Impact of provincial human capital on TFP growth through the FDI channel: The case of Indonesian manufacturing industries

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The study analyzes the relationship between provincial characteristics, especially provincial human capital, and Indonesian manufacturing firms' performance, represented by total factor productivity (TFP). The purpose of this study is to find out whether the impact of foreign direct investment (FDI) on the TFP of the manufacturing sector relies on the provincial human capital threshold. Using dynamic and non-dynamic threshold regression models, results show the existence of the threshold level of human capital and its consistency when applying different models based on various levels of educational attainment and human capital measures. The results indicate that, on average, provinces with human capital above the threshold level benefit from FDI through an increase in provincial TFP of the Indonesian manufacturing sector. These results suggest that the Indonesian Government should formulate policies that provide incentives to increase the educational attainment level of provincial human capital and apply strategies for the development of education covering all societies and regions.

Keywords:
human capital,
threshold regression,
foreign direct investment,
total factor productivity

Introduction

The relationship between foreign direct investment (FDI) inflow and total factor productivity (TFP) is not always linear (Fu–Li 2010). A possible reason is the varying size and quality of human capital available in different regions and industries of the host economy (Blalock–Gertler 2004, Borensztein et al. 1998, Yokota–Tomohara 2010). Human capital is considered to be a significant determinant of the ability of firms to copy, adapt, and create new and advanced technology (Ali et al. 2016, Cohen–Levinthal 1989), and a minimum level of human capital is required to benefit from FDI (Borensztein et al. 1998, Kottaridi–Stengos 2010, Lapan–Bardhan

1973, Su–Liu 2016). Human capital is also considered to be one of the key determinants of economic and social convergence and socio-economic development in a region (Egri–Tánczos 2018, Sungur–Zararci 2018, Foued 2021, Tésits et al. 2021, Alhendi et al. 2021). Spatial indicators are needed to support policymakers in analysing the characteristics of the region at a sub-national level (Brandmueller et al. 2017).

Indonesia has the fourth largest population in the world – its population, [1], spreading across 34 provinces[1] and 17,504 islands, increased significantly, by 79%, from approximately 147 million in 1980 to approximately 264 million in 2017. About 60% of the total population is in the productive age group of 15–64 years [2], which is a potential asset to drive national economic growth. This demographic condition should be leveraged by designing strategies for enhancing TFP through FDI inflow in the manufacturing sector. However, previous studies either measure TFP at a macro level, such as the provincial TFP based on macroeconomic characteristics of a province (Fu–Li 2010), or use economic growth rather than firm-level TFP to investigate FDI impact on host country performance (Borensztein et al. 1998, Ford et al. 2008, Kottaridi–Stengos 2010, Su–Liu 2016, Xu 2000). The extant literature lacks an investigation of the impact of provincial human capital on FDI–firm performance nexus. This study contributes to the literature by providing different insights on how FDI can benefit a firm's performance in the host country and answering the following question: 'What is the effect of provincial human capital on FDI–TFP nexus in the Indonesian manufacturing sector?' The answer to this question is expected to not only support decision-makers in developing provincial human capital but also provide data at the provincial level that are needed to inform society about the development of the manufacturing sector in the local area (Haldorson 2019).

The layout of the remainder of this study is as follows: literature review, hypothesis development, impact of FDI inflow on provincial TFP, research method, provincial human capital and provincial TFP growth of the Indonesian manufacturing sector, empirical findings, conclusions and policy recommendations.

Literature review

The term 'human capital', as used in the production function, became globally popular because it is believed to be one of the tacit assets of a firm (Riley et al. 2017, Romer 1990). Human capital is a factor of production functions that can complement unexplained varying production outputs among firms or countries (Romer 1990) and potentially has valuable, inimitable, and non-substitutable characteristics (Riley et al. 2017).

[1] The number of provinces changed gradually from 27 provinces in 1998 to 34 provinces in 2018.

Human capital is a factor of production that endogenously affects firm outputs (Mankiw et al. 1992, Riley et al. 2017). It represents the investment of human resources to acquire useful knowledge and skills through education, job training and learning by doing, which lead to varying human capabilities (Lucas 1978, Schultz 1961). Human capital also signifies the positive effect of human resources on organisational output and determines the distance in the technology gap between the technology frontier and the currently used technology (Benhabib–Spiegel 2005).

Previous studies have used a variety of proxies for human capital. Chen and Dahlman (2004) reviewed the proxies of human capital and divided them into two general approaches: quantitative and qualitative. The quantitative approach includes the adult literacy rate, school enrolment ratio, and average years of schooling. The qualitative approach measures human capital using several proxies, including the teacher-student ratio, expenditure on education, the salary of teachers, student dropout rates (school input approaches), scientific test scores, and cognitive test scores (school output approaches). However, such proxies cannot be used to investigate the impact of FDI inflow on provincial TFP of the Indonesian manufacturing sector as employees of manufacturing firms account for only a certain proportion of the provincial population. Therefore, the proxy of the provincial human capital by combining manufacturing sectors' and provincial data related to human capital is constructed.

The experimental findings on productivity, as well as economic growth related to FDI and human capital, vary. Using country-level analysis, Arazmuradov et al. (2014) demonstrate that FDI interacted with human capital contributed positively to technical efficiency in the former Soviet Union. Blalock and Gertler (2004) find that human capital in the manufacturing sector is a determinant of the absorptive capacity of FDI spillover in Indonesia and such capacity depends on employees' educational background. However, the authors do not define a threshold level of provincial human capital that could illustrate the minimum average level of human capital required in Indonesian provinces to benefit from provincial FDI inflow.

Previous studies reveal that human capital thresholds exist and the threshold level of human capital differs across countries. For example, using provincial-level analysis, Fu and Li (2010) illustrate three threshold levels in China, 4.92%, 10.99%, and 30.49%, to determine the impact of FDI on provincial TFP. The absorptive capacity of human capital reduces the negative impact of FDI if less than 4.92% of the labour force has a higher education degree. When this proportion becomes greater than 10.99%, the impact of FDI turns positive and becomes even better if this proportion increases beyond 30.49%. Using cross-country analyses, Xu (2000) demonstrates that in order to benefit from FDI, countries need to cross the threshold level of 1.9 years in terms of male secondary school attainment. This threshold is higher than the findings of Borensztein et al. (1998), who illustrate that to benefit from FDI, the minimum education level is 0.5 years. These results support the argument that the impact of FDI inflow integrated with human capital on economic growth is non-linear (Benhabib–Spiegel 2005).

Human capital determines the level of absorptive capacity of technology and knowledge diffusion resulting from FDI spillover. Absorptive capacity is defined as the capability of a firm to obtain and apply knowledge, including the tacit knowledge that comes from outside the firm, adopt technological change, and increase competitive advantage (Cohen–Levinthal 1990, 2000, Kedia–Bhagat 1988, Koza–Lewin 1998, Zahra–George 2002). Zahra and George (2002) reclassify absorptive capacity to merge potential absorptive capacity and realised absorptive capacity. The former is the capability to acquire or absorb external knowledge, while the latter is the capability to develop such knowledge or technology to optimise the benefit of the presence of current knowledge.

Hypothesis development

Some scholars argue that the impact of FDI on economic growth is non-linear and it is affected by the absorptive capacity of human capital (Borensztein et al. 1998, Fu–Li 2010, Xu 2000). A possible reason is that FDI inflow and TFP have a non-linear relationship that is affected by human capital, as absorptive capacity is the key factor that influences benefits through FDI.

Human capital, as a determinant of the capability of transferring and absorbing knowledge and technology, such as from FDI spillover at a regional level (Capello–Nijkamp 2009, Gennaioli et al. 2013), plays an important role in regional development. It also affects firm productivity both within a sector and a region (Gennaioli et al. 2013). Provincial human capital is a non-material asset with its amount and quality determining the competitiveness of each province (Capello–Nijkamp 2009). The level of human capital, as one of the provincial characteristics, varies across provinces, and thus, its impact on provincial economic growth may differ (Capello 2009, Faggian–McCann 2009). The transfer of tacit knowledge by provincial human capital through firm-level interactions is one of the determinants of provincial innovation capability (Capello–Nijkamp 2009). The provincial human capital measure is constructed as the ratio of the size of the labour force with a minimum of senior or vocational high school degree qualification in a province to its population.

The employment growth considerably affects national and regional output growth (Zsibók 2017). An increase in labour supply tends to reduce wages if the characteristics of the labour market competition are substitutable (Borjas 1987). Therefore, the increased labour force with the same skills or qualifications generates labour market competition, which leads to reduced labour cost and improved quality of the labour force. As technical efficiency changes and technical changes are two sources of change in TFP (Kumbhakar et al. 2015), the decreased labour cost increases the technical efficiency change, while the increased quality of the labour force enhances the technical change. This situation leads to improved TFP when other factors are constant.

As provincial human capital is believed to influence the impact of FDI inflow on provincial TFP of the manufacturing sector, and the relationship between FDI inflow and TFP is expected to be non-linear, this study analyses how provincial human capital influences the impact of FDI inflow on provincial TFP of the Indonesian manufacturing sector by proposing the following hypothesis:

The impact of FDI inflow on provincial TFP of the Indonesian manufacturing sector is non-linear and is influenced by provincial human capital.

Research method

Data

Data used in this study are secondary data obtained from the surveys conducted by the Indonesian Central Bureau of Statistics. The data comprise 600 observations from 25 Indonesian provinces[2] for the period from 1991 to 2014. The data provide information on the characteristics of Indonesian provinces, including the educational background of the labour force, the number of school buildings, the number of civil servants, and the total population. The required data to calculate provincial TFP of the manufacturing industry – labour, capital, and output – are sourced from the annual surveys of medium and large manufacturing firms conducted by the Indonesian Central Bureau of Statistics. These data are deflated using the wholesale price index. The FDI data are obtained from the Indonesian Investment Coordinating Board and these data are also deflated using the wholesale price index. Table 1 summarises the provincial characteristics used in this study.

[2] Some provinces' data are merged into one province as some new provinces have been established since 2000. They are Kepulauan Bangka Belitung merged into Sumatra Selatan (Sumatra Selatan), Kepulauan Riau (Riau), Banten (Jawa Barat), Gorontalo (Sulawesi Utara), and Maluku Utara (Maluku). The data used in this study do not include Papua and Papua Barat provinces because of the unavailability of the required time series data. The appendix illustrates the list of Indonesian provinces.

Table 1

Data description

Variable	Obs	Mean	Std. Dev.	Min	Max
Provincial TFP[a), b)]	600	0.1861	0.7395	–1.018	9.1106
Provincial FDI inflow[c)]	600	0.2008	0.3239	0.0000	0.9994
Total human capital (THC)[d), e)]	600	0.0677	0.0294	0.0244	0.1244
Human capital with senior high school attainment (SHS)	600	0.0282	0.0139	0.0074	0.0549
Human capital with vocational high school attainment (VHS)	600	0.0187	0.0075	0.0065	0.0336
Human capital with diploma attainment (diploma)	600	0.0084	0.0038	0.0022	0.0153
Human capital with vocational high university attainment (university)	600	0.0123	0.0082	0.0017	0.0279
Government size	600	0.0259	0.0161	0.0013	0.1452
IT infrastructure	600	0.0164	0.0182	0.0020	0.1420

a) This study follows Weber and Domazlicky (1999) in weighting provincial TFPG by using total output of the firms in each province.

b) The provincial TFP growth is measured using the value of capital and the number of laborers in each Indonesian manufacturing industries.

c) In this study, provincial FDI inflow is represented by the ratio of provincial FDI inflow over provincial GDP. This variable is winsorized using 1% and 90% level due to the suspection of the presence of data outlier.

d) Total human capital in this study means the ratio of the number of labor force with minimum senior or vocational high school university degree.

e) Total human capital in this study refers to the quantity of provincial human capital.

Notes: Provincial TFP is the total factor productivity growth in the manufacturing sector of each province weighted by the total output of the firms in each province. Provincial FDI inflow is the value of FDI inflow in each province deflated by the wholesale price index over provincial GDP. Total human capital is the ratio of the total labour force who has at least senior or vocational high school qualifications overpopulation in each province. SHS is a labour force who has only senior high school qualification overpopulation in each province. VHS is a labour force who has only vocational high school qualification overpopulation in each province. The diploma is a labour force who has diploma qualification overpopulation in each province. University is a labour force who has a bachelor degree. Government size is the ratio of the number of civil servants overpopulation in each province. IT infrastructure is the ratio between the number of universities over the number of primary schools in each province. University is commonly known as the place to acquire and to share the useful knowledge and technology (Chen–Kenney 2007). The number of the primary school buildings is used to weight the IT infrastructure as this study assumes that primary school has a basic infrastructure for learning activities (Kant 2014).

Data source: [3], processed by the author.

Testing for correlation

Table 2 depicts the result of multicollinearity tested in this study. The high correlation between variables may increase the standard errors and change the direction of coefficient estimates. Therefore testing the presence of high collinearity between variables is important. According to Table 2, the coefficient of correlation between variables employed in this study is below 0.8, indicating an acceptable level of multicollinearity.

Table 2

Correlation matrix between variables

Variables	Provincial TFP	Provincial FDI inflow	Provincial human capital (THC)	Government size	IT infrastructure
Provincial TFP	1				
Provincial FDI inflow	0.3397	1			
Provincial human capital (THC)	0.0985	0.2562	1		
Government size	–0.1062	–0.1842	0.2221	1	
IT infrastructure	0.0362	0.0553	0.6382	0.2643	1

Data source: [3], processed by the author.

Construction of variables and threshold measurement

To calculate TFP, a decomposition–parametric method using the stochastic frontier analysis approach suggested by Kumbhakar et al. (2015) is applied. One of the advantages of this approach is the ability to control the noise caused by uncontrolled factors affecting firms' output or value-added. The TFP in this study includes the accumulation of technical change, technical efficiency change, and the scale of efficiency change.

The base model to calculate TFP at a firm level is as follows:

$$Output_{kt} = \beta_0 + \beta_1\, Capital_{kt} + \beta_2\, Labor_{kt} + \frac{1}{2}\beta_3\, Capital_{kt.}\, Labor_{kt} + \frac{1}{2}\beta_4 t^2 + \frac{1}{2}\beta_5\, Capital_{kt.}\, t + \frac{1}{2}\beta_6\, Labor_{kt}.t + \varepsilon_{kt} \quad (1)$$

where $Output_{kt}$ is the output of firm k in year t; $Capital_{kt}$ represents the value of capital of firm k in year t; $Labor_{kt}$ is the number of labourers of firm k in year t; ε_{kt} is the general error term, which consists of v_{kt}, the normal error term, and u_{kt}, the half normal error term, that is, $\varepsilon_{kt} = v_{kt} - u_{kt}$; and β_0 is a constant or intercept, while β_1, β_2, β_3, β_4, β_5 and β_6 are the parameters of interest.

The theoretical framework of Chen and Dahlman (2004) is employed as a base model to investigate the impact of FDI inflow on provincial TFP of the Indonesian manufacturing sector for several reasons. Firstly, the determinants of provincial TFP as per Chen and Dahlman (2004) include the institutional and economic regime, education and training, the level of domestic innovation, and information and communication infrastructure, which vary across provinces. Secondly, these factors may affect the manufacturing sector both directly and indirectly. Thirdly, such determinants cover the main provincial characteristics that may vary among provinces, including provincial human capital.

According to Chen and Dahlman (2004), provincial TFP is a function of education and training[3], institutional and economic regime, the stock of knowledge or the level of domestic innovation, and communication and information infrastructure.

$$TFP_{it} = f\ (EDU_{it}, INS_{it}, INOV_{it}, INF_{it}) \qquad (2)$$

where TFP_{it} is the weighted TFP of Indonesian manufacturing sector in province i (i=1,....N) in year t (t=1,....T)[4]; EDU_{it} is education and training in province i (i=1,....N) in time t (t=1,....T) and represents the provincial human capital (HC_{it}); INS_{it} is the institutional and economic regime in province i (i=1,....N) in time t (t=1,....T) showing the level of the access to competitiveness, accountability, and effectiveness, which is represented by Indonesian Government size, GS_{it}, or the share of civil servants in the provincial population; $INOV_{it}$ represents the access to provincial innovation in province i (i=1,....N) in time t (t=1,....T) and denotes the supportive environment to acquire, adapt, and apply useful knowledge to increase competitiveness; and INF_{it} is the information technology (IT)infrastructure in province i (i=1,....N) in time t (t=1,....T) and reflects the ability to acquire and share product knowledge and information.

Various proxies for the determinants of provincial TFP are used. The proxy of provincial human capital is the ratio of the stock of labour force with minimum senior or vocational high school degree in each province to its total population. For the provincial institution, this study focuses on the routine Indonesian Government expenditure and corrupt-free Indonesian Government as parts of the institutional regime (Chen–Dahlman 2004), which are represented by provincial Indonesian Government size or the number of civil servants overpopulation. IT infrastructure is represented by the ratio of the number of universities to the number of primary schools. The other determinant of TFP is the access to provincial innovation, which is represented by provincial FDI inflow.

Replacing provincial education and training, EDU_{it}, by provincial human capital, HC_{it}, access to domestic innovation, $INOV_{it}$, by FDI inflow, FDI_{it}, and provincial institution, INS_{it}, by provincial Indonesian Government size, GS_{it}, Equation (2) can be written as follows:

$$TFPG_{it} = \partial HC_{it}\ \rho GS_{it}\ \gamma INF_{it}\ \delta_1 FDI_{it} \qquad (3)$$

The econometric regression model is as follows:

$$TFPG_{it} = \alpha_i + \partial HC_{it} + \rho GS_{it} + \gamma INF_{it} + \delta_1 FDI_{it} \qquad (4)$$

To test whether there is a threshold estimate between provincial TFP of the manufacturing sector and provincial human capital, Equation (3) can be changed into the following Cobb–Douglass equation.

[3] Education and training including human capital.

[4] We follow Weber–Domazlicky (1999) in weighting the provincial TFP by using the total output of firms in each province.

$$TFPG_{it} = \partial HC_{it}\ \rho GS_{it}\ \gamma INF_{it}\ \delta_1 FDI_{it}\ I(HC_{it} \leq \theta)\ \delta_2 FDI_{it}\ I\ (HC_{it} > \theta) \quad (5)$$

where $TFPG_{it}$ is the growth in TFP of the manufacturing industry in province i (i=1,....N) in year t (t=1,....T); HC_{it} is the total human capital in province i (i=1,....N) in year t (t=1,....T)[5]; GS_{it} is the Indonesian Government size in province i (i=1,....N) in year t (t=1,....T); INF_{it} is the IT infrastructure in province i (i=1,....N) in year t (t=1,....T); FDI_{it} is the ratio of FDI inflow to provincial gross domestic product in province i (i=1,....N) in year t (t=1,....T); ∂, ρ, γ, and γ are the marginal effect of the provincial TFP of the manufacturing sector concerning provincial human capital, provincial Indonesian Government size, IT infrastructure, and FDI inflow, respectively; and I() is the indicator function of FDI inflow where HC_{it} is treated as a threshold variable. The indicator function takes a value of 0 or 1, depending on whether the threshold variable is lower or higher than the threshold level. δ_1 and δ_2 represent FDI spillover coefficients below and above the threshold level, respectively.

Ramírez-Rondán (2015, 2018) models are employed to calculate the threshold level of provincial human capital using the following regression equations.

$$TFPG_{it} = \alpha_i + \partial HC_{it} + \rho GS_{it} + \gamma INF_{it} + \delta_1 FDI_{it}\ I(HC_{it} \leq \theta) + \delta_2\ FDI_{it}\ I\ (HC_{it} > \theta) + u_{it} \quad (6)$$

The compact model of the threshold variable is as follows:

$$d_{it}(\theta) = \begin{bmatrix} FDI_{it}\ I(HC_{it} \leq \theta) \\ FDI_{it}\ I\ (HC_{it} > \theta) \end{bmatrix}$$

Therefore, Equation (6) can be written as follows:

$$TFPG_{it} = \alpha_i + \partial HC_{it} + \rho GS_{it} + \gamma INF_{it} + \delta\ d_{it}(\theta) + u_{it} \quad (7)$$

where the constant, α_i, represents unobservable fixed effects comprising omitted time-invariant and cross-section fixed factors that are allowed to vary across provinces. It also represents the initial level of the technical capability of different provinces.

To reduce the individual fixed effect, α_i, Equation (6) is subtracted from the average of Equation (7) as follows:

$$\overline{TFPG_i} = \alpha_i + \partial \overline{HC_i} + \rho \overline{GS_i} + \gamma \overline{INF_i} + \delta \bar{d}_i(\theta) + \bar{u}_{it} \quad (8)$$

where $\overline{TFPG_i} = \frac{1}{T}\sum_{t=1}^{T} TFPG_i$; $\overline{HC}_{it} = \frac{1}{T}\sum_{t=1}^{T} HC_i$; $\overline{GS}_{it} = \frac{1}{T}\sum_{t=1}^{T} INS_i$; $\overline{INF}_i = \frac{1}{T}\sum_{t=1}^{T} INF_i$;

and

$$\bar{d}_i(\theta) = \frac{1}{T}\sum_{t=1}^{T} d_{it}(\theta) = \begin{pmatrix} \frac{1}{T}\sum_{t=1}^{T} FDI_{it}\ I(HC_{it} \leq \theta) \\ \frac{1}{T}\sum_{t=1}^{T} FDI_{it}\ I(HC_{it} > \theta) \end{pmatrix}$$

[5] Total human capital in this study means the total stock of labour force with minimum senior or vocational high school university degree. Following Echevarría (2004) and Fu–Li (2010), we assume that human capital stock depreciates every year at a rate of 2.5%.

Taking the difference between Equations (6) and (7):

$$TFPG_{it}^{*} = \partial HC_{it}^{*} + \rho GS_{it}^{*} + \gamma INF_{it}^{*} + \delta d_{it}^{*} + u_{it}^{*} \qquad (9)$$

Using the stacked data and errors for each observation with time deleted, Equation (9) is converted into the following equation.

$$TFPG^{*} = \partial HC^{*} + \rho GS^{*} + \gamma INF^{*} + \delta d^{*} + u^{*} \qquad (10)$$

Given θ, the following equation is used to estimate δ using the conditional least squares method.

$$\hat{\delta}\,(\theta) = (d^{*}(\theta)'\, d^{*}(\theta))^{-1}\, d^{*}(\theta)'\; TFPG^{*} \qquad (11)$$

The vectors for the residuals are the following:

$$\hat{u}^{*}(\theta) = TFPG^{*} - \; d^{*}(\theta)\hat{\delta}\,(\theta) \qquad (12)$$

The sum of the square of errors is defined using the following equation:

$$S(\theta) = \; \hat{u}^{*}(\theta)'\,\hat{u}^{*}(\theta) \qquad (13)$$

As mentioned in the Ramírez-Rondán article (2018), by using conditional least squares proposed by Hansen (1999) and Chan (1993) and grid search[6] (Hansen 1999, 2000), the threshold estimate, θ, with the least sum of the square of errors is defined where $\hat{\delta} = \hat{\delta}\,(\hat{\theta})$.To obtain the dynamic threshold level of provincial human capital, a fixed effect dynamic panel threshold is used by applying the maximum likelihood approach proposed by Hsiao et al. (2002). To calculate threshold estimates, the maximum likelihood method has a less biased estimator and root means square error than the generalised method of moments (Hsiao et al. 2002).

As the dynamic model treats the lag of the dependent variable as a regressor, Equation (6) above is changed into the dynamic equation model as follows:

$$\begin{aligned} TFPG_{it} = \; & \alpha_i + \beta TFPG_{it-1} + \partial HC_{it} + \rho GS_{it} + \gamma INF_{it} + \delta_1 FDI_{it}\, I(lnHC_{it} \le \theta_1) \\ & + \delta_2\, FDI_{it}\, I\,(HC_{it} > \theta_2) + u_{it} \end{aligned} \qquad (14)$$

The non-dynamic model is used to test the differences between dynamic and non-dynamic models for the threshold and other parameters.

The compact notation of the threshold variable is presented below.

$$d_{it}\,(\theta) = \begin{bmatrix} \delta_1 FDI_{it}\, I(HC_{it} \le \theta_1) \\ \delta_2\, FDI_{it}\, I\,(HC_{it} > \theta_2) \end{bmatrix}$$

If there is no threshold level, it means $\theta_1 = \theta_2$ and $\delta_1 = \delta_2 = \delta$. In this case, the standard linear regression model can be used to estimate the impact of FDI on provincial TFP of the Indonesian manufacturing industry.

Equation (14) can be written as Equation (15):

$$TFPG_{it} = \alpha_i + \beta TFPG_{it-1} + \partial HC_{it} + \rho GS_{it} + \gamma INF_{it} + \delta d_{it}\,(\hat{\theta}) + u_{it} \qquad (15)$$

According to Hsiao et al. (2002), the elimination of the individual specific effect is important to fulfil the assumption that the error term should be independent and identical normally distributed. Therefore, Equation (15) is converted into the following equation.

[6] Grid search means creating two equal spaces of the threshold variable, which is provincial FDI inflow.

$$\Delta TFPG_{it} = \beta \Delta TFPG_{it-1} + \partial \Delta HC_{it} + \rho \Delta GS_{it} + \gamma \Delta INF_{it} + \delta' \Delta d_{it} (\hat{\theta}) + \Delta u_{it} \quad (16)$$

To gain a consistent threshold estimate, the initial condition is needed as it assumes that $\Delta TFPG_{it}$ is affected by an external parameter such that $\Delta TFPG_{it} = \vartheta + \varepsilon_{it}$. Hsiao et al. (2002) demonstrate the presence of the same joint probability distribution of the dependent variable and the error term in the first difference, Δu_{pt}, and the Jacobian transformation from the error term to the dependent variable is unity. The following matrix is the covariance matrix of Δu_{it} with $\sigma_v^2/\sigma_u^2 = \eta$.

$$\omega = \sigma_u^2 \begin{bmatrix} \eta & -1 & 0 & \dots & 0 \\ -1 & 2 & -1 & & \\ 0 & -1 & 2 & & \\ \vdots & & & \ddots & -1 \\ 0 & & & -1 & 2 \end{bmatrix} \quad (17)$$

If $\vartheta_\delta = (\beta, \delta')$, the matrix of $\Delta FDIi - 1(\hat{\theta})$ can be defined as follows:

$$\Delta FDIi - 1(\hat{\theta}) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \Delta FDIi1 & \Delta di2(\hat{\theta}) \\ 0 & \Delta FDIi2 & \Delta di3(\hat{\theta}) \\ \vdots & \vdots & \vdots \\ 0 & \Delta FDIiT-1 & \Delta diT(\hat{\theta}) \end{bmatrix} \quad (18)$$

By assuming that the residual, u_{it}, is normally and independent and identically distributed, ΔFDI_i has a joint probability distribution as follows:

$$\ln L = (\vartheta_{\delta,} \sigma_u^2, \eta) = -\frac{nT}{2}\ln(2\pi) - \frac{n}{2}\ln|\omega(\theta)|$$
$$= -\frac{1}{2}\sum_{i=1}^{n}\left[\left(\Delta FDI_i - \Delta FDI_{t-1} 1(\hat{\theta})\,\vartheta_\delta\right)' \omega^{-1}\left(\Delta FDI_i - \Delta FDI_{t-1} 1(\hat{\theta})\,\vartheta_\delta\right)\right] \quad (19)$$

The maximum likelihood estimation of $\widehat{\vartheta_\delta}, \hat{\beta}, \hat{\delta}, \hat{\sigma}_u^2$ and $\hat{\eta}$ is the global maximum of $\ln L = (\beta, \delta, \sigma_u^2, \eta)$.

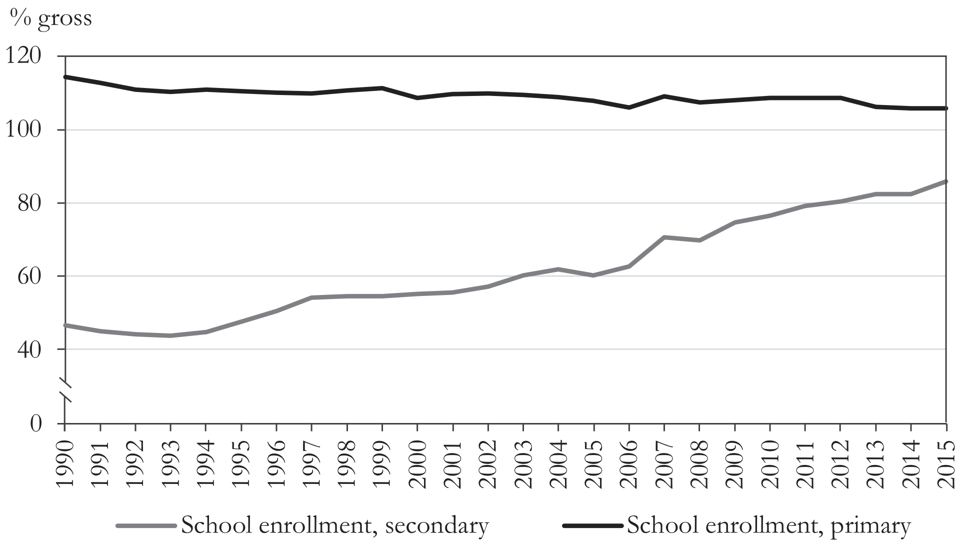
Provincial human capital and provincial TFP growth of the Indonesian manufacturing sector

The impact of FDI inflow on TFP is expected to be influenced by human capital. In this section, the stock of labour force classified into several groups, based on the most recent educational attainment in secondary high school is discussed. This information provides a picture of the source of provincial human capital in Indonesia.

Figure 1 illustrates the trend in the gross proportion of the population enrolled in primary and secondary school during the period from 1990 to 2017. School enrolment for primary education shows a declining trend, whereas that for secondary education exhibits an increasing trend. Based on these trends, in the future, the gross proportion of secondary education enrolment is expected to surpass that of primary education enrolment.

Figure 1

The proportion of primary and secondary school enrollment

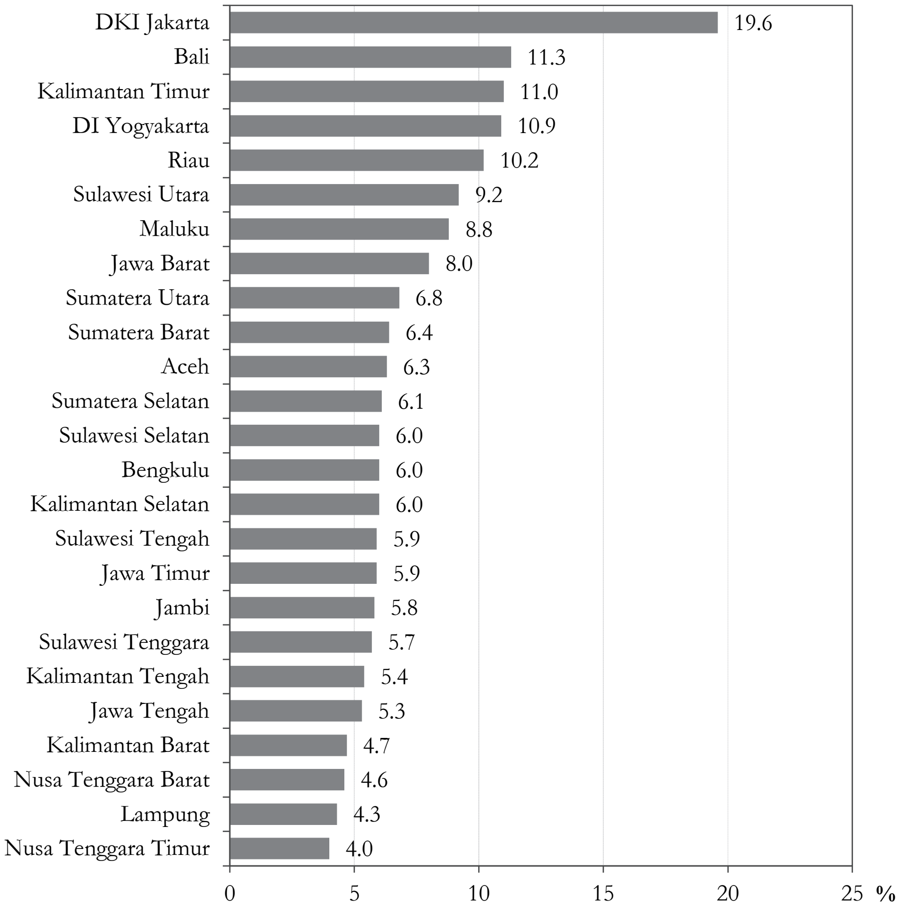


Data source: [1], processed by the author.

Figure 2 illustrates the proportion of provincial human capital with minimum senior or vocational high school degree. Jakarta dominates the average proportion of total provincial human capital at 19.6% followed by Bali (11.3%), Kalimantan Timur (11%), and Daerah Istimewa (DI) Yogyakarta (10.89%). The three provinces that have the lowest provincial human capital are Nusa Tenggara Timur (4%), Lampung (4.3%), and Nusa Tenggara Barat (4.6%).

Figure 2

The average proportion of human capital with minimum senior or vocational high school degree from 1991 to 2014

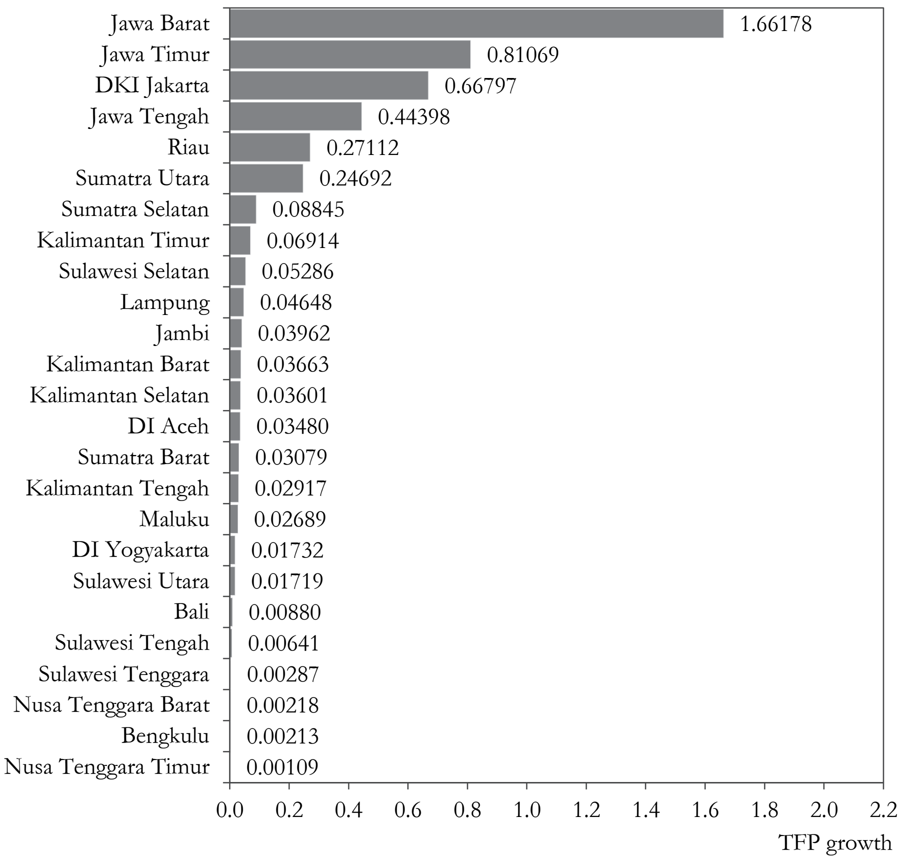


Data source: [1], processed by the author.

Figures 3 and 4 depict the distribution of TFP growth of the Indonesian manufacturing sector across Indonesian provinces. Of all the provinces, those in Java Island experienced relatively high TFP growth in the manufacturing sector from 1991 to 2014. Jawa Barat experienced the highest TFP growth, reaching 1.8808, followed by Jawa Timur and Jakarta with TFP growths of 0.8559 and 0.6236, respectively. Outside Java Island, Riau experienced the highest TFP growth of 0.4091, followed by Sumatera Utara and Sumatera Selatan with TFP growths of 0.2744 and 0.1062, respectively. The lowest TFP growths of 0.009 and 0.0015 occurred in Nusa Tenggara Timur and Nusa Tenggara Barat. Overall, the provinces in Java Island including Jawa Barat, Jawa Timur, Jakarta, Jawa Tengah, and DI Yogyakarta accounted for 77.44% of the TFP growth of the Indonesian manufacturing sector. Meanwhile, the three provinces in Sumatera, Kalimantan, Sulawesi, and Nusa Tenggara – the Maluku Islands[7] accounted for 16.35%, 3.68%, 1.71%, and 0.84% of the TFP growth of the Indonesian manufacturing sector.

Figure 3

The average of TFPG of Indonesian manufacturing sector across Indonesian provinces from 1991 to 2014

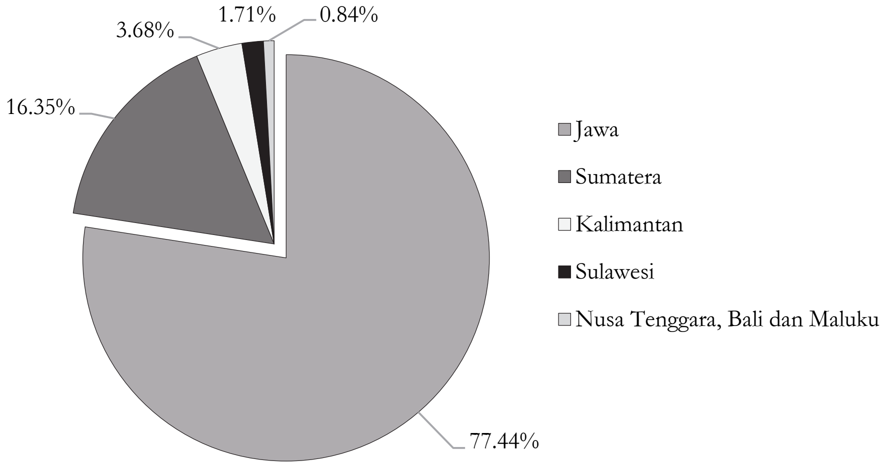


Data source: [3], processed by the author.

[7] These regions include Nusa Tenggara Barat, Nusa Tenggara Timur, Bali, and Maluku.

Figure 4

The distribution of TFP growth of Indonesian manufacturing sector across Indonesia main regions from 1991 to 2014



Data source: [3], processed by the author.

Empirical findings

The influence of provincial human capital in determining the impact of FDI inflow on provincial TFP of the Indonesian manufacturing sector is discussed in this section. The provincial human capital is proxied by the ratio of the labour force size with at least senior or vocational high school qualification in a province to its total population.

Table 3 illustrates the results of the impact of provincial human capital on provincial FDI–TFP nexus. According to Model I of Table 3, where provincial human capital is represented by the share of the labour force that graduated from at least senior or vocational high school, the dynamic and non-dynamic threshold estimates exist at 0.118570 and 0.111149. The result indicates the positive contribution of provincial human capital in generating TFP by utilising the presence of FDI inflow and supports the argument that human capital plays an important role in absorbing FDI spillover (Capello 2009, Gennaioli et al. 2013, Barrios et al. 2004). The result also demonstrates that provincial human capital has a positive, but statistically insignificant impact on provincial TFP where provincial human capital is treated as a direct control variable for provincial TFP. The absence of FDI inflow is one of the possibilities that explain such a result.

Table 3

The dynamic and non-dynamic panel threshold estimates

Dependent Variable = Provincial TFP	Provincial human capital as a threshold variable[a)]					
	Model I	Model II	Model III	Model IV	Model V	Model VI
Dynamic threshold estimates						
Threshold estimates	0.118570	0.052098	0.031806	0.010086	0.016137	0.368151
Regime 1 (provincial FDI inlow)	–0.098220 (0.063686)	–0.106032* (0.064720)	–0.104107* (0.061796)	–0.219599*** (0.074309)	–0.238361*** (0.069214)	–0.586801*** (0.102497)
Regime 2 (provincial FDI inlow)	0.857133*** (0.121993)	0.891320*** (0.123225)	0.943338*** (0.113805)	0.399823*** (0.080419)	0.489237*** (0.087028)	0.215617*** (0.063026)
Bootsrap p-value[b)]	0.003333	0.003333	0.003333	0.036667	0.006667	0.000000
Non-dynamic threshold estimates						
Threshold estimates	0.111149	0.052098	0.031265	0.011085	0.026445	0.410139
Regime 1 (provincial FDI inlow)	–0.239619** (0.115736)	–0.163298 (0.114889)	–0.251930** (0.111809)	–0.169769 (0.126047)	–0.194755* (0.116671)	–1.166171*** (0.183778)
Regime 2 (provincial FDI inlow)	1.779822*** (0.199201)	2.039613*** (0.210642)	1.925750*** (0.193917)	1.030594*** (0.166143)	1.688732*** (0.215450)	0.578608*** (0.117700)
Bootsrap p-value	0.003333	0.003333	0.003333	0.030000	0.013333	0.000000
Independent variable[c)]						
TFP_Lag1	0.972541*** (0.027798)	0.969726*** (0.028178)	0.961700*** (0.027146)	1.018975*** (0.027753)	1.014494*** (0.026970)	1.082979*** (0.027532)
Provincial human capital	0.788964 (0.974460)	0.032066 (2.046619)	11.433449*** (3.891092)	–5.127560 (6.278855)	0.679566 (3.034891)	0.535651* (0.317504)
Government size	–2.553863*** (1.124135)	–2.627990** (1.131004)	–2.450463** (1.098513)	–2.235865* (1.154619)	–1.862891* (1.126882)	–1.88029* (1.13344)
IT Infrastructure	7.845807*** (1.980607)	9.512871*** (1.951889)	8.856607*** (1.606126)	8.835538*** (1.884606)	5.847715*** (2.141690)	7.779318*** (1.710023)

a) Model I uses provincial human capital with minimum senior high school (SHS) or vocational high school (VHS) last education attainment. Model II uses provincial human capital with SHS last educational attainment. Model III uses provincial human capital with VHS last educational attainment. Model IV uses provincial human capital with with associate degree diploma last educational attainment. Model V uses provincial human capital with university last education attainment. Model VI uses average years schooling in secondary education.

b) Null hypothesis states that there is a linear relationship between FDI inflow and TFP of Indonesian manufacturing sector.

c) The coefficient estimates of independent variables are based on the result of dynamic panel threshold model using maximum likelihood technique.

Notes: *** The coefficient estimate is statistically different from zero at 1% significant level.

** The coefficient estimate is statistically different from zero at 5 % significant level.

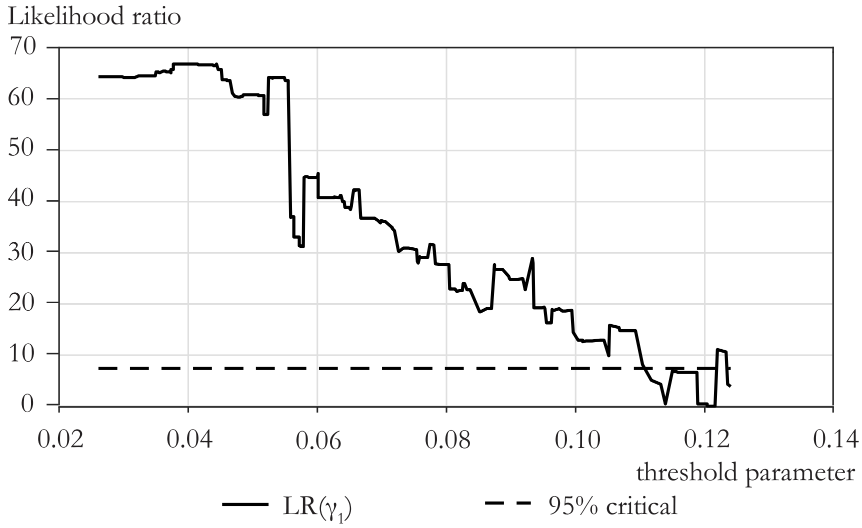
* The coefficient estimate is statistically different from zero at 10 % significant level.

Data source: [3], processed by the author.

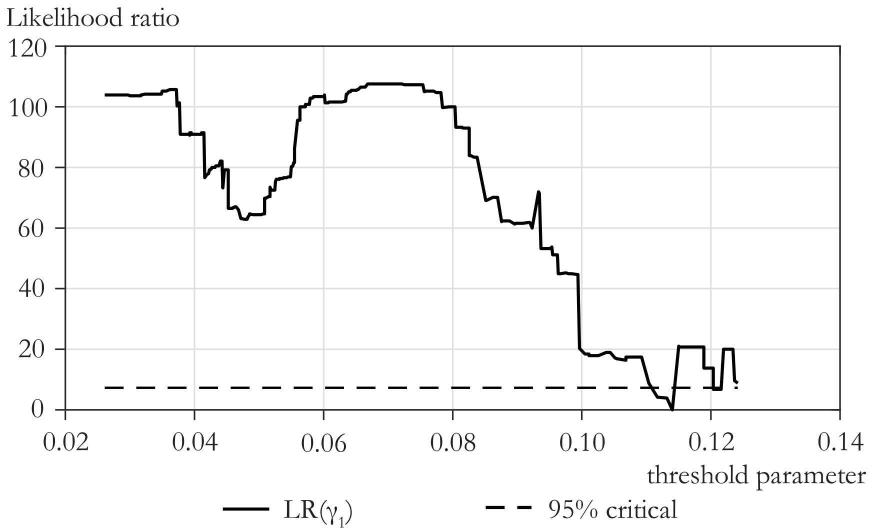
Figure 5

The likelihood ratio of the threshold of Model I

(A) The dynamic threshold estimate of total provincial human capital



(B) The non-dynamic threshold estimate of total provincial human capital



Data source: [3], processed by the author.

Figure 5 depicts the trend in the likelihood ratio of the threshold parameter of Model I employing dynamic (A) and non-dynamic (B) models. Using a 95% confidence level, the trends in the likelihood ratio of both models decrease but the likelihood ratio of the dynamic model exhibits more fluctuation than the non-dynamic model. The trends tend to convert into increasing tendencies after reaching threshold parameters of 0.118570 and 0.111149 when using dynamic and non-dynamic models.

The result of Model I is consistent with the rest of the models. Model III illustrates the relationship between provincial characteristics and provincial TFP of the Indonesian manufacturing sector where provincial human capital is represented by the share of the stock of labour force having only a vocational high school degree. The result shows that the threshold estimates for dynamic and non-dynamic models exist at 0.031806 and 0.031265. Such thresholds are smaller than those in Model II where the threshold level is 0.052098 for both dynamic and non-dynamic models.

Models IV and V in Table 3 illustrate the threshold estimates of provincial human capital with a diploma as well as with university degree. The results show that the threshold level using dynamic regression in Models IV and V are 0.010086 and 0.016551. The threshold level of Model IV is lower than those of Models I, II, III, and V, indicating that the increased share of labour force having diploma degree has a significant influence in generating positive impacts of FDI inflow on provincial TFP of the Indonesian manufacturing sector.

Model VI in Table 3 uses average years of schooling in secondary education in each province to represent provincial human capital. The result shows that the provincial human capital threshold exists at 0.368151 and 0.410139 years for dynamic and non-dynamic panel models. These thresholds are lower than the human capital thresholds of 1.9 and 0.5 determined by Xu (2000) and Borensztein et al. (1998). Although the proxy used in this model differs from those in other models, the estimated coefficients of FDI inflow in the second regime of this model, both using dynamic and non-dynamic panel models, display the same result as the other models that are positive and statistically significant. Meanwhile, the estimated coefficients of FDI inflow in the first regime of this model, using dynamic and non-dynamic panel models, are negative and statistically significant indicating the need to have average years of schooling above the threshold level in each province.

In terms of control variables, all coefficients show expected results. All the models except Model IV demonstrate that the direct impact of provincial human capital on TFP is positive but mostly statistically insignificant. The results of all models also illustrate that the decreased ratio of civil servants to the provincial population leads to a positive impact on provincial TFP. Another variable, provincial infrastructure shows a positive impact on the TFP. These results are aligned with the theoretical framework of the determinants of provincial TFP in which provincial human capital, institution, and infrastructure are expected to have a statistically significant impact on provincial TFP (Chen–Dahlman 2004).

Conclusions and policy recommendations

This study analyses the impact of provincial human capital on FDI–TFP growth nexus. This study differs from previous studies in three key ways: 1) provincial characteristics as the determinants of provincial TFP of the manufacturing sector are employed; 2) firm-level data rather than macro-level data are used to calculate provincial TFP; 3) dynamic and non-dynamic estimation techniques are applied.

The results demonstrated that provincial human capital influences the impact of FDI inflow on TFP of the Indonesian manufacturing sector. The threshold estimate of provincial human capital exists in all models, thereby reflecting the consistency of the results. The threshold estimates of total human capital were found to be 0.121610 and 0.113999 when dynamic and non-dynamic panel threshold models were used. For specific groups based on last educational attainments, namely, senior high school, vocational high school, diploma, and university degrees, the threshold levels of human capital using the dynamic threshold model were 0.053433, 0.032622, 0.010344, and 0.016551. The findings of this study support the argument that provincial human capital plays an important role in influencing the impact of FDI on TFP (Capello–Nijkamp 2009, Gennaioli et al. 2013). The first regime, less than or equal to the threshold level, showed a negative or no impact of FDI on TFP, while the second regime exhibited a positive impact of FDI on TFP. These results indicate that the provinces having human capital above the threshold level, on average, reap the benefits of FDI; otherwise, FDI either has a negative or no impact.

These results also contribute to the theory by strengthening the evidence of the positive impact of human capital on TFP growth or economic growth in an economy. Previous studies mostly investigated such impact at the macro or non-industry level (Arazmuradov et al. 2014, Fu–Li 2010, Xu et al. 2008, Romer 1990). The results of this study reveal that positive externalities of provincial human capital also occur at the industrial level, wherein the provincial human capital can affect, directly and indirectly, the TFP growth of manufacturing industries. The latter happens through FDI inflow in manufacturing industries in each province.

The results of this study suggest that the Indonesian Government should increase the proportion of qualified human capital in each province to surpass the threshold levels, to generate a positive impact of FDI on provincial TFP in the manufacturing sector. However, the gross retention rate of students at senior and vocational high schools[8] displays a decreasing trend from 96.79% in 2012 to 95.29% in 2013 and further to 94.44% in 2014, 90.34% in 2015, and 88.91% in 2016 [4], indicating the increasing proportion of students who drop out or do not complete

[8] The gross retention rate of senior and vocational high school is officially published by the Indonesian Ministry of Education. The formula to calculate this rate is the number of students in grade XII in year t divided by the number of students in grade X in year t−2.

senior or vocational high school degree. This condition is exacerbated by a decreasing trend in the participation rate of students at senior high school, from 65.43% in 2015 to 65.42% in 2016 and 64.86% in 2017 [3]. This situation entails the Indonesian Government to intervene, not only to stop but also to reverse such disconcerting trends.

The findings of this study underline the importance of implementing national compulsory education in Indonesia in order to increase the stock of the labour force with minimum senior or vocational high school qualification. The Indonesian Government Regulation No. 47 (2008) on compulsory education obligates the government to guarantee that all citizens attain nine years of school education from primary school to junior high school. The purpose of this regulation is to provide the minimum education for all Indonesian citizens so that they can develop their potential capacity for living independently and for continuing further school education. Under this policy, Indonesian children are expected to undergo six years of primary school and three years of junior high school. The result of this study not only supports this policy but suggests extending the years of compulsory education to at least twelve years to increase the stock of qualified human capital in each province to maximise the benefit of FDI in the manufacturing sector.

The Indonesian Government also needs to be concerned about families who cannot afford to pay fees to enrol their children at senior or vocational high schools. To help them, the Indonesian Government should provide free education, especially for relatively poor families, in all Indonesian provinces for twelve years so that students could attain senior or vocational high school qualifications. Currently, the Indonesian Government provides free education for nine years, based on Act No. 20 (2003). To increase the participation rate of students in senior and vocational high schools, the Indonesian Government should extend the coverage of free education policy to a period of at least 12 years, which has been implemented in several countries such as Chile, Germany, Belgium, Italy, Spain, France, and Norway. [5]

In general, the results of this study support the need to increase the number of students at senior and vocational high schools, diploma colleges, and universities. The increased stock of provincial labour force with sufficient qualifications to enter the labour market together with the FDI inflow contributes to increasing the TFP of the Indonesian manufacturing sector. The Indonesian Government should consider extending the number of years entitled for compulsory as well free education to at least 12 years to increase the stock of qualified labour force across Indonesian provinces.

For future research, the use of other factors such as cultural or institutional factors in investigating FDI–TFP nexus may provide different insights. Each province has different institutional characteristics and culture that may impact the extent to which each province benefits from the presence of foreign firms in a host country. Spatial econometrics can be employed to control the impact of spatial dependency of cultural or institutional characteristics in explaining the FDI–TFP nexus.

Acknowledgements

I would like to thank Associate Professor Anil V Mishra, Associate Professor Dilupa Nakandala and Dr Nelson R. Ramírez-Rondán for suggestions regarding a research method that provided insight and expertise.

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