DETERMINANTS OF TOTAL FACTOR PRODUCTIVITY ACROSS PHILIPPINE MANUFACTURING FIRMS: A SIMULTANEOUS QUANTILE REGRESSION ANALYSIS

Zandro Catacutan
Cavite State University, Philippines
Email: zmcatacutan@cvsu.edu.ph

Abstract: *Numerous studies found mixed evidence on the effects of firm-related factors toward the conditional distribution of TFP performance done in a cross-country, industry, and firm-level perspectives abroad. Unfortunately, there is still relatively little evidence to support these findings in the context of the Philippines. Thus, this study analyzed whether the conditional distribution of firm-level TFP performance varies according to the size of the firms, and forms of ownership, and examined the impact of firm-related factors such as firm size, form of ownership, R&D intensity, capital intensity, and export intensity on the conditional distribution of manufacturing firms' TFP performance. The study utilized the comprehensive firm-level data gathered from the World Bank Enterprise Survey conducted in 2015 across selected manufacturing firms in the Philippines, and incorporated ordinary least squares regression and simultaneous quantile regression models in the estimation analyses. Empirical findings revealed that the conditional distribution of firm-level TFP performance marginally varies across selected manufacturing firms while these firms solely focus on domestic operations supported by capital outlays with less engagement in R&D activities. Lastly, capital intensity and firms' form of ownership were found to have statistically significant effects on the conditional distribution of firm-level TFP performance observed across all quantiles.*

Keywords: *Total factor productivity, firm-specific determinants*

1. Introduction

Total factor productivity represents firms' efficiency and effectiveness in the management of factors of production as translated to firm's actual output. In most studies, this measure of productivity also served as metrics in gauging levels of economic growth and operational performance observed in at sectoral, industry, and firm levels. In the past three decades, the Philippines aggregate productivity growth landed on negative territory due to macroeconomic instability, political turmoil, energy crisis, natural calamities, deterring technological development and government protectionism (Austria, 1998; Cororaton et al., 1995; Cororaton & Caparas, 1999; Cororaton & Cuenca, 2001). As a result, these undesirable events led to structural reforms geared towards eradication and recovery from the negative shocks that hampered productivity growth of some industries like in the case of manufacturing sector

which among these industries managed to be resilient and stable in terms of their production and operational activities.

Today, the Philippines' aggregate productivity growth is mainly driven by within-sector yield through resource allocation devoted to more productive activities that boost firm-level productivity. Based on a recent finding, the country's TFP growth was recorded around 1.5% year-on-year growth indicating sustainable economic progress as manifested by robust macroeconomic fundamentals and policy reforms (World Bank, 2018). This astounding productivity growth was linked to key factors of development such as innovation, market efficiency, education, infrastructure, and institutions (Kim & Loayza, 2019). Likewise, fiscal policies related to infrastructure development, institutional reforms centered on business development, diversification strategies for high-value-added products and services, agricultural value chain development, educational reforms and workforce development, technological innovations, and livelihood and skills development were found to be vital in sustaining TFP growth (Glindro & Amodia, 2015).

Furthermore, empirical studies emphasized that firm-related factors such as foreign involvement and ownership share, capital intensity, firm and plant size, export intensity, and R&D intensity affect productivity distributions measured at the level of the firms (Kim, 2009; Powell & Wagner, 2014; Segarra & Teruel, 2011; Yasar & Paul, 2007). In addition, empirical findings also showed that foreign and larger firms' investment and spending in R&D has a major impact both directly and indirectly on productivity (Arza & López, 2010; Griffith et al., 2006; Hall et al., 2013). The variation on the distribution of productivity was also affected by export intensity wherein continuous exporters generated higher level of productivity compared with non-exporting firms' observable both on lower and upper quantiles (Kim, 2009; Powell & Wagner, 2014).

However, other significant findings revealed the disparities on the levels of TFP growth which were observed both at industry, firm, and cross-country levels. These variations on TFP growth can be associated to heterogeneity issues driven by firm related factors which varies across firms and industries. Despite of the sizeable literature that imply the effects of such firm-related factors on TFP growth, there is relatively little evidence that showed the conditional distribution of TFP growth evaluated across manufacturing firms in the Philippines. Thus, this study aims to fill this identified gap in the literature by specifically addressing the following objectives: (1) describe whether the manufacturing firms' TFP performance varies based on firm size, and form of ownership; and (2) examine the effects of firm-related factors such as firm size, form ownership, R&D intensity, capital intensity, export intensity on the conditional distribution of manufacturing firms' TFP performance.

Lastly, the results of this research would provide additional empirical findings in the literature that focuses on examining the distribution of productivity growth of manufacturing firms while dissecting various firm specific factors as indicators affecting firm-level TFP growth which was limitedly utilized by previous studies. The study also undertake analysis at the level of the firm which will extend empirical studies in the context of emerging economy like the Philippines wherein majority of the literature were commonly bounded on industry or sectoral level. This study also aims to provide valuable insights relevant in crafting laws and policies aiming to formulate steadfast and formidable business reforms and regulations that will spur and stimulate TFP growth and strategic directions for firms in relation with the effects of R&D, capital, and export intensities in driving and sustaining productivity.

2. Literature Review

TFP historical growth in the Philippines

In previous decades, few research were undertaken in relation to productivity growth and TFP increase in the country. Austria (1998) investigated the prevalence of productivity growth and development at the national and industrial levels. As a result of the continuous drop in aggregate output, the results revealed an indicative negative increase of 0.4 percent from 1960 to 1996. The government's protectionism-related measures were blamed for the drop in output. Meanwhile, TFP growth improved to 0.3 percent from 1986 to 1996 as a result of trade and liberalization policy improvements. Firms were able to adjust production capacities in both domestic and international markets, which facilitated productivity improvement while increasing exports and foreign direct investments, which has a positive retroactive effect on TFP; however, macroeconomic instability drives inflation, which has a negative and significant impact on TFP growth (Austria, 1998).

In this context, Austria (1998) findings are substantiated by Cororaton and Cuenca (2001) intensive investigation on TFP projections in the Philippines in the 1980s. During this period, the country's TFP growth was found to be in negative territory due to political turbulence, an energy crisis, and natural tragedies and disasters that dampened productivity development. In the 1990s, however, both favorable and unfavorable trends were noted. Structural reforms were made to mitigate the negative effects of geopolitical shocks, but they did not achieve the desired result, as persistent contraction of TFP was recorded in connection with the development of the Asian financial crisis in 1997. Despite the slowing of TFP growth, other sectors, such as agriculture, mining, manufacturing, and utilities, have managed to modestly improve.

Furthermore, Cororaton et al., (1995) and Cororaton and Caparas (1999) used the growth accounting approach, trans-log specification estimations, and econometric and stochastic frontier analysis, all of which are robust to estimate biases. The data revealed a sharp reduction in TFP growth, particularly in the manufacturing sector, as well as a wide range of TFP levels across industries. More industries were discovered to be in negative territory and experiencing unsustainable expansion, particularly in the 1980s and early 1990s. While deconstructing the amount of TFP growth, a decline in the level of technical advancement was also found. (Llanto, 2012), on the other hand, discovered that indicators of openness, as calculated by the ratio of foreign direct investment to GDP and the ratio of trade to GDP, were highly connected with TFP growth. Meanwhile, the Philippines has been able to attract international investment in electronic products while also developing a comparative advantage in garment products. However, improving the country's productivity growth necessitates investment in education, greater government expenditure on human capital, the country's attractiveness and openness to foreign investors, and solid macroeconomic policies and framework to sustain economic growth and resilience.

Additionally, Glindro and Amodia (2015) discovered a positive trend in TFP in the Philippines despite the rise of skills and technological advancement, which generated structural shocks and shifts in labor, employment, and production. These advancements necessitated an increase in skill and knowledge levels. Nonetheless, despite the steadfast and formidable macroeconomic policies and structural reforms designed to address these issues, structural recommendations related to infrastructure development, institutional reforms, diversification to high-value added products and services, value chain development in agriculture, continuous job quality generation, educational reforms, and workforce development were discovered to be the focal point of policies centered on stimulus.

Today, the Philippines' aggregate productivity growth has been entirely driven by within-sector productivity, which entails allocating resources to more productive activities, hence boosting firm-level productivity. According to World Bank (2018) empirical data, the country is dominated by small enterprises, which are less productive than medium and large firms. This was linked to a lack of credit, technology, resources, and exposure to structural shocks. In this regard, foreign ownership remained low in the overall economy, albeit it was slightly higher in some service and manufacturing sectors. Export capacity remains low as a result of global competitiveness and dwindling shares of exporting firms that have chosen to focus on the domestic market instead (World Bank, 2018).

Factors affecting conditional distribution of firm-level TFP
The majority of the literatures proposed using quantile regression to estimate the productivity effects of company-related parameters such as firm or plant size, ownership type, export intensity, laborforce skills, and R&D expenditures. This method handles heterogeneity, omitted error biases, and non-Gaussian normal distributions, all of which are typical assumptions in OLS parameter estimates (Buchinsky, 1998; Koenker & Bassett, 2013; Koenker & Hallock, 2001). In this regard, most empirical research used the nonlinear and semi-parametric estimation methods given by Koenker and Bassett (2013) and Buchinsky (1998) because their approaches both use modification on the variance-covariance matrix, resulting in robust standard errors.

In this connection, Kim (2009) and Yasar and Paul (2007) investigated the role of export activity in the conditional firm-level productivity distribution of Turkish and German manufacturing enterprises. The findings indicated that exporting activity, particularly in the firm category of continuous exporters, affects the conditional productivity distribution in all quantiles, with the influence increasing from the lower to the upper tail of the distribution (Yasar et al., 2006). These findings were also found to be consistent with Kim (2009) findings, which found that export intensity effects on productivity have a sizable effect on the productivity of continuous exporters and that the effects in the productivity distribution can be immensely prevalent on the upper quantiles. In conjunction, Vu et al., (2014) contributed findings demonstrating a positive relationship between export participation and profitability on high growth enterprises in the 70th and 80th percentiles but a negative relationship on firms with poor profitability growth in the 10th percentile. Powell and Wagner (2014) offered contradictory findings, claiming that 47 percent of the productivity distribution is on the lowest quantiles and just about 3 percent is on the upper quantiles.

Moreover, Coad and Rao (2007) demonstrated the relevance of innovation on the conditional growth distribution in the case of the fastest-growing firms, but they underlined that in the long run, inventive activities cannot guarantee the firms a high likelihood of high sales growth. Firms must continue to invest in innovation in order to pursue business prospects that will result in favorable returns and sales growth in the future. According to Nahm (2001), R&D-related expenditures increase swiftly in comparison to firm size, but costs incurred gradually increase in the case of larger firms. While (Segarra & Teruel, 2011) stated that the larger positive impact of internal R&D on productivity was evident on lower conditional quantiles. Empirical findings revealed that internal and external R&D have a bigger influence on high-tech manufacturing industries than on low-tech manufacturing companies. External R&D was discovered to be statistically insignificant in low-tech manufacturing businesses.

Meanwhile, it is also crucial to evaluate the industry's growth and size because it has a major impact on the firm's start-up size and has a stronger impact on the productivity of larger

enterprises (Görg et al., 2000; Mata & Machado, 1996). As a result, these findings were vulnerable to heterogeneity difficulties, which can be linked to plant size variation, resulting in large changes in production levels (Yasar & Paul, 2007). According to Wagner (2006), the firm size effect on firm productivity as assessed by the export to sales ratio is limited to the 0.25 quantile, but branch plant status effects can be found at higher quantile levels.

Lastly, Dimelis and Louri (2002) investigated the impact of foreign ownership on labor productivity, the magnitude of productivity spillovers, and the impact of foreign involvement on the conditional distribution of productivity across companies. Empirical findings revealed that foreign ownership has a favorable effect on labor productivity, which is especially noticeable in the middle quantiles. While productivity spillover effects differed across firms, they demonstrated large gains for local enterprises with minority shareholding affecting the majority of quantiles.

3. Research Method
Research design

This paper employed both descriptive and causal/explanatory designs. Descriptive research design was utilized to describe the conditional distribution of manufacturing firms' TFP growth according to firm size, form of ownership, and industry classification. On the other hand, the causal/explanatory design was used to examine whether firm-related factors such as firm size, form ownership, R&D intensity, capital intensity, export intensity significantly impact the conditional distribution of manufacturing firms' TFP growth.

Sources of Data

The study utilized comprehensive firm-level datasets based on the Philippine manufacturing industry obtained from http://www.enterprisesurveys.org, which contains the World Bank Enterprise Survey. This study covered two waves of data collection processes carried out in 2015. The study used 449 samples which were depicted from 731 firms from the 2015 completed survey of manufacturing firms engaging in the face-to-face interview from the designated areas of the country (i.e., Metro Manila, NCR excluding Manila, Metro Cebu, Central Luzon, and CALABARZON). Meanwhile, the manufacturing sector was served as the primary focus in the investigation and the assessment of pertinent data linking the effects of firm-related factors on the conditional distribution of firm-level TFP performance.

Method of Analysis
TFP estimation

The firm-level TFP growth was calculated following the modified Cobb and Douglas neoclassical production estimation proposed by Şeker and Saliola (2018). In this estimation, variables such as annual cost of labor, annual cost of capital, and annual cost of intermediate inputs served as predictors and the residual outcomes measured the firm-level TFP growth among selected manufacturing firms in the Philippines.

The Cobb-Douglas production equation is constructed as follows:
$$Y_i = A_i + K_i^{\alpha} + L_i^{\beta} + M_i^{\phi} \qquad (1)$$

Equation 1 shows the baseline specification of Cobb-Douglas productivity estimation method. The variables include Y_i represented by firms' value added output derived from the difference of total annual sales and total annual costs of intermediate inputs and energy; A_i is the TFP term; K_i represented by total annual cost of capital measured by net book value of

machinery, vehicles, and equipment; L_i measured as to total annual cost of labor including wages, salaries, bonuses, and social security payments; and M_i measured as to total annual cost of raw materials and intermediate goods, respectively. In addition, the parameters $\alpha, \beta, and\ \phi$ represent the factor elasticities derived from capital, labor, and materials, respectively.

$$Ln\hat{A}_{it} = LnY_{it} - \hat{\alpha}lnK_i - \hat{\beta}lnL_i - \hat{\phi}lnM_i \qquad (2)$$

Meanwhile, equation 2 shows the natural logarithm values of the given variables in the previous model. Here, the log of value-added output was regressed with the log of input factors. The coefficients of log input factors showed the corresponding elasticities in the log of value-added output. Lastly, the predicted values of TFP in log form were derived from the residual term of the production function estimates presented on equation 2.

Conditional Distribution of Firm-level TFP

It is critical to assess if firm-level TFP growth varies among firm categories in the Philippines' manufacturing industry. An alternative estimation method for OLS is quantile regression estimation, which decreases the sum of absolute residuals and adjusts estimation errors by using robust standard errors to account for deviations from the assumption of Gaussian normal distribution (Koenker & Bassett, 2013). Buchinsky (1998) proposed that the conditional distribution be included in the dependent variable to specify the possibly heterogeneous impact of firm-related characteristics.

The qth quantile $(0 < \theta < 1)$ of conditional distribution in the dependent variable with given sets of independent variables following Segarra and Teruel (2011) equation presented as follows:

$$Q_\theta(y_i|x_i) = x_i'\beta_\theta + h_\theta'(x_i, \gamma_\theta) + \varepsilon_\theta' \qquad (3)$$

In Equation 3, y_i represents the productivity level measured by log of firm-level TFP derived from the Cobb-Douglas production function estimation, x_i' is the vector of independent variables such as firm size (dummy variables categorized as to: small >= 5 and <= 9, medium >= 20 and <= 99, and Large >= 100), forms of ownership, R&D intensity (ratio of research and development expenditures over annual sales), capital intensity (the net book value of assets over sales), and export intensity (the percentage of the establishment's sales from direct exports). β_θ is the unknown vector of regression parameters associated with θth quantile and ε_θ' represents the bootstrapped error terms adjusted at 100 replications. In addition, $h_\theta'(x_i, \gamma_\theta)$ controls for the sample selection at θth quantile. The equation added a semi-parametric estimation of firms that invest in R&D which also considers their firm size.

4. Results and Discussion

Average conditional distribution of TFP performance

Table 1 depicts the quantile distribution of firm-level TFP performance increase among the manufacturing firms included in the study. Empirical findings revealed that 21.38 percent of firms' TFP performance belonged to the 10th and 50th quantiles, while the remainder of firms had TFP performance in the 25th (19.38 percent), 90th (19.38 percent), and 75th (18.49 percent) quantiles, respectively. The descriptive results demonstrated that TFP performance estimated on the basis of annual labor, capital, and raw material expenses have balanced distribution of TFP performance across the 10th, 25th, 50th, 75th, and 90th quantiles, as shown in Table 1.

Table 1
Quantile distribution of firm-level TFP growth

Quantile distribution of firm-level TFP performance	Frequency	Percent
10th	96	21.38
25th	87	19.38
50th	96	21.38
75th	83	18.49
90th	87	19.38
Total	449	100.00

Note: All of the given variables are computed based on log form. The data were gathered from the Enterprise surveys (http://www.enterprisesurveys.org), The World Bank.

Conditional distribution of TFP growth as to the size of the firm
Table 2 shows that 22.30 percent of firms' TFP performance was found to be in the uppermost quantile (0.90) followed by 20.95 percent identified under the upper quantile (0.75). Then, 19.59 percent of firms with TFP performance can be observed under both the median quantile (0.50) and the lower quantile (0.25). The remaining 17.57 percent falls under the lowest quantile (0.10). On the other hand, medium-category firms with TFP performance of 22.89 percent were identified under the median quantile (0.50). This is followed by 21.69 percent in the lower quantile (0.25), 20.48 percent in the lowest quantile (0.10), 18.07 percent in the upper quantile (0.90), and the remaining 16.87 percent in the uppermost quantile (0.90). Lastly, Table 2 also explains the quantile distribution of small-sized firms. Majority (26.67%) of firms' TFP growth as characterized by the small size category falls under the lowest quantile (0.10). This is followed by 21.48 percent of firms with TFP performance that were classified under the median quantile (0.50), 19.26 percent categorized under the uppermost quantile (0.90), and lastly, firms with TFP growth of 16.30 percent each, which falls under the upper quantile (0.75) and lower quantile (0.25), respectively.

Table 2
Conditional quantile distribution of firm-level TFP performance as to size of the firm

Firm size	Conditional quantile distribution of TFP performance					
	0.10	0.25	0.50	0.75	0.90	Total
Large (100 or more)	17.57	19.59	19.59	20.95	22.30	100.00
Medium (20-99)	20.48	21.69	22.89	18.07	16.87	100.00
Small (5-19)	26.67	16.30	21.48	16.30	19.26	100.00
Total	21.38	19.38	21.38	18.49	19.38	100.00

Note: All of the given variables are computed based on log form. The data values were in percentage form. The data were gathered from the Enterprise surveys (http://www.enterprisesurveys.org), The World Bank.

Conditional distribution of TFP growth as to firms' form of ownership

In addition, majority of the firms owned under the partnership category indicated 40% of TFP performance identified under the uppermost quantile (0.90) as shown in Table 3. Equal distribution of firms with TFP performance (equivalent to 20% each) can be observed across lowest quantile (0.10), lower quantile (0.25), and upper quantile (0.75). Conversely, there are no firms with TFP performance falling under the median quantile (0.50). In relation with firms classified under shareholding company with non-traded shares or shares traded privately, Table 3 reflected that 22.80 percent of firms' TFP performance were distributed under the median quantile (0.50). This is followed by 20.97 percent of firms with TFP performance under the upper quantile (0.75), 18.84 percent of firms with TFP performance under the lower quantile (0.25), and another 18.84% of firms observed to be at the lowest quantile (0.10). The remaining 18.54 percent of firms have TFP performance clustered under the uppermost quantile (0.90) (Table 3).

Furthermore, firms classified as shareholding company with shares trade in the stock market were also discussed in Table 3. Cross-tabulated results specified 36.84 percent of firms with TFP performance classified under the uppermost quantile (0.90). This is followed by 31.58 percent of firms having TFP performance seen under lower quantile (0.25), 15.79 percent of firms with TFP performance under the upper quantile (0.75), and 10.53 percent of firms with TFP performance under the lowest quantile (0.10), respectively. Lastly, the remaining 5.26 percent of firms have TFP performance falling under the median quantile (0.50). Finally, firms grouped as to sole proprietorship form of ownership were also presented in Table 3. Majority of these firms (33.71%) have TFP performance classified under the lowest quantile (0.10). This is followed by 17.98 percent of firms with TFP performance distributed under the lower quantile (0.25), another 17.98 percent of firms with TFP performance categorized under median quantile (0.50), and 19.10 percent of firms that have TFP performance observed under the uppermost quantile (0.90). Lastly, 11.24 percent of firms have TFP performance found in the upper quantile (0.70).

Table 3
Conditional quantile distribution of firm-level TFP performance as to firms' ownership

Firm Ownership	Conditional quantile distribution of TFP performance					
	0.10	0.25	0.50	0.75	0.90	Total
Limited partnership	14.29	28.57	57.14	0.00	0.00	100.00
Partnership	20.00	20.00	0.00	20.00	40.00	100.00
Shareholding company with non-traded shares or shares traded privately	18.84	18.84	22.80	20.97	18.54	100.00
Shareholding company with shares trade in the stock market	10.53	31.58	5.26	15.79	36.84	100.00
Sole proprietorship	33.71	17.98	17.98	11.24	19.10	100.00
Total	21.38	19.38	21.38	18.49	19.38	100.00

Note: All of the given variables are computed based on log form. The data values were in percentage form. The data were gathered from the Enterprise surveys (http://www.enterprisesurveys.org), The World Bank.

Descriptive results for other firm-related factors
The average TFP performance of manufacturing firms were recorded at 0.674 with a standard deviation value of 0.266. Meanwhile, other firm-related factors: R&D intensity garnered a mean value of 0.004 and a standard deviation of 0.063, capital intensity, which had a mean value of 0.702 and a standard deviation of 1.717, and export intensity, which had a mean value of 0.184 and a standard deviation of 0.353. (Table 4). Descriptive results revealed that, based on samples derived from manufacturing firms that participated in the World Bank's enterprise survey in 2016, the majority of manufacturing firms focused on capital accumulation rather than R&D expenditures, as evidenced by the average intensity of capital and R&D expenditures over sales (Table 4).

Table 4
Descriptive statistics for average firm-level TFP and other firm-related indicators

Variable	Obs.	Mean	Std. Dev.
Firm-level TFP	449	0.674	0.266
R&D intensity	466	0.004	0.063
Capital intensity	466	0.702	1.717
Export intensity	465	0.184	0.353

Note: All of the given variables are computed based on log form. The data were gathered from the Enterprise surveys (http://www.enterprisesurveys.org), The World Bank.

Impact firm-related factors on the conditional distribution of firm-level TFP performance
The results from the correlation and OLS regression analyses of firm-level TFP performance and firm-specific factors were elaborated in Table 5 and Table 6, respectively. Table 5 explained that size of the firms found to have very weak negative correlation to TFP with the correlation coefficient value of -0.091 and computed p-value of 0.053 which was

statistically significant at 90 percent confidence level. In addition, capital intensity found to have weak negative association with TFP as shown by the correlation coefficient value of -0.224 and high level of statistical significance with computed p-value of 0.000. On the other hand, other firm-related factors such as firm size, R&D intensity, and export intensity in contrast have insignificant associations on TFP (Table 5).

Table 5

Pairwise correlation results between firm-related factors and firm-level TFP performance

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) TFP performance	1.000					
(2) Ownership	-0.067	1.000				
	(0.159)					
(3) Size	-0.091	0.243	1.000			
	(0.053)	(0.000)				
(4) R&D intensity	-0.051	0.035	0.010	1.000		
	(0.279)	(0.463)	(0.825)			
(5) Capital intensity	-0.224	0.097	0.089	0.000	1.000	
	(0.000)	(0.039)	(0.060)	(0.995)		
(6) Export intensity	0.040	-0.153	-0.237	-0.003	0.058	1.000
	(0.396)	(0.001)	(0.000)	(0.950)	(0.221)	

Note: All of the given variables are computed based on log form. First indicated values represent the correlation coefficient and the p-value is shown on parentheses. The data were gathered from the Enterprise surveys (http://www.enterprisesurveys.org), The World Bank.

Furthermore, Table 6 also depicted the impact of firm-related factors on firm-level TFP performance, which were assessed using estimates derived from ordinary least squares (OLS) regression and simultaneous quantile regression to evaluate the distribution of firm-level TFP performance across the 10th, 25th, 50th, 75th, and 90th percentiles, respectively. The results of OLS regression demonstrated that R&D intensity and capital intensity have significant impact on firm-level TFP performance. According to these findings, a percentage increase in R&D intensity reduces firm-level TFP performance by 30.1 percent, while a percentage increment in capital intensity leads in a 3.33 percent decrease in firm-level TFP performance.

On the other hand, the impact of ownership measured by OLS estimates showed that the average firm-level TFP performance varies in terms of the types of ownership wherein limited partnership category served as the reference group. Empirical results revealed that the effects of types of ownership to TFP was found to be statistically significant only for firms with shares traded in the stock market. The TFP performance of the firms classified under this type of ownership was greater compared to others by almost 22.3 percent. Lastly, firm size was found to have insignificant effects to firm-level TFP performance (Table 6).

Moreover, using simultaneous quantile regression, empirical results showed the variation in the level of significance as compared with the estimation results generated from the estimates of OLS regression. Table 6 exhibited results showing the positive impact of ownership on firm-level TFP performance with high level of statistical significance which was highly pronounced at the uppermost quantile (90th) for firms operating under partnership, shareholding company with non-traded shares or shares traded privately, and sole proprietorship. These firms classified under given forms of ownership were productive by approximately 70.2 percent, 25.8 percent, and 27.3 percent, respectively relative to other firms TFP performance. The results were in consonance with Dimelis and Louri (2002) wherein they

found out that local firms type of ownership significantly contributed to the improvement of firms' TFP performance across all quantiles.

On the other hand, capital intensity found to have contractionary effect on firm-level TFP performance across lower (25th) to uppermost (90th) quantiles, respectively. These results implied that a percentage increase in capital intensity will lead to slump performance in firm-level TFP performance accounted to 3.04 percent in lower quantile (25th), 3.52 percent in median (50th) quantile, 2.59 percent in the upper quantile (70th), and 3.05 percent in the uppermost quantile (90th). These empirical results stipulated that an increment on capital investment without proper maximization directed towards productivity will result to negative TFP performance. Likewise, the results were in accordance with empirical studies that highlighted targeting of capital allocation from lowest quantile (10th) to upper quantile (75th) while achieving improvements on production output will lead to increase firm-level productivity (Segarra & Teruel, 2011; Yasar et al., 2006; Yasar & Paul, 2007). Lastly, other factors such as firm size, R&D intensity, and export intensity have no significant impact on firm-level TFP performance (Table 6).

Table 6

Impact of firm-related factors effects on conditional distribution of firm-level TFP performance

VARIABLES	OLS	q10	q25	q50	q75	q90
Partnership	0.273*	0.250	0.0612	0.0966	0.251	0.702***
	(0.161)	(0.205)	(0.247)	(0.216)	(0.268)	(0.271)
Shareholding company with non-traded shares or shares traded privately	0.114*	0.222	0.0306	0.0176	0.0487	0.258***
	(0.0586)	(0.161)	(0.151)	(0.0876)	(0.0702)	(0.0634)
Shareholding company with shares traded in the stock market	0.232**	0.307*	0.0704	0.175	0.153*	0.280
	(0.0976)	(0.172)	(0.176)	(0.121)	(0.0877)	(0.431)
Sole proprietorship	0.0791	0.125	-0.0418	-0.0343	0.0290	0.273***
	(0.0649)	(0.159)	(0.151)	(0.0928)	(0.0897)	(0.0769)
Medium (20-99)	-0.00782	-0.00721	-0.00353	0.0152	-0.0877*	-0.0854
	(0.0321)	(0.0264)	(0.0195)	(0.0297)	(0.0448)	(0.0848)
Small (5-19)	-0.0323	-0.0211	-0.0115	0.0219	-0.0658	-0.0953
	(0.0330)	(0.0292)	(0.0303)	(0.0358)	(0.0661)	(0.0764)
R&D intensity	-0.301***	-0.0981	-0.125	-0.293	-0.328	-0.425
	(0.0636)	(0.929)	(0.528)	(0.960)	(1.127)	(1.824)
Capital intensity	-0.0333***	-0.0389*	-0.0304***	-0.0352***	-0.0259**	-0.0305**
	(0.00690)	(0.0204)	(0.0100)	(0.00646)	(0.0115)	(0.0126)
Export intensity	0.0144	-0.0184	-0.0231	0.0402	0.0290	0.0347
	(0.0389)	(0.0325)	(0.0266)	(0.0476)	(0.0442)	(0.111)
Constant	0.597***	0.261	0.528***	0.621***	0.792***	0.794***
	(0.0607)	(0.162)	(0.151)	(0.0862)	(0.0758)	(0.0862)
Pseudo R-squared / Pseudo R-squared	0.0770	0.0951	0.0707	0.0543	0.0474	0.0457

F statistic	13.47***	3.79***	2.39**	4.17***	2.07**	3.84***
Observations	449	449	449	449	449	449

Note: All of the given variables are computed based on log form. First indicated values represented the indicators' coefficients and the robust / bootstrapped standard errors (100 replications) are shown on parentheses. P-values significance level were presented with *** $p<0.01$, ** $p<0.05$, * $p<0.1$ The data were gathered from the Enterprise surveys (http://www.enterprisesurveys.org), The World Bank.

Furthermore, the effects of firm-specific factors on firm-level TFP performance can be further analyzed through graphical representation of estimated coefficients. Figure 1 illustrated the adverse effect of capital intensity on firm-level TFP which showed sideways movement across the lower quantile (25th) running to the upper most quantile (90th) with an average of 3.05 percent that found to be statistically significant both at 95 percent and 99 percent confidence levels. This result implied contractionary effect of additional capital outlays that was higher than generated production output of firms which resulted to lower TFP performance observed from lower (25th) to uppermost (90th) quantiles, accordingly. On the other hand, R&D intensity also displayed consistent negative effects of this variable to firm-level TFP which signals sideways movement across all quantiles but lack existence of statistical significance. This finding showed inadequate R&D expenditures of manufacturing firms in the Philippines that led to lower TFP performance (Glindro & Amodia, 2015). Lastly, export intensity identified to have positive effects running from the median quantile (50th) to the uppermost quantile (90th) which showed slow growth progress comparable with the findings of World Bank (2018) relating low export capacity due to globalization and declining shares of manufacturing / exporting firms in the foreign markets.
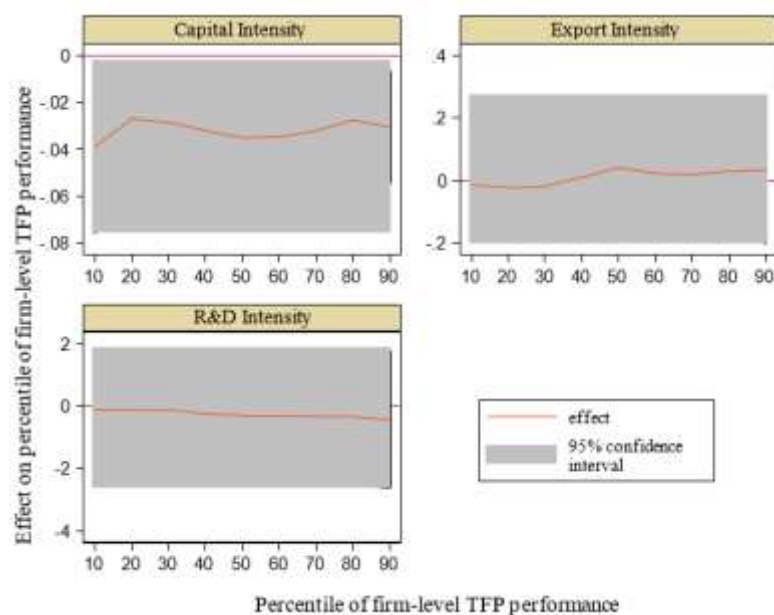

Figure 3. The effects of firm-specific factors on conditional distribution of firm-level TFP performance.

Note: It presents the coefficients of capital intensity, R&D intensity and export intensity across different quantiles. The coefficient values are represented by solid orange line along with an estimated 95% confidence interval band.

5. Conclusion

This study looked at the conditional distribution of manufacturing firms' TFP performance in two ways. The first stage involved determining if the conditional distribution of TFP performance changed with firm size and ownership structure. When the distribution of firms' TFP performance is evaluated based on firm size and form of ownership, descriptive results show that it varies slightly from the lowest quantile to the uppermost quantile. These results illustrate that the majority of manufacturing firms managed to correctly and efficiently control the costs of production and operations on a yearly basis. Furthermore, the results revealed the majority of manufacturing firms' heavy reliance on capital acquisitions, which were not entirely spent in R&D-related activities. While, most of these firms focus on local operations rather than exportation, as shown by the low average ratio of exports to sales.

The second step of estimation, which combined OLS regression and simultaneous quantile regression, revealed that when other firm-related factors were included in the model estimation, mixed results could be seen in the conditional distribution of firm-level TFP performance across different quantiles. Empirical findings reveal that different types of ownership have a positive and significant impact on average firm level TFP performance, which is most noticeable among firms having stock market shares and is highly pronounced at the uppermost quantile. Meanwhile, capital intensity was found to have a contractionary effect on firm-level TFP performance, ranging from the lowest to the highest quantiles. This conclusion implies that excessive capital accumulation will lead to a reduction in firm-level TFP performance across all quantiles.

However, the analysis discovered a lack of evidence explaining the significant effects of firm size and other firm-related factors such as R&D intensity and export intensity. Future research can extend the examination of firm-level TFP performance using these predictors by incorporating other measures or proxies, as well as the integration of time series lags in the estimation process, to explain causation among these given variables in both short-run and long-run orientations. This study can be replicated in different industries and firms to assess the robustness and validity of the simultaneous equation model.

References

Arza, V., & López, A. (2010). Innovation and Productivity in the Argentine Manufacturing Sector. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1817297

Austria, M. (1998). Productivity Growth in the Philippines After the Industrial Reforms. *Discussion Papers*, *98*.

Buchinsky, M. (1998). Recent advances in quantile regression models: A practical guideline for empirical research. *Journal of Human Resources*, *33*(1), 88–126. https://doi.org/10.2307/146316

Coad, A., & Rao, R. (2007). Innovation and firm growth in high-tech sectors: A quantile

regression approach. LEM Working Paper Series, No. 2006/18, Scuola Superiore Sant'Anna, Laboratory of Economics and Management, Pisa, Italy.

Cororaton, C., & Caparas, M. (1999). Total Factor Productivity: Estimates for Philippine Economy. *Discussion Papers*, *99*.

Cororaton, C., & Cuenca, J. (2001). *Estimates of Total Factor Productivity in the Philippines Estimates of Total Factor Productivity in the Philippines*. *May*.

Cororaton, C., Endriga, B., Ornedo, D., & Chua, C. (1995). Total Factor Productivity of Philippine Manufacturing Industries. *Discussion Papers*, *November 1995*.

Dimelis, S., & Louri, H. (2002). Foreign ownership and production efficiency: A quantile regression analysis. *Oxford Economic Papers*, *54*(3), 449–469. https://doi.org/10.1093/oep/54.3.449

Glindro, E. T., & Amodia, R. A. (2015). Decomposing Sources of Potential Growth in the Philippines Authors. *Bangko Sentral Review*.

Görg, H., Strobl, E., & Ruane, F. (2000). Determinants of Firm Start-Up Size: An Application of Quantile Regression for Ireland. *Small Business Economics*, *14*(3), 211–222. https://doi.org/10.1023/A:1008164123105

Griffith, R., Huergo, E., Mairesse, J., & Peters, B. (2006). Innovation and productivity across four European countries. *NBER Working Paper*.

Hall, B. H., Lotti, F., & Mairesse, J. (2013). Evidence on the impact of R&D and ICT investments on innovation and productivity in Italian firms. *Economics of Innovation and New Technology*, *22*(3), 300–328. https://doi.org/10.1080/10438599.2012.708134

Kim, M. (2009). *Productivity Performance and Exporting Activity of Korean Manufacturing Firms : Quantile Regression Approach*. *May 2013*, 97–120.

Kim, Y. E., & Loayza, N. V. (2019). Productivity Growth: Patterns and Determinants across the World. *Economía*, *42*(84), 36–93. https://doi.org/10.18800/economia.201902.003

Koenker, R., & Bassett, G. (2013). No Title Regression Quantiles. *Journal of Chemical Information and Modeling*, *53*(9), 1689–1699.

Koenker, R., & Hallock, K. F. (2001). Quantile regression. *Journal of Economic Perspectives*, *15*(4), 143–156. https://doi.org/10.1257/jep.15.4.143

Llanto, G. (2012). Philippine Productivity Dynamics in the Last Five Decades and Determinants of Total Factor Productivity. *Discussion Papers*, *April*.

Mata, J., & Machado, J. A. F. (1996). Firm start-up size: A conditional quantile approach. *European Economic Review*, *40*(6), 1305–1323. https://doi.org/10.1016/0014-2921(95)00034-8

Nahm, J. W. (2001). Nonparametric quantile regression analysis of R and D-sales relationship for Korean firms. *Empirical Economics*, *26*(1), 259–270. https://doi.org/10.1007/s001810000055

Powell, D., & Wagner, J. (2014). The exporter productivity premium along the productivity

distribution: evidence from quantile regression with nonadditive firm fixed effects. *Review of World Economics*, *150*(4), 763–785. https://doi.org/10.1007/s10290-014-0192-7

Segarra, A., & Teruel, M. (2011). Productivity and R&D sources: Evidence for Catalan firms. *Economics of Innovation and New Technology*, *20*(8), 727–748. https://doi.org/10.1080/10438599.2010.529318

Şeker, M., & Saliola, F. (2018). A cross-country analysis of total factor productivity using micro-level data. *Central Bank Review*, *18*(1), 13–27. https://doi.org/10.1016/j.cbrev.2018.01.001

Vu, H., Holmes, M., Lim, S., & Tran, T. (2014). Exports and profitability: A note from quantile regression approach. *Applied Economics Letters*, *21*(6), 442–445. https://doi.org/10.1080/13504851.2013.866197

Wagner, J. (2006). Export intensity and plant characteristics: What can we learn from quantile regression? *Review of World Economics*, *142*(1), 195–203. https://doi.org/10.1007/s10290-006-0063-y

World Bank. (2018). Growth and Productivity in the Philippines. *Growth and Productivity in the Philippines*. https://doi.org/10.1596/30450

Yasar, M., & Morrison Paul, C. J. (2007). International linkages and productivity at the plant level: Foreign direct investment, exports, imports and licensing. *Journal of International Economics*, *71*(2), 373–388. https://doi.org/10.1016/j.jinteco.2006.03.004

Yasar, M., Nelson, C. H., & Rejesus, R. (2006). Productivity and exporting status of manufacturing firms: Evidence from quantile regressions. *Review of World Economics*, *142*(4), 675–694. https://doi.org/10.1007/s10290-006-0088-2