fintech-supporting institution using the function  $FINTECH_{it}^1 = calibration(FINTECH, 0.95, 0.50, 0.05).$