Gadjah Mada International Journal of Business
May 2003. Vol. 5. No. 2. pp. 221— 247

WHY MANUFACTURING INDUSTRY PERSISTED TO CLUSTER SPATIALLY IN JAVA?*

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This paper attempts to examine which theory is best in explaining the geographic concentration in Java, an island in which most of the Indonesia's large and medium manufacturing industries have located overwhelmingly. Using the regional specialization index as a measure of geographic concentration of manufacturing industry and pooling data over the period 1991-1996, our econometric analysis integrates the perspectives of industry, region (space), and time. The most striking result is that most of the NCT (Neo-Classical Theory) hypotheses can be rejected. Moreover, most of the findings support the NTT (New Trade Theory) and NEG (New Economic Geography).

Our findings suggest that manufacturing firms in Java seek to locate in more populous and densely populated areas to enjoy both localization economies and urbanization economies, as shown by the significance of scale economies and income per capita. The interplay of agglomeration economies is intensified by the imperfect competition of Java's market structure.

This paper gives empirical evidence with respect to path dependency hypotheses. This finding supports the NEG's belief that history matters: older firms tend to enhance regional specialization. In addition, the results, as shown by statistical significance of its regional dummy, suggest that most of the specialized industries in Java have better access to infrastructure.

Keywords: agglomeration; concentration; NTT; NCT; NEG

* Earlier version of this paper has been presented at the international conference "Location of Economic Activity, Regional Development and the Global Economy", University of Le Havre, Le Havre, France, 26-27 September, 2001. The author acknowledges a partial financial assistance from Master of Management Program, GMU, to attend the conference.

** I am grateful to J. Malcolm Dowling, Howard Dick, and Lisa Cameron for their critical and constructive comments on this paper.

Introduction

During the last century, geographers, economists, urban planners, business strategists, regional scientists, and other social scientists have developed explanations as to why and where economic activities locate (e.g. Krugman 1991; Kuncoro 2000a; O'Sullivan 1996; Porter 1998). An uneven regional distribution of economic activity within a nation has been a primary concern, and hence, encouraged increasing research in this field. There are three major theories that explain *why* and *where* firms tend to concentrate geographically in a certain region: neo-classical, new economic geography, and new trade theory. From a theoretical perspective, we expect that some basic agglomeration forces are at work in the region. Each theory has offered some valid hypotheses. Yet there is virtually no rigorous empirical work that assess the relative importance of these three theories.

This paper examines which theory is best in explaining the geographic concentration in Java, in particular in the period of trade liberalization. There has never been a comprehensive study on industrial agglomeration that takes Indonesia (i.e. Java) as a case study and uses the recent framework of the new economic geography and the new trade theory. Nevertheless, our previous study demonstrates that Indonesia, and in particular Java, represents an excellent example of both the uneven geographic distribution of manufacturing industry and the relationship between urbanization and industrial development (Kuncoro 2001).

We focus our analysis on Java for the following reasons. *First*, main industrial areas in Indonesia have been located overwhelmingly in Java. Most of Indonesian modern manufacturing establishments have continued to be predominantly located on Java and to a much lesser extent, Sumatra Island during 1976-1999. Even when we classify 27 provinces of Indonesia into five main islands (i.e. Sumatra, Java, Kalimantan, Sulawesi, and Eastern Islands), Java and Sumatra provided more than 90 percent of Indonesia's employment over the period (Table 1). The share of Java's employment tended to decline slightly, while Sumatra's share tended to increase substantially. Java's share declined from 89 percent in 1976 to 81 percent in 1999. Sumatra's share grew from 7 to 11 percent in the same period. Other main islands in Indonesia played a minor role in the Indonesia manufacturing em-

Table 1. **Employment Distribution of Manufacturing Large & Medium Establishments by Main Islands (% of total), 1976-99**

Main Island	1976	1980	1985	1990	1995	1999
Sumatra	6.7	8.7	12.1	13.0	10.8	11.7
Java	**89.1**	**85.8**	**78.6**	**78.0**	**82.2**	**81.1**
Kalimantan	1.8	3.5	5.6	5.3	3.9	3.8
Sulawesi	0.9	1.0	1.7	1.5	1.4	1.6
Eastern Islands	1.5	1.0	1.9	2.2	1.8	1.9
INDONESIA	**100**	**100**	**100**	**100**	**100**	**100**

Source: Calculated from BPS, Industrial Survey

ployment. Even when we sum up the share of Kalimantan, Sumatra, and Eastern Island, their share in Indonesian employment was about 4 percent in 1976 and 7 percent in 1999.

Second, Java with more than half of Indonesians inhabitants offers a huge potential market and is important by its own rights. In terms of total population, Indonesia is the fourth biggest country in the world after China, India, and USA. The number of Indonesian populations was 179.4 millions in 1990 and became 194.8 millions in 1995 (BPS1999: 61). Yet the increasing number of inhabitants, with an annual average increase 1.7 percent between 1990 and 1990, was not followed by an equal distribution of population geographically. In 1995, according to Central Bureau of Statistics (BPS), Java Island resided by around 59 percent of Indonesia population (i.e. around 115 millions) but it has area of only 7 percent of total area of Indonesia.

Third, most of investments, either foreign or domestic, have been concentrating in Java. During the period 1967-1994, around 63 percent of total approved domestic investments were located in Java; while 66 percent of total foreign investment flowed to Java (Kuncoro 1996). Finally, perhaps more importantly, not only most firms are privately owned, in contrast to government-owned or joint venture firms in Outer Islands, but also most firms belong to footloose and more modern industries, while most industries in Outer Islands are resource-based such as timber and petroleum (Hill 1997; Kuncoro 1994).

Our previous studies on Java have found that there was a stable —albeit increasing trend— and persistent geographic concentration in Java over the period 1976-1995 (Kuncoro 1999; Kuncoro 2000b). Yet some critical and unresolved questions exist: Why geographic concentration in Java persisted during this period? To what extent relevant theories and empirical literature can be used as an explicit test of competing theories on agglomeration forces?

This paper will attempt to address these unresolved questions. At the onset, three major competing theories of geographic concentration will be reviewed critically. This review will provide a guide for developing some testable hypotheses. This study will test these hypotheses in the Java context. An econometric model will be developed and tested using pooling time-series and cross-sectional data.

Theoretical Framework

Neoclasical

One of the most important contributions of NCT is its early recognition of agglomeration advantages (Preer 1992: 34). Arguably, an agglomeration arises from the behavior of agents to seek agglomeration economies, either localization or urbanization economies.[1] Traditional location theories argue that cluster of industries arise mainly because of either transport or production costs (Isard 1956; Weber 1909). These theories rest on some assumptions in which the geographical basis of raw material, size of consumption

[1] *Localization economies* occur if the production costs of firms in a given industry decrease as the total output of the industry increases. In contrast, *urbanization economies* occur if the production cost of the individual firm decreases as the total output of the associated urban area increases. These economies result from the scale of the entire urban economy, not just the scale of a particular industry. Further detailed discussion see Henderson (1988); O'Sullivan (1996).

location, and the immobile and unlimited supply of labor are regarded as given.[2]

Cities offer various advantages in terms of higher productivity and income that attract new investment, new technology, and educated and skilled workers to a disproportionate degree (Kuncoro 2000a). Neoclassical urban system models the centripetal forces for agglomeration as pure external economies and the centrifugal forces as arising from the need to commute to a central business district within each city.

The literature highlights two NCT of trade, namely theory the comparative advantage and the Heckscher-Ohlin (H-O) model. The former is derived from the work of Ricardo in the early part of the nineteenth century, which was reinforced by Mill's reciprocal demand analysis and extended Marshall's and Edgeworth's neoclassical graphical presentations. The theory of comparative advantage postulates that: (1) countries trade in order to take advantage of their differences in natural resources; (2) regions will specialize according to their comparative advantage.

The latter is the result of Heckscher's article *Foreign Trade and the Distribution of Income* (1919) and Ohlin's book *International and Interregional Trade* (1933). The H-O analysis establishes that "comparative advantage is determined by the absolute distribution of resources between countries and particularly by the relative factor endowment ratios between countries" (Johns1985: 178-181).

One of the most serious problems with NCT is its failure to capture the dynamic of geographic changes at the global level. As pointed out by Preer, the major geographic changes include: (1) The decline of the traditional manufacturing belts in Europe and North America, and the rise of new industrial regions in Sun Belts; (2) The decline of cities and the growth of suburban and rural areas; (3) The emergence of large cities as centers of corporate, producer, and personal services; (4) The rise of the technopolis—propulsive regional centers of technological innovation (Preer 1992: 46-50).

The New Economic Geography

The recent state of play in the empirical agenda has been stimulated by the emergence of the NEG. The basic argument of NEG is that increasing returns, economies of scale and imperfect competition are far more important than constant return to scale, perfect competition and comparative advantage in explaining trade and uneven distribution of economic activity. Indeed, there are at least three reasons why economists start doing economic geography and incorporating space dimension. As Krugman points out:

> *First*, the location of economic activity within countries is an important subject in its own right... *Second*, the lines between international economics and regional economics are becoming blurred... however, the most important reason to look again at economic geography is the intellectual and empirical laboratory it provides (Krugman 1991:8).

Central to the recent development of the NEG is Krugman's works (Krugman 1995; Krugman 1996; Krugman 1998). As has been identified by Martin and Sunley (1996), the main Krugman contributions involve: *First*, his effort to link external economies and regional industrial agglomeration with trade. Krugman's geographical economics is a hybrid com-

[4] Further detailed discussion of methodological aspects on conventional theories see for example Johns (1985); Krugman (1990).

bination of the models of imperfect competition and scale economies used in new trade theory with location theory's emphasis on the significance of transport costs. *Second*, the recognition that regional economic development is a historical, path-dependent process. *Third*, region-specific shocks can have long-term growth consequences.

Although NEG offers interesting insights on the uneven geographic distribution of economic activities, the approach

Table 2. **A Comparison of Three Major Grand Theories of Geographic Concentration**

	NCT	NTT	NEG
Seminal paper	Ricardo (1817), Heckscher (1919), Ohlin (1933), Weber (1909), Vanek (1986)	Krugman (1979, 1980, 1981), Dixit & Norman (1980), Helpman & Krugman (1985), Weder (1995)	Marshall (1920), Krugman (1991a, 1991b, 1993), Krugman & Venables (1995a, 1995b), Venables (1996), Markusen & Venables (19960, Puga & Venables (1997), Fujita et.al (1998)
Market structure	Perfect competition	Monopolistic competition	Monopolistic competition
Determinant of location	• Technological differences • Natural resource endowments • Factor endowment & factor intensities	• Degree of plant-level increasing returns • Substitutability of differentiated goods • Size of home markets	• Pecuniary externalities (labour-market pooling, input-output linkages, migration induced demand linkages) • Technological externalities • Trade costs
Location of industry	• Overall distribution of economic activity (labour) determined by given endowments • Inter-industry specialization • Unique equilibria	• Overall distribution of economic activity (labour) exogenously given • Intra- and inter-industry specialization • Unique equilibria	• Overall distribution of economic activity (labour) endogenous • Centripetal agglomeration forces • Intra- and inter-industry specialization • Multiple equilibria • "u curve"
Trade structure	Inter-industry trade	Intra- and inter-industry trade	Intra- and inter-industry trade
Welfare effects of non-discriminatory trade liberalisation	• Net welfare gain • All countries gain • Owners of scarce factors lose	• Net welfare gains • Large countries benefit more than small ones • Possibility that owners of all factors gain	• Net welfare gain • "u curve": periphery/ core can lose at intermediate/ advanced stages

Source: Brulhart (1998: 778)

still has significant drawbacks. A recent critical survey on the new 'geographical turn' in economics concludes that NEG is neither that new nor is it geography, instead it is a reworking (or re-invention) of traditional location theory and regional science (Martin 1999). Moreover, the direct testing of the spatial agglomeration models using NEG frameworks are still in an infant stage (Ottaviano and Puga 1998).

New Trade Theory (NTT)

The NTT offers a different perspective with that of the new economic geography (Table 2). Its basic belief is that the nature and character of international transactions have changed so much in recent years that contemporary cross-border flows of goods, services, and assets are poorly understood by the traditional trade theories. Major criticism of NTT on the "old" trade theory focuses largely on the assumption of perfect competition and constant returns, devotion of too much time on the data and theory rather than the issues that drive economics, and failure to pander to protectionist causes (Dodwell 1994).

Despite its attractiveness, NTT still has some significant shortcomings. Ottaviano and Puga (1998) identified three major shortcomings. *First*, NTT, like traditional theory, explains differences in production structures through differences in underlying characteristics. *Second*, it does not explain why firms in a particular sector tend to locate close to each other, leading to regional specialization. *Third*, it presents industrial development as taking place gradually and simultaneously in all developing countries, while in practice, industrialization often takes the form of waves of rapid industrialization in which industry spreads successively from country to country.

Variables and Hypotheses

Most of the empirical studies on agglomeration forces, as can be seen in Table 3, have not tried to assess the relative merits of competing theories across industries or regions. Previous empirical studies vary considerably according to the following respects. *First*, we may discriminate between studies which use sectorally disaggregated production data (e.g. Henderson and Kuncoro 1996) and those which use aggregate production data (e.g. Krugman 1991). *Second*, we can differentiate between studies that apply regression analysis (e.g. Gelder 1994; Mody and Wang 1997), location choice model (e.g. Kuncoro 1994), or descriptive empirics (e.g. Amiti 1998).

Perhaps the most intuitive method to estimate the relative merit of various location theories or models is to regress a measure of industry concentration over a set of determinants as identified in the theories or previous empirical studies (Brulhart 1998; Kim 1995; Kim 1999). We believe that there is no single theory that may become the most "suitable" explanation of the geographic concentration in a particular region, such as Java, and at a particular time. We will explore rigorously the nature and dynamics of agglomeration forces underpinning the uneven geographic distribution of manufacturing activities in Java by testing some key variables below. The "nature" of those variables is derived either from theories or previous studies that have been discussed. The "dynamic" perspective attempts to incorporate explicitly the behavior of the variables over time (e.g. Gujarati 1995: 485; Matyas and Sevestre 1992: 311-3).

Dependent Variable

Which variable can be used as a measure of geographic concentration of manu-

Table 3. **Summary of Existing Empirical Studies**

Study by	Method	Dependent Variable	Independent Variables	Conclusion
Mody & Wang (1997)	OLS, Pooling time-series & cross-section	Output growth of 23 Industrial sectors in Seven provinces & counties of China 1985-1989	• Industry specific (specialisation index) • Regional specific (secondary school enrollment, FDI per person, roads, population/km, telephones, GDP per capita) • Regional spillover (growth in industry in region, growth in industry outside region)	• Low specialisation promote growth in light industries; specialisation is conducive to growth in heavy industry. • Foreign investment is a spur to growth. • Only for light industries, secondary school enrollment is influential. • Growth of an industrial sector in any region is influenced by the growth of the same industry in other regions
Kim (1995)	OLS, panel data	US regional localization, 1880, 1914, 1947, 1967, 1987	• Resource (raw material intensity) • Scale (plant size by production workers) • Year specific effect • Industry dummies	Changes in resources use and in scale economies, rather than external economies, explain the long-run trends in US regional localisation
Henderson et al. (1995)	Location choice, OLS	Employment growth in 8 industries in 224 metropolitan areas between 1970 and 1987 in US	• Diversity • Labour force in higher education • Past concentration (HHI)	• Employment growth in traditional industries is higher in cities with past employment concentrations. • Jacobs externalities (diversity) are not important for matures industries but play an important role in high tech sector
Kuncoro (1994)	Conditional Logit	Profit of Large, Medium, Small in Java using 1986 Economic Census	• log of other industries wage • Distance • Past employment • Diversity index (HHI) • Past population • Age index • Electricity (old firm with generator)	• Wages are only important in textile, wood, and miscellaneous industry. • The impact of history is mixed. • Diversity does not affect location decision, except in textile. • Age is significant: new firms are more likely to locate in *kabupaten* (districts) with older firms. • Unrelialibility of electricity provision is unimportant in wood, paper, chemical, and machinery industry.

Continued from Table 3

Study by	Method	Dependent Variable	Independent Variables	Conclusion
Gelder (1994)	OLS, Cobb-Douglas	Output of L&M 3-digit ISIC industry 1986-1989 in Indonesia	• Capital (total horse power of all motorised machinery and equipment) • Labour in industry *j* • Average labour employed	• Reject constant return to scale assumption and Herderson approach • Results are not robust due to data aggregation and non-spherical disturbances, and spatial correlation
Wang (1994)	Translog Production	Log (value addded/labor) of Taiwanese 1983-87	• Labor (L) • Physical capital stock (K) • Scale (K/L) • Dummy (state-owned, foreign-owned, top exporters, location in EPZs)	• Higher exporting industries tend to facilitate faster productivity progress • State-owned firms are less productive than private ones and foreign firms are more productive than domestic ones • Exported prosperity is not confined to EPZ
Glaeser et al. (1992)	OLS	City industry employment growth between 1956 and 1987 in US	• Specialisation • Competition • Initial conditions (wage, empl. in 1956) • Diversity • Concentration • Dummy (South)	• At the city-industry level, specialisation hurts, competition helps, and city diversity • Support Jacobs-Rosenberg-Bairoch model (inter-industry knowledge spillover are less important for growth than spillover across industries)
Amity (1998)	OLS	Log of the EU countries gini coefficient	• Time trend	• The average increase in specialisation is 2% for all countries except Italy

facturing industry? Although there have been various spatial concentration indices in particular Table 4, only a few of them are used in econometric analysis. The existing empirical-based econometric analyses usually utilize from among the following dependent variables:

- Employment or growth of employment (Glaeser et al. 1992; Keeble 1976)
- Growth in value added (Sjoholm 1999)
- Output growth (Mody and Wang 1997)
- Localization coefficient and or locational (industry) Gini coefficient (Amiti 1998; Kim 1995; Krugman 1991)
- Regional specialization index (Aziz 1994; Kim 1995)
- Growth quotient (modified form of location quotients) (Shilton and Stanley 1999).

The dependent variable in our model is the regional specialization index *(LQ)*. This index is a measure for determining

Table 4. **Existing Spatial Concentration or Dispersion Index**

Name of Index	Author	Distribution Compared or Description
● Coefficient of geographic association	Florence, et al.	Shares of manufacturing employment by states: industry *i* versus industry *j*
● Coefficient of concentration of population	Hoover (1971)	Shares by states: population versus areas
● Coefficient of redistribution	Hoover; Florence et al.	Shares of population (or total wages earners, or employment in selected manufacturing industries) by states: year α versus year β
● Coefficient of deviation	Hoover	Shares of population by states: White versus Negro
● Index of dissimilarity	Duncan	Shares of workers by areas: occupation group *A* versus *B*
● Index of segregation	Duncan	Shares of workers by areas: specific occupation group versus all other occupation groups
● Coefficient of specialization (Location Quotient, LQ)	Malecki	Shares of employment *i* in region r versus shares of industry i to total employment in the nation
● Geographic concentration	Ellison and Glaeser	The index tries to captures localized industry-specific spillovers and natural advantages
● Index of regional/national divergence	Krugman	The sum of absolute difference between share of industry i and other industry in total employment
● Industry (locational) Gini coefficient	Krugman, Amiti	(1) for each locational unit, calculate both the share of total national manufacturing employment and the share of national employment in the industry; (2) rank the units by the unit by ratio of these two numbers; (3) run down the ranking, keeping acumulative total of both the sum of employment share and the sum of employment share in the industry

Source: Amiti (1998); Ellison and Glaeser (1997); Isard (1960); Krugman (1991); Malecki (1991)

the extent to which an industry is concentrated in a district relative to Indonesia, a benchmark region. Indeed, it is either based on Hoover's coefficient of localization (Hoover 1971: 156-8, 209-11) or is popularly called as location quotient (e.g. Hayter 1997: 435). The regional specialization index of industry *i* in district *r* (LQ_{ir}) is calculated by:

$$LQ_{ir} = \frac{E_{ir}/E_{r}}{E_{iINDO}/E_{INDO}} \qquad (1)$$

where

E_{ir} = employment in industry *i* for district *r*;

E_{j} = total employment in district *r*;

E_{iINDO} = employment in industry *i* for all districts in Indonesia;

E_{INDO} = total employment for all districts in Indonesia.

A rising LQ_{ir} for a region-industry indicates an increasing specialization of that industry in that region, and *vice versa*. We believe that high specialization of an industry in a region may speed growth of that industry in that region. This stems from the fact that knowledge gained by a firm may benefit other firms, in particular, those in the same industry. As far as the regional perspective is concerned, the specialization index could provide: (1) a foundation for a preliminary and tentative judgment for industries to seek and encourage further (Isard 1960: 251-4); (2) an indicator whether a region is self-sufficient, importing, or exporting products (Malecki 1991: 39-40).

Explanatory Variables

Some key explanatory variables that determine the regional specialization of manufacturing activities will be discussed. Those variables are selected on the basis of analytical considerations and an attempt to test various location models. More specifically, we will employ some principal explanatory variables as follows (Table 5).

Scale Economies. Scale economies are interpreted as a key variable by both the new economic geography and the new trade theory. Both theories argue that geographically concentrated industry is subject to scale economies. We measured scale economies (ISIZE) by average plant size in terms of the number of production workers as suggested by Kim (1995) and Amiti (1997). In addition, plant size may provide information about factor intensity and location behavior in a particular industry: small firms with flexibility in adjusting its scale operation could operate in isolated regions where infrastructure is still poor (Kuncoro 1994: 10-11); whereas L&M firms tend to agglomerate in and around metropolitan areas. Based on this measure, we will test whether scale economies can explain the industrial concentration in Java: size tends to be larger at industrial centers but smaller firms tend to operate in areas farther away from industrial centers.

Resource intensity. Resource intensity represents the forces that are highlighted by NCT economists such as Heckscher-Ohlin. A measure of resource intensity will be used: cost of raw materials as a proportion of value added (RESOURCE) (Kim 1995). We will test whether industries intensive in resources should be more localized given that resources are relatively immobile.

Import content. NTT advocates the importance of vertical linkages in the international context. More specifically, high proportions of intermediate inputs are

Table 5. **Key Variables in the Empirical Study**

Explanation	Hypothesis	Variables
Scale economies (ISIZE)	Average plant size by production workers	Size tends to be larger at industrial centres but smaller firms tend to operate in areas farther away from industrial centres
Resource intensity	Cost of raw materials divided by value (RESOURCE)	Industries intensive in resources should be more localized given that resources are rela are relatively immobile
Import content (IMPOR)	Ratio of imported inputs to total raw materials	Higher import content will induce higher specialized industry in a region
Income per capita (YCAP)	Gross Regional Domestic Product (GRDP) per capita	Increasing return industry concentrates in the large market
Competition (CI)	Competition index as a proxy of market structure	Higher CI will tend to encourage regional specialization
Labor cost (WAGES)	Average annual wage for production workers in manufacturing establishments	Higher wage rates are negatively associated with the location of new manufacturing establishments on both U.S.-owned and foreign manufacturing establishments, but Japanese automotive-related manufacturers prefer location with high wages
Path dependency (AGE)	Age distribution of firm	New firms in all industries are more likely to locate in the district with older firms
Export orientation (EXPORT)	Percentage of output that was exported	Higher export of specific industry in a region will reinforce greater agglomeration forces
Foreign investment (FDI)	Percentage of foreign ownership	Foreign investment tend to spur or retard geographic concentration
D1, ...D8	Industry dummy	Different industry influence regional specialization differently
Rjkt, Rsby	Regional Dummy for Greater Jabotabek and Greater Surabaya	Regional variation matters in regional specialization
T91, ...T95	Time dummy	Different time influence regional specialization

found in geographically specialized industries. There has been a growing debate as to whether the share of intermediate inputs also includes raw materials, whether these inputs are domestically produced or imported, or whether vertical linkages only relate to downstream firms (Amiti 1998: 50-1). Since we are concerned about raw materials and their sources, we use the imported inputs as a proportion of total raw material (IMPOR). We argue that a higher import content will induce higher industry specialized in a region.

Home market effect. The NTT emphasizes the existence of home-market effects. We include either the total population by district (POPULATION) or Gross Regional Domestic Product per capita (YCAP), as a proxy of market size. Krugman (1991: 23-4) argued that the more populated locations will attract a concentration of manufacturing production, assuming that the location offers a sufficiently larger local market than others, and fixed costs are large enough relative to transport costs. We will test this Krugman hypothesis.

Market structure. Both the NEG and NTT believe that monopolistic competition helps to explain geographic concentration of manufacturing activities (see Table 2). We will use competition index (CI) as a possible measure of entrepreneurial strength and the degree of competition. The competition index for industry i in a district r (CI_{in}) is calculated by the following formula (Glaeser et al. 1992: 1138; Mody and Wang 1997: 301-2):

$$CI_{in} = \frac{(\text{firm} / \text{output})_{ir}}{\text{firm} / \text{output})_{iINDO}} \qquad (2)$$

where 'firm' refers to number of firms; 'output' refers to total output; iINDO is industry i in all districts in Indonesia; r indicates that the index is in a given year. A high CI_{in} implies greater competition, meaning more firms for a given output in that district relative to the average number of firms divided by output in the industry across all districts. We argue that a higher competition index will tend to encourage regional specialization.

Labor market condition. Labor market factors, particularly wage rates or labor cost and labor skills, are viewed by the NCT as a central factor in the location decision of manufacturing establishments. We include labor cost variable (WAGES), which is measured as the average annual wage for production workers in manufacturing establishments. The empirical studies indicate that higher wage rates are negatively associated with the location of new manufacturing establishments on both U.S.-owned and foreign manufacturing establishments, but Japanese automotive-related manufacturers prefer locations with high wages (Smith and Florida 1994). Kuncoro (1994: 51-52) found that wages are important in the textile, wood and miscellaneous industry, but turn out to be less important variables in more modern industries such as machinery, chemical, and paper. We will test whether our data supports or rejects the finding of previous studies.

Path Dependency. Historical patterns can be explained by the age distribution of firms. Instigated by Krugman (Krugman 1995; Krugman 1998), the NEG believes that history matters in explaining the persistence of unequal distribution of economic activity. The age profile of an industry can provide some inferences about the nature of entry and exit process (Henderson and Kuncoro 1996; Kuncoro 1994). Kuncoro (1994) using a location choice model found that new firms in all industries —except paper, chemical, and

machinery— are more likely to locate in the district with older firms. We may calculate the AGE from the starting year of production. We will test NEG hypothesis that history does matter, in particular: new firms are more likely to locate in districts with older firms. In other words, the older the AGE of a firm the more likely that there will be greater regional specialization.

Export orientation. NTT and NEG postulate that greater export orientation enhances spatial concentration. This has been an emerging view among the international economists, in which much trade represents arbitrary specialization based on increasing returns, rather than exploiting exogenous differences in resources or productivity (e.g. Helpman and Krugman 1985; Krugman 1990). An empirical study in Taiwan, for example, shows that high-exporting industries tend to facilitate faster productivity progress of an individual firm than low-exporting industries (Wang 1994). Other evidence from the Brazilian *supercluster* in Sinos Valley indicates that export growth increased the demand for local inputs and machinery, thus contributing to the development of the cluster (Schmitz 1995: 14). We use percentage of production exported (EXPORT). We will test to what extent the higher EXPORT of specific industry in a region will reinforce agglomeration forces.

Foreign Investment. NTT recognizes that there has been a convergence between trade theory and the theory of the MNEs. The focus is not only on the institutional form of overseas involvement, but also on the decision of the MNE to locate in a particular country (e.g. Dunning1997; Dunning1998). A number of studies of geography of Japanese investments in the UK and Australia which found foreign investors have generally preferred to invest in core regions and adjoining border regions (Fuchs and Pernia 1989). The open door policies and special economic zones in China have successfully attracted foreign investment mainly in the coastal regions (Mody and Wang 1997: 320). However, policy factors are found to be unimportant in the location decision process of 134 Japanese MNEs in Singapore, Australia, Thailand, Malaysia, Indonesia, Phillipines (Nicholas, Gray, and Purcell 1999). We will use percentage of foreign ownership (FDI) to examine whether greater foreign investment spurs retard regional specialization.

Model Specification and Data

Model

Based on theoretical and empirical studies that have been explained above, we may derive the following model.

$$Y_{in} = \beta 1_{in} + \sum_{l}^{k} \beta_{kin} X1_{kin} + \sum_{l}^{n} \beta_{nn} X2_{nn} + D_i + T_t + Rjkt + Rsby + e_{in} \quad (3)$$

where

Y_{in} = the specialization index;
i=1,...,9 = refers to a two-digit industry sector;
r=1...., 107 = refers to a district unit;
t=1,..., 6 = refers to a given time period;
k = number of industry-specific variables;
n = number of regional-specific variables;
X1 = a vector of industry-specific variables including ISIZE, RESOURCE, WAGES, AGE, EXPORT, FDI, CI, IMPOR;

Table 6. **Summary of Descriptive Statistics**

	LLQ	ISIZE	RESOURCE	IMPOR	YCAP	WAGES	AGE	EXPORT	FDI
Mean	-0.503566	6.596741	-0.399442	-2.434932	14.16298	10.58319	2.302890	-1.550329	0.765457
Median	-0.371064	6.614726	0.309028	-1.709258	14.00741	10.88365	2.397895	-1.036765	1.609438
Maximum	3.653252	12.27685	7.055334	0.000000	17.02371	16.96030	4.532599	0.054109	4.605170
Minimum	-4.605170	2.995732	-9.210340	-9.210340	13.06779	2.197225	0.000000	-9.210340	-4.710531
Std. Dev.	1.368232	1.990499	2.891118	2.010637	0.670931	2.239984	0.728008	1.544881	2.391023
Skewness	-0.357691	0.079996	-1.291606	-1.209631	1.218600	-0.809948	-0.830856	-1.443541	-0.573071
Kurtosis	3.123464	2.274915	4.533552	3.938134	4.743160	3.112212	4.088966	5.090401	2.094539
Jarque-Bera	91.78815	96.09479	1559.781	678.0614	1564.887	458.6684	678.0845	1347.791	93.60730
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	4180	4183	4148	2417	4183	4175	4123	2546	1053

Sources: Calculated from BPS

X2 = a vector of region-specific variables consisting of POP and YCAP;
D_i = industry dummy;
T_t = time dummy;
Rjkt and Rsby are regional dummy for Greater *Jabotabek* (Jakarta, Bogor, Tangerang, and Bekasi) and Greater Surabaya respectively.

Data

The model attempts to highlight three dimensions of our data: industry, region, and year. Industry in our data is two-digit industrial sectors, i.e. food (ISIC31), textile (ISIC32), wood (ISIC33), paper (ISIC34), chemicals (ISIC35), non-metal (ISIC36), basic metal (ISIC37), fabricated metal (ISIC38), and others (ISIC39) industry. The region is *kabupaten* or *kotamadya*, or approximately a district-county, of which Java has 107. Years include the period from 1991 to 1996.

Most of the data are from the *Annual Industrial Survey* data collected by BPS (Central Bureau of Statistics) of Indonesia. The surveys provide the plant-level data of large and medium manufacturing firms, with more than 20 workers, that can be disaggregated by industry code (ISIC) and district, providing all data of industry-specific variables. To give an overview of the data used, Table 6 shows a summary of the descriptive statistics.

We also use the population data either from the 1990 Population Census and the 1995 Intercensal Population Survey. Data from the Gross Regional Domestic Product of Regencies/Municipalities in Indonesia supply the regional-specific variable such as income per capita.

Given the three dimensions of our data, we deal with a model that pools time series and cross-sectional data. In theory, there are five cases of pooling model: (1) all coefficients are constant and the disturbance is assumed to capture differences over time and individuals; (2) slope coefficients are constant and the intercepts vary over individuals; (3) slope coefficients are constant and the intercept vary over individuals and time; (4) all coefficients vary over individuals; (5) all coefficients vary over time and individuals (Judge et al. 1980: 326-59). We should identify which of the case is the most appropriate for our model.

Empirical Results

Specification

The empirical results estimating the equation of 3 are sensitive to the variable included. We apply some methods suggested by Belsley (Belsley et al. 1980). These methods have proved useful in a sensitivity analysis of empirical study of industrial growth in Coastal China (Mody and Wang 1997). *First*, to what extent dropping one observation at a time, or sets of observations (excluding from regression a province, a year, an industry, a district-industry, a year-industry, and a year-district) influence the coefficients. *Second*, to what extent adding or dropping independent variables brings an effect on the signs and magnitude of the coefficients. We perform the sensitivity analysis tests by using White Heteroskedasticity Test, redundant and omitted variable(s) test. As we introduce either industry dummies, regional dummies, or time dummies, the results show some improvement in the goodness of fit.

In the reported regressions, as shown in Table 7, we weight the observation by the district population. With this weighting, the goodness of fit of the models

Table 7. **Determinants of Regional Specialization, 1991-96**

Variable	1	2	3	4	5
Constant	-0.769 (-12.02)**	-0.683 (-6.78)**	-0.761 (-6.38)**	-0.529 (-5.07)**	-0.664 (-5.55)**
Resource intensity (RESOURCE)	0.0005 (1.06)				
Import content (IMPORT)	0.3835 (3.65)**	0.4073 (3.28)**	0.3959 (3.15)**	0.6729 (5.20)**	0.6422 (4.96)**
Labour costs (WAGES)	0.0003 (2.06)*	0.0006 (5.45)**	0.0006 (5.29)**	0.0006 (5.47)**	0.0006 (5.34)**
Scale economies (ISIZE)	0.0207 (8.23)**	0.0143 (8.89)**	0.0142 (8.79)**	0.0179 (8.67)**	0.0179 (8.80)**
Export orientation (EXPORT)	0.2561 (3.75)**	0.5838 (6.06)**	0.8137 (6.36)**	0.6496 (7.12)**	0.8137 (6.58)**
Foreign investment (FDI)	0.0029 (1.37)	-0.0009 (-0.36)	-0.003 (-1.05)	0.0021 (0.76)	0.0014 (0.49)
Competition index (CI)	-0.005 (-5.12)**	-0.004 (-4.32)**	-0.005 (-4.30)**	-0.006 (-4.35)**	-0.006 (-4.35)**
Path dependency (AGE)	0.0183 (5.88)**	0.0159 (3.56)**	0.0160 (3.51)**	0.0102 (2.34)*	0.0088 (1.97)*
Income per capita (YCAP)	-0.059 (-5.74)**	0.0039 (0.41)	0.0047 (0.45)	0.0383 (3.56)**	0.0491 (4.26)**
Dummy					
● Industry	No	Yes	Yes	Yes	Yes
● Time	No	No	Yes	No	Yes
● Regional	No	No	No	Yes	Yes
Adjusted R^2	0.1575	0.2974	0.2995	0.333	0.336
No. observation	4179	4179	4179	4179	4179
DW	1.837	1.675	1.767	1.835	1.836
F	92.947	111.510	86.097	117.19	92.947

Note: *) indicate statistical significance at the 0.05 level.
**) indicate statistical significance at the 0.01 level.
The dependent variabel is log of LQ_{in}. All regressions are weighted by district population and are tested by White Heteroskedastucity Consistent Standard Errors & Covariance test. The t-statistics are in parentheses.

improved substantially. In addition, this weighting procedure is conducted to solve the problem of what the spatial econometricians call *spatial heterogeneity* due to the lack of "stability" over space of the behavioral/relationship under study (e.g. Anselin and Florax 1995; Paelinck and Klaassen 1979). This is relevant to our study as the data shows dissimilar spatial units, such as the huge agglomeration of Jakarta and Surabaya, and far smaller districts such as Surakarta.

Principal Results

Table 7, which provides estimation results for 4179 observations during the period 1991-1996, presents an empirical support for models of regional specialization based on industry-specific and regional-specific variables. Scale economies (ISIZE), import content (IMPORT), labor cost (WAGES), export orientation (EXPORT), foreign investment (FDI), competition index (CI), and path dependency (AGE) constitute industry-specific variables that influence regional specialization significantly. Likewise, the regional income per capita (YCAP) as a regional-specific variable also explains the regional specialization well.

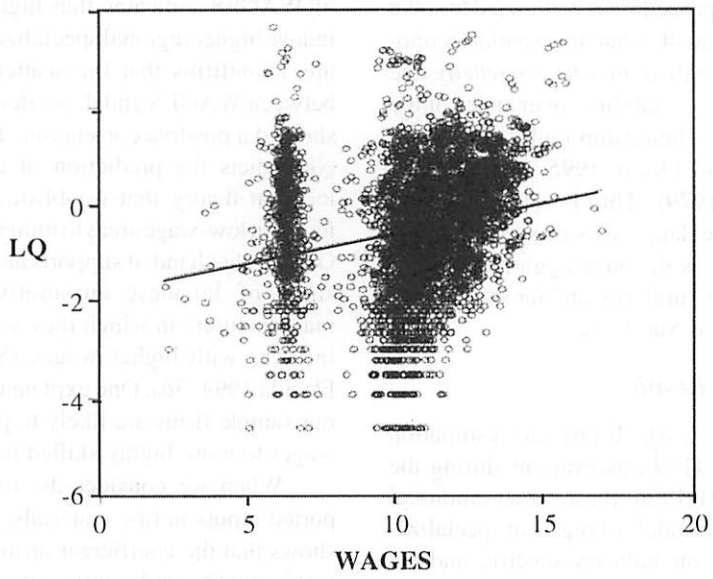
As far as the underlying theory is concerned, most of the results are consistent with the NTT and NEG theories, but not the NCT. Column 1 of Table 7 shows that the relevance of NCT is only supported by the scale economies, while resource intensity is rejected by the insignificance of RESOURCE. The omitted test of RESOURCE indicates that dropping this variable does not bring any effect on both *F* and *LR* (Likelihood Ratio). At face value, this result implies that regional specialization in Java is not based on the comparative advantage of factor endowments, but on other factors such as labor cost. Interestingly the positive coefficient of WAGES indicates that higher wages induce higher regional specialization. Figure 1 confirms that the scatter diagram between WAGES and dependent variable showed a positive correlation. This result contradicts the prediction of traditional location theory that establishments will locate in low-wage areas to minimize costs. On the other hand, it supports an empirical study of Japanese automotive-related manufacturers in which they are locating in areas with higher wages (Smith and Florida 1994: 36). One explanation is that our sample firms are likely to pay higher wages to more highly skilled labor.

When we consider the role of imported inputs in raw materials, our result shows that the coefficient of import content is positive and significant in all cases. The result supports the NTT suggesting high import content occurs in more specialized industries. It implies that most specialized industries in Java have advantages in terms of vertical integration with foreign suppliers and relatively better access to infrastructure.

Export orientation (EXPORT) plays an important role in this study. The coefficient of EXPORT shows a positive, very statistically significant coefficient in all of the equations, suggesting that higher export orientation has reinforced greater regional specialization. The evidence confirms the argument of NTT and findings of previous studies.

Industry size (ISIZE) and regional income per capita (YCAP) show positive and very statistically significant coefficients in all of the equations. The positive coefficient of ISIZE and YCAP show that both scale economies and large market size explain regional localization over time, confirming the prediction of NTT and NEG: scale economies and home market

Figure 1. **Scatter Diagram: Wages and LQ (in logarithm)**



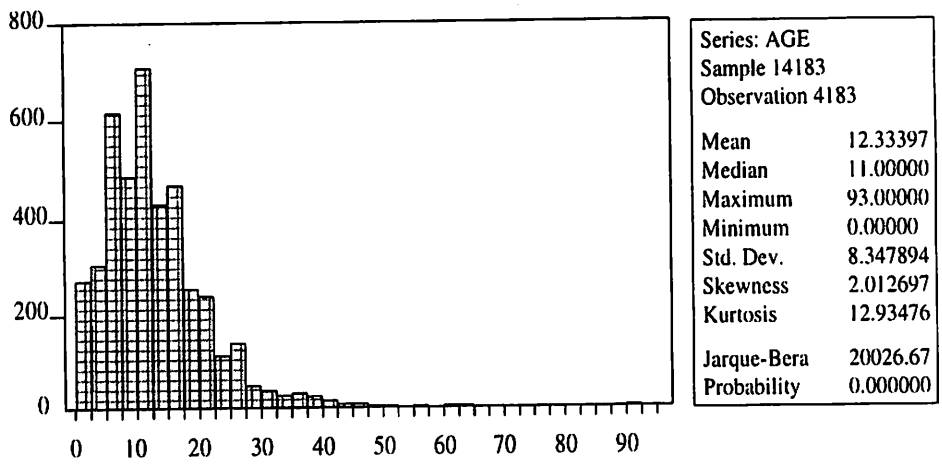
do matter. These results suggest that manufacturing firms in Java seek to locate in more populous and densely populated areas to enjoy both localization economies, which are associated with the size of a particular industry, and agglomeration economies, which reflect the size of market of a district, in a particular urban area.

The statistical significance of the coefficients for competition index (CI) are negative and statistically significant. The general thrust of the results is consistent across various specifications and hence worth noting: increasing competition has a detrimental effect on regional specialization. In other words, Java's market structure may restrict competition so that firms tend to specialize geographically. If it is true that the Indonesian industrial structure can be generally classified as an oligopoly industry where the four biggest firms controlling almost every industry (Hill 1997; Kuncoro et al. 1997; Pangestu 1997). This structure is likely to augment further regional specialization. Our finding is consistent with NTT and NEG rather than NCT, with respect to the role of imperfect competition in explaining the uneven distribution of economic activity.

The role of path dependency in this study is strong. This is indicated by positive and statistical significance of the coefficients for AGE across various specifications. The thrust of the results are clear: older firms tend to enhance regional specialization. This finding supports the NEG, in particular Krugman's hypothesis, with respect to the persistence of regional specialization in many cases. Figure 2 shows AGE has a positive skewness, suggesting that the mean of firm age in our study is higher than it's median. This is due to very high discrepancy in terms of age between the old and new firm in Java. In contrast to a new firm, the old firm can reach 93 years.

The statistical significance of foreign investment is weak. In all equations, the coefficient of Indonesian abbreviation (PMA—*Penanaman Modal Asing*) is insignificant implying that direct foreign

Figure 2. **Histogram and Descriptive Statistics of AGE**



investment has not played an important role in regional specialization. This result challenges the finding of a study of foreign investment in Indonesia over the period 1980-1991 (Sjoholm 1999) arguing inter-industry knowledge spillover from foreign investment. Instead, the evidence supports a number of studies of geography of Japanese investments in the UK and Australia which found foreign investors have generally preferred to invest in the core regions and adjoining border regions (Fuchs and Pernia 1989).

Industry Dummies

When the industry dummies are added to the model, the goodness of fit improves considerably (Table 8). Adding industry dummies increases the F and R^2, indicating their high explanatory power. Since other industry (ISIC39) is omitted, the omitted category becomes a base or benchmark to which the others are compared. The statistical significance of industry dummy is sensitive to whether the regression includes or excludes regional dummies. *D31*, *D34*, and *D36* are not significant statistically, indicating that there is no substantial difference between regional specialization of other industry and the food industry, between other industry and the paper industry, and between other industry and nonmetallic industry respectively. The significance of other dummies (D32, D33, D35, D37, D38) indicates that regional specialization of textile, wood, chemicals, basic metal, and fabricated metal do differ from that of other industry.

Time Dummies

Applying a redundant variable test for the time dummies of equation in column 5 Table 7 shows that time variation does matter in explaining regional specialization. This is reflected by the high value of F and Likelihood Ratio that statistically significant at $\alpha = 1$ percent. Since year 1996 is omitted, the omitted category becomes a base or benchmark to which the other times are compared. The statistical significance of industry dummy is sensitive to whether the regression includes or excludes regional dummies. Table 9 indicates that the inclusion of industry dum-

Table 8. **Industry Dummy Coefficients, 1991-1996**

Industry Dummy	Regression with Time Dummies but Without Regional Dummies[a]	Regression with Regional Dummies but Without Time Dummies[b]	Regression with Time and Regional Dummies[c]
D31=Food	-0.089624 (-0.72882)	-0.082325 (-0.726969)	-0.047483 (-0.41843)
D32=Textile	-0.987586 (-8.90945)**	-1.125870 (-9.46847)**	-1.112544 (-9.37692)**
D33=Wood	-0.991117 (-8.50260)**	-0.924627 (-8.14060)**	-0.941147 (-8.46991)**
D34=Paper	-0.205902 (-1.96000)*	-0.153521 (-1.439137)	-0.110666 (-1.02513)
D35=Chemicals	-0.263138 (-2.63302)**	-0.317772 (-3.278217)**	-0.274330 (-2.76484)**
D36=Nonmetallic	-0.030956 (-0.28799)	-0.033466 (-0.313637)	0.010501 (0.09676)
D37=Basic metal	-0.474058 (-3.10293)**	-0.379882 (-2.57492)**	-0.345648 (-2.32736)*
D38=Fabricated metal	-0.462573 (-4.40165)**	-0.525136 (-4.95109)**	-0.48575 (-4.49374)**

Note: *) indicate statistical significance at the 0.05 level.
**) indicate statistical significance at the 0.01 level.
The *t*-statistics are in parentheses.
a. Overall regression results are given in column 3 Table 7.
b. Overall regression results are given in column 4 Table 7.
c. Overall regression results are given in column 5 Table 7.

mies and regional dummies cause *T92* statistically significant, a sharp contrast with the exclusion of regional dummies. The significance of *T92* can be interpreted that regional specialization in 1992 does differ from that of 1996.

Regional Dummies

Table 10 exhibits the coefficient for regional dummies, using non-agglomeration area as the base of comparison. The coefficients of *Rjkt* and *Rsby* in the first column are positive and significantly different from 0 (at least at the 5 percent level of confidence), implying that both Greater Jabotabek and Greater Surabaya areas do differ substantially from non-agglomeration areas in terms of regional specialization. Indeed, adding industry and regional dummies improve the goodness of fit (see column 4 in Table 7). When we add time dummies, the second column of Table 7

Table 9. **Time Dummy Coefficients, 1991-1996**

Time dummy	Regression with industry dummies but without regional dummies[a]	Regression with industry and regional dummies[b]
T91	-0.213161	-0.061385
	(-1.8737)	(-0.5447)
T92	0.054115	0.184660
	(0.6206)	(2.2098)*
T93	0.058495	0.153294
	(0.6713)	(1.8687)
T94	0.058344	0.115858
	(0.7238)	(1.5262)
T95	0.054529	0.087069
	(0.6759)	(1.1372)

Note: *, indicate statistical significance at the 0.05 level.
**, indicate statistical significance at the 0.01 level.
The *t*-statistics are in parentheses.
a. Overall regression results are given in column 3 Table 7.
b. Overall regression results are given in column 5 Table 7.

Table 10. **Region Dummy Coefficients, 1991-1996**

Region Dummy	Regression with Industry Dummies but Without Time Dummies[a]	Regression with Industry and Time Dummies[b]
Rjkt	-0.6166	-0.6184
(-8.668)**	(-8.631)**	
Rsby	-0.1228	-0.1443
(-1.904)*	(-2.241)*	

Note: : *, indicate statistical significance at the 0.05 level.
**, indicate statistical significance at the 0.01 level.
The t-statistics are in parentheses.
a. Overall regression results are given in column 4 Table 7.
b. Overall regression results are given in column 5 Table 7.

shows it makes little difference to the results. These results provide some confidence that regional dummies are good explanatory variables for differences in the regional specialization.

Conclusions

One of the big issues of economic geography and regional studies is to what extent the industrial concentration toward LME and metropolitan regions is driven by market forces. This paper attempts to address this unresolved question in Java using the regional specialization index as a measure of geographic concentration of manufacturing industry and pooling data over the period 1991-1996. Indeed, it integrates the perspectives of industry, region (space), and time. More importantly, it also explores which theory—the Neo-Classical Theory (NCT), the New Economic Geography (NEG), or the New Trade Theory (NTT) —is best at explaining geographic concentration in Java.

Our findings suggest that there has been a natural market-led tendency toward the spatial concentration of manufacturing industry in metropolitan regions. From the supply side, we find that import content, export orientation, scale economies, and labor costs have played a key role in LME spatial concentration. High import content and export orientation imply that most specialized industries in Java have advantages in terms of vertical integration with foreign suppliers and greater access to the international market. The positive and significant coefficient of scale economies suggests that manufacturing firms in Java enjoyed localization economies. The positive coefficient of labor costs indicates that higher wages induce higher regional specialization. From the demand side, size of market has explained spatial concentration in the manufacturing industry. It implies that manufacturing firms in Java seek to locate in more populous and densely populated areas to enjoy urbanization economies, as reflected by the size of the market of a district in a particular urban area. Furthermore, the interplay of the market forces is intensified by the imperfect competition of Java's market structure. Java's market structure may restrict competition so that firms from the same group tend to concentrate geographically to optimize the benefits of agglomeration. Yet further detailed research is needed to identify which business groups are able to and exploit the agglomeration economies in metropolitan regions.

The most striking result is that most of the NCT hypotheses can be rejected. This conclusion is supported by the econometric results that resource intensity is insignificant and that the coefficient on labor costs is positive. The former implies that regional specialization in Java is not based on the comparative advantage of factor endowments. The latter suggests that the prediction of NCT— that establishments will locate in low-wage areas to minimize costs— is not supported by our data. Instead, our sample firms are likely to pay higher wages to more highly skilled labor. We may conclude that regional specialization in Java is based on neither natural resources nor low labor costs.

Most of the findings support the NTT and NEG hypotheses. Proponents of NTT argue that increasing returns to industry leads to concentration in the large market, while NEG has identified linkages, thick markets, knowledge spillover and other pure external economies as major centripetal forces that pull industries to urban regions (Fujita et al. 1999: 345-6; Krugman 1996). Yet the results are not strong enough

to enable us to differentiate between these two theories. Our findings suggest that manufacturing firms in Java seek to locate in more populous and densely populated areas to enjoy both localization economies and urbanization economies, as shown by the significance of scale economies and income per capita. The former is associated with the size of a particular industry, while the latter reflects the size of a market of a district in a particular urban area. More importantly, the results suggest that there is a synergy between thickness of market and agglomeration forces. The interplay of agglomeration economies is intensified by the imperfect competition of Java's market structure. We find that Java's market structure may restrict competition so that firms tend to concentrate geographically.

This paper gives empirical evidence with respect to path dependency hypotheses. Krugman points out that history clearly determined what happened in the case of the U.S. manufacturing belt and has become a self-fulfilling prophecy (Krugman 1991: 27-33). Our econometric analysis finds the robust role of path dependency, as shown by the positive and statistical significance of the coefficients for age of firms across various specifications. This finding supports the New Economic Geography's belief that history matters: older firms tend to enhance regional specialization. Java has been long known as a center of economic activity since the nineteenth century (Dick et al. 1993; Dick 1996; Sato 1994). In addition, the results, as shown by statistical significance of its regional dummy, suggest that most of the specialized industries in Java have better access to infrastructure. This is more prevalent in Greater Jabotabek and Greater Surabaya metropolitan regions that have far superior infrastructure such as seaports, airports, toll roads, than other regions in Java, or even other areas in Indonesia.

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