

## DOES STUNTING ASSOCIATE TO THE TOTAL FACTOR PRODUCTIVITY? A CASE OF EAST JAVA, INDONESIA

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### ABSTRACT

Although stunting prevalence and many economic indicators are claimed associating to long-term correlation, the finding of this question might signal the policy arrangement that should be taken. This study aims to examine the correlation of Total Factor Productivity (TFP) growth and stunting prevalence of the 38 districts in East Java, Indonesia from 2017 to 2019. By employing fixed-effect model to estimate TFP growth using Growth Accounting approach, as well as quantitative approach and pairwise correlation, to identify the correlation between TFP growth and stunting prevalence, this study found that there is a negative association between TFP growth and stunting prevalence. Moreover, an intriguing finding reveals that districts with largest Gross Domestic Regional Product (GDRP) shows the strongest correlation amongst others. A plausible reason of this result is that district with large GDRP might allocate more budget for stunting reduction programs, for example the district of Sidoarjo. The negative association between TFP growth and stunting prevalence is then confirmed by statistical results of pairwise correlation from Pearson and Spearman's Rho that both show significant correlation between those two indicators by larger than 0.3, indicating a non-trivial association between TFP growth and stunting prevalence.

**Keywords:** Stunting Prevalence, TFP Growth, East Java.

**JEL :** I15, I18, O47

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### ABSTRAK

Meskipun prevalensi stunting dan banyak indikator ekonomi diklaim memiliki korelasi jangka panjang, temuan pertanyaan ini mungkin menandakan pengaturan kebijakan yang harus diambil. Penelitian ini bertujuan untuk menguji korelasi pertumbuhan Total Factor Productivity (TFP) dengan prevalensi stunting di 38 kabupaten di Jawa Timur, Indonesia dari tahun 2017 hingga 2019. Dengan menggunakan model fixed-effect untuk memperkirakan pertumbuhan TFP menggunakan pendekatan Growth Accounting, serta pendekatan kuantitatif dan korelasi berpasangan, untuk mengetahui hubungan pertumbuhan TFP dengan prevalensi stunting, penelitian ini menemukan adanya hubungan negatif antara pertumbuhan TFP dengan prevalensi stunting. Selain itu, temuan menarik mengungkapkan bahwa kabupaten dengan Produk Domestik Regional Bruto (PDRB) terbesar menunjukkan korelasi yang paling kuat di antara yang lain. Alasan yang masuk akal dari hasil ini adalah bahwa kabupaten dengan PDRB besar mungkin mengalokasikan lebih banyak anggaran untuk program pengurangan stunting, misalnya kabupaten Sidoarjo. Hubungan negatif antara pertumbuhan TFP dan prevalensi pengerdilan kemudian dikonfirmasi oleh hasil statistik korelasi berpasangan dari Pearson dan Spearman's Rho yang keduanya menunjukkan korelasi yang signifikan antara kedua indikator tersebut dengan lebih besar dari 0,3, menunjukkan hubungan yang tidak sepele antara pertumbuhan TFP dan prevalensi pengerdilan.

**Kata Kunci:** Prevalensi Stunting, Pertumbuhan TFP, Jawa Timur.

**JEL :** I15, I18, O47

## Introduction

The issue of child stunting remains captivating many researchers and policy makers to explore further. It is because child stunting is a multidimensional issue and may lead to both immediate and long-term effects for a country's development (Beal et al., 2018). Child stunting may increase likelihood of adverse outcomes throughout the life cycle: lower immunity, lack of brain development, lower cognitive and socioemotional skills, as well as noncommunicable diseases in adulthood (Beal et al., 2018; Galasso & Wagstaff, 2016; Stewart et al., 2013). Along with these potential detrimental effects, therefore, World Health Organization (WHO) places child stunting as a primary of six goals to achieve Zero Hunger vision through the Sustainable Development Goals (SDGs) (Beal et al., 2018).

Since child stunting eradication requires multidimensional actions, its policy arrangement is frequently associated to both within and outside the health sector channels. A common example of within health sector program is through fulfilling sufficient nutritional status which in turn fosters physical working capacity and productivity (Biadgilign et al., 2016; Ranis et al., 2000). An empirical evidence is the supplementary feeding program in Indonesia called *Program Makanan Tambahan* (PMT) for both mothers and children that was implemented between 1998-2000 and was identified significantly alleviating 1.2 per cent likelihood of severe stunting (Giles & Satriawan, 2015). Meanwhile, outside-health-sector program, which was dominantly centralized on economic welfare, such as women's empowerment, poverty alleviation strategies, and policies to discount prices to nutritious foods and diverse diets, is found improving child growth by approximately 50 per cent (Bhutta et al., 2020)<sup>1</sup>. Nonetheless, both channels eventuate to the human capital development in a country.

A progressive number of studies have devoted efforts to examine the impact of child stunting to the health indicators (Prendergast & Humphrey, 2014; De Onis & Branca, 2016). Those studies conclude relatively similar findings, i.e., stunting is an intergenerational problem requiring various nutrition-sensitive and nutrition-specific interventions, otherwise the children will be posed to the severe irreversible neurocognitive damage and detrimental physical problems. Meanwhile, some studies also associated child stunting to the economic growth (Bershteyn et al., 2015; Harttgen et al., 2013; Hou, 2016; Mary et al., 2019). These studies also recognized that economic indicators are associated positively to child stunting and malnutrition eradication.

This study aims to identify the correlation of stunting prevalence and economic indicator which is Total Factor Productivity (TFP) growth in East Java, Indonesia. Although stunting and economic perspective may associate to the long-term effect, however, there is a good reason to examine this issue. Present evidence of child stunting and economic indicator indicates whether prior health programs have been successfully achieved. If not, the findings may contribute to the evaluation which in turn accelerates future health programs in stunting eradication.

This study contributes to the literature in several ways. First, this is the first study using the indicator of TFP growth associating to the stunting prevalence. Many prior studies merely employed economic income in macroeconomic indicator, such as Gross Domestic Product (GDP), or microeconomic indicator, such as individual and household income. However, there are dearth of studies exploring the association of stunting to the TFP growth. TFP growth is different with economic growth as it considers aggregated factors, such as capital and labor (that can be elaborated to the human capital and number of workers), in contributing to the

<sup>1</sup>Bhutta et al. (2020) employed five countries (Nepal, Ethiopia, Peru, Senegal, Kyrgyz Republic) to examine the determinants of child stunting acceleration program

regional productivity growth. In other words, TFP growth will capture the extent to which factors devote to the outputs for which many studies used GDP. Second, this study refers to the [Cole & Neumayer \(2006\)](#) in calculating TFP growth as this approach can capture the contribution of factors such as investment, number of labors, as well as human capital. However, this study is obviously different to the [Cole & Neumayer \(2006\)](#) as they investigated the impact of health factors (i.e. malaria morbidity and waterborne disease) to the TFP growth. Third, the case of East Java is unique as it covers 38 districts that most of them still have high prevalence of stunting.

The following section discusses the overview of child stunting in East Java following with prior findings in Indonesia and other countries. Section 3 explains the data, methodology, and econometric specification of TFP growth and how this study analyse these indicators. Section 4 presents the findings of this study and offers further discussion. Finally, the conclusion and policy implications are provided in Section 5.

## Literature Review

### *The Issue of Stunting in East Java*

According to [WHO \(2019\)](#), children under five years of age ( $U_5$  children) are considered stunting when their height-for-age or length-for-age Z-score are below -2 standard deviation (SD). [WHO \(2019\)](#) also stated that stunting prevalence of 20% or higher is a significant public health problem requiring a wide range of interventions. In 2018, 30.8% of Indonesian  $U_5$  children were stunted, and it decreased to approximately 27% of  $U_5$  children were stunted in 2019 ([Ministry of Health, 2018](#); [Statistics Indonesia, 2019](#)). Stunting prevalence of East Java only was 32.8% in 2018, and it declined to 26.8% in 2019 ([Ministry of Health, 2018](#); [Statistics Indonesia, 2019](#)). Despite the marked decrease, stunting remains the public health problem in East Java, and many districts still have stunting prevalence higher than 20% ([Statistics Indonesia, 2019](#)).

Stunting is affected by various factors, and a set of interventions are required during the first thousand days of life to address this undernutrition problem. According to the [East Java Provincial Government \(2020\)](#), stunting in this province were caused by at least four determinants. The first determinant is poor care practices, including poor knowledge on maternal nutrition and health, inadequate breastfeeding practices, and inadequate complementary feeding. The second determinant is limited health service, such as low level of antenatal care. Meanwhile, [Ridwanah et al. \(2020\)](#) reported high stunting prevalence in the regencies and cities of East Java with low coverage of toddler health services, while the cities and regencies performing a higher level of immunization coverage tend to have lower stunting prevalence.

The third determinant is related to food insecurity, particularly poor access to nutritious food. The nutritious food commodities in Indonesia generally had a high price elasticity, which means that the demand for vegetables, meats, and fruits were easily influenced by the price changes ([Faharuddin et al. 2017](#)). The impact of price elasticities on the consumption of vegetables and fruits were reflected by the tendency that the lower income groups consumed fewer fruits and vegetables, compared to the middle and high-income groups ([Arifin et al., 2018](#)). The other determinant is limited access to clean water and sanitation facilities. According to Statistics Indonesia of [East Java Province \(2021\)](#), there was around 80% of households in East Java had their own toilets, with the highest percentage was in Kota Batu (96.07%), while the lowest percentage was in Bondowoso (40.88%). [Ridwanah et al. \(2020\)](#) also found that the higher percentage of households in East Java accessing healthy latrines correlates with the lower stunting prevalence.

### **Prior studies**

Stunted growth is not only about shorter stature, but it is a syndrome followed by a number of pathological issues, the decreased neurocognitive capacity, and the increased risk of noncommunicable diseases during their adulthood (De Onis & Branca, 2016). Stunted children have a higher risk of suffering from infectious diseases, such as pneumonia and diarrhea (Prendergast & Humphrey, 2014). Stunted children also have shorter dendrites because they faced inadequate nutrient intake during their first thousand days of life (De Onis & Branca, 2016). Furthermore, stunted children are likely to have low performance at school (Prendergast & Humphrey, 2014).

Stunting also has detrimental effect on productivity, in which stunted children were found to have a 20% lower income when they become adult, compared to those who were not stunted (De Onis & Branca, 2016). McGovern et al. (2017) reported that a 1-cm increase in body height is correlated with 6% wages increase for women and 4% increase for men. The same study also found that a 1-SD increase of height-for-age may lead to the decreased probability of poverty by 10% among productive age population. This is in line with Prendergast & Humphrey (2014), which stated that the low height-for-age contributed to the lower physical stamina and economic productivity.

The impact of stunting and other undernutrition issues on productivity has been investigated in many countries. Cole & Neumayer (2006) revealed that health problems negatively affect growth through total factor productivity. They also concluded that poverty and underdevelopment significantly impact health status, as being happened in Indonesia and many developing countries. Another study by Galasso and Wagstaff (2018) illustrated the impact of stunting on productivity as “stunting penalties”, referring to the reduction of GDP per capita acquired from their workforce being stunted during their childhood. The penalties ranged from 1% to 13%, with Indonesia had around 10% penalties due to 53% of its workforce being stunted in childhood. On the other hand, Galasso and Wagstaff (2018) also stated that the rate-of-return to the nutrition interventions’ package to address stunting is 17%, with the benefit-cost ratio of 15:1.

### **Methodology**

#### **Data and Variable**

This study uses panel data of 38 districts and municipalities in East Java, Indonesia (hence to forth, we name it “district”). The data was rendered from the Statistics Indonesia (BPS)’s annual reports and the percentage of U<sub>5</sub> children having length-for-age or height-for-age Z score less than -2SD (hence to forth, we name it “stunting prevalence”) from 2017-2019. Stunting prevalence was obtained from the 2017 Nutritional Status Assessment (*Pemantauan Status Gizi*), the 2018 Basic Health Research (*Riset Kesehatan Dasar*), and the 2019 Indonesia’s U<sub>5</sub> Children Nutritional Status Study (*Studi Status Gizi Balita di Indonesia*). This period is selected due to limited availability of the dataset regarding stunting prevalence and the postponed stunting surveillance during the pandemic situation.

There are two divisions of variable in this study: variables to calculate TFP growth and the variable of stunting. There are four variables to calculate TFP growth (see Cole & Neumayer (2006)): constant gross domestic regional product (GDRP) in Rupiah, constant gross fixed capital formation (GFCF) in Rupiah, number of labors (those who have economic activity to earn income or profit, at least 1 hour (uninterrupted) in the past week), and human capital. The basic year of the constant values is 2010. This study refers to the study of Barro & Lee (2001) to proximate the human capital by utilizing the following formula:

$$hc_{it} = \frac{Pr Yr_{it} \times P_{it} + Js Yr_{it} \times Js_{it} + SHs Yr_{it} \times SHs_{it}}{\sum Yr_{it}} \quad (1)$$

Where  $hc_{it}$  is human capital of district  $i$  in year  $t$ .  $Pr Yr_{it}$ ,  $Js Yr_{it}$ , and  $SHs Yr_{it}$  are respectively the years of schooling from primary school (*Sekolah Dasar*), junior high school (*Sekolah Menengah Pertama*), and senior high school (*Sekolah Menengah Atas*).  $P_{it}$ ,  $Js_{it}$ , and  $SHs_{it}$  are respectively the net enrollment ratio<sup>2</sup>. To make it interpretable, all variables to calculate TFP growth are the deviation from its geometric mean (Arazmuradov et al., 2014). The variable of stunting stems from the percentage of  $U_5$  children having height-for-age Z score less than -2SD (including length-for-age for  $U_2$  children). The descriptive statistics of all variables are reported in the Table 1.

**Table 1: Descriptive Statistics**

Variable	Unit	Obs	Mean	Std. Dev.	Min	Max
Gross Domestic Regional Product	Billion Rupiah	114	41788.834	64652.742	4315.01	410954.09
GFCF	Billion Rupiah	114	10696.279	17512.196	2.296	113217.94
Number of Labour	Thousand Workers	114	551.379	346.459	64.4	1666.227
Human Capital	Ratio	114	85.284	4.266	71.342	93.075
Stunting Prevalence	Ratio	114	0.287	0.073	0.103	0.548

**Note:** Mean is arithmetic average, Std Dev is standard deviation, Min is minimum amount value in observation, Max is maximum amount in observation.

### Empirical Model

This study employs Translog production function to estimate TFP growth (see. Heshmati & Rashidghalam, 2016). Compared to rudimental Cobb Douglas production function that strict the assumption of constant elasticity, Translog production function enables inputs' elasticity to be well-captured. The specification of the Translog production function of this study is as follows.

$$y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 l_{it} + \beta_3 hc_{it} + \beta_4 (k_{it} \times l_{it}) + \beta_5 (k_{it} \times hc_{it}) + \beta_6 (l_{it} \times hc_{it}) + \frac{1}{2} (\beta_7 k_{it}^2 + \beta_8 l_{it}^2 + \beta_9 hc_{it}^2) + \beta_{10} t + \beta_{11} (k_{it} \times t) + \beta_{12} (l_{it} \times t) + \beta_{13} (hc_{it} \times t) + \frac{1}{2} \beta_{14} t^2 + A_{it} \quad (2)$$

Where  $y$  is the gross domestic regional product,  $k$  is gross fixed capital formation,  $l$  is labour,  $hc$  is human capital. Those variables are expressed in natural logarithmic and the deviation from its geometric mean. Subscript  $i$  and  $t$  denote  $i$ -th district and  $t$ -th year.  $A_{it}$  is the residual that represents TFP growth where generally  $A_{it} = \exp\left(\frac{Y_{it}}{K_{it} \cdot L_{it} \cdot E_{it} \cdot R_{it}}\right)$ .  $t$  is a time variable. The coefficients are estimated using fixed-effect model. For comparison, this study shows the estimates from the Cobb-Douglas production function where  $\beta_5 - \beta_{14} = 0$ .

The coefficients from Translog production function cannot be directly interpreted. Instead, it is necessary to calculate the elasticity of inputs toward the output to identify monotonicity condition (Yasin, 2021). Referring to the Equation (2), the elasticities of capital (3a), labour (3b), and human capital (3c) are specified as follows.

<sup>2</sup> The utilization of school enrolment ratio has evolved significantly. Barro & Lee (2001) argued that the gross enrolment ratio might overstate the human capital's accumulation when the student repeats grade (see. Barro & Lee (1993), Arazmuradov et al. (2014)). Therefore, net enrolment ratio was used (e.g. Barro & Lee, 1996). However, net enrolment rate was then also revised as it might exclude students in primary level that are younger than 6 years old and older than 11 years old. Still, we refer to the net enrolment ratio as the utilization.

$$E_k = \frac{\partial y_{it}}{\partial k_{it}} = \beta_1 + \beta_4 l_{it} + \beta_5 hc_{it} + \beta_7 k_{it} + \beta_{11} t \quad (3a)$$

$$E_l = \frac{\partial y_{it}}{\partial l_{it}} = \beta_2 + \beta_4 k_{it} + \beta_6 hc_{it} + \beta_8 l_{it} + \beta_{12} t \quad (3b)$$

$$E_{hc} = \frac{\partial y_{it}}{\partial hc_{it}} = \beta_3 + \beta_5 k_{it} + \beta_6 l_{it} + \beta_9 hc_{it} + \beta_{13} t \quad (3c)$$

Where  $E_k, E_l, E_{hc}$  are the elasticities of capital, labour, and human capital respectively.

The panel analysis requires diagnostic test to ensure suitable model utilized. F-test and Hausman Test is used to determine fixed-effect model is the valid for analysis. F-test is to select between pooled least-square model (POLS) (as the null hypothesis) and fixed effect model (FEM) (as the alternative hypothesis). The significant by 10% of the F-statistic in the FEM model concludes the valid utilization of FEM model. The following test is Hausman test to select between FEM (as the alternative hypothesis) and random effect model (REM) (as the null hypothesis). Supposing p-value is less than 10%, then it rejects null hypothesis, hence FEM is employed for the analysis.

The analysis of the correlation between TFP growth and stunting prevalence employs two approaches: qualitative graphical analysis and correlation analysis using Pairwise Pearson and Spearman Rho correlation. Pairwise correlation using those two coefficients enables the result to be verified statistically (Gaißer & Schmid, 2010). Therefore, where associations between two variables are detected by more than 0.3, it concludes that the correlation is nontrivial so that the judgment of indicative relationships is plausible and adjustments for potential confounding variables must be made (National Research Council, 2011).

## Findings and Discussion

Table 2 reports the estimate of production function from six different specifications. columns 2-4 refer to the Cobb-Douglas production function using POLS, FEM, and REM, respectively. Columns 5-7 refer to the Translog production function using POLS, FEM, and REM respectively.

**Table 2: Estimate of Production Function**

	Cobb Douglas			Translog		
	POLS	FEM	REM	POLS	FEM	REM
<i>k</i>	0.266*** (0.038)	0.076 (0.048)	0.109 (0.075)	0.765*** (0.042)	-0.006 (0.053)	0.608*** (0.115)
<i>l</i>	0.703*** (0.075)	0.088 (0.158)	0.379** (0.176)	0.322*** (0.069)	0.0517* (0.028)	0.071 (0.044)
<i>hc</i>	3.980*** (1.039)	0.908* (0.505)	0.695 (0.448)	2.195*** (0.778)	0.235** (0.098)	0.087 (0.112)
<i>k x l</i>				-0.359*** (0.056)	-0.043 (0.028)	-0.020 (0.041)
<i>k x hc</i>				-0.931 (1.070)	0.155* (0.081)	0.005 (0.109)
<i>l x hc</i>				5.297*** (1.486)	-0.349*** (0.115)	-0.074 (0.108)

	Cobb Douglas			Translog		
	POLS	FEM	REM	POLS	FEM	REM
$k^2$				0.208*** (0.014)	-0.003 (0.008)	0.092*** (0.017)
$l^2$				0.917*** (0.137)	-0.006 (0.026)	-0.061 (0.046)
$hc^2$				58.610*** (16.520)	-2.322 (1.403)	-1.683 (1.380)
$t$				0.023 (0.035)	0.049*** (0.003)	0.0125* (0.006)
$k \times t$				-0.071*** (0.025)	0.004** (0.002)	-0.002 (0.002)
$l \times t$				0.076 (0.047)	-0.002 (0.001)	-0.001 (0.002)
$hc \times t$				0.291 (0.619)	0.113*** (0.033)	0.076** (0.033)
$t^2$				0.005 (0.105)	-0.003 (0.002)	0.006* (0.003)
<i>Constant</i>	0.0000932 -0.0504	-0.0000369 -0.0000334	-0.0000144 -0.113	-0.339*** (0.0508)	0.0212 (0.0203)	-0.075 (0.096)
<i>Observation</i>	114	114	114	114	114	114
$R^2$	0.7034	0.1978	0.1661	0.9365	0.9839	0.9720

Note: Robust standard errors are in parentheses. \*\*\*, \*\*, \*: significant at  $\alpha = 1\%$ , 5%, 10%

According to Table 2, the estimates of production function are sufficiently robust as these show relatively similar sign. Pooled Least-Square approach for both from Cobb-Douglas and Translog is also alike for the coefficients of  $k$ ,  $l$ , and  $hc$ . Meanwhile, when fixed-effect is included, there is significant changes of the coefficient. For example, Translog production function that captures the interaction of each input reveal that GFCF ( $k$ ) does not significantly associate to the GDP if it is alone. However, according to FEM of Translog, it significantly promotes GDP if human capital ( $hc$ ) interacts with it. This finding indicates that when it comes to the investment utilization, the human capital, approximated by school enrollment, should be considered to the process of the development. In this regard, education matters for effective investment development in East Java.

The coefficient of the Translog model in the Table 2 cannot be directly interpreted. Hence, elasticity of inputs towards output is required. Table 3 reports the elasticity of each input based on four-quartile of GDRP and year.

Table 3 reports that the elasticity of capital is negative for both Based on Quartile and Based on Year. Meanwhile, the largest contribution of elasticity stems from the human capital, notably in the year of 2019.

**Table 3: Elasticity of Inputs Towards Outputs**

	$E_k$	$E_l$	$E_{hc}$	$E_{total}$
<b>Based on Four-Quartile of GDRP</b>				
Q1	0.045	0.111	0.329	0.485
Q2	-0.011	0.083	0.246	0.318
Q3	-0.028	0.026	0.200	0.199
Q4	-0.030	-0.016	0.244	0.199
<b>Based on Year</b>				
2017	-0.010	0.058	0.139	0.186
2018	-0.006	0.053	0.256	0.302
2019	-0.001	0.044	0.370	0.413

Note:  $E_{total} = E_k + E_l + E_{hc}$

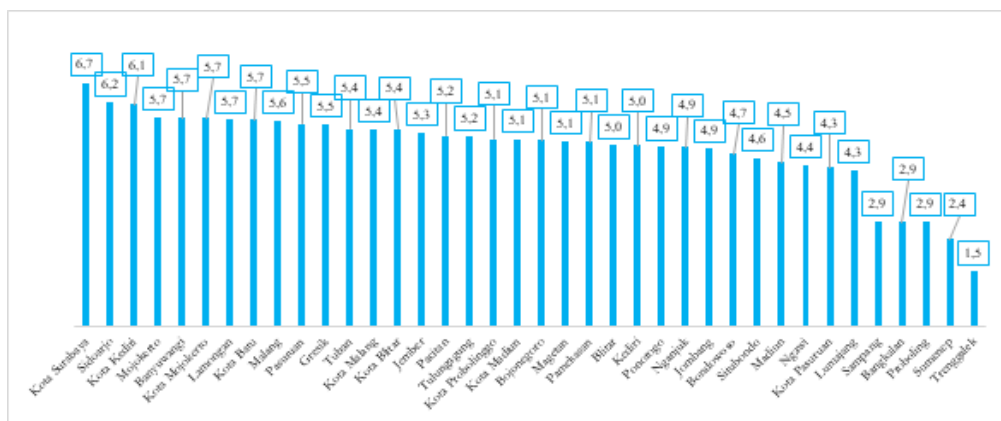
The selection of suitable model, either POLS, FEM, or REM, is necessitated to decide the fittest specification of the data. Since the estimate using robust standard error in Table 2 is unable to accommodate this diagnostic test, this study does not employ robust standard error. The result is reported in the Appendix. The first test is to determine either POLS or FEM is the best for this study’s specification. Briefly speaking, this test reveals that whether the existence of fixed-effect (such as individual effect) matters in the study’s dataset. The second test is the Hausman test to identify the suitable model for either FEM or REM. This test represents whether fixed-effect should be explicitly included in the model or it is better to incorporate it to the random error terms. The results for both tests on the Translog production function are reported in Table 4. According to Table 4, the result shows that FEM is the most suitable model for this study’s dataset to identify TFP growth.

**Table 4: F-Test and Hausman Test**

<b>F-Test</b>	
F(37, 62)	3491.27
P-Value	0.000
<b>Hausman Test</b>	
Chi-square test value (14)	58.69
P-value	0.000

Source: Author’s Calculation

The following investigation is to calculate the TFP growth using growth accounting. Figure 1 illustrates the calculation of TFP growth from 38 districts in East Java.



**Figure 1: TFP growth of 38 Districts in East Java from 2018-2019**

Source: Author’s Calculation

According to Figure 1, Kota Surabaya (City of Surabaya) experiences the largest TFP growth amongst all. This finding is plausible as Surabaya, the capital of East Java, possesses more than 9% of the total GDRP in the East Java. Likewise, Surabaya also possesses the largest GFCF and labor. Nonetheless, it is essential to address that larger value of inputs and output might not necessarily larger TFP growth if a district does not perform well technological progress revealing TFP growth. This argument proves in the Table 5 reporting the rank of the scores of TFP growth, GFCF, labor, and human capital.

**Table 5: The Score Rank of TFP Growth, GDRP, GFCF, Labour, and Human Capital (HC)**

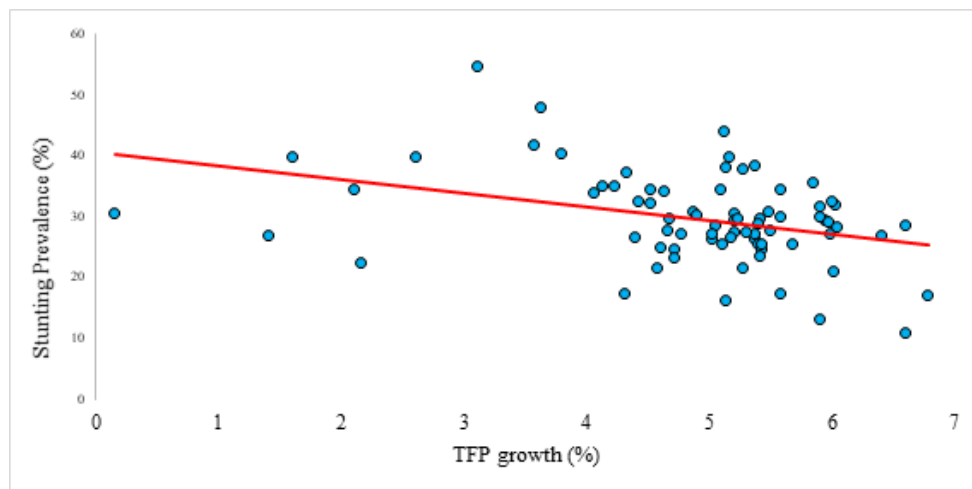
District	TFPg	GDRP	GFCF	Labour	HC
Bangkalan	34	21	20	22	36
Banyuwangi	4	9	5	5	22
Blitar	23	17	17	14	25
Bojonegoro	18	6	11	9	24
Bondowoso	28	26	29	25	32
Gresik	10	4	3	13	7
Jember	15	10	13	4	30
Jombang	25	14	15	11	15
Kediri	24	13	14	6	19
Kota Batu	5	31	27	34	14
Kota Blitar	12	38	37	37	3
Kota Kediri	3	5	7	32	2
Kota Madiun	19	34	33	36	6
Kota Malang	13	11	6	26	21
Kota Mojokerto	6	37	34	38	1
Kota Pasuruan	32	36	36	35	29
Kota Probolinggo	20	35	35	33	9
Kota Surabaya	1	1	1	1	11
Lamongan	7	15	10	10	17
Lumajang	33	20	22	18	35
Madiun	30	29	24	30	10
Magetan	21	28	32	29	5
Malang	9	7	4	2	28
Mojokerto	8	8	9	16	8
Nganjuk	26	22	21	19	16
Ngawi	31	25	31	23	20
Pacitan	16	33	23	31	23
Pamekasan	22	32	28	24	31
Pasuruan	11	3	2	7	33
Ponorogo	27	24	26	20	12
Probolinggo	35	19	18	15	38
Sampang	36	23	25	21	37
Sidoarjo	2	2	16	3	4
Situbondo	29	27	30	28	34
Sumenep	37	18	19	8	13
Trenggalek	38	30	38	27	26

District	TFPg	GDRP	GFCF	Labour	HC
Tuban	14	12	8	12	27
Tulungagung	17	16	12	17	18

Source: BPS with Author's Calculation

Table 5 concludes that a district that has lower level of output and inputs remains possible to experience larger TFP growth than a district with higher level of output and inputs. For example, Kota Batu (City of Batu) shows the largest 5-th TFP growth with the 31<sup>st</sup>, 27<sup>th</sup>, 34<sup>th</sup>, and 14<sup>th</sup> places of output and inputs level respectively for GDRP, GFCF, number of labor, and human capital. In this regard, the TFP growth of districts depends on whether a district has experienced technological progress in the perspective of development.

The following analysis, this study's main point of attention, is to emphasize the correlation between TFP growth and stunting prevalence. The analysis is conducted using graphical analysis and pairwise correlation. Figure 2 illustrates the scatter plot between stunting prevalence and TFP growth of districts in East Java.

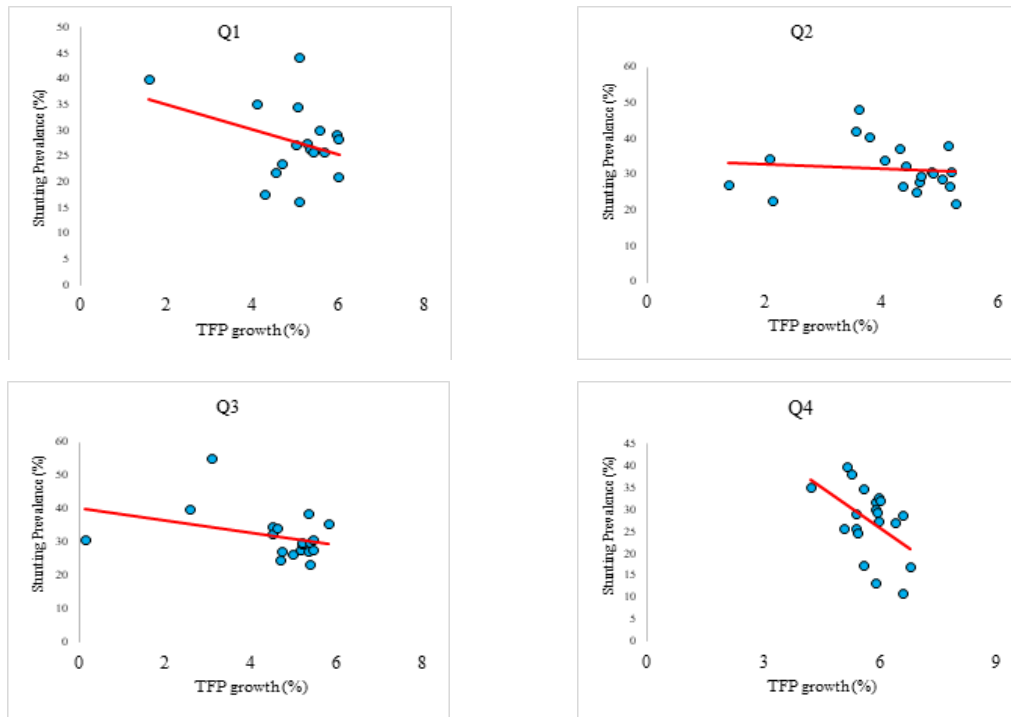


**Figure 2: Correlation of Stunting and TFP Growth**

Source: Author's Calculation

According to Figure 2, it is obvious that there is negative association between TFP growth and stunting prevalence. Districts with higher TFP growth experience relatively lower stunting prevalence. This finding supports the study of [McGovern et al. \(2017\)](#) which also highlighted the high benefit-cost ratios of investments to reduce stunting. To strengthen the argument, this study also reports the correlation of TFP growth and stunting prevalence in the perspective of four-quartiles of GDRP (Figure 3).

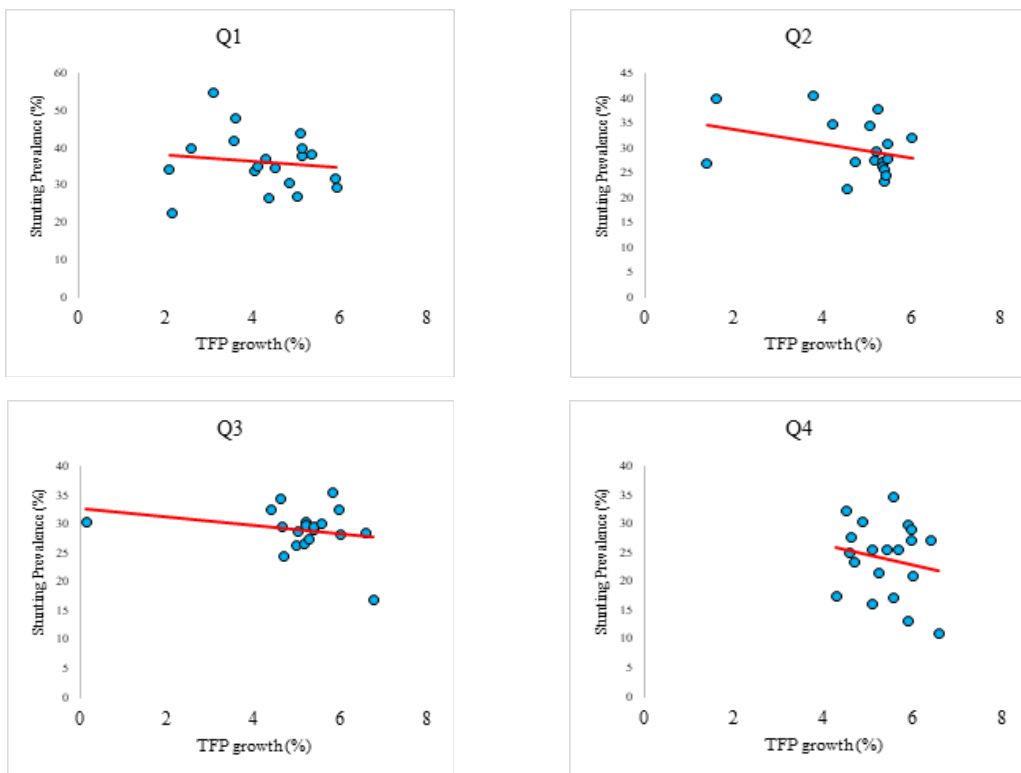
According to Figure 3, there are negative correlations between TFP growth and stunting prevalence for all four quartiles of GDRP. An intriguing finding reveals that Q4 shows the steepest correlation amongst others. This finding implies that the correlation between TFP growth and stunting prevalence might be more rigorous for districts with large GDRP. This finding supports the study of [Monteiro et al. \(2010\)](#) arguing that a larger GDRP of a district might be associated to a larger allocation for health indicators, leading to deaccelerated stunting prevalence. Empirically, data of [Statistics Indonesia \(2020\)](#) shows that Sidoarjo as one of the districts with high TFP growth, as well as the second largest GDRP, also has the high index of stunting reduction (i.e., *Indeks Khusus Penanganan Stunting*). This finding is surely plausible to the prior arguments.



**Figure 3: Correlation of Stunting and TFP Growth Based on Four Quantile of GDRP**

Source: Author's Calculation

Human capital is also essential in the presence of stunting and TFP growth correlation. This is because a better human capital, shown by higher enrollment rate, might associate to the better insight about health literacy and the importance of health itself (Dukic et al., 2013). The finding is shown in the Figure 4.



**Figure 4: Correlation of Stunting and TFP Growth Based on Four Quantile of Human Capital**

Source: Author's Calculation

Figure 4 confirms prior arguments that TFP growth and stunting is negatively correlated. However, it is essential to emphasize that the slope of each quartile is not immensely different. Roughly, it indicates that although school enrolment of district is high, it might not perfectly capture the quality of education in each district. Consequently, the difference between quartile is not obvious. This argument is relevant to the studies of [Bold et al. \(2017\)](#) and [Mwirigi & Muthaa \(2015\)](#) arguing that a large increase of school enrolment rate might not encourage the quality of learning. In other words, school enrolment rate may be a necessary condition of development, but it is somehow not a sufficient condition to ensure the human capital development for long-term.

The graphical analysis of correlation between TFP growth and stunting prevalence abovementioned is confirmed by the statistical test using pairwise correlations. This study employs Pearson and Spearman's Rho Correlation. The result is reported in Table 6.

**Table 6: Pearson and Spearman's Rho Correlation**

<b>Pearson Correlation</b>		
Variables	TFP growth	Stunting Prevalence
TFP growth	1.000	
Stunting Prevalence	-0.3617*	1.000
<b>Spearman's Rho Correlation</b>		
Variables	TFP growth	Stunting Prevalence
TFP growth	1.000	
Stunting Prevalence	-0.3305**	1.000

\*: significant at  $\alpha = 10\%$ , \*\*: significant at  $\alpha = 5\%$ .

Source: Author's Calculation

Table 6 confirms the argument of negative correlation between TFP growth and stunting prevalence. The result for Pearson correlation shows that there is significant negative correlation between TFP growth and stunting by -0.3617. Meanwhile, Spearman's Rho correlation reveals lower correlation by -0.3305. This finding strengthens the argument of [National Research Council \(2011\)](#) suggesting a nontrivial correlation between two variables that is larger than 0.3.

Although the TFP growth and stunting prevalence might be a long-term correlation ([Dewey & Begum, 2011](#)), the finding of this study is a signal that there is negative association between TFP growth and stunting prevalence. Reflecting on the index of stunting reduction ([Statistics Indonesia, 2020](#)), the greater support for stunting reduction attempts were shown by the districts with high TFP growth. This urges the greater support for dealing with stunting in other districts, while at the same time, encourages the districts to continuously address the local determinants of stunting based on each district's situational analysis. However, in terms of index of stunting reduction, there are still many districts having a higher relative standard error in their data, which lead to the inavailability of index reflecting the districts' attempts to reduce stunting.

## Conclusion

This study has demonstrated the correlation between TFP growth and stunting prevalence in 38 districts in East Java from 2017-2019. The finding from graphical illustration reveals that there is a negative association between TFP growth and stunting prevalence. Moreover, the impact gets stronger for districts with large GDRP. A plausible reason of this result is that the district with large GDRP might allocate more budget for stunting reduction, for example

the district of Sidoarjo. The negative association between TFP growth and stunting prevalence is then confirmed by statistical results of pairwise correlation from Pearson and Spearman's Rho that both show significant correlation between those two indicators by larger than 0.3, indicating a non-trivial association between TFP growth and stunting prevalence.

This study delivers some policy implication. First, as stunting is a multidimensional issue, the government should tackle this issue by concerning on all possible impact caused by stunting, as well as stunting determinants existing in each district. For example, through the implementation of stunting convergence actions comprising both nutrition-specific and sensitive interventions. Second, human capital development is also an intergenerational issue that requires complex and long-term policy planning. For instance, if parents who have had limited concern on child health issue do not realize the importance of education, they might not encourage their children go to school, leading to acceleration of children's lack of brain development, lower cognitive and socioemotional skills. In this regard, current government's program such as early childhood education, nutrition, and health education, as well as behavioral change campaigns aimed at improving health and nutrition literacy should be intensively fostered to tackle low-quality human capital development. Although this study has concluded that there is negative association between TFP growth and stunting, the limitation remains existed. In this regard, future studies are required to strengthen the finding in more rigorous approach, notably by addressing the impact of stunting prevalence to the TFP growth both in the short-term and in the long-term models.

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## Appendix

**Table 7: Matrix of correlations**

Variables	(1)	(2)	(3)
(1) GFCF	1.000		
(2) Labour	0.580	1.000	
(3) Human Capital	0.067	-0.122	1.000

**Table 8: Variance Inflation Factor**

	VIF	1/VIF
<i>k</i>	6.768	0.148
<i>l</i> <sup>2</sup>	6.622	0.151
<i>k</i> <sup>2</sup>	5.683	0.176
<i>l</i> x <i>hc</i>	5.234	0.191
<i>l</i>	5.085	0.197
<i>k</i> x <i>l</i>	4.679	0.214
<i>k</i> x <i>hc</i>	3.159	0.317
<i>hc</i>	2.626	0.381
<i>hc</i> <sup>2</sup>	2.43	0.412
<i>l</i> x <i>t</i>	1.64	0.61
<i>k</i> x <i>t</i>	1.512	0.661
<i>t</i>	1.427	0.701
<i>t</i> <sup>2</sup>	1.423	0.703
<i>hc</i> x <i>t</i>	1.138	0.879
Mean VIF	3.53	.

**Table 9: Estimates of Translog Using Non-Robust Standard Errors**

	Translog		
	POLS	FEM	REM
<i>k</i>	0.765*** (0.042)	-0.006 (0.096)	0.608*** (0.054)
<i>l</i>	0.322*** (0.069)	0.051* (0.026)	0.071* (0.036)
<i>hc</i>	2.195*** (0.778)	0.235** (0.093)	0.087 (0.139)
<i>k</i> x <i>l</i>	-0.359*** (0.056)	-0.043 (0.030)	-0.020 (0.041)
<i>k</i> x <i>hc</i>	-0.931 (1.070)	0.155 (0.125)	0.005 (0.192)
<i>l</i> x <i>hc</i>	5.297*** (1.486)	-0.349** (0.141)	-0.074 (0.210)

	Translog		
	POLS	FEM	REM
$k^2$	0.208*** (0.014)	-0.003 (0.015)	0.092*** (0.008)
$l^2$	0.917*** (0.137)	-0.006 (0.032)	-0.061 (0.045)
$hc^2$	58.61*** (16.520)	-2.322* (1.278)	-1.683 (1.972)
$t$	0.023 (0.035)	0.049*** (0.005)	0.012*** (0.003)
$k \times t$	-0.071*** (0.025)	0.004** (0.002)	-0.002 (0.002)
$l \times t$	0.076 (0.047)	-0.002 (0.001)	-0.001 (0.002)
$hc \times t$	0.291 (0.619)	0.113*** (0.025)	0.076** (0.038)
$t^2$	0.005 (0.105)	-0.003 (0.003)	0.006 (0.004)
<i>Constant</i>	-0.339*** (0.050)	0.0212 (0.022)	-0.075 (0.067)
<i>Observation</i>	114	114	114
<i>Within-R<sup>2</sup></i>	0.9365	0.9839	0.9720

Note: Robust standard errors are in parentheses. \*\*\*, \*\*, \*: significant at  $\alpha = 1\%$ , 5%, 10%