The influence of agglomeration externalities on five-digit manufacturing growth within Indonesian locations

Abstract

This paper investigates the influence of agglomeration externalities on the growth of manufacturing at the five-digit sector and firm level in terms of employment, value added and labor productivity for Indonesian cities and regencies between 2000 and 2009. Urbanization, competition, specialization and a set of varieties are tested; in particular, a measure of variety without any sectorial linkages is decomposed into related and unrelated using the industrial classification and technology intensity industries in order to assess their idiosyncratic economic roles within locations. The findings of this research support the conceptualization that economic relatedness and diversity are the preponderant sources for sectoral and firm manufacturing growth within locations. Whereas, specialized clusters and competition are inversely related to manufacturing growth though the latter source fosters the sectoral employment within Indonesian regencies.

Key words: Agglomeration externalities, related and unrelated varieties, Indonesia.

JEL Classification: D62, O18, R11

1. Introduction

Indonesia has witnessed deep transformations in terms of industrial scale and structure, urban concentration, socio-economic conditions, and this transformation has been characterized by stable economic growth. During the period beginning in 2000 and ending in 2009, Indonesian GDP grew annually between 4% and 6%, GDP per capita increased between 2% and 5%, the population grew between 1% and 2% (World Bank 2014). People living within urban centers accounted for 42% (2000) and 49% (2009) of the total population (almost a quarter of a billion), and more than a half lived in urban areas in 2011 (World Bank 2014). Given the large Indonesian market, there is a notable tendency of industries to re-focus on domestic markets. The exportation of goods and services, as a percentage of GDP, markedly decreased from 41% in 2000 to 24% in 2009. Manufacturing exports, as a percentage of merchandise exported, decreased from 57% in 2000 to 41% in 2009 (World Bank 2014). In the same period exports of high technology industries declined from 16% in 2000 and 13% in 2009 of total manufacturing exports (World Bank 2014). Despite the reduction of exports, medium and large manufacturing industries have experienced significant growth in terms of number of establishments with around 11% between 2000 and 2009 (Badan Pusat Statistik 2014).

From the dataset used in this paper we see that manufacturing localization and growth has not spread all over Indonesia, but tends to cluster in certain locations between 2000 and 2009 such as the cities of Jakarta (with particular reference to its Northern and Eastern areas), Tangerang, Bandung and Surabaya, and the regencies of Tangerang, Bogor, Bekasi, and Bandung. Although Java Island is characterized by the highest concentration of manufacturing within the country between 2000 and 2009, Indonesia has witnessed diverse manufacturing growth where numerous locations with lower economic agglomeration growth faster than denser locations. In addition, numerous industries have higher performance within regencies characterized by lower competition and cost of factors of production, though established firms are more productive within Indonesian cities characterized by large local demand, heterogeneous industries, avalibility of skilled workers, and localization of high and medium-high technology intensity industries. Thus some questions emerge: Why economic activities have higher growth in certain places and under a certain industrial regime? What are the determinants of such growth? A large body of literature has been made in order to explain these questions; theoretical and empirical literature point out that firms and workers have higher performance within large and dense economic environment though this arises costs of agglomeration (see, for instance, Puga 2010; Rosenthal and Strange 2004; Melo, Graham, and Noland 2009). This can be associated with the proximity effect of economic activities, from which arises agglomeration externalities. Moreover, a more recent vein of literature refers to the Darwinian selection of firms as competition pushes weaker economic activities out from the market where the most efficient and innovative firms survive enhancing their performance and the relative aggregations (i.e. sectors and locations) (Combes et al. 2012; Duranton and Puga 2003; Melitz 2003).

Although, there is a general agreement among researchers that agglomeration externalities play a paramount role in regional innovation and growth (Karlsson and Manduchi 2001), scholars debate which externality is the most important for economic expansion of a location and knowledge spillovers, and under which market structure the innovation is optimized (see, for instance, de Groot, Poot, and Smit 2009; Beaudry and Schiffauerova 2009; Feldman and Audretsch 1999; van der Panne 2004). This debate has increased over time as researchers have found evidence to support different theoretical conceptualizations (see, for instance, Henderson

1986; Glaeser et al. 1992). A potential source of this inconclusive debate might be due to different types of sectors analyzed (Bishop and Gripaios 2010), methodologies employed and misspecification of economic variety (Boschma, Minondo, and Navarro 2012). Jacobian externalities (Jacobs 1969) are commonly measured as general variety without differentiating sectoral linkages, though it incorporates two idiosyncratic economic effects: location resilience to external industry-specific demand shocks and inter-industry knowledge spillovers. This study aims to contribute to the aforementioned academic debate by using several measures of agglomeration externalities to assess the influence of urbanization, specialization, competition, and industrial varieties on the five-digit sectors and firms' growth in terms of employment, value added and labor productivity within Indonesian cities and regencies between 2000 and 2009. In particular, industrial variety is decompose into unrelated and related varieties using entropy indices as proposed by Frenken, van Oort, and Verburg (2007) based on the Indonesian industrial classification (KBLI 2005) and technology intensity classification (OECD 2011) in order to assess more accurately their idiosyncratic economic roles. All explanatory variables are measured at the first time point of the full dataset (2000) underlying the notion of path dependency mechanism of agglomeration economies, which can explain the sectoral and firm' growth between 2000 and 2009. The data employed refers to established manufacturing sectors and firms that are present within Indonesian regencies and cities during 2000 and 2009. We find evidence to support the conceptualization that Jacobian externalities (Jacobs 1969), computed as general variety and related varieties, are the preponderant sources for manufacturing growth, whereas specialized clusters negatively influence it contradicting the assumption of the MAR model (Glaeser et al. 1992).

To our knowledge, no similar studies have been conducted in Indonesia and most work has considered developed economies (see, for instance, Frenken, van Oort, and Verburg 2007; Bishop and Gripaios 2010; Boschma and Iammarino 2009; Quatraro 2010; Boschma, Minondo, and Navarro 2012). Also, numerous researchers have focused their attention within cities since they argued that the most innovations are generated within urban areas given by their economic dense proximity (Glaeser et al. 1992; Henderson, Kuncoro, and Turner 1995). We extend our investigation to wider geographic scales (Indonesian regencies), since due to recent technological progress, the close proximity has become less relevant in order to build inter and intra-linkages between economic activities (Bathelt, Malmberg, and Maskell 2004; Rallet and Torre 1999). In addition, agglomeration externalities are often tested on aggregation growth (i.e. locations and sectors) omitting their micro-foundation nature and the micro level heterogeneity losing information regarding single units, and often without considering the unobservable characteristics of observations causing a potential estimation biased. Thus, this paper also aims to addresses these issues testing the agglomeration externalities at the sectoral and firm level controlling for unobservable characteristics of two broader groups: two-digit sectors and provinces, which ensures that our estimates are not affected by the variation of their developments that are unrelated to five-digit sectors and Indonesian cities and regencies characteristics.

The rest of the paper is organized as follows. In section 2 we outline the theoretical framework of agglomeration externalities and the idiosyncratic economic effects of related and unrelated varieties. Section 3 we examine the agglomeration externalities measures employed. Section 4 is devoted to illustrate the dependent variables and the specification of the models. Section 5 we illustrate the data sources and the description of the datasets employed. Section 6 the empirical results are presented and discussed with regard to employment, value added, and labor productivity growth at the sectoral and firm's level. Section 7, we summarize our results and discuss them in the light of the effects of agglomeration externalities on the overall manufacturing growth and their relative policy implications. Finally we provide conclusions, limitations and suggestions for further research in section 8.

2. Theoretical framework

2.1. Agglomeration economies

Agglomeration economies can be categorized into three main forces: localization externalities, Jacobian externalities, and urbanization externalities. They explain economic agglomerations and knowledge spillovers in three different ways: 1) firms are encouraged to operate in proximity within the same industry due to intra-industry knowledge spillovers (Glaeser et al. 1992); 2) firms take advantages of locating their activities close to other industries exploiting inter-industry knowledge spillovers (Jacobs 1969); and 3) economic localization occur regardless of the nature of established industries since benefits arise from a dense and heterogeneous environment within a location, in terms of population, R&D centers and business services among other "pull" forces, which foster the outputs of all firms localized in the area (Hoover 1937). Agglomeration externalities can be generated through industrial configuration of inter and intra-industry establishments and/or large market size generating a mechanism of economic path-dependency. There is not doubt that economic proximity arise agents' benefits, which can be associated with sharing facilities and infrastructures, availability of a large and skilled labor pool, large and heterogeneous suppliers, gaining from external economies, better matching between agents, and learning through knowledge exchange due to interactions between agents (Duranton and Puga 2003). However, agents' concentration arises the costs of agglomeration such as pollution, congestion, and local market competition creating selection of firms where the weaker economic activity is forced to exit from the market and the most efficient and innovative firm survive (Melitz 2003; Melitz and Ottaviano 2008). The trade off between agglomeration benefits and costs make a location more or less competitive in attracting economic activities and dwellers.

Marshall (1890) examined pecuniary and technological externalities in order to explain the formation and development of economic agglomerations, he theorized the concept of external economies in the production process within a specialized cluster in the presence of mass production (analogous to economies of scale at the firm level). Marshall argued that a specialized conglomeration allows the reduction of transaction and coordination costs, and increase networks of relationships facilitating knowledge exchange with positive implications for firms' innovation, creativity, and idea transfer. Glaeser et al. (1992) extended the idea of Marshallian externalities, combining the works of Arrow (1962) and Romer (1986), into what has become known as the Marshall-Arrow-Romer (MAR) model. However, Glaeser et al. (1992), in their studies, find evidence of Jacobian externalities (computed as general variety without any sectorial linkages) as the main source of city's growth. The MAR model points out that knowledge spillovers are predominantly industry-specific as intra-industry linkages foster flows of know-how, which stand behind firms' innovation capability and growth. Thus, we expect to see higher manufacturing growth within locations with higher specialization. Although distance can be seen as an important factor since ideas are more easily transferred among firms in close proximity rather than far way, knowledge spillover can be also seen detached from the regional context since it can occurs between agents often not in proximity (Breschi and Lissoni 2001). The MAR model also supports the Schumpeterian idea that local monopolies foster innovation in contrast with the view of Porter (1990) of local competition, though this latter author agreed with the MAR's conceptualization that knowledge spillovers are more predominantly industry-specific.

Hoover (1937) introduced the concept of urbanization economies and distinguished between localization and urbanization externalities, where localization externalities are internal to a given industry and external to the firms, whereas urbanization externalities are internal to the city and external to the industry. Hoover (1937) suggested that urbanization externalities foster the output of all firms locates in a given area increasing the dimensions of the overall economy. Often, urbanization externalities have been associated with the Jacobian externalities since they have been measured as general variety without considering any sectoral linkages. However, it is more appropriate to associate urbanization externalities with urban scale and density, which foster the localization of heterogeneous industries, a larger and more diverse labor pool, highly educated workers, universities, R&D centers and business services (Harrison, Kelley, and Gant 1997; van Oort et al. 2012). Thus, we expect to have a higher degree of unrelated variety within locations with higher population levels and this should then have positive implications for location's employment growth. Henderson (1986) argued that high local demand refers to urbanization externalities, though it does not fully explain why firms from different industries want to locate in close proximity to each other, in contrast to the Krugman's model (1991, 1991) of city formation based on local demand. Henderson (1986) supported the idea that the main driver of innovation and growth stems from intra-industry knowledge spillovers. Embracing the idea that urbanization is more associated to large and dense local demand, Krugman (1991, 1991) points out that the market-size effect through linkages is the main cause of agglomeration genesis and development, which are the result of migratory flows of workers enlarging or shrinking local demand, generating economic asymmetry and symmetry due to an invisible hand mechanism of backward (demand side) and forward (cost side) path-dependence linkages.

In contrast with the MAR model, Jacobs (1969) argued that the diffusion of knowledge is more relevant between complementary industries rather than within the same industry, since innovation generated by an industry could be applied to other related industries. Jacobs (1969) also supported the idea that local competition better facilitates inter-industry knowledge spillovers, and this also drives localization economies. However, Jacobian externalities measured as general variety without any sectorial linkages incorporate two idiosyncratic economic roles within a location (Frenken, van Oort, and Verburg 2007): the degree of location resilience to external industry-specific demand shocks, which stems from industrial portfolio diversification (Conroy 1974, 1975); and inter-industry knowledge spillovers due to ideas transferring across industries (Jacobs 1969). In order to assess these two distinct effects, it is necessary to rethink the measure of variety employed. Recently, Frenken, van Oort, and Verburg (2007) disaggregated variety into related and unrelated based on sectoral interconnectedness in order to distinguish and measure more accurately their idiosyncratic economic role within locations. Although, the cognitive proximity between sectors can be defined in numerous ways, it should be based in terms of explicit economic relationships such as type of sector and sectorial interaction based on, for instance, production process and inputs, technology used, and sharing the same infrastructures; rather than just number of sectors (Siegel, Johnson, and Alwang 1995).

We distinguish large and small cognitive distance between industries in order to decompose general variety into unrelated and related varieties. The former concept recalls the notion of portfolio diversification effect since a higher degree of diverse economic activities protects locations from external industry-specific demand shocks, increasing regional stability, and more balanced growth where given sectors perform better than others (Essletzbichler 2007; Siegel, Johnson, and Alwang 1995). The portfolio effect was originally conceptualized and adopted as a strategy to reduce the risk of financial assets through diversification (see, for instance, Markowitz 1959). Conroy (1974, 1975) suggests a portfolio-theoretic approach to regional economic diversity and diversification in order to reduce the risk of regional instability associated with a high degree of specialization in a location. The degree of heterogeneous configuration is more associated with the level of local demand rather than industrial regime since a large market is characterized by diverse customers' needs favoring the localization of unrelated varieties. However, the geographic concentration of unrelated sectors within a location is not purely random, as a certain degree of coherence can exist between related established sectors within locations (Neffke 2009). Also, Porter (1990) recognizes the importance of diversified clusters within locations since institutional organizations should create the environmental conditions to support the development of heterogeneous activities, since the future success of an economic agglomeration is unpredictable. Institutions can reduce the risk of a cluster's failure by promoting diverse specialized agglomerations increasing the location resilience and achieving more balanced growth.

Related variety is more associated with inter-industry knowledge spillovers since knowledge is likely to be transferred between related industries with some degree of cognitive proximity rather than unrelated industries with large cognitive distance (Nooteboom 2000; Frenken, van Oort, and Verburg 2007). However when the cognitive proximity is too high among agents (specialization), this might generate a lock-in effect as the relevance of the learning process becomes less effective due to the similarity of agents' expertise (Nooteboom 2000; Boschma 2005). The relatedness of varieties can also support the genesis of new related branches of economic activities through the recombination of competences from different sectors (Boschma and Frenken 2009; van Oort 2004). Existing sectors are expected to foster related activities within a location rather than unrelated sectors due to knowledge spillovers from established sectors to their related sectors generating regional branching (Hidalgo et al. 2007). Thus, we expect to have high sectoral and firm' growth in locations with higher degree of related variety. Given the importance of interconnectedness between sectors and economic resilience within a location, the reconceptualization of variety can provide for researchers and policymakers with more insights into locations' economic growth since it can be pursued by promoting economic diversification and the identification of key regional sectors characterized by large inter-sectorial linkages.

3. Measuring agglomeration externalities

In order to investigate the influence of agglomeration economies on five-digit manufacturing growth, we employ several indicators computed at the initial time within the full dataset of the annual survey of large and medium manufacturing industries in 2000. We employ the location quotient (LQ), which measures the locational ratio of employment in a focal area with respect to its aggregation in a particular sector defined as follows:

$$LQ_{r,i} = \frac{e_{r,i} / \sum_{i=1}^{N} e_{r,i}}{\sum_{r=1}^{R} e_{r,i} / \sum_{i=1}^{N} \sum_{r=1}^{R} e_{r,i}} \tag{1}$$

where $e_{r,i}$ represents the annual average of total workers per working day of five-digit sector r (=1,2,...,R) within a location i (=1,2,...,N). The location quotient is defined as the share of employment of five-digit sector r within location i with respect to the share of its aggregate employment. We also assess the degree of local competition of five-digit sector by measuring the ratio of the number of establishments per employee within a location i with respect to the ratio of number of firms per worker of the same five-digit sector r at the national level. It can be expressed as follows:

$$COMP_{r,i} = \frac{f_{r,i} / e_{r,i}}{\sum_{r=1}^{R} f_{r,i} / \sum_{r=1}^{R} e_{r,i}} \tag{2}$$

where $f_{r,i}$ denotes the number of firms in sector r within location i. The $LQ_{r,i}$ and $COMP_{r,i}$ denote overrepresentation (higher sectoral specialization or competition within a location in comparison to the national level) when the value is greater than 1, whereas underrepresentation is denoted with values lower than 1. The $LQ_{r,i}$ and $COMP_{r,i}$ measures the relative sectoral specialization and competition within a location and have an important advantage that they allows comparison between coefficients with regard to a certain time and over time within and across locations, useful to overseeing the evolution of locations towards a more or less sectoral specialization and competition. We also employ the entropy formula in order to measure unrelated and related varieties as proposed by Frenken, van Oort, and Verburg (2007). The first conceptualization of entropy was elaborated by Boltzmann (1877), and Shannon (1948) developed its probabilistic interpretation. The first economic application of entropy measure goes back to Henri Theil (1972, 1967), who applied it in information theory, and afterwards numerous researchers have employed entropy statistics within numerous economic fields such as: industrial concentration, regional diversification, income inequality, among others. Entropy can be considered as a measure of uncertainty or probability that a certain event occurs. It has an attractive and superior advantage in comparison to other statistics (i.e. Herfindahl index) due to the decomposition analysis, which allows aggregation and disaggregation of the entropy formula through its property of additivity (see, for instance, Theil 1972). Thus, it represents a suitable measure to disentangle general variety into related and unrelated varieties. We employ a decomposition of general variety based on industrial classification though it does not capture other possible elements that make two sectors interconnected such as technology, same regulatory framework, and the use of the same infrastructure, among others interconnectedness. Therefore, we adopt an alternative decomposition of relatedness based on manufacturing classification of technology intensity industries proposed by OECD (2011). The general variety index for Jacobian externalities in the old fashion without taking into account any sectoral linkages can be expressed as the sum of entropy at the five-digit level by weighting its share values (p_r) by their respective probability ($1/p_r$) given as:

$$VARIETY_i = \sum_{g=1}^{G} p_r \, log_2\left(\frac{1}{p_r}\right) \tag{3}$$

where p_r represents the five-digit sector share with a location i and g (=1,2,3...G) denotes the two-digit industry. $VARIETY_i$ indicates the degree of location diversity in its economic composition where a higher value corresponds to higher economic diversification and vice versa. Given the property of additivity of the entropy measure, $VARIETY_i$ can be decomposed as the sum of the between-group entropy referring to unrelated variety (UV_i) and the average within-group entropy denoting related variety (RV_i) (see for the decomposition theorem, Theil 1972) as follows:

$$VARIETY_i = \underbrace{\sum_{g=1}^{G} P_g log_2\left(\frac{1}{P_g}\right)}_{\textit{Unrelated variety}} + \underbrace{\sum_{g=1}^{G} P_g\left(\sum_{r\epsilon S_g} \frac{p_r}{P_g}\ log_2\left(\frac{1}{p_r/P_g}\right)\right)}_{\textit{Related variety}} \quad (4)$$

The between-group entropy computed for unrelated variety can be defined as the weighted sum of entropy at the two-digit level (S_g) within location *i,* where P_g is the sum of two-digit share, in which *r* falls exclusively within a two-digit sector S_g within a location *i,* as follows:

$$P_g = \sum_{r\in S_g} p_r$$

The higher value of UV_i denotes higher portfolio diversification at the two-digit level increasing location resilience to industry-specific external demand shocks, and vice versa. Whereas, the related variety can be defined as the five-digit sectors weighted sum of the entropy within each two-digit industry, which is the average within group entropy. A higher value of RV_i indicates a higher degree of sectoral interconnectedness within the two-digit industry in a location, and vice versa. Related variety can be associated with inter-industry knowledge spillover since it is more likely to flow among related economic activities than unrelated. We compute UV_i and RV_i using the Indonesian industrial classification (KBLI 2005, which is based on ISIC Rev. 3). However, this could be seen as a shortcoming since the industrial classification does not capture other possible elements that make two sectors interconnected. Thus, a further decomposition of related variety have been adopted using the manufacturing classification of technology intensity industries proposed by OECD (2011). It classifies technology intensity manufacturing industries into four classes based on the relationship of R&D expenditure, value added and production activities. Hartog, Boschma, and Sotarauta (2012) use a similar methodology to compute their high-tech, and low and medium-tech related varieties. Based on OECD's classification (2011), we construct two classes of technology intensity industries merging high with medium-high technology industries, and medium-low with low technology intensity industries. Based on these aggregations, we compute two indicators of relatedness: $RVHMH_i$ (high and medium-high technology intensity industries) and $RVMLL_i$ (medium-low and low technology intensity industries). These indices can be useful to unfold whether related variety with different degrees of technology intensity influence the five-digit sectors and firms' growth within Indonesia regencies and cities.

4. Model specification

We employ the five-digit average annual employment growth rate between two points in time (2000 and 2009) as a predicted variable. This type of measure has been adopted by numerous authors as a proxy for manufacturing growth though it does not accurately assess the increase of productivity due to the learning process (Hartog, Boschma, and Sotarauta 2012). Thus, we also employ the five-digit average annual sectorial value added and labor productivity growth rates between 2000 and 2009 in order to determine more precisely the idiosyncratic influence of agglomeration economies on manufacturing growth within Indonesian locations. The three dependent variables are defined as follows:

$$EMPGROWTH_{r,i} = 100 \cdot \left(\log\left(E_{r,i,2009}\right) - \log\left(E_{r,i,2000}\right)\right)/9 \tag{5}$$

$$VAGROWTH_{r,i} = 100 \cdot \left(\log\left(VA_{r,i,2009}\right) - \log\left(VA_{r,i,2000}\right)\right)/9 \tag{6}$$

$$PRODGROWTH_{r,i} = 100 \cdot \left(\log\left(VA_{r,i,2009}/E_{r,i,2009}\right) - \log\left(VA_{r,i,2000}/E_{r,i,2000}\right)\right)/9 \tag{7}$$

where $E_{r,i}$ represents the annual average of total workers per working day of five-digit sector r in location i, and $VA_{r,i}$ denotes the value added of r within i, which has been deflated based on the Indonesian Consumer Price Index (CPI). The year is indicated by subscripts. $EMPGROWTH_{r,i}$ refers to the five-digit average annual employment growth rate within a location between 2000 and 2009. $VAGROWTH_{r,i}$ indicates the average annual value added growth rate of five-digit sector r within i between 2000 and 2009. $PRODGROWTH_{r,i}$ denotes the average annual labor productivity growth rate in r within i between 2000 and 2009. Although, the value added per worker is commonly used to measure labor productivity though labor productivity is partially measured, since it is computed based on a single factor of productivity but also depends on the degree of other inputs utilized in the production process such as capital, intermediate inputs and technology (see, for instance, OECD 2001). However, this requires more data that is not available in our datasets. Furthermore using the same structure of equation 5, 6, and 7, we compute manufacturing growth at the firm level f (=1,2,3...,F) for employment ($EMPGROWTH_{f,r,i}$), value added ($VAGROWTH_{f,r,i}$) and labor productivity ($PRODGROWTH_{f,r,i}$) of f which belongs to a five-digit sector r within location i. We construct our OLS models to estimate the relationship of the predictors with the average annual employment, value added and labour productivity growth rate of five-digit sectors and firms manufacturing within Indonesian cities and regencies between 2000 and

2009. Furthermore, in order to capture the heterogeneity of unobservable characteristics within sectors and geographical areas, we control for the fixed effects of two-digit sectors and provinces. The baseline model for sectoral growth is defined as follows:

$$y_{r,i} = \alpha + \beta_1 \mathrm{EMP}_{r,i} + \beta_2 \mathrm{VAEMP}_{r,i} + \beta_3 LQ_{r,i} + \beta_4 COMP_{r,i} + \beta_5 \mathrm{POPDEN}_i + \beta_6 \mathrm{HUMCAP}_i + \beta_7 \mathrm{VARIETY}_i + \sum_{g=1}^{G} \delta_g SECT_g + \sum_{v=1}^{V} \theta_v PROV_v + \varepsilon_{r,i} \quad (8)$$

where $y_{r,i}$ is the response variable for either employment growth ($EMPGROWTH_{r,i}$), value added growth ($VAGROWTH_{r,i}$) or labor productivity growth ($PRODGROWTH_{r,i}$) within five-digit sector r and location i. The right-hand side of the model includes sector-specific and location-specific characteristics. In addition to the measures previously exposed, we include sectoral employment ($EMP_{r,i}$) and labor productivity ($\mathrm{VAEMP}_{r,i} = VA_{r,i,2000} / E_{r,i,2000}$) within r in location i at the initial time in order to unfold if their initial status fosters further growth. Also, we incorporate the urban population density ($POPDEN_i$) computed as the ratio of number of people within households in a location over its area size, considered as a proxy of urbanization; and the share of number of scholars who have completed the secondary and tertiary level of education within a location over its aggregation of all country ($HUMCAP_i$), as a proxy for relative human capital concentration. $SECT_g$ and $PROV_v$ are dummy variables in order to control for the fixed effects within two-digit sectors g and provinces v (=1,2,3...,V) respectively. Whereas β, δ and θ are the parameters to be estimated, which determine the slope of the relative variable. Whereas, $\varepsilon_{r,i}$ represents the disturbance term. Furthermore, we estimate a similar model at the firm level defined as follows:

$$y_{f,r,i} = \alpha + \beta_1 \mathrm{EMP}_{f,r,i} + \beta_2 \mathrm{VAEMP}_{f,r,i} + \beta_3 \mathrm{FSMALL}_{f,r,i} + \beta_4 \mathrm{FLARGE}_{f,r,i} + \beta_5 LQ_{r,i} + \beta_6 COMP_{r,i} + \beta_7 \mathrm{POPDEN}_i + \beta_8 \mathrm{HUMCAP}_i + \beta_9 \mathrm{VARIETY}_i + \sum_{g=1}^{G} \delta_g SECT_g + \sum_{v=1}^{V} \theta_v PROV_v + \varepsilon_{f,r,i} \quad (9)$$

where $y_{f,r,i}$ represents either employment growth ($EMPGROWTH_{f,r,i}$), value added growth ($VAGROWTH_{f,r,i}$) or labor productivity growth ($PRODGROWTH_{f,r,i}$) at the firm f which belongs to a five-digit sector r and location i. From the equation 8, we substitute the number of employment and labor productivity at firm level f within sector r and location i ($EMP_{f,r,i}$ and $VAEMP_{f,r,i}= VA_{f,r,i,2000} / E_{f,r,i,2000}$, respectively). We also introduce dummy variables for small and large firm' size, where a small firm is defined between 20 and 49 ($FSMALL_{f,r,i}$) workers and large equal and over 250 ($LSMALL_{f,r,i}$). These are included in our model since the highest average firm' growth is given by small firms, and large firms can influence the overall manufacturing growth within Indonesian locations since they lead large operations (see **Figure 1**). In addition, we extend the equations 8 and 9 by disaggregating variety ($VARIETY_i$) into unrelated (UV_i) and related (RV_i) varieties based on KBLI 2005, and the latter indicator is further decomposed into high and medium-high ($RVHMH_i$), and medium-low and low ($RVMLL_i$) technology intensity related industries based on OECD's classification (2011). All explanatory variables are assesed at the initial time point to identify the impact of the initial conditions on manufacturing growth within Indonesian cities and regencies, underling the notion of path dependency mechanism of agglomeration externalities. We expect to have locations with higher intial status grow faster than locations with lower values. All continuos predictors are log transform with exception of the set of varieties and we control for heteroskedasticity running all regressions using robust standard errors.

5. Data sources and description

Raw data are collected from the Badan Pusat Statistik (BPS, which is the Indonesia Statistic Office) from the annual survey of large and medium manufacturing industries (with more or equal to 20 employees) of 2000 and 2009, with reference to five-digit manufacturing firms within regencies and cities. The Indonesian industrial classification code refers to KBLI 2005, which is based on ISIC Rev.3. For each observation, we obtained data with regard to the annual average of total workers per working day and value added. The two datasets have been matched selecting five-digit sectors and firms within Indonesian cities or regencies between 2000 and 2009. These observations can be considered as firms and sectors that survive and evolve over time within Indonesian locations. Moreover, several locations in 2009 have been merged as new administrative units have been created in Indonesia during the period of time considered. The aggregation was straightforward since their genesis was made over only one location. Furthermore, we check for outliers within the dataset and forty-one five-digit sectors and thirteen firms' observations have been excluded from our estimations. As a result we constructed two datasets for sectors and firms, the latter includes 244 five-digit sectors within 162 Indonesian locations including 3,315 observations, whereas the former contains 6,557 firms within 183 locations. However, the observations are not homogeneously distributed geographically. We also employ data collected through the University of Minnesota's Population Center (Minnesota Population Center 2014) with regard to a 10%

geographically stratified systematic sample (around 20,000,000 observations), which stems from the Indonesian population census of 2000 generated by the BPS. This data has been aggregated by location and the following variables have been employed: the number of persons within households to compute population density and the number of people who have completed the secondary and tertiary levels of education.

Table 1 shows that Indonesian regencies were characterized by higher sectorial average growth of employment, value added and labor productivity in comparison to cities between 2000 and 2009, whereas firms were more productive within urban areas. The initial condition of agglomeration forces are markedly higher within cities, even if regencies cover much larger areas, denoting a dense concentration of agents within urban places with exception of specialization ($LQ_{r,i}$) and localization of medium-low and low technological related industries ($RVMLL_i$). Thus in 2000, cities were more developed though regencies attracted more manufacturing activities from the same sector and labor intensive related sectors, since firms can take advantages of being in a location with less competition and costs of factors of production. In addition, it is notable that large local demand ($POPDEN_i$) within cities drives the concentration of heterogeneous industries (UV_i) due to diverse and large customer demand, and this also increases the availability of skilled workers ($HUMCAP_i$) favoring the establishment of high and medium-high technology industries ($RVHMH_i$) within cities as Table 1 describes. **Table 2** shows that several industries significantly enhanced their performance all over the country (i.e. publishing, printing and reproduction of recorded media; rubber and plastics products; machinery and equipment n.e.c.; and recycling), whereas others had lower growth or a reduction of employment. It is notable that during the time considered, the Indonesia manufacturing activities have seen an increase of productivity followed by a reduction of their employment with particular reference to cities. This might be due to the introduction of new technologies within the production processes enhancing their efficiency. Almost all two-digit industries located within regencies have higher growth denoting a diversification of growth within the country, as previously mentioned, where less dense locations such as regencies grew faster than cities due to the possibility to exploit lower competition and cost of factors of production. **Figure 1** shows that high and medium-high (H-MH) firms have, in almost all classifications, a higher average growth than medium-low and low (ML-L) technology intensity within Indonesian locations between 2000 and 2009. Although according to our database, H-MH firms account of only 10% observations of the overall database, we expect that H-MH technology intensity related industries foster the manufacturing growth. Also, it is interesting to note that small firms experienced a significant growth on average, in almost all classifications, where ML-L is characterized by small firm' size whereas the medium firm' size was predominant for H-MH.

Table 1
The nomenclature of variables and their mean and standard deviation of the full dataset of sectors and firms datasets disaggregated by cities and regencies.

Variable	*Description*	*Full Dataset*		*Cities*		*Regencies*	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Five-digit sector indicators							
Explained variables							
$EMPGROWTH_{r,i}$	Sectoral average annual employment growth between 2000 and 2009.	-0.12	5.63	-0.73	5.14	0.19	5.85
$VAGROWTH_{r,i}$	Sectoral average annual value added growth between 2000 and 2009.	5.74	8.79	5.10	8.13	6.07	9.09
$PRODGROWTH_{r,i}$	Sectoral average annual labor productivity growth between 2000 and 2009.	12.67	1.77	12.61	1.49	12.71	1.90
Sector-specific characteristics explanatory variables							
$EMP_{r,i}$ (log)	Sectorial employmen in 2000.	2.39	0.67	2.43	0.66	2.37	0.67
$VAEMP_{r,i}$ (log)	Sectorial labor productivity in 2000.	4.12	0.56	4.19	0.51	4.09	0.59
$LQ_{r,i}$ (log)	Specialization ias a measure of MAR's externalities in 2000.	0.30 (0.61)	0.72 (0.75)	0.24 (0.39)	0.68 (0.60)	0.33 (0.75)	0.74 (0.79)
$COMP_{r,i}$ (log)	Competition denoting the local rivalry degree in 2000.	0.28 (0.19)	0.49 (0.43)	0.30 (0.19)	0.47 (0.42)	0.27 (0.20)	0.50 (0.43)
Firm indicators							
Explained variables							
$EMPGROWTH_{f,r,i}$	Firm average annual employment growth between 2000 and 2009.	-0.27	2.98	-0.36	2.72	-0.21	3.12
$VAGROWTH_{f,r,i}$	Firm average annual value added growth between 2000 and 2009.	5.51	6.26	5.71	5.99	5.38	6.42
$PRODGROWTH_{f,r,i}$	Firm `average annual labor productivity growth between 2000 and 2009.	5.78	5.75	6.07	5.51	5.60	5.89
Firm-specific characteristics explanatory variables							
$EMP_{f,r,i}$ (log)	Employment at the firm level in 2000.	1.93	0.54	1.95	0.55	1,91	0.53
$VAEMP_{f,r,i}$ (log)	Labor productivity at the firm level in 2000.	3.96	0.56	4.06	0.50	3.89	0.58
$FSMAL_{f,r,i}$ and $FLARGE_{f,r,i}$	Dummy variables for Small (S) and Large (L) firm's size.	# obs.: S:2,858; L:1,300		# obs.: S:1,023; L:515		# obs: S:1,835; L:785	
Location-specific characteristics explanatory variables							
$POPDEN_i$ (log)	Population density as a proxy of urbanization in 2000.	2.28 (2.33)	0.49 (0.50)	2.86 (2.88)	0.25 (0.24)	1.98 (2.00)	0.27 (0.26)
$HUMCAP_i$ (log)	Location share of scholars, who have completed the secondary and tertiary level of education in 2000 as a proxy of skilled workers.	-2.17 (-2.14)	0.40 (0.41)	-1.96 (-1.91)	0.45 (0.42)	-2.28 (-2.27)	0.32 (0.34)
$VARIETY_i$	General variety in 2000 as a measure of Jacobian externalities computed without any sectorial linkages.	4.24 (4.14)	1.23 (1.33)	4.45 (4.53)	1.25 (1.15)	4.13 (3.91)	1.21 (1.38)
UV_i	Unrelated variety in 2000 based on KBLI 2005 measuring industrial diversity, which is associated with portfolio diversification.	2.79 (2.71)	0.90 (0.96)	3.03 (3.07)	0.81 (0.76)	2.67 (2.49)	0.92 (1.00)
RV_i	Related variety in 2000 based on KBLI 2005 as an indicator of inter-industry knowledge spillovers.	1.45 (1.44)	0.51 (0.55)	1.42 (1.46)	0.53 (0.49)	1.46 (1.42)	0.49 (0.58)
$RVHMH_i$	Related variety of high and medium-hight technology intensity industry in 2000 based on OECD's classification.	0.17 (0.16)	0.19 (0.18)	0.23 (0.23)	0.20 (0.19)	0.14 (0.12)	0.17 (0.16)
$RVMLL_i$	Related variety of medium-low and low technology intensity industry in 2000 based on OECD's classification.	1.28 (1.28)	0.45 (0.49)	1.19 (1.23)	0.44 (0.41)	1.32 (1.30)	0.45 (0.53)
N. observations		**3,315 (6,557)**		**1,124 (2,465)**		**2,191 (4,092)**	

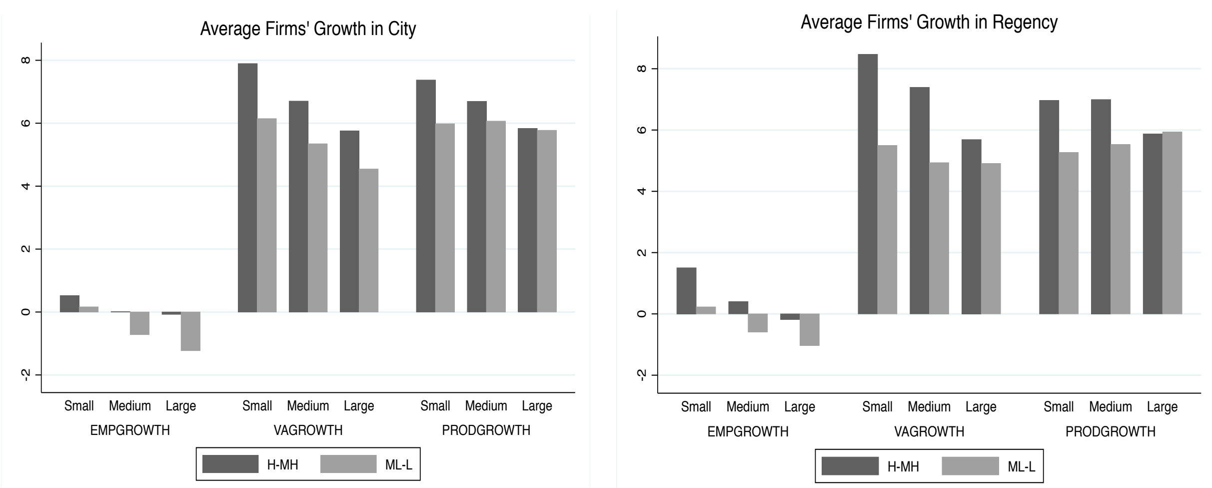
Notes: The databases at the firm and sectorial level are not identical, thus the values between brackets refer to the firm's dataset.

Table 2
The annual employment, value added and labor productivity growth rate between 2000 and 2009 aggregated by two-digit sectors within cities and regencies.

Code	*Description*	EMPGROWTH$_{r,i}$		VAGROWTH$_{r,i}$		PRODGROWTH$_{r,i}$		Technology Intensity*
		Citiy	*Regency*	*Citiy*	*Regency*	*Citiy*	*Regency*	
15	Food products and beverages	-0.07	0.74	5.51	6.77	12.60	12.75	ML-L
16	Tobacco	-1.40	1.80	3.06	9.92	12.35	13.53	ML-L
17	Textiles	-2.03	-1.03	2.10	4.31	12.20	12.79	ML-L
18	Wearing apparel	-0.32	0.24	4.62	5.75	12.42	12.65	ML-L
19	Tanning and dressing of leather	-2.16	-0.98	2.23	4.39	12.23	12.54	ML-L
20	Wood and products of wood except furniture and plaiting materials	-3.68	-2.04	1.20	2.87	12.42	12.47	ML-L
21	Paper and paper products	-1.66	1.18	4.21	7.76	12.59	12.76	ML-L
22	Publishing, printing and reproduction of recorded media	0.24	1.40	7.01	9.29	12.80	13.28	ML-L
23	Coal, refined petroleum products and nuclear fuel	0.24	-0.18	5.68	6.65	12.28	12.79	ML-L
24	Chemicals and chemical products	0.10	-0.06	6.90	6.44	12.78	12.75	H-MH
25	Rubber and plastics products	0.36	0.49	6.96	7.36	12.76	12.93	ML-L
26	Other non-metallic mineral products	-2.58	0.14	2.57	5.77	12.47	12.66	ML-L
27	Basic metals	-1.76	-1.25	3.83	6.49	12.42	13.01	ML-L
28	Fabricated metal products, except machinery and equipment	-0.78	0.76	5.15	5.52	12.58	12.36	ML-L
29	Machinery and equipment n.e.c.	0.65	0.49	10.77	7.45	13.88	12.92	H-MH
31	Electrical machinery and apparatus n.e.c	-0.48	0.78	4.21	8.39	12.24	12.93	H-MH
32	Radio, television and communication equipment and apparatus	-3.15	-4.89	5.46	-0.79	13.30	12.09	H-MH
33	Medical, precision and optical instruments, watches and clocks	-3.53	-0.67	0.56	5.88	12.10	12.77	H-MH
34	Motor vehicles, trailers and semi-trailers	-0.95	1.29	7.94	9.81	13.16	13.25	H-MH
35	Other transport equipment	-1.57	0.92	5.53	5.54	12.80	12.34	H-MH**
36	Furniture and manufacturing n.e.c.	-0.54	0.49	4.91	5.34	12.58	12.42	ML-L
37	Recycling	0.58	0.92	10.20	6.11	13.79	12.50	ML-L
Average		-0.81	0.14	5.00	6.02	12.60	12.71	-

*Notes: The industrial code 30 has been omitted since it was characterized by few observations. ** The code 35 belongs to H-MH with an exception of 351, which has been included within ML-L.*

Figure 1 The average of annual employment, value added and labor productivity growth rate between 2000 and 2009 at the firm level disaggregated by type of location, technology intensity industries and firm' size.



Notes: the firm's size is expressed in terms of employment where small denotes firms between 20 and 49 workers, medium between 50 and 249, and large equal and over 250 employees.

6. Estimation results

We test the influence of agglomeration forces on the average annual employment, value added and labor productivity growth rates between 2000 and 2009 at the five-digit sector and firm manufacturing level within the country and disaggregated by cities and regencies.

Employment growth

The results of annual employment growth rate between 2000 and 2009 within Indonesian locations are illustrated in **Table 3** for sectors and **Table 4** for firms. It is notable that specialization ($LQ_{r,i}$) plays a negative role for sectors and firm' employment growth (S.4-9 and F.7-9) thought it is not significant within cities at the firm level (F.4-6). This is in contrast with the conceptualization of the MAR model (Glaeser et al. 1992), which supports the foundation that specialized clusters enhance innovation and growth due to intra-industry knowledge spillovers. On the other hand, competition ($COMP_{r,i}$) has a positive influence of employment growth for sectors (S.7-9) though it has negative coefficients at the firm level (F.4-9). These diverse results can be associated with the selection of firms within sectors, since higher rivalry cause smart selection of firms making the aggregation of the overall sector more efficient and innovative. On the other hand, new start-ups and firm survivors need to allocate their resources more efficiently in order to cope higher competition with negative repercussion to employment growth.

Population density ($POPDEN_i$) seems to have a positive influence on sectoral employment growth within regencies (S.7-9) and negative for firms within cities (F.4-6), whereas human capital negatively affects regencies manufacturing growth (F.6-9). This dichotomy influence, city-regency, is also confirmed for value added and labor productivity growth (see, **Table 5**, **Table 6** and **Table 7**). Our results also reveal that general variety ($VARIETY_i$) positively affects the average annual employment growth rate within cities for sectors (S.4) and within regencies for firms (F.7) underpinning the concept of Jacobian externalities computed without any sectoral linkages. When general variety is disaggregated into unrelated (UV_i) and related (RV_i) varieties based on Indonesian industrial classification, the former accrues employment growth within regency for firms (F.8-9) and the latter positively influences the sectoral employment growth within cities (S.5) though it is only significance at 10%. A further disaggregation of related variety based on technological intensity shows that sectors benefit from having high and medium-high ($RVHMH_i$) industries within urban areas (S.6), thus we expect to have higher sectoral employment growth in cities with higher levels of concentration of those industries. Whereas, medium-low and low related variety industries ($RVMLL_i$) seem to have a negative influence on firms' employment growth within urban areas (F.6). The significant and positive outcomes of related varieties for employment growth is associated with inter-industry knowledge spillovers, which favor location's growth and industrial portfolio diversification through the recombination of competences between related activities (Boschma and Frenken 2009; van Oort 2004). Moreover, we expect to have a higher employment growth in cities with large number of small firms (F.4-6), whereas large economic activities foster the employment growth within regencies (S.7-9). Indonesian cities are characterized by a higher localization of small operations with 42% of the total numbers of urban manufacturing activities, although the localization of large firms accounted with only 20% in regencies though they lead large operations roughly with 70% of the total employment of regencies according to our full dataset of 2000 and 2009.

Table 3
The average annual employment growth rate of five-digit sectors within all country, cities and regencies between 2000 and 2009.

Variables	All country			City			Regency		
	S.1	S.2	S.3	S.4	S.5	S.6	S.7	S.8	S.9
$EMP_{r,i}$	-2.682***	-2.681***	-2.732***	-2.634***	-2.654***	-2.664***	-2.755***	-2.755***	-2.789***
	(0.208)	(0.208)	(0.210)	(0.380)	(0.383)	(0.382)	(0.263)	(0.263)	(0.264)
$VAEMP_{r,i}$	0.798***	0.797***	0.738***	0.829*	0.831*	0.781*	0.782***	0.782***	0.724**
	(0.197)	(0.198)	(0.200)	(0.381)	(0.380)	(0.379)	(0.232)	(0.232)	(0.236)
$LQ_{r,i}$	-0.963***	-0.963***	-0.951***	-0.805**	-0.798**	-0.840**	-1.059***	-1.059***	-1.043***
	(0.167)	(0.167)	(0.167)	(0.303)	(0.303)	(0.302)	(0.208)	(0.208)	(0.207)
$COMP_{r,i}$	0.824**	0.824**	0.767**	0.474	0.458	0.391	0.931**	0.931**	0.907**
	(0.282)	(0.283)	(0.284)	(0.567)	(0.569)	(0.568)	(0.339)	(0.339)	(0.340)
$POPDEN_i$	-1.169***	-1.176***	-1.158***	-1.074	-1.367	-0.688	1.522*	1.525^	1.695*
	(0.243)	(0.252)	(0.252)	(1.412)	(1.492)	(1.523)	(0.759)	(0.780)	(0.783)
$HUMCAP_i$	-0.062	-0.058	-0.017	-0.766	-0.711	-0.914	-0.936	-0.939	-0.860
	(0.387)	(0.389)	(0.388)	(0.697)	(0.702)	(0.702)	(0.628)	(0.641)	(0.642)
$VARIETY_i$	0.285**			0.589**			0.081		
	(0.103)			(0.220)			(0.142)		
UV_i		0.297*	0.099		0.343	0.192		0.079	-0.164
		(0.141)	(0.166)		(0.387)	(0.401)		(0.170)	(0.224)
RV_i		0.262			1.013^			0.086	
		(0.211)			(0.588)			(0.276)	
$RVHMH_i$			1.950*			3.290*			1.913
			(0.826)			(1.378)			(1.193)
$RVMLL_i$			0.169			0.649			-0.030
			(0.214)			(0.607)			(0.285)
Constant	4.773**	4.810**	5.737**	0.076	0.945	-0.314	1.804	1.792	2.651
	(1.824)	(1.860)	(1.906)	(5.466)	(5.638)	(5.643)	(2.696)	(2.766)	(2.833)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3315	3315	3315	1124	1124	1124	2191	2191	2191
R^2	0.202	0.202	0.204	0.196	0.196	0.199	0.220	0.220	0.221
Adjusted R^2	0.193	0.192	0.193	0.167	0.167	0.169	0.206	0.206	0.206

Robust standard errors of the coefficients are given in parentheses.
*Level of statistical significant: *** 0.1%; ** 1%; * 5%; ^ 10%.*

Table 4
The average annual employment growth rate at the firm level within all country, cities and regencies between 2000 and 2009.

Variables	All country			City			Regency		
	F.1	F.2	F.3	F.4	F.5	F.6	F.7	F.8	F.9
$EMP_{f,r,i}$	-1.750***	-1.749***	-1.750***	-1.044***	-1.031***	-1.046***	-2.328***	-2.325***	-2.313***
	(0.210)	(0.209)	(0.209)	(0.302)	(0.303)	(0.304)	(0.293)	(0.292)	(0.293)
$VAEMP_{f,r,i}$	1.150***	1.147***	1.129***	1.083***	1.087***	1.069***	1.196***	1.196***	1.183***
	(0.090)	(0.090)	(0.090)	(0.142)	(0.142)	(0.142)	(0.115)	(0.115)	(0.116)
$FSMALL_{f,r,i}$	0.386**	0.389**	0.397**	0.566**	0.571**	0.589**	0.271	0.271	0.281^
	(0.122)	(0.122)	(0.122)	(0.181)	(0.181)	(0.181)	(0.165)	(0.165)	(0.166)
$FLARGE_{f,r,i}$	0.426*	0.424*	0.420*	-0.065	-0.074	-0.077	0.767**	0.766**	0.757**
	(0.195)	(0.195)	(0.195)	(0.288)	(0.289)	(0.289)	(0.263)	(0.263)	(0.264)
$LQ_{r,i}$	-0.334***	-0.317***	-0.321***	-0.112	-0.116	-0.127	-0.386***	-0.379***	-0.382***
	(0.067)	(0.068)	(0.068)	(0.128)	(0.128)	(0.128)	(0.085)	(0.085)	(0.085)
$COMP_{r,i}$	-0.718***	-0.707***	-0.716***	-0.621**	-0.610**	-0.646**	-0.901***	-0.896***	-0.893***
	(0.134)	(0.135)	(0.135)	(0.225)	(0.225)	(0.225)	(0.180)	(0.180)	(0.180)
$POPDEN_i$	-0.410***	-0.487***	-0.480***	-1.499**	-1.378**	-1.096*	0.425	0.328	0.359
	(0.103)	(0.107)	(0.107)	(0.506)	(0.519)	(0.530)	(0.328)	(0.356)	(0.356)
$HUMCAP_i$	-0.305*	-0.256^	-0.254^	0.319	0.249	0.231	-0.735**	-0.660*	-0.633*
	(0.152)	(0.151)	(0.151)	(0.239)	(0.244)	(0.243)	(0.277)	(0.287)	(0.289)
$VARIETY_i$	0.158***			-0.074			0.199***		
	(0.040)			(0.080)			(0.052)		
UV_i		0.267***	0.195**		0.060	-0.005		0.236**	0.174^

		(0.061)	(0.070)		(0.160)	(0.165)		(0.072)	(0.095)
RV_i		-0.058			-0.265			0.111	
		(0.089)			(0.216)			(0.117)	
$RVHMH_i$			0.573^			0.545			0.625
			(0.346)			(0.488)			(0.546)
$RVMLL_i$			-0.087			-0.473*			0.083
			(0.089)			(0.238)			(0.118)
Constant	-1.431^	-1.099	-0.901	2.870	2.249	1.823	-3.170*	-2.780^	-2.637^
	(0.760)	(0.761)	(0.766)	(1.984)	(2.082)	(2.069)	(1.387)	(1.466)	(1.472)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6557	6557	6557	2465	2465	2465	4092	4092	4092
R^2	0.115	0.116	0.116	0.115	0.115	0.116	0.133	0.133	0.134
Adjusted R^2	0.108	0.109	0.109	0.097	0.097	0.098	0.123	0.123	0.123

Robust standard errors of the coefficients are given in parentheses.
*Level of statistical significant: *** 0.1%; ** 1%; * 5%; ^ 10%.*

Value added growth

The **Table 5** and **Table 6** show the influence of agglomeration externalities on average annual value added growth between 2000 and 2009 for five-digit sectors and firms respectively within Indonesian locations. The location quotient ($LQ_{r,i}$) still plays a negative influence on manufacturing growth (S.16-18 and F.16-18) though it is not statistical significant within cities (S.13-15 and F.13-15). Also, competition ($COMP_i$) affect negatively firms' value added growth (F.13-18) since firms need to face price and factors of production rivalry within higher competition. If we look back to the employment growth (**Table 3** and **Table 4**), it is notable that the set of varieties become more statistical significance holding the same sign with particular regard to related varieties (**Table 5** and **Table 6**). Thus, we argue that an increase of industrial related varieties is beneficial for sectoral and firm's productivity growth since interconnected industries within a location accrues inter-industry knowledge spillovers favoring innovation within and across sectors and firms. General variety ($VARIETY_i$) computed without any sectorial linkages fosters value added growth within Indonesian locations (S.13, S.16, and F.16). Disaggregating general variety, we find that unrelated variety (UV_i) play a positive role for firms within regencies (F.17-18) and related variety (RV_i) are beneficial for sectors and firms (S.14, S.17 and F.17) though it is not significant for firms within cities (F.14). The role of related variety becomes more evident when we consider high and medium-high technology intensity ($RVHMH_i$) industries, which foster the sectoral and firms' value added growth within Indonesian locations (S.15, S.18 and F.15, S.18) since they play a paramount role in the process of location' growth. These industries mainly compete based on innovations generating incremental and radical changes fostering the genesis and development of new related and unrelated branches with positive implications on manufacturing growth. Also, medium-low technology intensity related industries ($RVMLL_i$) play a positive role in enhancing firm's value added growth though it is significant only within regencies (F.18). Population density ($POPDEN_i$) has a positive effect on sectoral value added growth rate within regencies (S.16-18) and a negative effect within cities for firms (F13-F14). Instead, we expect to have higher value added growth within cities (F.13-15) and lower value added growth within regencies (S.16-18 and F.16-18) due to an increase of human capital (*$HUMCAP_i$*) level.

Table 5
The average annual value added growth rate of five-digit sectors within all country, cities and regencies between 2000 and 2009.

Variables	All country			City			Regency		
	S.10	**S.11**	**S.12**	**S.13**	**S.14**	**S.15**	**S.16**	**S.17**	**S.18**
$EMP_{r,i}$	-2.007***	-2.007***	-2.149***	-2.514***	-2.542***	-2.553***	-1.996***	-2.042***	-2.137***
	(0.295)	(0.296)	(0.297)	(0.518)	(0.522)	(0.521)	(0.376)	(0.379)	(0.379)
$VAEMP_{r,i}$	-6.847***	-6.847***	-7.014***	-7.214***	-7.212***	-7.269***	-6.947***	-6.937***	-7.109***
	(0.313)	(0.313)	(0.319)	(0.594)	(0.594)	(0.599)	(0.372)	(0.371)	(0.377)
$LQ_{r,i}$	-1.720***	-1.720***	-1.686***	-0.453	-0.443	-0.491	-2.114***	-2.101***	-2.057***
	(0.247)	(0.247)	(0.245)	(0.413)	(0.412)	(0.413)	(0.313)	(0.313)	(0.310)
$COMP_{r,i}$	-0.204	-0.204	-0.366	-0.665	-0.688	-0.765	-0.165	-0.195	-0.264
	(0.413)	(0.413)	(0.413)	(0.791)	(0.795)	(0.798)	(0.504)	(0.505)	(0.503)
$POPDEN_i$	-1.297***	-1.297***	-1.251***	-4.428*	-4.825*	-4.045^	3.352**	3.684**	4.180***
	(0.361)	(0.372)	(0.370)	(2.075)	(2.189)	(2.266)	(1.118)	(1.153)	(1.152)
$HUMCAP_i$	0.549	0.549	0.673	1.595	1.670	1.436	-2.165*	-2.447**	-2.189*
	(0.563)	(0.566)	(0.565)	(1.026)	(1.035)	(1.041)	(0.897)	(0.931)	(0.932)
$VARIETY_i$	0.693***			0.994**			0.560**		
	(0.157)			(0.347)			(0.216)		
UV_i		0.693***	0.135		0.661	0.487		0.378	-0.345
		(0.205)	(0.245)		(0.603)	(0.623)		(0.245)	(0.324)
RV_i		0.693*			1.569^			1.058*	
		(0.326)			(0.904)			(0.443)	
$RVHMH_i$			5.452***			4.188^			6.470***
			(1.220)			(2.176)			(1.676)
$RVMLL_i$			0.410			1.151			0.676
			(0.329)			(0.923)			(0.457)
Constant	40.783***	40.782***	43.454***	50.250***	51.429***	49.980***	32.062***	30.767***	33.417***
	(2.658)	(2.711)	(2.814)	(8.141)	(8.397)	(8.427)	(3.859)	(4.010)	(4.118)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3315	3315	3315	1124	1124	1124	2191	2191	2191
R^2	0.287	0.287	0.291	0.306	0.306	0.307	0.303	0.303	0.307
Adjusted R^2	0.279	0.278	0.282	0.281	0.280	0.281	0.291	0.291	0.294

Robust standard errors of the coefficients are given in parentheses.
*Level of statistical significant: *** 0.1%; ** 1%; * 5%; ^ 10%.*

Table 6
The average annual value added growth rate at the firm level within all country, cities and regencies between 2000 and 2009.

Variables	All country			City			Regency		
	F.10	**F.11**	**F.12**	**F.13**	**F.14**	**F.15**	**F.16**	**F.17**	**F.18**
$EMP_{f,r,i}$	-0.240	-0.239	-0.243	0.327	0.296	0.269	-1.027*	-1.030*	-0.943^
	(0.368)	(0.368)	(0.367)	(0.550)	(0.550)	(0.548)	(0.486)	(0.487)	(0.487)
$VAEMP_{f,r,i}$	-6.011***	-6.014***	-6.098***	-6.868***	-6.877***	-6.910***	-5.847***	-5.847***	-5.939***
	(0.175)	(0.175)	(0.177)	(0.276)	(0.277)	(0.278)	(0.226)	(0.226)	(0.228)
$FSMALL_{f,r,i}$	0.067	0.071	0.111	0.277	0.263	0.295	-0.129	-0.129	-0.062
	(0.230)	(0.230)	(0.230)	(0.341)	(0.341)	(0.341)	(0.301)	(0.301)	(0.302)
$FLARGE_{f,r,i}$	0.294	0.292	0.274	0.018	0.040	0.034	0.701	0.703	0.637
	(0.353)	(0.353)	(0.352)	(0.542)	(0.541)	(0.540)	(0.457)	(0.457)	(0.457)
$LQ_{r,i}$	-1.441***	-1.423***	-1.442***	-0.073	-0.061	-0.082	-1.640***	-1.648***	-1.668***
	(0.131)	(0.132)	(0.132)	(0.241)	(0.240)	(0.240)	(0.164)	(0.165)	(0.164)
$COMP_{r,i}$	-2.145***	-2.134***	-2.173***	-1.321**	-1.349**	-1.416***	-2.471***	-2.478***	-2.454***
	(0.259)	(0.259)	(0.259)	(0.418)	(0.419)	(0.422)	(0.339)	(0.339)	(0.339)
$POPDEN_i$	-0.224	-0.306	-0.277	-1.745^	-2.058*	-1.533	0.346	0.477	0.694
	(0.188)	(0.195)	(0.195)	(0.922)	(0.936)	(0.969)	(0.583)	(0.631)	(0.633)
$HUMCAP_i$	-0.388	-0.335	-0.327	1.642***	1.823***	1.791***	-1.093*	-1.194*	-1.004^
	(0.278)	(0.280)	(0.280)	(0.474)	(0.503)	(0.503)	(0.482)	(0.518)	(0.522)
$VARIETY_i$	0.642***			0.051			0.884***		
	(0.075)			(0.156)			(0.099)		
UV_i		0.759***	0.430***		-0.296	-0.418		0.834***	0.393*
		(0.109)	(0.130)		(0.316)	(0.328)		(0.128)	(0.172)
RV_i		0.413*			0.544			1.004***	
		(0.167)			(0.391)			(0.223)	
$RVHMH_i$			3.286***			2.052*			4.620***
			(0.671)			(0.974)			(1.011)
$RVMLL_i$			0.279^			0.155			0.809***
			(0.170)			(0.420)			(0.228)
Constant	28.560***	28.913***	29.813***	41.667***	43.270***	42.478***	25.960***	25.433***	26.438***
	(1.425)	(1.440)	(1.460)	(3.800)	(3.999)	(3.998)	(2.385)	(2.555)	(2.573)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6557	6557	6557	2465	2465	2465	4092	4092	4092
R^2	0.263	0.264	0.266	0.310	0.311	0.311	0.266	0.266	0.269
Adjusted R^2	0.258	0.258	0.260	0.296	0.297	0.297	0.257	0.257	0.260

Robust standard errors of the coefficients are given in parentheses.
*Level of statistical significant: *** 0.1%; ** 1%; * 5%; ^ 10%.*

Labor productivity growth

The results of five-digit average annual labor productivity growth rate within Indonesian locations between 2000 and 2009 are illustrated in **Table 7** for sectors and **Table 8** for firms. Specialized clusters ($LQ_{r,i}$) continues to negatively affect manufacturing growth (S.25-27 and F.25-27), though it is notable that the location quotient turn to be positive within cities (S.22-24 and F.22-24) though it is statistical significant in only one regression (S.24). Also, sectorial competition ($COMP_{r,i}$) continues to negatively influence manufacturing growth (S.22-27 and F.22-27). We find robust evidence to support intra-industry knowledge spillovers as a preponderant source for sectoral and firm growth. General variety ($VARIETY_i$) and related varieties, based on industrial classification and technology intensity (RV_i, $RVHMH_i$ and $RVMLL_i$), are positively related to labor productivity growth though several coefficients are not statistical significant within cities (S.22-27 and F.22-27). Furthermore, our results in **Table 7** and **Table 8** seem to confirm the previous outcomes that an increase of population density ($POPDEN_i$) plays a positive role on manufacturing growth within regencies (S.25-27) and slow down growth within city (S.22-24), whereas with an increase of human capital ($HUMCAP_i$) we expect to have a positive manufacturing growth within cities (S.22-24 and F.22-24) and a negative growth within regencies (S.25-27).

Table 7
The average annual labor productivity growth rate of five-digit sectors within all country, cities and regencies between 2000 and 2009.

Variables	All country			City			Regency		
	S.19	S.20	S.21	S.22	S.23	S.24	S.25	S.26	S.27
$EMP_{r,i}$	0.108*	0.108*	0.078	-0.078	-0.079	-0.201**	0.135*	0.121^	0.102
	(0.051)	(0.051)	(0.051)	(0.077)	(0.078)	(0.076)	(0.068)	(0.070)	(0.070)
$VAEMP_{r,i}$	-2.339***	-2.339***	-2.374***	-2.218***	-2.218***	-2.008***	-2.456***	-2.453***	-2.489***
	(0.119)	(0.119)	(0.122)	(0.134)	(0.134)	(0.135)	(0.159)	(0.158)	(0.160)
$LQ_{r,i}$	-0.256***	-0.256***	-0.249***	0.056	0.057	0.171*	-0.338***	-0.333***	-0.325***
	(0.049)	(0.049)	(0.049)	(0.067)	(0.067)	(0.067)	(0.063)	(0.063)	(0.062)
$COMP_{r,i}$	-0.396***	-0.396***	-0.430***	-0.376**	-0.377**	-0.261*	-0.440***	-0.449***	-0.464***
	(0.094)	(0.094)	(0.096)	(0.120)	(0.121)	(0.115)	(0.125)	(0.126)	(0.126)
$POPDEN_i$	-0.093	-0.093	-0.084	-0.986**	-0.996**	-0.787***	0.513*	0.613**	0.717**
	(0.061)	(0.062)	(0.062)	(0.303)	(0.302)	(0.179)	(0.206)	(0.219)	(0.221)
$HUMCAP_i$	0.151	0.150	0.178^	0.639***	0.641***	0.875***	-0.434*	-0.519**	-0.461*
	(0.097)	(0.097)	(0.097)	(0.172)	(0.174)	(0.142)	(0.170)	(0.182)	(0.181)
$VARIETY_i$	0.130***			0.108^			0.173***		
	(0.030)			(0.056)			(0.046)		
UV_i		0.130***	0.014		0.100	-0.027		0.119*	-0.033
		(0.038)	(0.043)		(0.094)	(0.082)		(0.047)	(0.057)
RV_i		0.131*			0.122			0.322**	
		(0.065)			(0.133)			(0.101)	
$RVHMH_i$			1.119***			0.788**			1.460***
			(0.212)			(0.273)			(0.312)
$RVMLL_i$			0.069			0.092			0.237*
			(0.064)			(0.097)			(0.101)
Constant	22.205***	22.205***	22.767***	25.317***	25.346***	25.312***	20.698***	20.310***	20.881***
	(0.625)	(0.626)	(0.663)	(1.385)	(1.379)	(1.079)	(0.790)	(0.805)	(0.838)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3315	3315	3315	1124	1124	1124	2191	2191	2191
R^2	0.449	0.449	0.453	0.478	0.478	0.390	0.462	0.464	0.467
Adjusted R^2	0.442	0.442	0.446	0.459	0.459	0.386	0.453	0.454	0.457

Robust standard errors of the coefficients are given in parentheses.
*Level of statistical significant: *** 0.1%; ** 1%; * 5%; ^ 10%.*

Table 8
The average annual labor productivity growth rate at the firm level within all country, cities and regencies between 2000 and 2009.

Variables	All country			City			Regency		
	F.19	F.20	F.21	F.22	F.23	F.24	F.25	F.26	F.27
$EMP_{f,r,i}$	1.511***	1.511***	1.507***	1.370**	1.327**	1.315**	1.300**	1.295**	1.370***
	(0.311)	(0.311)	(0.310)	(0.462)	(0.461)	(0.460)	(0.413)	(0.413)	(0.414)

$VAEMP_{f,r,i}$	-7.161***	-7.161***	-7.226***	-7.951***	-7.963***	-7.979***	-7.043***	-7.044***	-7.123***
	(0.148)	(0.148)	(0.150)	(0.240)	(0.240)	(0.242)	(0.189)	(0.189)	(0.190)
$FSMALL_{f,r,i}$	-0.318^	-0.318^	-0.287	-0.289	-0.308	-0.294	-0.399	-0.400	-0.343
	(0.193)	(0.193)	(0.192)	(0.284)	(0.284)	(0.284)	(0.253)	(0.253)	(0.254)
$FLARGE_{f,r,i}$	-0.132	-0.132	-0.146	0.083	0.114	0.111	-0.066	-0.063	-0.120
	(0.303)	(0.303)	(0.302)	(0.457)	(0.456)	(0.456)	(0.395)	(0.395)	(0.395)
$LQ_{r,i}$	-1.107***	-1.106***	-1.121***	0.039	0.055	0.045	-1.254***	-1.269***	-1.286***
	(0.113)	(0.114)	(0.114)	(0.210)	(0.209)	(0.209)	(0.141)	(0.142)	(0.142)
$COMP_{r,i}$	-1.427***	-1.427***	-1.457***	-0.701^	-0.739*	-0.770*	-1.570***	-1.582***	-1.561***
	(0.224)	(0.224)	(0.224)	(0.365)	(0.365)	(0.367)	(0.288)	(0.288)	(0.288)
$POPDEN_i$	0.186	0.181	0.204	-0.245	-0.680	-0.437	-0.079	0.148	0.334
	(0.161)	(0.165)	(0.165)	(0.695)	(0.701)	(0.732)	(0.497)	(0.529)	(0.532)
$HUMCAP_i$	-0.082	-0.079	-0.072	1.323***	1.574***	1.559***	-0.358	-0.534	-0.371
	(0.235)	(0.236)	(0.236)	(0.396)	(0.429)	(0.429)	(0.406)	(0.438)	(0.441)
$VARIETY_i$	0.484***			0.126			0.685***		
	(0.063)			(0.129)			(0.084)		
UV_i		0.491***	0.235*		-0.357	-0.413		0.598***	0.220
		(0.093)	(0.110)		(0.269)	(0.278)		(0.109)	(0.145)
RV_i		0.471**			0.809*			0.893***	
		(0.144)			(0.328)			(0.195)	
$RVHMH_i$			2.713***			1.507^			3.994***
			(0.560)			(0.801)			(0.849)
$RVMLL_i$			0.366*			0.629^			0.726***
			(0.146)			(0.351)			(0.199)
Constant	29.991***	30.012***	30.714***	38.797***	41.022***	40.655***	29.129***	28.214***	29.075***
	(1.204)	(1.213)	(1.226)	(2.998)	(3.180)	(3.190)	(2.035)	(2.170)	(2.181)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6557	6557	6557	2465	2465	2465	4092	4092	4092
R^2	0.378	0.378	0.379	0.442	0.443	0.443	0.370	0.370	0.372
Adjusted R^2	0.373	0.373	0.374	0.431	0.432	0.432	0.362	0.363	0.365

Robust standard errors of the coefficients are given in parentheses.
*Level of statistical significant: *** 0.1%; ** 1%; * 5%; ^ 10%.*

7. Discussion of the overall manufactruing growth and policy implications

Our results show a certain consistency in terms of the positive influence of industrial varieties, in particular we find robust evidence to support the conceptual framework that the Jacobian externalities, computed as general variety without any sectorial linkages ($VARIETY_i$). However disaggregating it, we can assess the idiosyncratic economic role within Indonesian locations associated with related and unrelated varieties and our results highlighted the important role played by related varieties for sectoral and firm' manufacturing growth computed based on KBLI 2005 (RV_i) and high and medium-high technology intensity ($RVHMH_i$). This positive outcome is supported by numerous authors' findings (see, for instance, Glaeser et al. 1992; van Oort 2002; Frenken, van Oort, and Verburg 2007; Hartog, Boschma, and Sotarauta 2012; Bishop and Gripaios 2010; Boschma and Iammarino 2009; Quatraro 2010; Boschma, Minondo, and Navarro 2012). In particular, RV_i and $RVHMH_i$ increased their significance for value added and labor productivity since the learning process between interconnected industries is more intense than unrelated activities enhancing their capability to develop innovations and productivity growth within and across sectors. This can generate regional related branching throughout a process of diversification where established sectors are assumed to boost start-ups of new interconnected sectors rather than unrelated. Moreover, knowledge spillovers can generate radical innovations, which can be adopted by unrelated industries and it can create new market opportunities fostering new regional unrelated branching with positive implications on the overall growth. We expect to have higher sectoral and firm's growth in locations with higher degree of related varieties (RV_i and $RVHMH_i$). These outcomes have important implications for Indonesian policymakers since they can pursue location and country's growth through the identification and promotion of certain key regional sectors characterized by large interconnectedness generating expansion within relatedness and the genesis of more diverse industries. The increase of portfolio diversification enhances Indonesian location's economic resilience to industry-specific demand shocks and it can avoid the lock-in effect due to very similar competences between actors since a prerequisite of knowledge transfer is the heterogeneous of know-how between actors. Policymakers recognize the importance of promoting key related sectors in order to favor the overall growth, for instance, the Industrial Cluster Initiative of the State of Texas aims to develop strategies to increase the strength of log-term competitiveness of key industrial clusters (primarily technology-based) in order to accrue local employability within and across industries (Office of the Governor of Texas 2004). In a similar way, policymakers in Ireland support the findings of the Culliton Report, which recommends promoting the development of clusters of related industries in order to increase the national competitive advantage in the view of Porter (Doyle and Fanning 2007).

Our findings also reveal some evidence that unrelated variety are beneficial for manufacturing growth though only within regencies. We find weak evidence that competition increases sectors' performance due to smart selection of firms since it positively influence the sectoral employment growth only within regencies and plays a negative role for labor productivity. The estimation coefficients associated with competition negatively influence firms' growth since competition can reduce firms' return to scale on average though certain economic activities can experience an increase of their predominant position in the market due to the accumulation of knowledge in order to face higher rivalry. The negative effect of competition is in contrast to the view of Porter (1990) and Jacobs (1969), who argue that local competition accrues innovation and growth but is supported by the MAR model (Glaeser et al. 1992), which embraces the Schumpeterian notion. We also found evidence that specialized clusters are negatively associated to sectoral and firms' manufacturing growth within Indonesian locations. These findings are not really surprising since Indonesia experienced a process of diversification of growth in terms of sectors and locations. This tendency is also confirmed by the role of varieties in fostering the manufacturing growth in Indonesian locations and this can explain the inverse relationship of specialization with manufacturing growth. The diversification growth within the country is further supported by the influence of population density, which fosters growth in the regencies, which are less developed in comparison to urban areas, and slows down manufacturing growth within cities. In addition, employment and labor productivity for sectors and firms at the initial time are inversely related to value added growth, however they play a positive role for labor productivity and employment growth respectively. Whereas, human capital is positively associated within cities and negatively related to regencies since the highest concentration of high and medium-high technology intensity related industries are within urban areas. This can be seen as a reciprocal effect where the training of more skilled workers is favored in urban centers since more qualified jobs are demanded due to the higher localization of those industries, and also high and medium-high technology intensity industries prefer to be in places where can exploit higher skilled labor. This favors further concentration of those industries and immigration of high-educated workforce within urban areas.

8. Conclusions, limitations, and suggestions for further research

This paper investigated the influence of agglomeration externalities on employment, value added and labor productivity growth rate of five-digit sectors and manufacturing firms within Indonesian cities and regencies between 2000 and 2009. We find evidence to support that the economic diversity and the Jacobian externalities, measured as general variety, are the preponderant sources for determining manufacturing growth in Indonesia locations. Furthermore when we disaggregate general variety into unrelated and related in order to assess their idiosyncratic economic role, our evidence confirms the positive role played by related varieties, which are positively relevant for sectoral and firm' manufacturing growth since intra-industry knowledge spillovers increase innovation and performance of the aggregation and the single unit. In addition, we find evidence that the presence of high and medium-high technology intensity related industries foster growth within Indonesian locations since most innovations are generated by these industries with positive impacts on growth within and across manufacturing sectors and firms. On the other hand, our results reveal that MAR externalities have a negative impact on overall manufacturing growth, as well as competition though it is beneficial for the sectoral employment growth. Whereas population density seems to have a negative influence within Indonesian cities and positive effect within regencies, and vice versa for the human capital.

The overall findings highlight the importance of industrial relatedness for manufacturing growth and it can bring new insights for Indonesian policymakers since economic growth within a location can be pursued through the identification and promotion of key sectors with large inter-sectorial linkages stimulating manufacturing growth within and across sectors and firms. However, it is possible to identify two shortcomings of the present work.

Firstly, this research measured industrial relatedness based on the Indonesia industrial classification (KBLI 2005) and the technology intensity classification proposed by OECD (2011) without considering other possible elements that might capture sectorial interconnectedness such as common regulatory frameworks, the use of the same infrastructures and sources, among others factors. A potential challenge for researchers and policymakers regard to the identification of cognitive proximity linkages between sectors within locations, and how the promotion of industries with certain large inter-linkages impacts the locations, sectors and firms' growth in order to develop *ad-hoc* policies. Secondly, this research investigated the influence of agglomeration economies on manufacturing growth without considering different stage of sectors and firms' life cycles since agglomeration forces may play different influence based on their development phase. These two shortcomings can represent the directions for further research.

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