Debt Maturity and Firm Productivity—The Role of Intangibles

Nakatani, Ryota

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Ryota Nakatani, Ph.D.

Abstract

Does the maturity of debt matter for productivity? Using data on Italian firms from 1997 to 2015, we study the relationship among debt maturity, productivity, and firm characteristics. We find that productivity is positively associated with short-term debt and negatively associated with long-term debt. This result supports the hypothesis that the less intense monitoring of firm performance and fewer liquidation fears stemming from the long maturity of debt causes a moral hazard, while short-term debt serves as a disciplinary device to improve firm performance in the short run. This effect is evident in small- and medium-sized enterprises and old firms. In contrast, large firms can utilize long-term financing to improve productivity through long-term investments. Firms improve productivity by purchasing intangible assets financed by short-term debt.

Keywords: Debt maturity; Productivity; SMEs; Firm size; Firm age; Intangibles

JEL Classification Codes: D22; D24; G32; L52; O16; O34

I. INTRODUCTION

How does debt maturity affect productivity? The literature only focuses on how debt maturity influences output (Jaramillo and Schiantarelli 1997) and firm growth (Léon 2020) but not productivity. For instance, Léon (2020) found that long-term debt does not stimulate the growth of small and young firms but that short-term debt spurs firm growth.

It would be interesting to explore how debt maturity influences firm productivity because the effects can be either positive or negative. On the one hand, a long debt maturity can avoid liquidity risk, allowing firms to focus on productivity-enhancing activities. On the other hand, a long maturity causes a moral hazard for firms due to less intense monitoring by creditors.

In theory, an optimal financing strategy is to match the maturity of liabilities and assets (Hart and Moore 1995). The implication of this theory is that companies use long-term debt to purchase tangible fixed assets and short-term debt to finance working capital or intangible assets. In the absence of long-term finance, which is often the case for small and medium-sized enterprises (SMEs), companies tend to favor investments in technologies with immediate payoffs because of liquidation fears. Diamond (1991) demonstrates that companies face liquidity or roll-over risk when they finance long-term investments using short-term debt, as creditors may refuse to roll over their credits. On the other hand, the agency theory by Jensen (1986) predicts that short-term debt may be a tool that disciplines managers by imposing frequent renegotiations.

The effects of debt maturity on productivity could differ between large companies and SMEs. This is because SMEs tend to face credit constraints for long-term financing due to insufficient eligible collateral. Therefore, we also study whether the effects of long- and short-term debt on firm productivity differ between SMEs and large companies.

We also analyze how firm age affects the influence of debt maturity on productivity. Older firms may face a moral hazard due to their long relationships with lenders. Alternatively, older firms can survive in the market as a result of disciplinary efforts to improve firm performance and productivity. Thus, the effects of firm age are ex ante unclear. We further study the effects of debt maturity in relation to intangible assets because these assets are likely to be purchased through short-term loans to quickly raise productivity.

This paper analyzes firm-level total factor productivity (TFP) dynamics from the viewpoint of corporate balance sheets to answer the research question. We use Italian firms' data compiled in the Orbis database from 1997 to 2015 to analyze productivity dynamics. The detailed data and empirical methodology are explained in the following sections.

II. DATA

We use the Orbis database compiled by Bureau van Dijk. Bajgar et al. (2020) discussed data issues regarding Orbis, and they found that Orbis has good coverage of larger firms. Thus, we show the share of SMEs in Table 1. We use NACE four-digit industry classifications to control for industry-specific time fixed effects, such as changes in industry-specific market regulations.

Table 1. Descriptive Statistics

Variable	Mean	Std Dev
ln(TFP)	3.5502	1.6508
Long-Term Debt/Total Assets	0.0510	0.1115
Short-Term Debt/Total Assets	0.0987	0.1424
Intangible Assets/Total Assets	0.1719	0.2454
ln(Number of Employees)	2.0087	1.2531
ln(Firm Age)	2.5478	0.8022
Share of SMEs (%)	99.1802	

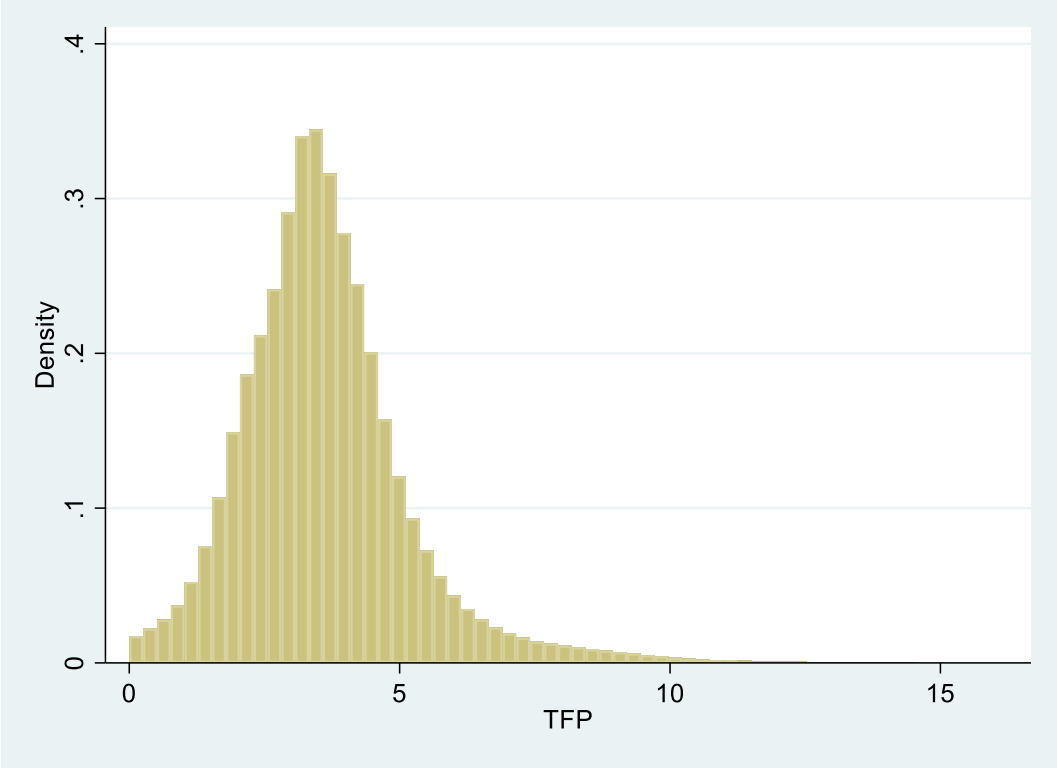
The definitions of the variables included in our analysis are as follows. Short-term debt is financial debt payable within one year. Long-term debt is financial debt with maturities greater than 12 months. Both types of debt are divided by total assets. Asset intangibility is the ratio of intangible assets to total assets. We also include the firm age and size as firm characteristics. Firm size is measured by the natural logarithm of the number of employees. The natural logarithm of firm age is also taken to capture the nonlinear effects of the lifecycle of firm dynamism.

We estimate TFP using the method in Gandhi et al. (2020). Their method is superior to that in Ackerberg et al. (2015) because Ackerberg et al.'s dependent variable is the log of revenue minus materials expenditure, which is called a restricted profit production function that has problems since it is justified as a local approximation, and the variation in production data is not small. The method in Gandhi et al. (2020) uses labor input as the cost of employees and capital input as tangible fixed assets. In the Orbis database, tangible fixed assets include all tangible assets, such as buildings and machinery. The actual depreciation reported in the data is used to calculate capital. Note that we do not include intangible fixed assets in the estimation of TFP because we treat intangible assets in our regression as one of the determinants of TFP dynamics. In other words, if we include intangible assets as capital inputs in the estimation of TFP, then the relationship between intangible assets and TFP would be determined in the estimation of TFP, which is inconsistent with the empirical strategy used in this paper. Figure 1 shows the distribution of estimated TFP levels.

One major issue to consider when constructing firm-level data is the need for data cleaning. We cleaned the Orbis database as follows. First, we eliminated observations involving apparent reporting mistakes. For example, we eliminated firms with negative values for (total, tangible, or intangible) assets, sales, or number of employees in any year. We also eliminated observations for which the cost of materials or cost of employees are missing or have nonpositive values. Firms that lack NACE codes were also eliminated

because we cannot create industry-specific time fixed effects. Observations with a negative firm age or negative liability were also eliminated.

Figure 1. Distribution of TFP



III. EMPIRICAL METHODOLOGY

We study productivity drivers from the viewpoint of debt maturity and asset intangibility, controlling for firm characteristics. The regression equation is defined as[1]:

[1] This econometric specification is an extension of the empirical strategy developed by Nakatani (2021, 2023a), whose dependent variable was the differenced natural logarithm of TFP, approximating TFP growth. Nakatani (2023b) studies the same topic, using cross-country firm-level data.

$$ln(TFP_{i,j,t}) = \beta_1 + \beta_2 ln(TFP_{i,j,t-1}) + \beta_3 ShortTerm\_Debt_{i,j,t-1} + \beta_4 LongTerm\_Debt_{i,j,t-1} + \beta_7 Asset\_Intangibility_{i,j,t-1} + \beta_5 ln(Size_{i,j,t}) + \beta_6 ln(Age_{i,j,t}) + \mu_{j,t} + v_i + \varepsilon_{i,j,t}$$

where the subscripts i, j, and t represent the firm, industry, and period, respectively; $ln(TFP_{i,j,t})$ is the natural logarithm of TFP; β_1 is a constant term; $ShortTerm\_Debt_{i,j,t}$ is short-term debt divided by total assets; $LongTerm\_Debt_{i,j,t}$ is long-term debt divided by total assets; $Asset\_Intangibility_{i,j,t}$ is intangible fixed assets divided by total assets; $ln(Size_{i,j,t})$ is the natural logarithm of the number of employees; $ln(Age_{i,j,t})$ is the natural logarithm of firm age; $\mu_{j,t}$ represents the industry-specific time fixed effects; v_i represents the firm fixed effects; and $\varepsilon_{i,j,t}$ is an error term.[2] To avoid endogeneity problems arising from simultaneous decisions made by firms, the relevant explanatory variables (i.e., short-term debt, long-term debt, and asset intangibility) are lagged.

IV. RESULTS

The baseline results in Table 2 show that long-term debt is negatively associated with the TFP level. This finding supports the hypothesis that the informational asymmetry between lenders (commercial banks) and borrowers (firms) causes negative effects on firm productivity. Namely, the less intense monitoring by borrowers due to the long maturity of debt and fewer fears of liquidation associated with long-term debt could lower firm productivity.

[2] We believe that omitted variable bias in our specification is not serious. Potential omitted variable bias comes from exports/foreign ownership (Chauvet and Ehrhart 2018), business environment (Commander and Svejnar 2011), regulatory environment (Aterido et al. 2011), training, etc., although there is no such information in our data. Nevertheless, omitted variables that are common for the same industry, such as business and regulatory environments, are controlled by the four-digit level, industry-specific, time-varying fixed effects ($\mu_{j,t}$). Furthermore, firm-specific omitted variables, such as export status, foreign ownership, and training, are captured by the firm-specific fixed effects, v_i, if they are not time-variant.

In contrast, we find that short-term debt is positively associated with firm productivity. The short maturity of debt prevents firms from moral hazards due to informational asymmetry, and firms make efforts to improve productivity by purchasing new productivity-enhancing technology. The fear of liquidity risks also stimulates firms' effort to perform better by improving productivity.

Moreover, asset intangibility is found to have positive effects on TFP. We also find that firm size is positively associated with TFP. This shows the presence of economies of scale. Finally, in Italy, firm age is found to be positively associated with TFP.

Table 2. Results of the Baseline Estimation and Different Company Sizes

	Baseline	SMEs	Large Companies
Lagged TFP	0.3486***	0.3463***	0.5344***
	(0.0021)	(0.0021)	(0.0234)
Long-Term Debt	-0.0637***	-0.0645***	0.0754***
	(0.0048)	(0.0049)	(0.0265)
Short-Term Debt	0.0193***	0.0199***	-0.0129
	(0.0033)	(0.0033)	(0.0259)
Asset Intangibility	0.0229**	0.0228**	0.0575**
	(0.0090)	(0.0091)	(0.0285)
Size	0.0029**	0.0010	0.0721***
	(0.0011)	(0.0011)	(0.0141)
Age	0.0181***	0.0192***	-0.0098
	(0.0021)	(0.0021)	(0.0128)
Constant	2.2512***	2.2604***	1.2195***
	(0.0093)	(0.0093)	(0.1219)
4 Digit Industry-Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Observations	2,749,525	2,723,865	22,678
R-squared	0.936	0.936	0.989

Notes: Dependent variables are the natural logarithm of TFP calculated by the method in Gandhi et al. (2020). Robust standard errors are in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Table 2 also shows the effects of long- and short-term debt on the productivity of SMEs versus large companies. If the number of employees is smaller than 250, a company is classified as an SME. The results for SMEs are quite similar to the baseline results, which is not surprising given that most of the samples in the data are SMEs. The results for large companies show that the effect of long-term debt on productivity is positive. This can be explained by the fact that large companies do not face credit constraints because they have sufficient collateral; thus, large companies can use long-term financing for productivity-enhancing long-term investments.

Table 3. Results for Older and Younger Firms

	Older Firms	Younger Firms
Lagged TFP	0.3911***	-0.0426***
	(0.0029)	(0.0053)
Long-Term Debt	-0.0600***	-0.0427***
	(0.0059)	(0.0162)
Short-Term Debt	0.0269***	-0.0101
	(0.0039)	(0.0131)
Asset Intangibility	0.0319***	0.0316***
	(0.0113)	(0.0091)
Size	0.0160***	-0.0165***
	(0.0016)	(0.0034)
Age	-0.0157***	0.0603***
	(0.0061)	(0.0210)
Constant	2.1109***	3.7674***
	(0.0216)	(0.0313)
4 Digit Industry-Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Observations	1,715,124	354,842
R-squared	0.946	0.950

Notes: Dependent variables are the natural logarithm of TFP calculated by the method in Gandhi et al. (2020). Robust standard errors are in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Table 3 shows the estimation results for different firm ages. Older firms are those that are older than 10 years. Younger firms are those that are younger than 5 years. According to our results in Table 3, the sign of the coefficient of each TFP driver for older firms is the same as the baseline. In terms of the magnitude of the coefficient, the positive effect of short-term debt is somewhat larger for older firms compared to the baseline result. In contrast, Table 3 shows that younger firms only have a statistically significant and negative coefficient of long-term debt (i.e., the coefficient of short-term debt is statistically insignificant). This can be attributed to the practice that younger firms are in the learning-by-doing stage in new markets and, thus, cannot materialize benefits from financial resources.

Table 4. Results of Financing and Asset Intangibility

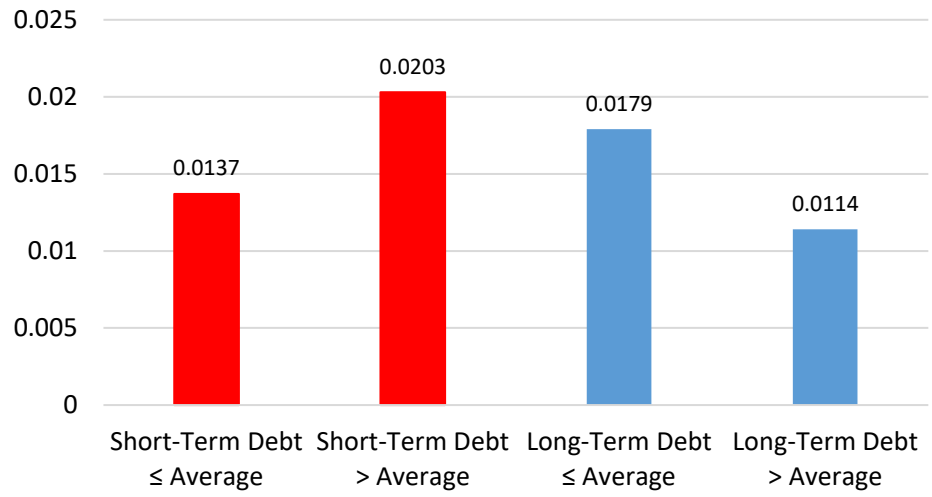
Lagged TFP	0.3488***
	(0.0021)
Long-Term Debt x Asset Intangibility	-0.0883***
	(0.0253)
Short-Term Debt x Asset Intangibility	0.0382***
	(0.0107)
Asset Intangibility	0.0320***
	(0.0084)
Size	0.0029**
	(0.0011)
Age	0.0188***
	(0.0021)
Constant	2.2460***
	(0.0092)
4 Digit Industry-Year Fixed Effects	Yes
Firm Fixed Effects	Yes
Observations	2,749,525
R-squared	0.936

Notes: Dependent variables are the natural logarithm of TFP calculated by the method in Gandhi et al. (2020). Robust standard errors are in parentheses. *significant at 10%, **significant at 5%, ***significant at 1%.

Finally, in Table 4, we study the productivity effects of debt maturity in relation to intangible assets. Our hypothesis is that investments in tangible fixed assets such as machinery and equipment could be financed by long-term financing, while intangible assets such as digital technology or patents could be financed through short-term financing. Thus, we expect a positive coefficient of the cross-term of short-term debt and intangible assets. Note that due to a high correlation between the cross-term (e.g., short-term debt multiplied by asset intangibility) and the financing variable by itself (e.g., short-term debt), we drop the financing variables to avoid a multicollinearity issue. Our results in Table 4 corroborate our hypothesis that intangible assets financed by short-term debt could positively improve TFP, as evidenced by the statistically significant positive relevant coefficient.

As the final analysis, we elucidate the sources of the correlation between short-term debt and productivity. As we have seen in Table 4, we focus on the role of intangible assets. The optimal financing theory predicts that firms use short-term debt to finance intangible assets or working capital and long-term debt to purchase tangible fixed assets. Thus, our hypothesis is that when firms increase short-term borrowing, they can acquire intangible assets, such as patents, software, digital technology, etc., that improve productivity. Therefore, we study whether productivity shocks, defined as TFP growth, are associated with changes in intangible assets when the short-term debt is increased. Figure 1 corroborates this hypothesis. The figure shows that when short-term debt increases (from below average to above average), the correlation between productivity shocks and changes in asset intangibility becomes higher. This means that companies tend to purchase more intangible assets through short-term financing, which improves productivity. In contrast, when companies increase long-term financing, the correlation between productivity shocks and changes in asset intangibility decreases, indicating that long-term financing is used for increasing tangible fixed assets. Therefore, it would be fair to conclude that the sources of the positive correlation between short-term debt and productivity are intangible assets that improve productivity, such as digital technology.

Figure 1. Correlation between TFP Shocks and Changes in Asset Intangibility



V. CONCLUSION

We reached the following conclusions from our firm-level analyses of productivity drivers that focus on debt maturity. First, we found that long-term debt is negatively associated with productivity, which implies that the moral hazard for firms is due to less intense monitoring of performance. Second, we found that short-term debt improves firm productivity, which can be explained by liquidation fears that serve as a disciplinary device to improve firm performance and productivity. This effect is absent for young firms, possibly because they are still in the learning-by-doing process in new markets and do not have sufficient know-how to effectively reap the benefits from financing. Third, our results show that the effects of long-term debt on productivity can be positive for large firms probably because they can use long-term financing for long-term productivity-enhancing investments. Fourth, we found that intangible assets have positive effects on TFP if they are financed through short-term debt. This reflects the fact that intangible assets, such as digital technology, software, intellectual property rights (e.g., patents), and so forth, can quickly improve productivity in the short term.

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