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The Importance of Agglomeration Economies and Technological Level on Local Economic Growth: the Case of Indonesia

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Abstract
The centralised regime and variation of resources have led persistent regional disparities in Indonesia. Presently, there is lack of study that examines the impact of agglomeration economies and technology of firm establishment on regional growth in Indonesia. This paper applies agglomeration economies, approximated using proxy variables of concentration of four largest sectors (CR4), specialisation (LQ), diversity (DIV) and competition (COM) variables and technological capacity, approximated by total factor productivity (TFP), to explain the impact of firm establishment on economic growth. The paper found that districts with less specialisation and more advance technology would have higher economic growth. The paper recalls the importance of higher share of high-tech industry and a more spatial dispersion of industry to accelerate economic growth.

Keywords Agglomeration economies · Technological level · Regional growth · Indonesia

Introduction

Studies on regional growth convergence have been for more than five decades. The neoclassical economy argues the process of regional convergence through cumulative causation and growth centre theories (Hirschman, 1957; Myrdal, 1957; Perroux, 1950) and recently diminishing returns that enable the catching up of lagging regions (Barro & Sala-I-Martin, 1991). On the other hand, the emergence of a new branch literature, the economic geography literature, emphasises the importance role of such technology and knowledge accumulation (Lucas,

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1988; Romer, 1990), and lately, the literature has attempted to demystify the black box of cumulative causation and growth centres using tangible data and measurements, such as spatial concentration of industry input-output linkages and technological variety (Rigby and Essletzbichler, 2002), the importance of proximity in the creation of economically useful knowledge in technology innovation (He & Wang, 2012; Sonn & Storper, 2008) and knowledge productivity that are more efficient in larger cities due to agglomeration economies (Dias, 1991; Fan & Scott, 2003; Sonn & Park, 2011).

However, presently, there is lack of study that explains the effect of agglomeration economies and technology level on regional economic growth under the context of decentralisation. As such, this paper attempts to bridge local economic growth literature and endogenous growth literature through analysis on the role of industrial structure and technological progress on local economic growth under decentralisation in developing countries.

Specifically, the research questions to what extent are the contribution of industrial concentration and technological level on local economic growth Indonesia districts (refers to both municipalities/*kota* and regencies/*kabupate*n), after decentralisation. In this paper, we employ the regional development in Indonesia as a case study for two reasons. First, the regional development and industry growth in Indonesia have been widely divergence, with development priorities in the Java island, whereas several metropolitans such Jakarta, Bandung and Surabaya host more than 30% of total firm establishment in Indonesia. As there are a rich data on firm establishment, the industrial studies have been extensively conducted in Indonesia including studies on manufacturing micro-data and productivity (Vial, 2006; Amiti & Konings, 2007; Daumal & Özyurt, 2011; Widodo et al., 2014, 2015; Khoirunurrofik, 2018), clustering of firms (Kuncoro, 2001) and linkages with policies and trade (Vidyattama, 2010, Topalova & Khandelwal, 2011; Negara & Adam, 2012; and Nehru, 2013).

Second, the introduction of decentralisation of political, administration and fiscal delegation to provincial and districts has delegate economic and industrial policies. Previous studies found evidence of declining inequality rate in the following decades as result of redistributive growth in the decentralisation period (Akita et al., 2011; Vidyattama, 2013).

This paper applies two approaches, first, the paper constructs agglomeration economy and TFP variables to capture the interest explanatory variables. Second, the paper employs the ß convergence model developed by Barro and Sala-I-Martin (1991), later modified for the panel fixed-effects in Barro (2015), to examine the level of local economic growth. Using this model, the paper hypothesis agglomeration economies and technology advancement lead to higher economic growth.

The structure of the article is as follows. In “Regional and Industrial Development”, we discuss the main theoretical framework and “Research Design” presents research design. In “Empirical Results”, we present and discuss the econometric results of the estimation model. “Conclusion and Contribution” presents our conclusions and suggests several policy implications.

Regional and Industrial Development

Endogenous Growth Model and Knowledge Creation

The endogenous growth concept of increasing returns implies two characteristics of regional development, which are agglomeration and geographical spillovers. We refer agglomeration as accumulation of knowledge and distance proximity, that lead the production of new ideas and technological know-how that is internalised in the production function. Here, the production function is determined by the number of workers in the knowledge-producing industries, the existing stock of knowledge and technological transfer (Romer, 1990). In this sense, variation between regional industrial policies and innovative environments determines both embodied and disembodied technological change (Pike et al., 2006, p. 104) and both technical progresses are both related with each other and should be treated simultaneously (Uri, 1983). Recent study by Busom and Velez-Ospina (2017) suggests that all types of innovations increase productivity of firms, although the magnitude varied between types of industry such as knowledge-intensive, manufacturing and retails. The model illustrates how technological change and innovation determine economic growth.

Second, endogenous model explains that knowledge is an increasing marginal productivity, which implies that local education and the transfer of knowledge are embedded and accumulate within each region (Romer, 1986). Thus, the non-rivalry and non-excludability of knowledge as a source of production are the main cause of knowledge spillovers. However, Romer (1990) also argues that knowledge is semi-non-excludable due to technological and knowledge mobility decrease as distance increases; thus, it is restricted and geographically limited. Hence, spillovers are bounded by specific locations where knowledge is exchanged and over time, leads to accumulation of knowledge and skilled workers.

The discussion above highlights that agglomeration and knowledge spillover are spatially bounded. In the case of decentralisation, variation of local endowments and policy design would exaggerate development gaps. As a result, appropriate industrial policies on agglomeration and knowledge spillover are required to prevent further regional economic divergence.

Decentralisation in Indonesia: a Regional Development Policy

After the fall of New Order regime in 1999, Indonesia embarks a new political and economic era that emphasises on decentralisation. Through the decentralisation laws (*undang-undang*) 22/1999 and 25/1999, the government established regional autonomy on both politic and fiscal decentralisation. These laws impact urban and regional development in Indonesia significantly, whereas the decentralisation law 22/1999 abolished the hierarchical relationship between the central, provincial and district governments and empowered the local governments and local parliaments. The Law 25/1999 regulated fiscal decentralisation that specifies each government levels fiscal rights and obligations (Booth, 2003).

Decentralisation has brought immediate change on regional development in Indonesia. For example, the early process of devolution highlights difference between levels of governments. For instance, in the first 3 years of devolution, out of 3510 local regulations on taxes and fees, 3312 of these have been scrutinised and evaluated, 237 were recommended for annulment and 108 cancelled by the Ministry of Home Affairs. In the environment and natural resource sector, decentralisation has very small contribution to empower regions to benefit from the natural resources of the conservation and cultivation area (Kartodiharjo & Jhamtani, 2006 p.64). Since the previous regime, natural resource sector has been managed by special ministerial agencies or state-owned enterprises.

In a broader scale, Java Island contributes 56% of labour and 31% of the value-added shares to the country. However, the manufacturing industry contribution on regional disparity has fallen from 25.5 to 22% between 1999 and 2004. On the other hand, service sector industries such as trade and transportation sector have increased its contribution on regional disparity, from 18.3 to 20.3% and 5.4 to 7.7%, respectively (Akita et al., 2011). Recent studies indicate that Indonesian regional disparities are found the highest between Java-Bali and the rest of the country due to comparative advantage that attracts the concentration of footloose industries (Hill, 2000; Akita, et al, 2011).

The above literatures suggest the critical shift of regional policy and capital expenditure that may result exaggerate regional economy differences in decentralisation. Contrary with the New Order regime in which industry policy and government expenditure are centralised, the decentralisation period witnesses delegation and authority of local governments on these issues. As a result, a decade of decentralisation suggests that increasing manufacturing development and variation of infrastructure expenditure may lead to increasing differences of regional policies and thus, local economic growth. However, it should be noted that this capital expenditure by the government is bounded by the spatial plan (*Rencana Tata Ruang Wilayah*/RTRW) that regulates spatial allocation of manufacturing and industrial development. Thus, manufacturing development and its spatial location is determined by local polices.

Industrial Development and Decentralisation

There are numerous studies on industrial concentration with its proxy variables. For instance, the study by Henderson (2003) suggests that localisation economies in high-tech industries could be assessed by looking at the number of plants in the same industry, as knowledge spillover within an agglomeration correlates to the number of firms. While the study by Hu et al. (2015) adds average output size of firms to capture both input (demand and labour pooling) and proxy of productivity, on the other hand, the study French firms, Martin et al. (2011) uses firm value-added, employees and capital to measure the agglomeration variable.

The study on manufacturing development is dominantly approximated by labour and value-added variables. In Indonesia, manufacturing industries are important for generating employment (Tham, 1997). The manufacturing and employment share of total industry are 24.7% and 13.9%, respectively. On the other hand, there is evidence of declining relative importance of manufacturing with the value-added share to GDP declining from 29.1 to 24.3% in 2001 and 2011, respectively (Nehru, 2013, p. 41).

The literature suggests that economic concentrated regions attract both manufacturing industries and market (Fujita et al., 2001). This is particularly true for the Indonesian manufacturing industry as Jakarta metropolitan area (JMA) hosted 26.7% of labour and contributed 19.2% of the value-added shares to the country's manufacturing industry in 1995 (Kuncoro, 2002).

A recent study on Indonesia's manufacturing industry indicates that Java Island consistently accounted for approximately 80% of employment and value-added total shares in Indonesia's manufacturing sector (Aritenang, 2016). The paper also found a shift in manufacturing towards West Java with a decline rate on Jakarta's employment share from 11.7 to 9.1% in the same period. In the Riau province, however, the Batam district retained the highest employment and value-added share within the province. It should be noted that despite its lower concentration of labour, the value-added share in Batam is slightly larger than the Bandung metropolitan area (Kuncoro, 2001). This finding confirms Batam's export-oriented production as a free-trade zone (FTZ) and its inclusion in the Singapore-Riau-Johor growth triangle, which benefited from industrial and knowledge spillovers (Aritenang, 2016).

The above discussion suggests that the level of concentration of manufacturing industries is influenced by national policies and the private sector's substantial role. There are at least two periods when the national policies determined manufacturing development. First, in the early period of the New Order Regime in the late 1960s, industrial development was supported through the industrial zones resulting in a concentration of industrial activities. Later, government enterprises and private companies introduce industrial parks that are equipped with specifically built production facilities and infrastructure. Thus, foreign and high-tech industries prefer to operate in these industrial parks, which are found in Jakarta Industrial Park Pulogadung (Hudalah et al., 2013, p. 9).

Second, the market-oriented policies in the 1980s, with deregulation and debureaucratisation, attracted domestic and foreign private investments (Hudalah et al., 2013). The manufacturing concentration and employment in the suburban industrial parks around Jakarta, not only in the traditional JMA, that include Bogor city and regency, Depok city, Tangerang city and regency, but also Serang city in the west (Banten Province) and Karawang regency in the east (West Java province). This suggests the declining role of metropolitan cores and followed by the increasing role of the respective suburbs, suggesting the importance of policies in shaping metropolitan spatial and economic structures (Hudalah & Aritenang, 2017).

Despite numerous studies on manufacturing performance and spatial distribution as discussed above, there are limited studies on the technological level and industrial concentration activities on local economic growth. In terms of technological level, there is a report by Santoso et al. (2012) that studies the technology readiness index[1] that shows that Jakarta has the most technology innovation products compared with other provinces in Java Island, despite that it has less agglomeration. This confirms the study by Shearmur (2011) that suggests that face-to-face contacts, knowledge spillovers and "buzz" are only a small part of innovation process, rather it is the access to innovation inputs both local and more distant that are important.

While other studies highlighted that technological level is spatially bounded, an analysis by Aritenang (2016) shows highly concentrated innovation activities in the manufacturing industry Indonesia (with a CV of 3.92). The highest dispersion (CV of 1.14) is found in East Java, while Riau and West Java have the highest spatial concentration of innovation activity (around 0.46–0.81), while other studies look at agglomeration economies, such as specialisation (MAR), location quotient (LQ), diversity externalities (DIV) and externalities (COM) and impact on manufacturing growth (Widodo et al., 2014, 2015; Khoirunurrofik, 2018).

Another estimation of research and development (R&D) data is using the total factor productivity (TFP). This approach has been widely used to estimate the impact of trade exposure on firm-level productivity such as in India and Indonesia (Amiti & Konings, 2007; Topalova & Khandelwal, 2011). The research on the role of TFP in Indonesian development is very limited. A preliminary study by Prihawantoro et al. (2012) uses TFP growth as a proxy for technological growth in three provinces in Indonesia. The study shows that technology's role in regional development is influenced by the macro economy as higher economic growth provides the necessary climate for technological use. Taking a more advanced step, Aritenang (2013) studies the role of TFP on regional development using an econometric approach. The study argues that the share of manufacturing industries influences the technological impact on regional development, while industrial agglomeration and interaction provide opportunities for the transfer and development of technology.

Despite that these studies have demonstrated that manufacturing industries are knowledge-producing and know-how are spatially bounded, there is lack of evidence on the importance of technological level and industrial concentration on local economic growth, as suggested by the endogenous growth literature.

Research Design

Data and Methodology

This paper studies for the period between 2006 and 2013, and it was chosen as the Central Statistics Office (*Badan Pusat Statistik*/BPS) changes the industry definition

[1] Technology readiness index refers to the market-ready level of a technology product. Please see Mankins (1995).

from International Standard Industrial Classification (ISIC) Revision 2, prior to 2006, to ISIC Revision 3 afterwards for the large and medium manufacturing industry (LMI) database. Correspondence between the two revisions due to difference among several detail categories has been reported to be impossible (Ramstetter and Narjoko, 2014).

There are two sources of statistics data for this paper. First, the Ministry of Finance website provides data on local fiscal decentralisation regarding annual budget, revenue, intergovernmental transfer and routine and development expenditures[2]. This paper only uses the capital expenditure data to capture the size of local governments' expenditure for capital and development.

The second source is the Indonesian LMI database published by BPS. The database contains more than 20,000 firms annually and includes information about manufacturing raw material sources, energy utilisation, number of labours and firm expenditure, capital stock, output and value added. The depth of data allows us to construct the TFP and the concentration of firms at the district level. The manufacturing industry data are aggregated to the district level. The data were aggregated at the district (municipality and regencies) as decentralisation and industrial policies are decided at this level. As there were dynamic regional splitting throughout the first decade of decentralisation (Hill, 2014), we define 418 districts as observation which is the number of districts in 2006, the first year of our period of analysis. It should be noted that due to data availability, the data is unbalanced and the missing data are interpolated with the average mean of nearest period that is available. As a result, of 418 districts, there are only 1996 observations for 7 years of analysis. Furthermore, to address firms' "entry" and "exit", the paper only uses firm that is in operation during the period of study.

Furthermore, we also obtain other data from BPS including GRDP data, share of urban population, share of population with high school education and share of road that is accessible by vehicle.

Methodology

This section provides explanation on econometrics equation for OLS and panel model fixed-effects (FE) as follows:

$$\begin{aligned}\text{Log } GRDPpc_{\mathrm{i,t}} - \log GRDPpc_{\mathrm{i,t-1}} = {} & \beta_0 + \beta_1(lnGRDP_{\mathrm{it-1}}) \\ & + \beta_2(lnAgglomeration\_economies_{\mathrm{it-1}}) \\ & + \beta_3(lnTFP_{\mathrm{it-1}}) + \beta_4(lnCapex_{\mathrm{it-1}}) \\ & + \beta_5(lnEduc_{\mathrm{it-1}}) + \beta_6(lnRoad_{\mathrm{it-1}}) \\ & + \beta_7(lnshare\_urban\_pop_{\mathrm{it-1}}) \\ & + \beta_8(D\_Metropolitan) + \varepsilon_{\mathrm{it}}\end{aligned} \tag{1}$$

[2] http://www.djpk.depkeu.go.id/

Table 1 Variable description

Variable	Explanation	Source	Explanation of data level
Growth per capita	Growth of GRDP per capita (log)	Ministry of Finance (MoF)	Districts
Economy Initial Level	GRDP per capita initial level (log)		
LnCapex	The size of district's capital expenditure		
LnPopulation	Number of population	Statistics Office (BPS) Data	
LnEduc_sen	Proportion of people that has high school education	SUSENAS from Statistics Office (BPS)	
LnRoad	Proportion of road that is accessible for vehicle	PODES from Statistics Office (BPS)	Village level aggregated into districts
Tech Level	Total Factor Productivity (log)	Data construction from Statistics Office (BPS)	Plant-level manufacture aggregated into district
Concentration	CR4 Production Value of 4 largest industries		
LQ (Firm)	Average of LQ per districts (Firm)		
Competitive	Competition size		
Diversity	Diversity Level		
Interaction	Jakarta*Concentration (CR4)		Districts

The dependent variable is the growth of GDRP pc for 2006–2013. The paper uses the panel fixed-effects analysis to capture regional characteristic effects. The model also includes year fixed-effect for factors changing each year that are common to all districts for a given year. This gives us more robust calculations since the variation of the numbers of firms within districts will be exaggerated. The above model follows the beta convergence model for fixed-effects in Barro (2015). The "Economy Initial Level" is the lagged GDP per capita for the panel regression.

The descriptive statistics of variables used in this paper are presented below (Table 1). The dependent variable is the growth of district GRDP per capita and the explanatory variables are the annual lag of district GRDP per capita, TFP and local expenditure.

Dependent Variable: District Gross Regional Domestic Product Growth

This paper uses the districts' growth GRDP per capita data. The data is available from the World Bank data website, The Indonesia Database for Policy and Economic Research (INDO-DAPOER).[3] The GRDP per capita is chosen because of two reasons. First, the GRDP per capita data is the most common measure of economic growth in previous studies on Indonesia (Pepinsky & Wiharja, 2011; Suwanan & Sulistiani, 2009; McCulloch & Syahrir, 2008; Resosudarmo & Vidyattama, 2006). Second, while the district GRDP and population survey is annual, alternative measures such as income per capita are not available annually in Indonesia.

Independent Variables

First, the effects of industrial agglomeration economies are approximated using few indices. We construct specialisation (MAR), externalities measured by location quotient (LQ), diversity or Jacobs' externalities (DIV) and competition or Porter's externalities (COM) following previous studies elsewhere (Glaeser et al., 1992; Widodo et al., 2015). The construction of each of these agglomeration economy indices is explained as follows.

The *Concentration* (CR4) is measured as the share of four largest firms in 2-digit ISIC level at each individual region. While the regional *specialisation* (LOC) measured by location quotient (LQ) to approximate regional specialisation and defined as the share of industry i's employment relative to total industry employment in a specific region j, compared with the share of region j's employment relative to total (provincial) employment in industry i (Glaeser et al., 1992; Henderson et al., 1995; Widodo et al., 2015) (see Eq. 2). The LQ measures the relative specialisation of a place in an industry against a national average (Boix-Domenech et al., 2015; Lazzeretti et al., 2008). A low index indicates a

[3] https://databank.worldbank.org/reports.aspx?source=1266

competitive industry with no dominant players. If all firms have an equal share, the reciprocal of the index shows the number of firms in the industry. When firms have unequal shares, the reciprocal of the index indicates the 'equivalent' number of firms in the industry.

$$LQ = \frac{l_i/l}{L_i/L} \tag{2}$$

where l_i = the number of high-tech firms in the region, l = total number of firms in the region; L_i = the number of high-tech firms in nationally and L = the total number of firms nationally (see also Boix-Domenech et al., 2015). Furthermore, LQs can also be calculated using employment data, rather than number of firms. However, the latter are more favourable as the employment data for regions outside of Java and Bali are unreliable (Fahmi et al., 2016).

Next, *The Diversity (DIV) define as the* Jacobs' externalities that are measured as the inverse of Hirschman–Herfindahl Index (HHI) in terms of regional specialisation (Widodo et al., 2015) (Eqs. 3 and 4). The DIVAj takes a value of I (the number of industries in the industrial classification) if industrial employment in region j is evenly distributed among all industries which are maximum diversification (Nakamura & Paul, 2009).

Competitive (COM) *is measured as ratio* of the employment-based location quotients to the plant-based location quotients (Widodo et al., 2015) (Eq. 5). If the employment-based LQ is larger than the plant-based LQ, then a region has a relatively monopolistic/oligopolistic regional economy, and if employment-based LQ is smaller than the plant-based LQ, then a region has a relatively small plant or competitive regional economy.

$$DIV_{\mathrm{j}}^{\mathrm{A}} = 1/\sum\nolimits_{i=1}^{I} \left(S_{\mathrm{ij}}^{\mathrm{S}}\right)^{2} \tag{3}$$

where as

$$S_{\mathrm{ij}}^{\mathrm{S}} = \frac{X_{\mathrm{ij}}}{\sum_{\mathrm{i}=1}^{\mathrm{I}} X_{\mathrm{ij}}} \tag{4}$$

share of industry i's employment relative to total industry employment in a specific region j

$$COM_{\mathrm{j}}^{\mathrm{A}} = LQ_{\mathrm{ij}}^{\mathrm{S(E)}}/LQ_{\mathrm{ij}}^{\mathrm{S(P)}} \tag{5}$$

Second, the estimation of TFP of each region follows the methods used by previous papers (Topalova and Khandelwal, 2011; Amiti and Konings, 2007). The firms' raw material inputs is used as proxies for unobservable productivity shocks to control for the simultaneity in the firms' production functions (Levinsohn and Petrin, 2003). The construction of this follows a Cobb-Douglas production function and requires data on the physical quantities of outputs, capital and intermediate inputs. Without firm-specific price deflators, we use the industry-specific deflators. As such, the TFP captures both technical efficiency and price-cost markups and technical efficiency. This method allows to construct the TFP by subtracting a firm i's predicted output from its actual output at time t (Topalova and Khandelwal, 2011). The following shows the TFP formula (Eq. 6) is as follows:

$$y_t = \beta_0 + \beta_k k_t + \beta_l l_t + \beta_r r_t + \beta_{fe} fe_t \tag{6}$$

where y_t is the log of gross output in year t, k_t is the log of the plant's capital stock, I_t is the log of labour input, r_t denotes log levels of raw materials and fe_t denotes fuels and electricity.

Finally, after the TFP value for each manufacturing plant is obtained, the paper clusters the plants into the districts where they are located.[4] This is conducted to capture the level of technology development of manufacturing within districts. TFP is expected to have a positive sign implying that local industries' technology level is associated with higher economic growth (Romer, 1986, 1990, 1994).

The above variables are expected to have a positive sign as larger manufacturing industry has the advantage of size and the market for innovation, which increase high productivity and economic growth (Tham, 1997). These variables are widely used to approximate manufacturing levels in both industrial studies in Indonesia (Negara & Adam, 2012; Vidyattama, 2010) and internationally (Nehru, 2013; Vial, 2006).

Control Variables

In line with previous studies, the capital expenditure on infrastructure and socio-economic infrastructure is used to examine the decentralisation effect. Districts with higher capital expenditure size would have more infrastructure development, and thus leading to larger economic growth variation among districts.

Finally, variables that control for explaining other determinants of regional performance, such as number of populations, proportion of people that has high school are also included in the models (Pepinsky & Wiharja, 2011; McCulloch & Syahrir, 2008). These variables are employed to examine the urbanisation level at the district level. The paper also uses capital expenditure to represent the level of decentralisation and regional institutional capacities.

To ensure that the models are robust and unbiased, we also conduct sensitivity analysis using the robust standard errors (Driscoll–Kraay standard errors based on Driscoll and Kraay (1998)) to avoid any presence of heteroscedasticity, autocorrelation and cross-sectional dependence. The study also employs natural logs for all variables to obtain normality of the data.

The descriptive statistics of variables are presented below (Table 2).

[4] This is done using STATA's built-in 'collapse' command, and the level of TFP of districts is simply the mean value of plants' TFP within the district.

Table 2 Summary statistics of variables

Variable	Mean	SD	Minimum	Maximum
Economic growth	0.016	0.021	−0.166	0.279
Economy initial level	15.376	0.600	13.464	18.589
LnCapex	25.497	0.712	18.194	28.146
LnPopulation	40.617	32.033	0.785	100.000
LnEduc_sen	46.606	13.478	1.350	86.620
LnRoad	0.862	0.197	0.034	1.000
Tech level (TFP)	9.500	1.022	5.293	13.250
Concentration (CR4)	0.447	0.235	0.072	1.000
Specialization (LOC)	5.384	10.258	0.614	305.869
Competitive (COM)	1.148	0.418	0.151	4.054
Diversity (DIV)	0.708	0.761	0.003	6.250
Interaction	0.220	0.871	0.000	6.977

All variables are in natural logarithm; LOC, COM and DIV are indexes; CR4 is in percentage; Rich Regions, Metropolitan and Interaction are dummy variables

Empirical Results

Before discussing the econometric analysis, it is important to examine the current state of industrial level across metropolitan areas in Indonesia (Table 3). There is a large variation of TFP per district, especially between metropolitan and non-metropolitan areas. On average, the non-metropolitan areas have a TFP level at 9.64 while the metropolitan areas have TFP at 10.25, suggesting higher average of technology level among these districts. The highest average TFP is found in Palembang, Jakarta and Semarang metropolitans, respectively. On the other hand, the CR4 index shows that Jakarta metropolitan has lower oligopolistic or monopolistic industrial structure, revealing more dispersed industries in Jakarta compared with Palembang.

This descriptive analysis suggests two important findings. First, we calculate the correlation between TFP growth and competitiveness of districts. The result is unexpected as the TFP has a low and negative correlation with district competitiveness in the metropolitan area (− 0.38) and even lower in the non-metropolitan (− 0.08). This suggests that the technological activities in the manufacturing sector are not related with district competitiveness level. Second, the TFP has a low and negative correlation with the concentration of manufacturing (LQ) in the metropolitan area about − 0.21 and lower correlation in the non-metropolitan areas at − 0.16. This simple analysis confirms various studies that suggest the limited innovation and R&D activities of manufacturing industries in the country (Kuncoro, 2012, p. 5; Hill and Tandon, 2010; Aminullah, 2000).

The following table presents the industrial concentration ratio (Table 4). From the table, it appears there are nine industries have an oligopolistic structure. Comparing with the result in 2009 from Widodo et al (2015) that analyse the period of 2009-2011, the number of sectors with industrial concentration ratios (CR4) higher than 40%, has reduce from 11 to 9 sectors and the average decline from 42.82% to 34.6%.

Table 3 Industrial indicator levels in Indonesia metropolitans, 2011

Districts		Tech level	CR4 (%)	Specialization (LOC)	Competitive	Diversity
Metropolitan areas						
1	Jakarta	10.433	0.488	1.674	0.950	0.459
2	Surabaya	9.702	0.523	1.750	1.033	0.190
3	Semarang	10.360	0.657	1.651	0.957	0.583
4	Medan	10.078	0.673	2.668	1.451	0.468
5	Bandung	10.291	0.524	1.044	0.884	0.128
6	Riau Islands	10.259	0.693	8.058	0.786	1.106
7	Palembang	10.505	0.853	3.033	0.815	0.486
	Metropolitan	10.249	0.589	2.406	0.975	0.458
Other areas						
1	Non Jakarta Metropolitan	9.684	0.821	8.227	1.190	0.886
2	Non Metropolitan Areas	9.643	0.833	8.590	1.204	0.914
3	All Districts	9.711	0.812	8.042	1.184	0.874

However, it should also be noted that the BPS has change the ISIC code between the period, thus the number of sectors has increased from 23 to 24 sectors.

The estimation results are presented in Table 5. First, all estimations have low explanatory power between 11.8 and 12.9% that suggests agglomeration economies and technological level play limited role on the variation of regional growth among Indonesian districts. For instance, using district characteristics and fiscal decentralisation variables, previous studies found higher explanatory power between 60 and 85% (Aritenang, 2020; McCulloch & Syahrir, 2008; Resosudarmo & Vidyattama, 2006).

Second, the five models of fixed-effect regression show that convergence is evident with significant β convergence suggesting that districts with higher initial economy levels have slower growth rates compared with the lagging districts. Both OLS and panel FE results are similar with previous findings on Indonesia convergence rate about 0.34% and 38%, respectively (Vidyattama, 2006; Resosudarmo & Vidyattama, 2006). The findings also confirm that cross-regional convergence rate, such as in Indonesia, is about 59.2% (Resosudarmo & Vidyattama, 2006), China (2.44–73.8%) (Zhang et al., 2019) and Turkey (25–26%) (Gömleksiz et al., 2017) that is much faster compared to cross-country convergence in Barro and Sala-I-Martin (1991) and Barro (2015) at about 2%.

Third, the table also provides evidence of the importance of technology level on the district's economic performance. A 1% increase in technology level would accelerate economy slightly higher than 0.1%. Next, both concentration variables, the concentration of four largest sectors (CR4) and coefficient of specialisation are insignificant and have negative effect. The CR4 has higher economic impact with a 1% increase that would lead the economy by about 1.7–1.8%. The industrial concentration (CR4) variable shows a negative sign, indicating that districts with

Table 4 Industrial concentration ratio (CR4) in 2-digit ISIC, 2011

ISIC	Industries	CR4 (%)
10	Food products	8.76
11	Beverages	24.02
12	Tobacco	53.45
13	Textiles	29.17
14	Wearing apparel	8.83
15	Tanning and dressing of leather	43.38
16	Wood and products of wood except furniture and plating materials	14.94
17	Paper and paper products	48.18
18	Publishing, printing and reproduction of recorded media	20.09
19	Coal, refined petroleum products and nuclear fuel	63.59
20	Chemicals and chemical products	46.49
21	Pharmacy, Medicine and Herbal products	66.48
22	Rubber and plastics products	36.64
23	Other nonmetallic mineral products	35.35
24	Basic metals	28.78
25	Fabricated metal products, except machinery and equipment	19.57
26	Radio, television and communication equipment and apparatus	30.50
27	Electrical machinery and apparatus n.e.c	25.87
28	Machinery and equipment n.e.c	31.77
29	Motor vehicles, trailers and semi-trailers	47.91
30	Other transport equipment	63.89
31	Furniture and manufacturing n.e.c	13.44
32	Other Manufacturing Industries	26.35
33	Reparation and Machine Assembling	43.57

Constructed from the Large and Medium Industrial Statistics 2011, Statistics Indonesia (Badan Pusat Statistik – BPS), author's calculation

higher average level of industrial competition are more likely to experience higher economic growth than districts with less competitive industry sector. This may also highlight the impact of persistent oligopolistic or monopolistic industrial structure on Indonesia's economic growth.

The negative sign of interaction variable between CR4 and metropolitan also confirms the significance of β convergence as higher initial economy and metropolitan districts experience slower growth than the lagging districts between 2006 and 2013. Furthermore, there is no evidence that industrial agglomeration and economies, both competitive and diversity, are significant for regional economic growth.

Furthermore, the table shows that the coefficient of specialisation (MAR externalities) is negative and significant at 1% suggesting that lower economic growth is found in regions with higher industrial specialisation. Thus, a region

Table 5 Determinants of regional economic growth 2006–2013

	Model 1		Model 2		Model 3		Model 4		Model 5	
Variables	Coefficient	*t*-Ratio	Coefficient	*t*-Ratio	Coefficient	*t*-Ratio	Coefficient	*t*-Ratio	Coefficient	*t*-Ratio
Economy initial level	−0.385***	−14.27	−0.396***	−14.65	−0.394***	−14.54	−0.388***	−14.22	−0.389***	−14.25
Capital expenditure	0.0205**	2.8	0.0187*	2.55	0.0196**	2.67	0.0193**	2.62	0.0188*	2.55
Share of urban population	0.00267***	3.41	0.00242**	3.1	0.00245**	3.13	0.00243**	3.1	0.00242**	3.09
Share of population with high school education	0.00187***	3.56	0.00200***	3.82	0.00197***	3.75	0.00204***	3.89	0.00204***	3.89
Proportion of road access	−0.0874**	−2.89	−0.0868**	−2.88	−0.0862**	−2.86	−0.0849**	−2.82	−0.0862**	−2.86
Tech level (TFP)			0.0282***	3.59	0.0285***	3.63	0.0270***	3.42	0.0265***	3.35
Concentration (CR4)					−0.0558	−1.40	−0.0534	−1.33	−0.0678	−1.63
Specialization (LOC)							−0.000779*	−1.99	−0.000772*	−1.9
Competitive (COM)							0.00647	0.47	0.00556	0.4
Diversity (DIV)							0.00132	0.17	0.00145	0.19
Concentration in metropolitan									0.041	1.28
Constant	5.367***	12.63	5.327***	12.58	5.309***	12.53	5.226***	12.28	5.263***	12.34
N	418		418		418		418		418	
R-square for panel	0.118		0.125		0.126		0.128		0.129	

*, ** and ***Significance at 1%, 5% and 10%, respectively. Dependent variable is the district GRDP growth

with more specialised in the industries in a particular region relative to the specialisation of industries in all regions, the less economic growth rate. This finding is in contrast with Khoirunurrofik (2018) that found specialisation is important for city-industry growth. One possible explanation for this contrary finding is that the above studies the impact of industrial structure on the TFP growth at the district level, while this paper studies on the district GRDP growth.

The competition or Porter's externality variable is positive indicating economic growth increase with higher level of competition. The estimation results indicate that the regions with high level of competition, or the regions dominated by small firms, tend to have higher economic growth. The results also mean that competitive regions tend to experience higher economic growth than oligopolistic or monopolistic regions, suggesting the importance of local competition on knowledge spillovers among firms. This confirms that competitive regions are positive for firm-level technical efficiency, especially with the presence of large-scale firms to the manufacturing industry (Widodo et al, 2015).

As expected, the impact of diversity or Jacobs' externality estimation results shows a positive relation between diversity and district economic growth. This indicates that a high level of firm diversity in a region tends to promote economic growth. This fact confirms that economic growth is more nurtured in regions where firms are more diversified of different industries than of the same industry. Furthermore, the Kuncoro (2012) and Widodo et al. (2015) studies argued that the magnitude of the influence of specialisation is greater than that of diversity, or localisation is seen to be stronger than urbanisation effects.

The control variable's significant value suggests that local economic growth is determined by the capital expenditure and the share of population that has a high school education. However, capital expenditure has much higher economic impact than the latter with a 1% increase in each variable would lead economic growth to about 2% and 0.3%, respectively. This finding highlights the importance of capital expenditure by the local governments. On the other hand, there are no evidence of urban agglomeration impact on economic growth, with the insignificance of share of urban population and the share of roads that is accessible by vehicle.

Conclusion and Contribution

This paper studies the effect of industry structure and technology level on local economic growth in Indonesia districts. The paper found that variables of interest, agglomeration economies and technological advancement are associated with higher economic growth. The negative significant effect of industrial concentration suggests that the more specialised the industries in a district relative to the specialisation of industries in all regions, the local economic growth is lower. This finding confirms Drucker and Feser (2012) finding that found that agglomeration does not directly lead to productivity. Furthermore, this finding confirms the presence of a critical level of concentration that determines economic growth as an excessive proportion of large monopoly firms, which aims for profit and lucrative production, which would depress innovation (Smulders & Klundert, 1995). Thus, industry concentration leads to economic growth only if there is learning externalities, in which it is not found in this study.

Our finding confirms the significant contribution of high-technology on spatially dispersed industrial concentration. As argued elsewhere, the findings suggest that expenditure on research and development, and the size of urban area, as approximated by the industrial concentration and urban population, are associated with more advance development (Aritenang & Sonn, 2018; McCulloch & Syahrir, 2008; Resosudarmo & Vidyattama, 2006). The study also shows that regions with higher endowments and industry specialisation contract regional economic growth, partly due to the fact that lack of competitiveness of these regions is lower to its counterparts, as also found in the global north (Drucker, 2011; Meijers & Burger, 2010; Rodriguez-Pose & Hardy, 2017).

The research contributes to the economic geography literature in two arguments. First, the significant proportion of high-tech industry within regions to accelerate economic growth. The technology advancement may represent the knowledge creation; one side is the capacity on knowledge management and on the other, the development of knowledge competencies to ensure learning capabilities (Qvortrup, 2010 p.267). Furthermore, our study confirms Klein (2019) that foreign firms are lack of strategies on technology transfer to domestic firms; productivity spillovers from FDI-supported firms are locally bounded. This result explains previous studies' argument that productivity spillovers are higher for regions near to metropolitan city such as Jakarta metropolitan area (JMA) that hosts high-tech and global manufacturing industries (Firman, 2002; Hudalah et al., 2013; Indraprahasta and Derudder, 2019).

Second, central government experiences to develop industrial zones would be valuable to strengthen decentralisation by policies that expedite agglomeration and urbanisation economies to generate new polycentricities. Specifically, industrial policies that accelerate capital expenditure to improve local endowments and infrastructure to develop new urbanised cities that would prevent over-agglomeration of industry sector or districts, which in turn, promotes urban polycentricity. As urban polycentric promotes the dispersion of space and reducing long-distance travel (Sorensen & Okata, 2011), in the long run, polycentric improves wider access to urban services and employment opportunities, and hence, accumulating agglomeration economies and economic growth.

Declarations

Ethics Approval and Consent to Participate This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of Interest The authors declare that they have no conflict of interest.

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