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Trade Openness and Spatial Inequality: Evidence from ASEAN9

Ploypailin Tinkan
Chulalongkorn University
Faculty of Economics

Abstract

Income inequality has been extensively studied by economists for several decades. However, there are considerably few studies on spatial inequality, which refers to the inequality in the economic and social indicators of well-being across geographical units within countries, have been conducted because of the limited within-country income data; as a result, the relationship between income and spatial inequality remains poorly understood. This study uses the satellite night images of light density as a proxy of spatial inequality and determined whether changes in trade openness were essential for the evolution of spatial disparities in ASEAN countries from 1992 to 2010. Two different measures of inequality are employed: Gini and Theil indices. Using static and dynamic panel data analyses to separate short- and long-term results, we find that an increase in international trade can lead to a high short-term spatial inequality; nevertheless, trade openness exhibits a long-term association with spatial inequality to a less extent. Therefore, short-term spatial inequalities resulting from changes in trade openness are persistent when these inequalities occur for a long time. This conclusion may reinforce pre-existing inequality in each ASEAN country.

Keywords: Trade Openness, Spatial Inequality, Theil, Gini

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Introduction

Over the past three decades, international trade has been considered as one of the key features of globalization. World trade increased from 38.8% of GDP in 1990 to 55.6% in 2010 (World Bank, 2009). In ASEAN countries, trade openness evolution has shown an increasing trend since the last decade.

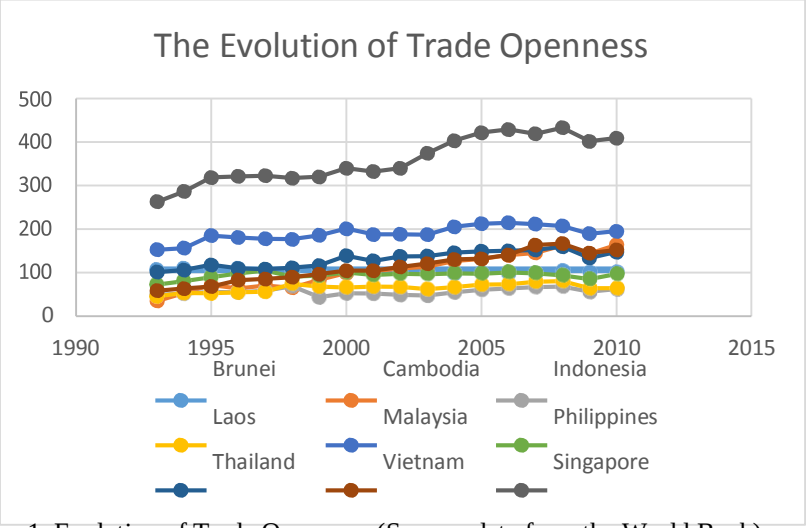

Figure 1: Evolution of Trade Openness. (Source: data from the World Bank)

International trade can lead to considerable spatial inequality, which is defined as the inequality in the economic and social indicators of well-being across geographical units within countries. International trade particularly causes economic agglomeration in geographic areas benefitting from trade; these areas include those located near seaports, airports, and industrial estates. Figure 2 illustrates the GDP densities of Thailand, Myanmar, and Vietnam. The dark colors represent high values, which are concentrated in the economic center of each country. Thailand's GDP is significantly concentrated in Bangkok and Rayong, where numerous international airports, seaports, and industrial estates are located.

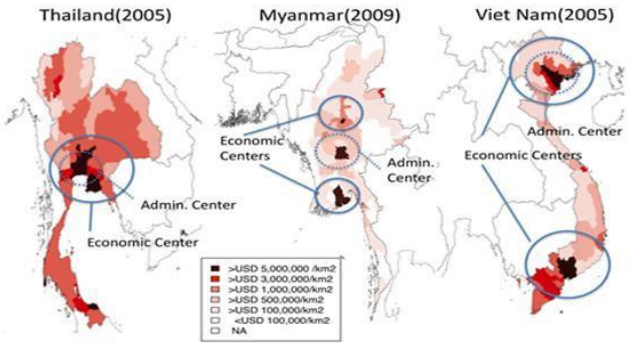

Figure 2 Geographical concentration of economic activities in several countries Source: Institute of Developing Economies (IDE-JETRO)

Spatial inequality is an urgent economic issue that should be raised because this issue leads to migration from suburban areas to cities. As a consequence, immigrants become second-class citizens in cities while they work in an assembly line and live in congested or poor-quality residence instead of first-class citizens working in familiar areas in their hometown. Several immigrants also cannot find jobs in cities because of limited competence in certain skills. A few of these immigrants later become homeless, several immigrants resort to prostitution, a few immigrants commit suicide, and other immigrants become involved in activities promoting social unrest. Therefore, economic agglomeration encourages people in suburban areas to leave the agriculture sector in favor of the industrial sector. As a result, these individuals are at a risk of becoming permanent second-class citizens.

The evolution of spatial disparities can result in permanent inequality; however, lagging regions unlikely keep pace with leading regions particularly when disparities occur in countries with high levels of spatial inequality. Therefore, trade openness may strengthen pre-existing social, political, cultural, and ethnic divides; as a consequence, national unity and social stability are threatened.

Several economists concurred that spatial inequality may be essential for a short time but not for a long time. On the basis of theoretical principles, Kuznets (1955) and Lucas (2000) suggested that the nature of growth unlikely appears simultaneously everywhere, and income inequality is related to spatial inequality; thus, spatial inequality should occur when a country facilitates development but then experiences downfall when a certain development stage is reached. However, this condition remains true when spillovers are sufficiently strong to transmit growth and technological progress across regions. This idea is reinforced by empirical studies from developed countries where a considerably small gap exists between urban and rural inequalities caused by development; in this case, international trade is at the center. Nevertheless, evidence from developing countries remains insufficient; as such, studies have yet to determine whether the conclusion from studies in developed countries is similar to that in developing countries. Therefore, the perspective of eliminating spatial disparities should be considered.

Studies related to the relationship between international trade and spatial disparity likely focus on developed countries because within-country level data are accessible, particularly in the case of the European Union (EU) (Barrios and Strobl, 2009). Limited evidence has also been obtained from developing countries because of the insufficient within-country income data and the disturbance of economic activities in the informal sector. Hence, the relationship between international trade and spatial inequality is inconclusive.

This study uses the satellite night images of light density to provide spatially within-country differences defined as "nightlight spatial inequality." In ASEAN countries, nightlights can efficiently proxy the diffusion of economic activities (Chaiwat, 2013). The areas with a high degree of economic activity likely exhibit a high light intensity.

Nightlight data (NL) are collected in a raster image form by using Defense Meteorological Satellite Program (DMSP) and Department of Defense program, and NL data are provided by NOAA's Earth Observation Group, a sub-organization of NASA. Figure 3 illustrates the image of light at night in 2010. Light is dense in the eastern US and

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Asia, western Europe, southern Africa, and northern and southwestern India. This analysis has clipped an image in the ASEAN region. The image is at the global level of lights generated mostly by human activities; thus, light from the sun, moon, aurorae, forest fires, and clouds has been removed algorithmically. Luminosity or light intensity is a digital number between 0 and 63, where zero represents no light and 63 refers to maximum light. This study uses nightlights to proxy spatial inequality.

This study presents and evaluates an alternative conjecture that focuses on the relationship between international trade and spatial inequality by using a sample set of nine ASEAN countries, particularly Brunei, Cambodia, the Philippines, Indonesia, Malaysia, Laos, Thailand, Singapore, and Vietnam. Myanmar is excluded from the analysis because of inadequate data in this country. This thesis focuses on whether changes in trade openness should be considered essential for the evolution of spatial disparities and whether this association changes over time. Two different measures of inequality are employed: (1) Theil, which allows the parsing of inequality in a group and between group components; and (2) Gini, which allows direct comparison between the units with different population sizes. The analyses are estimated by running balanced static and dynamic panel data covering the period between 1992 and 2010 when data availability is the same in all countries.

Data are analyzed by running balanced static panels with country and time fixed effects to address whether the evolution of trade openness is related to the evolution of spatial inequality in a short term. The other part of the analysis is devoted to assess whether this relationship changes over time. Dynamic panel estimation is employed to differentiate the short- and long-term effects. The findings indicate that an increase in international trade can lead to high spatial inequality in a short term; however, trade openness is less associated for a long time. Therefore, short-term spatial inequality as a result of the changes in trade openness is persistent for a long time. This conclusion may reinforce pre-existing inequality in each ASEAN country.

This paper is organized as follows. Section 2 presents the literature review. Section 3 provides the methodology, including detailed data and spatial inequality measures, and presents basic correlations. Section 4 reports the results of the static and dynamic analyses associating trade openness with spatial inequality across the nine ASEAN countries. The last section summarizes the findings and policy implications and discusses topics for future studies.

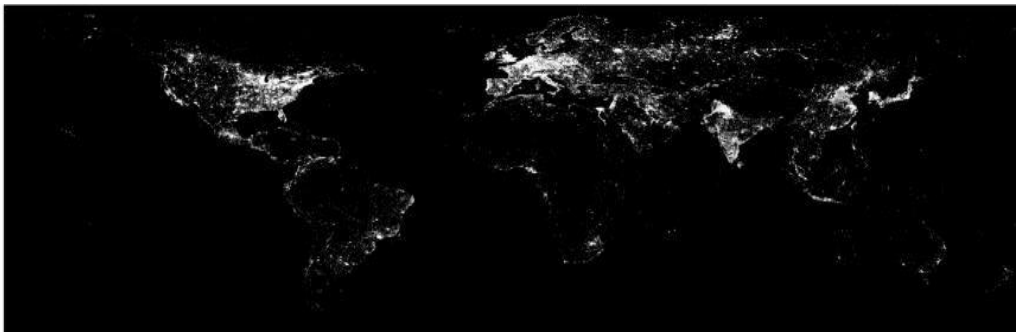

Figure 3 Satellite image of the Earth at night from NOAA Earth Observation Group, 2010. Source: NOAA Earth Observation Group, 2010

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Literature Review

Trade and Inequality

Globalization may either encourage or discourage spatial inequality. The fact that several regions may gain more than other regions allows external trade to increase spatial inequality. In neoclassic economics, spatial inequality determined by international trade is likely to increase if regions exhibit different comparative advantages. Regions with natural resources for exports, such as coasts, transportation networks, and proximity to rivers, likely benefit more from international trade than those that lack these resources. In terms of increasing returns, spatial inequality increases possibly because a few regions remain more dependent on domestic trade; by contrast, other regions benefit from the increasing returns as a result of international trade.

Puga and Venables (1999) suggested that trade liberalization may reduce spatial inequality over time. Once industries concentrate in one region, the wage in this region is higher than that in underdeveloped regions; thus, a wage gap is generated. Industries will then migrate to one of the lagging regions. Over time, economic agglomeration will be distributed to the lagging regions. In the aforementioned researchers' model, both trade liberalization, which discourages tariff; and import substitution policy, which encourages tariff, are mechanisms that facilitate the migration of industries to lagging regions. However, the welfare levels are higher under the trade liberalization scenario than those of import substitution.

Krugman and Livas (1996) demonstrated that foreign trade may also reduce urban inequality. In particular, urban inequality factors (forward and backward linkages) are counterbalanced by transportation costs and land rental. An equilibrium is the concentration of industries in one primate area when tariff rates for international trade are prohibitively high. Given this assumption, firms and workers concentrated in one primate city produce significant forward and backward linkages to offset the urban congestion costs.

Spatial Inequality

Both theoretical and empirical studies on the factors determining spatial agglomeration have emerged in recent years (Henderson and Thisse, 2004). Although theoretical studies tend to highlight the micro-foundations of spatial agglomerations, empirical studies take advantage of the advances in empirical methods that have considerably expanded the quality of empirical evidence on agglomeration economies.

Spatial inequality is fundamentally determined by the location decisions of firms and households. Although firms select locations to maximize profits, households do so to maximize job market outcomes and utility. Both firms and households care about the quality of their respective regional and urban environments. However, a unified theory of spatial location decision has yet to be developed (Fujita et al., 1999; Fujita and Thisse, 2002; Berliant, 2007).

Economic geography is divided into two fields, namely, regional and urban economics (Kim and Margo, 2004). The regional models that possess a regional–urban perspective have been discredited because of inadequate theoretical foundation. Regional models are also fundamentally based on international trade models. By contrast, urban models lack a useful dimension for regional location decisions. According to Handerson's (1974) model, cities are

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defined as islands with different scales. The distribution sizes of cities are being discussed among urban economists.

In the revision of economic geography theories, Kim (2008) demonstrated that theoretical advancements in increasing return models in recent years reflect a plethora of traditional concepts. For example, Marshallian externalities (emphasizing technological spillovers, labor market pooling, and access to non-traded intermediate inputs) and non-pecuniary externalities (focusing on forward and backward linkages and market size) have clarified the forces of spatial agglomeration and dispersion. Therefore, spatial inequality is the net result of the balance of forces of concentration and dispersion. The regional perspective has suggested that the centripetal forces of geographic concentration are naturally advantageous. The centrifugal forces of dispersion are the immobility of factors and goods caused by high transportation and communications costs. The urban perspective has suggested that the most important difference is the addition of new costs of concentration in the form of congestion costs caused by the fixed land supply. Concentration leads to increased housing and commuting costs, as well as costs caused by numerous crime, pollution, and exposure to disease.

Only a few methods are used to measure regional inequality. The simplest and most extensively used measure is the location Gini coefficient (Krugman, 1991). Its application is similar to the Gini coefficient used to measure household income inequality but in the geographic activity concentration dimension. Moreover, Ellison and Glaeser (1997) proposed an alternative measure that corrects an industry's scale economy. Brülhart and Traeger (2005) suggested that entropy indices are decomposable into within-region and between-regions components. To measure urban inequality, urban productivity and the size distribution of cities are placed at the center. Differences in wages and productivity measure urban inequality because both wages and productivity are generally positively correlated with city sizes. Urban inequality is also often measured using the rank–size distribution of cities. In particular, urban primacy or the urban population concentration in the largest cities is often used as a measure of urban inequality. However, a measure that relates urban inequality with regional inequality is still lacking.

Based on the nature of geography, the development of spatial inequalities is related to both neoclassical and increasing returns models. The neoclassical model focuses on the role of resources endowments and geographic proximity to rivers and ports. By contrast, the increasing returns model focuses on the density of human interactions. Economic development allows regions to benefit from the nature of geography; thus, spatial inequality may be beneficial because productivity increases. Nevertheless, spatial inequality in the form of excessive urban concentration or urban primacy may be detrimental because congestion costs are not internalized by individuals. Therefore, the theory suggests that an optimal level of spatial inequality is present (Kim, 2008)

Evidence of Spatial Inequality in Developing Countries

The concept of regional inequality is quite challenging because studies vary in terms of indices of geographic concentration, geographic units of observation, as well as theoretical motivation and empirical specifications. Moreover, international cross-sectional, or panel analysis, either in the urban inequality literature, or the household income literature are considerably rare; thus, constructing inequality measures to compare across countries is difficult. Consequently, the literature on regional inequality is dominated by country-specific

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studies. Nevertheless, the review of various developed and developing countries may facilitate comparisons. However, evidence for developing countries is often based on survey data because of the scarcity of reliable data in these countries. Evidence on spatial inequality is also highly varied probably because of poor data quality or significant variance in the economic circumstances of developing countries. The industrial patterns of spatial localization are fairly similar across many developed countries even though significant variations in the spatial inequality levels are present. In developing countries, country-specific geographic and political factors may play an out-of-balance significant role in shaping the patterns of spatial inequality in development compared to developed countries. These variations in the inequality patterns of developing countries represent significant challenges in identifying the causes of spatial inequality.

Urban/Rural Development in Developing Countries

Tacoli (1998) reported that selecting the correct combination of investments between agriculture and industry is still debatable. One party may support the agriculture sector because it can provide the surplus for industrial and urban development. The other may argue that industrial and urban growth is required for a modern and productive agricultural sector.

Modernization through Industrialization and Urbanization

The concept of development in the early 1950s focused on increasing the domestic market and investment inducement sizes. Moreover, the important components of the modernization process at that time were industrialization and urbanization. Lewis (1954) assumed that minimally marginal productivity would occur in densely populated rural settlements in developing countries; hence, agricultural productivity will not decline when labor from rural agriculture migrate to the urban industry. In the mid-1960s, the settlement of migrant workers and their families in urban areas became permanent. However, the job supply level in the manufacturing sector was clearly significantly low to absorb the increasing urban population. Therefore, initial studies on the urban informal sector were conducted because of the emergence of concerns with over-urbanization.

Structural Adjustment, Globalization, and Decentralization

An export-oriented economy, underpinned by neoclassical economics that encourages competitive free markets rolled-back governments, is a strategy for development of many developing countries. The primary commodities of export is food; "...local agricultural production will blossom and expand" (Corbridge, 1989). For a few small-scale individual farmers, agricultural inputs cost and consumer goods increase at a more rapid rate than the price of agricultural products. With the reduction of government subsidies, farmers cannot buy inputs and sell agricultural products in volume immediately after harvesting because of high transportation costs. At best, they can wait and then sell their products. Therefore, reducing both the rural–urban income gap and the rates of rural to urban migrants seems challenging because access to international markets is unequal among producers. This situation deepens inequality in cities and the countryside. Administrative decentralization also plays an important role in rural–urban associations in the 1990s to deal with international financial institutions and democratic support. In terms of policy, decentralization has continued the interest for regional development planning.

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Data and Variables

Inequality Indices

To generate the spatial inequality indices, I exploit the luminosity variations at the pixel level, which is the lowest geographical unit affordable.

Theil index

Under the context of information theory proposed by Theil (1967), the indices are calculated as follows:

$$T(1)ct = \sum_{i=1}^{n} (pit \frac{yit}{\mu ct}) \log(\frac{yit}{\mu ct})$$

where *pit* represents the grid share of level *i* in country *c* during year *t*;

yit denotes the average light intensity of level *I* during year *t*;

$\mu ct = \Sigma\, pit\, yit$; and
T(1)ct denotes the Theil's index of inequality.

Ezcurra and Rodriguez-Pose (2014) concurred that this measure offers a plethora of advantages. First, this measure is independent of scale and population size, as well as satisfies the Pigou–Dalton transfer principle (Cowell, 1995). Second, *T(1)* is additively decomposable by population subgroups (Bourguignon (1979) and Shorrocks (1980)); thus, this variable is well-recognized by the literature on territorial inequalities (Ezcurra & Rodriguez-Pose, 2009). Finally, omitting population size may immensely distort the perceptions of spatial inequality (Petrakos et al., 2005); thus, *T(1)* considers the differences in population sizes across a spatial unit. This consideration is constantly left unnoticed by studies on economic connection that have prospered since the contributions of Barro and Sala-i-Martin (1992).

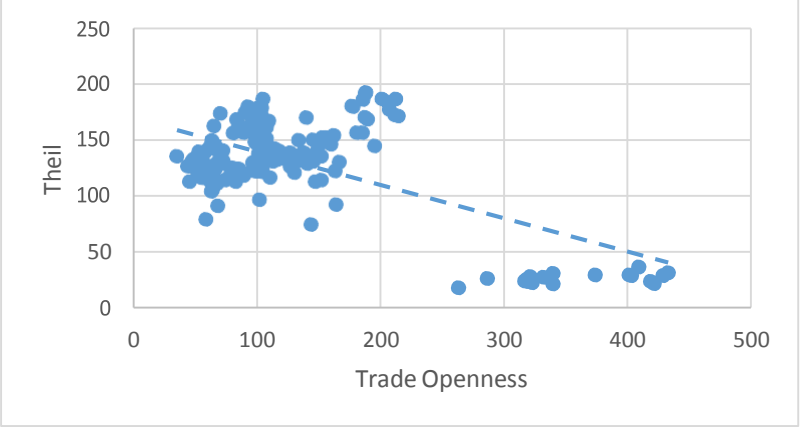

Figure 4 Preliminary relationship between trade openness and spatial inequality (Theil, 1967). Notes: Spatial inequality is measured using the Theil index and represents in (*1000 units). Trade openness is the ratio between exports plus imports and GDP

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Gini index

The Gini coefficient is the simplest and most extensively used measure to quantify spatial inequality (Krugman, 1991). This ratio's locational counterpart measures the extent to which geographic activity is concentrated because it is used to measure household income inequality (Kim, 2008).

The Gini index is defined as follows:

$$Gini = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} pipj\,|xi - xj|}{2\mu}$$

where pi and pj represent grid population share of level i and j, respectively, in country c during year t; yit and yjt denote average light intensity of level I and j, respectively, during year t; μct = Σ pit yit; and Gini denotes the Gini's index of inequality.

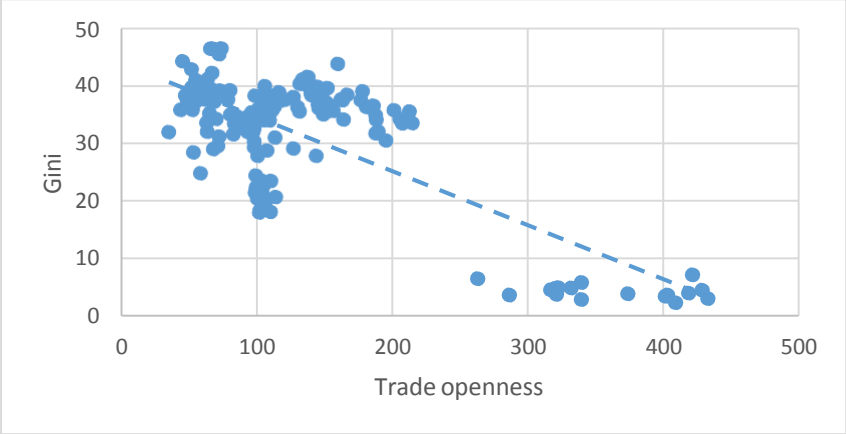

Figure 5 Preliminary relationship between trade openness and spatial inequality (GINI). Notes: Spatial inequality is measured using the Gini's index and represents in (*1000 units). Trade openness is the ratio between exports plus imports and GDP.

Figures 4 and 5 display the bivariate relationship between trade openness and spatial inequality in ASEAN countries using Theil and Gini's index of inequality, respectively. These preliminary results suggest that the openness of national economies to international trade may have spatial implications and affect the level and evolution of regional disparities within the ASEAN countries. Moreover, these results may be the result of neoclassical economics, suggesting the presence of different comparative advantages among regions. Therefore, regions that have natural resources critical for exports, such as coasts, transportation networks, and proximity to rivers, are more likely to benefit from external trade than lagging regions do. An increasing return perspective also suggests that this phenomenon is caused by several regions remaining more reliant on autarkic trade, while others gain increasing returns from trade openness. However, certain country-specific characteristics have also been identified in the literature as factors enhancing or diminishing the influence of trade openness on regional

inequality (as presented in Table 1, Appendix). A considerably extensive detail will be examined in the next section.

Control variables

In the literature, country-specific characteristics have been identified as factors enhancing/diminishing the influence of trade openness on spatial inequality.

Urban Population (+) A shift from rural locations to cities, which is associated with a shift from agricultural to manufacturing and service sectors, will impinge upon the costs of trade, provided that the infrastructure concentration is essential for international trade activities. This case implies that trade is a primary factor of spatial inequality. Urban population is expressed as the percentage of the total population living in urban areas. The higher the urban population percentage, the less spatial distribution of international trade benefits. Therefore, urban population encourages spatial inequality (Source: World Development Indicators).

Polity2 (−) Inefficient institutions caused by rampant corruption and pervasive rent seeking by durable local elites are barriers to wealth diffusion from international trade. Polity2 is expressed as the revised combined Polity score of Polity IV databases (Marshall and Jaggers, 2005). This process combines the scores for constraints on the chief executive, competitiveness of political participation, and openness and competitiveness of executive recruitment. The scores range from −10 to +10, where the +10 spectrum indicates more democratic institutions. The more democratic the institutions, the less influence trade openness exerts in spatial dimension. Therefore, polity2 decreases spatial inequality (Source: Polity Project).

Government Size (−) A government with a considerable social and territorial redistributive capacity through public policies will have a sturdy position to transfer the benefits of international trade from prosperous regions to lagging ones, thereby leading to low influence on spatial inequality. Government size is defined as the total government consumption as a percentage of the national GDP. The variable is expressed at 2005 constant prices. The higher the government expenditure percentage, the more considerable the spatial redistributive capacity; thus, spatial disparities decrease (Source: Penn World Tables 7.1).

Life Expectancy (+) Life expectancy at birth indicates the number of years a newborn infant would live if the prevailing mortality patterns at the time of birth were to remain constant throughout his/her life. The differences in the distribution of human capital can be envisaged that the greater the spatial differences, the greater the influence of trade openness in spatial dimension (Source: CEIC database).

GDP in Purchasing Power Parity (+) GDP per capita based on purchasing power parity (PPP). PPP GDP is GDP converted to international dollars using PPP rates. An international dollar has the same purchasing power over GDP as the US dollar has in the US. Hence, GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the products' value. GDP is calculated without making deductions for depreciation of

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fabricated assets or for depletion and degradation of natural resources**.** The ASEAN countries' respective GDPs have been mainly driven by industrialization in urban areas.

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Consequently, migration occurred from rural to urban areas, and urban population increased at a higher rate than the rural population, thereby resulting in rapid urbanization with widening rural–urban income disparities and worsening intra-urban income disparity. In theory, both results cause nationwide inequality. Therefore, the higher the GDP in PPP, the greater is the effect on spatial disparity (Source: Penn World Tables 7.1).

Population (+) Population is included to control country size because the latter can cause hidden spatial heterogeneity. Population is measured as a natural log of the total population. The larger the population, the more influence international trade exerts on spatial inequality (Source: Penn World Tables 7.1).

Agglomeration (+) Inter-regional labor mobility can be bound to influence the effect of trade openness on the distribution of wealth. The reason is that workers tend to concentrate in prime areas expecting more job opportunities, as well as higher salaries, thereby leading to considerable agglomeration that promotes spatial inequality. Agglomeration is defined as the percentage of urban population living in the largest city of a country. The higher the urban population percentage living in the largest city of the country, the less spatial distribution of wealth results from trade. Hence, agglomeration promotes spatial inequality (Source: World Development Indicators).

Paved Road and Railway Density (−) Based on a new economic geography (NEG) framework, accessibility to markets affects spatial performance. Locations with high relative access to foreign markets will attract the winners of integration, resulting in higher medium- to long-term spatial growth rates than in locations with constrained access to foreign markets. In the current study, accessibility to foreign markets are determined as two factors, namely, paved-road density, which is calculated by the fraction of the total length of paved road over the total area of a specific country; and railway density, which is approximated by the fraction of the total length of railway over the total area of the country considered. The higher the density of paved road and railway, the lower the spatial inequality (Source: National Statistic Offices).

After we identified an appropriate set of conditioning variables capturing the relationship between international trade and internal spatial inequality, the next task is to set the model.

Methodology

Model

The overall trade openness in ASEAN countries is considered as our dependent variable in the econometric model, which is formulated as follows:

$$INQ^*ct = \alpha + \beta TRADEct + \varphi Xct + \varepsilon ct \quad (1)$$

where X is a set of control variables (Table 1) and INQ*ct is the level of inequality in country c at time t.

Rodriguez-Pose (2012) discussed that spatial inequality is bound to be a time-persistent phenomenon with a high degree of inertia. To address this potential inertia, a dynamic model with past levels of spatial inequality on the dependent variables side is formulated. The effect of both short- and long-term can be observed by using dynamic panels.

Adapting Brown's (1952) classical habit persistence model and adding inertia into the model yields

$$INQct - INQct - 1 = \lambda(INQ^*ct - INQct - 1), \quad 0 < \lambda < 1 \qquad (2)$$

where the $INQct - INQct - 1$ ratio is the actual observed change of the spatial configuration and

λ is the speed of adjustment ranging between 0 and 1. If λ is close to 1, then the adjustment is almost instantaneous and the relationship between the theoretical determinants Xct and the actual observed spatial consequences INQct is static. If λ is less than 1, then the difference between the observed spatial outcome and their inertia-free theoretical counterpart INQ*ct becomes significant, resulting in the need to control for partial adjustment in a dynamic model. Rearranging and substituting for INQ*ct yields

$$INQct = \lambda (\alpha + \beta TRADEct + \Sigma\varphi Xct + \varepsilon ct) + (1 - \lambda)INQct - 1 \qquad 0 < \lambda < 1 \qquad (3)$$

Equation (3) shows the basic specification followed in the dynamic panel regressions. The dependent variable that represents the observed inequality is on the left side of the equation, while the theoretical determinants of the inertia-free spatial configuration plus the previous value of the inequality variable are on the right. The latter effectively controls for potential inertia and partial adjustment. By fixing the previous spatial outcome $INQct - 1$, the short-term effect of any independent variable Xct is given by its revealed regression coefficient when running this equation. Conceptually, this coefficient represents the product $\lambda\beta$. The assumption for the long term is that a country's spatial configuration reaches a stable equilibrium, thereby making the current and previous year's inequality levels close to identical. Setting $INQct - 1$ equal to INQct in this equation, the long-term effect of any independent variable on the spatial configuration can be obtained by dividing the observed regression coefficient $\lambda\beta$ by the speed of the adjustment parameter λ.

The foregoing consideration leads to the transformation of equation (1) into the following empirical specification:

$$INQ^*_{ct} = \alpha + \beta TRADE_{ct} + \varphi_1 UrPop_{ct} + \varphi_2 Polity2_{ct} + \varphi_3 Govt_{ct} + \varphi_4 LifEx_{ct} + \varphi_5 GDP_{ct} + \varphi_6 \ln(Pop_{ct}) + \varphi_7 Agglomeration_{ct} + \varphi_8 Road_{ct}\&Railway_{ct} + \varepsilon_{ct} \qquad (4)$$

In the static analysis, I estimate equation (4) by running static ordinary least squares with country- and time-fixed effects. The standard errors are clustered by country. Given that all unobserved invariant country and time heterogeneity was eliminated from the model, the coefficients can be interpreted as partial effects that annual variations of independent variables around the country mean have had on annual variations of spatial inequality around the country mean.

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Findings

Static Analysis

This section attempts to assess whether trade openness has an effect on spatial inequality. The static analysis presents the results of estimating equation (4) by using both the Theil and Gini indices.

The impact of trade openness on spatial inequality: static analysis		
Dependent variable	Theil	Gini
tradeopenness	0.209***	0.0684
urbanpopulation	1.8398**	-0.0515
polity2	-0.976*	-0.673
governmentsize	-1.1624	-0.401
life_expectancy	-0.9128	0.0175
gdp_in_ppp_log	-14.697	1.9467
population_log	-6.0099***	-0.0714
agglomeration	-0.1568	0.1079
road density	-0.2972	-0.0249
Constant	318.2951***	11.6677
R-sq: within	0.2044	0.1499
Observations	162	162

Table 1: Results from the Static Analysis Note: All the regressions include a constant and the full set of control variables of the baseline model. *Significant at 10% level, **Significant at 5%, *** Significant at 1%

The result shows that trade openness is positively associated with spatial disparities at the 1 percent significance level when using the Theil index. However, no significant association exists between trade openness and the evolution of spatial inequality by using the Gini index. The reason is that the Theil index can calculate inequality both within a group and among groups, whereas Gini cannot. Therefore, Theil can calculate inequality more precisely than Gini. The implication of this result is that a 1 percent increase in trade openness may result in a 0.21 percent increase in spatial inequality. Regions or areas that have comparative advantage in infrastructure, such as areas located near seaports and industrial estates, are more likely to benefit from openness to international trade than the lagging areas that have limitation in assessment. Although several regions gain from the increasing returns that foreign trade offers, the others remain more reliant on domestic trade. Hence, the result that international trade can lead to higher spatial inequality in the short term satisfies both neoclassical economics and increasing returns theories.

Dynamic Analysis

This analysis is devoted to assess whether the relationship between trade openness and spatial inequality changes with time. The short- and long-term results can be differentiated by using the "xtabond" command in STATA to correspond to the first difference Arellano–Bond GMM estimation (Arellano & Bond, 1991); the long-term results are emphasized in this section.

The impact of trade openness on spatial inequality: dynamic analysis		
Dependent variable:Theil	Theil	Gini
Lagged Theil	293.1244***	378.517***
tradeopenness	0.1797*	0.0118
urbanpopulation	1.4775	-0.109
polity2	-0.68	-0.0931
governmentsize	-1.1952	-0.3027**
life_expectancy	-0.7709	-0.4034
gdp_in_ppp_log	-21.7877	2.5105
population_log	-2.1926	0.5282
agglomeration	-0.8468	-0.0375
road_dense	-0.2526	0.0024
railway_dense		
Observations	144	144

Table 2: Results from the Dynamic Analysis Note: All the regressions include a constant and the full set of control variables of the baseline model. *Significant at 10% level, **Significant at 5%, *** Significant at 1%

With the inclusion of lagged level on the right-hand side of equation (4), I determined that all the differences in the current levels of within-country spatial inequality are explained by previous levels of within-country inequality. The high degree of inertia inferred from the coefficient of the lagged level of spatial inequality causes the influence of international trade to be irrelevant or less relevant than in the static analysis in either using the Theil or Gini index as a dependent variable. Kuznets (1955) and Lucas (2000) suggested that spatial inequality should increase when a country started to develop and then fall when a certain level of development is reached, as long as spillovers are strong enough to transmit growth and technological progress across regions. This situation means that a decline in spatial inequality comes with the condition of spillover effect to transfer benefits from trade and technological advancement to the poor areas. Although empirical studies from developed countries reveal that external trade-led development causes a small gap between urban and rural inequalities, this finding confirms that such condition may be inapplicable for the case of developing countries. Poor countries do not possess an effective process to transfer trade benefits from primate city to the lagging ones as that in developed countries.

Conclusion and Policy Implications

This study aims to present and evaluate an alternative conjecture that focuses on the relationship between international trade and spatial inequality by using a sample set of nine ASEAN countries. To overcome the shortage of within-country income data and informal sector information, this study provides spatially within-country differences in terms of "nightlight spatial inequality" from satellite night images of light density. Two different measures of inequality are employed, namely, Theil and Gini indices.

Using static and dynamic panel data analyses to separate short- and long-term results, the findings indicate that an increase in international trade can lead to a higher spatial inequality in a short period; however, trade openness is associated with spatial inequality to a less extent as time passes. This result shows that the short-term spatial inequalities resulting from the changes in trade openness are persistent for a long time. This conclusion may reinforce pre-existing inequality in each ASEAN country.

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The result may be specific to ASEAN countries because of the types of exports and imports. Consider the case of Thailand. Table 3 presents Thailand's main exports and imports in 2013. Vehicles, computers and electronic equipment, and oil are among the top either in imports or exports. Therefore, these products are concentrated in a few specific areas and not distributed to other areas. People in suburban areas migrate to cities to find numerous jobs. This economic activity is not distributed to other areas, and the agriculture sector remains underdeveloped as a result of the economy's export-oriented structure; thus, growth diffusion has become poor. Therefore, trade openness leads to spatial inequalities because of (1) international trade in industrial commodities and (2) inefficient income distribution mechanism to lagging regions.

Exports	Imports
1. Vehicles	1. Crude oil
2. Computers and electronic equipment	7. Vehicle components
3. Oil	9. Computers and electronic equipment

Table 3 Thailand's main exports and imports in 2013

Knowledge and technology spillovers will drive economy forward; as such, the government is encouraged to support the export-oriented economy but to leave the agriculture sector behind. However, only a few production processes, such as car assembly requiring a low skill set, are transferred. This condition is attributed to cheap labor resulting from low grain prices and cheap food; thus, a relatively low cost of living is observed.

Therefore, the Thai government should pay more attention to the lagging regions, particularly in agriculture, because this institution plays a major role in providing welfare to the country; in this manner, developments in international trade will not lead to further territorial disparities. This objective can be achieved by implementing policies, such as grain price insurance, universal health coverage service, unemployment insurance, education and skill development, and risk insurance.

Instead of focusing on urban development, policymakers should also pay significant attention to rural development; thus, the government should put the agriculture sector at the center of development. Thailand's agricultural employment is from 35 percent to 50 percent; hence, a majority of workers are in this sector. In the context of international trade in the globalized era, agriculture also plays a role in global food stability. The agriculture sector will survive when farmers survive; therefore, grain prices insurance should be implemented. This case is unlike that of developed countries, such as the US, where farmers are capitalist. Farmers in developing countries need government intervention to aid in setting grain prices so that farmers will be able to thrive in the agriculture sector. Enhancing grain quality should also be supported. Furthermore, once a number of workers are concentrated in a few agricultural areas, wages in those particular areas will decrease. Thus, the government should encourage a variety of jobs in agriculture. The ageing society also necessitates that the government provide universal health coverage service to ensure that farmers obtain the health services they need without suffering financial hardship when paying for them and make the system convenient and efficient. Finally, low-skilled industry workers should have more opportunities in

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education and skills development to enable them to contribute significantly to the industry sector instead of merely engaging in assembly in factories.

This analysis provides a more complete understanding of the relationship between international trade and within-country spatial inequality in ASEAN countries where income data is inadequate and uncompleted. Further studies should focus on the different samples using nightlight spatial inequality as a proxy for inequality and other potential control variables. Pursuing this analysis provides a comprehensive view of the association between trade and spatial inequality.

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Appendix

Control Variables	Definitions	Expected Signs	Sources
Urban population	Percentage of the total population living in urban areas	+	World Development Indicators
Polity2	Combined scores for constraints on the chief executive, competitiveness of political participation, and the openness and competitiveness of executive recruitment ranging from - 10 to +10 in which +10 spectrum indicates more democratic institutions	-	Polity IV databases, Polity Project
Government size	Total government consumption as a percentage of national GDP	-	Penn World Tables 7.1
Life expectancy	Reflects the health dimension of the Human Development Index (HDI)	+	CEIC database
GDP in Purchasing Power Parity	Gross domestic product converted to international dollars using purchasing power parity rates	+	Penn World Tables 7.1
Population	Natural log of total population	+	Penn World Tables 7.1
Agglomeration	Percentage of urban population living in the largest city of the country.	+	World Development Indicators
Paved road and Railway density	The fraction of total length of paved road and railway over total areas of the specific country	-	National Statistic Office

Table 1 Set of Controlled Variables Derived from the Literature

Variable	Obs	Mean	Std. Dev.	Min	Max
Urban population	162	47.26056	25.57036	16.6016	100
Polity2	162	0.685185	5.726122	-7	9
Government size	162	9.980247	5.474901	3.12	26.5
Life expectancy	162	70.41849	5.769323	56.4541	82
GDP in purchasing power parity	162	293772.8	377578.5	5627.46	1,900,000
Population log	162	9658.924	26029.4	0.27133	97,976.6
Agglomeration	162	34.74657	27.26842	7.31846	100
Road density	162	79.86069	135.4578	9.170608	473.6

Table 2 Descriptive Statistical Table

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