Trade Openness and Spatial Inequality

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พลอยไพลิน ถิ่นกาญจน์ : การค้าระหว่างประเทศและความเหลื่อมล้ำเชิงพื้นที่ (Trade Openness and Spatial Inequality) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: อ. ดร. ธานี ชัยวัฒน์, 54 หน้า.

นักเศรษฐศาสตร์ให้ความสนใจเรื่องความเหลื่อมล้ำเชิงรายได้มาเป็นเวลายาวนาน หากแต่ข้อมูลภายในแต่ละประเทศยังมีไม่เพียงพอ ทำให้การศึกษาความเหลื่อมล้ำเชิงพื้นที่มีจำกัด ดังนั้นความสัมพันธ์ระหว่างการค้าระหว่างประเทศและความเหลื่อมล้ำเชิงพื้นที่ยังไม่มีข้อสรุป วิทยานิพนธ์เล่มนี้ใช้ภาพถ่ายดาวเทียมของแสงไฟยามค่ำคืนเป็นตัวประมาณค่าความเหลื่อมล้ำเชิงพื้นที่และหาความสัมพันธ์ของการค้าระหว่างประเทศที่มีต่อวิวัฒนาการของความเหลื่อมล้ำเชิงพื้นที่โดยใช้กรณีศึกษาจากข้อมูลระหว่างปี 1992 ถึง 2010 ของประเทศสมาชิกอาเซียน ดัชนีที่ใช้วัดความเหลื่อมล้ำ ได้แก่ สัมปสิทธิ์จีนี่ และดัชนีทีล ใช้การวิเคราะห์ข้อมูลแบบแผงทั้งสถิตและพลวัตน์เพื่อจำแนกผลในระยะสั้นและระยะยาว ผลการศึกษาพบว่าการเพิ่มขึ้นของการค้าระหว่างประเทศนำมาสู่ความเหลื่อมล้ำเชิงพื้นที่ในระยะสั้นแต่มีผลน้อยมากในระยะยาว กล่าวคือ ความเหลื่อมล้ำเชิงพื้นที่ในระยะสั้นของประเทศสมาชิกอาเซียนอันเป็นผลมาจากการค้าระหว่างประเทศจะสะสมเพิ่มขึ้นไปจนถึงระยะยาว

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Income inequality had been focused by economists for a long time, but due to the shortage of within-country income data, there has been still limited studies on spatial inequality and leave this relationship inconclusive. This paper used satellite images of light density at night as a proxy for spatial inequality and put forward whether changes in trade openness matter 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 analysis to separate short- and long term results, the findings indicate that an increase of international trade can lead to higher spatial inequality in short run, but trade openness has less association with spatial inequality in the long-run. It can be interpreted that short-run spatial inequalities resulting from changes in trade openness are persistent in the long-run. This conclusive remark may reinforce preexisting inequality in each ASEAN country.

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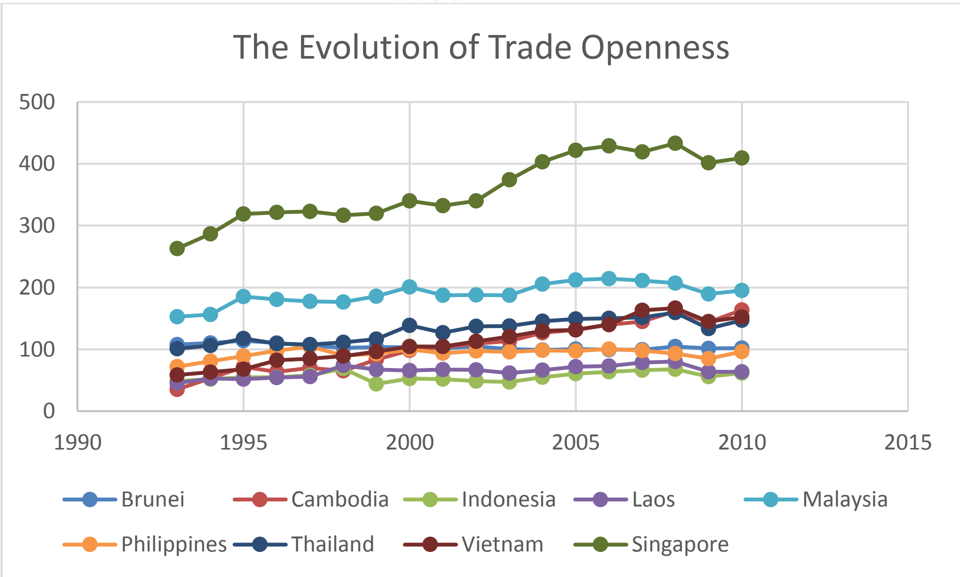
Introduction

Over the past three decades, international trade has been among the key features of the process of globalisation. The level of world trade has increased from 38.8 per cent of the GDP in 1990 to 55.6 per cent in 2010 (Ezcurra, 2014). In the case of ASEAN countries, there has been an increasing trend for the evolution of trade openness since the last decade.

Figure 1 The Evolution of Trade Openness

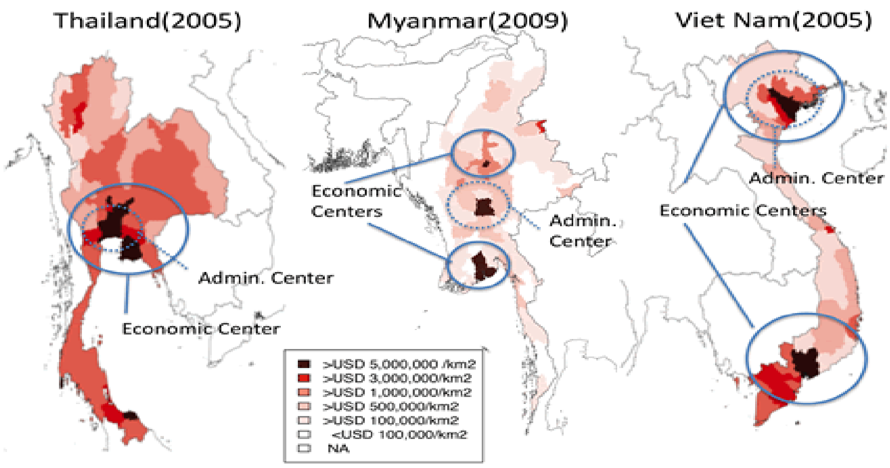


Source: Own Development, using PWT 7.1 Data.

Note: Openness at 2005 constant prices (%)

However, international trade can lead to greater spatial inequalities within countries. In particular, international trade causes economic agglomerations in areas that geographically benefit from trade such as the areas located near seaports, airports, and industrial estates. Figure 2 illustrates GDP density of Thailand, Myanmar and Vietnam. The darker colors represent the higher values, which are concentrated in the areas located in economic center of each country. In the case of Thailand, GDP is most concentrated in Bangkok and Rayong which consist of international airports, seaports, and industrial estates.

Figure 2 Geographical concentration of economic activity in some countries



Source: Institute of Developing Economies (IDE-JETRO)

Economically spatial inequality is an important and urgent issue to be raised because it brings about immigration from suburban to cities. Immigrants becomes second class people in the city working in assembly line, being congested in slum or poor quality residence instead of being first class people working in the areas they are familiar in their home town. Even worse, some immigrants cannot find jobs in the city due to the lack of competence in certain skills. Some of them become homeless, prostitute, some commit suicide, and other illegal activities. In short, economic agglomeration encourages people in suburban to leave agriculture for industry. This causes them to become permanent second class people.

The evolution of spatial disparities can bring about permanent inequality which lagging regions have no hope for catching up the winning ones, particularly when disparities take place in countries that high level of disparities across space already exists. In other words, trade openness may strengthen pre-existing social, political, cultural, ethnic divides, and thus threaten national unity and social stability.

Some economists concurred that spatial inequality may matter only for the short-term, but not in the medium- and long-term. In theory, the work conducted by Kuznets (1955) and Lucas (2000) has suggested that the nature of growth is unlikely to appear everywhere at the same time, and because income inequality is related to spatial inequality, spatial inequality should then rise when the country started to develop and then fall when a certain level of development is reached (Kuznets, 1955; Lucas, 2000). This phenomenon occurs as long as spill over effects are strong enough to transmit growth and technological progress across regions. This is reinforced by the empirical studies from developed countries which reveal the smaller gap between urban and rural inequalities, caused by development. To this extent, international trade is at the heart of the debate. Evidence from developing countries are still absent. It remains unclear whether the conclusion from the study of developed countries are similar to that of developing countries. Hence, the perspective of eliminating spatial disparities should not be overlooked.

As a matter of fact, spatial inequality may have both positive and negative effects on development. From a standpoint of economic efficiency, on the positive side – according to returns to scale or comparative advantage in production – spatial disparity can help increase productivity (S. Kim, 2008). Autarchic economies are likely to be dwarfed by those with lower barriers for international trade. The case of industrial economies, in particular, where the rewards of promoting trade has well been documented. On the negative side, the evolution of spatial disparities can bring about permanent inequality which the lagging regions have no hope for catching up the winning ones – in particular when disparities take place in countries that high level of spatial inequality already exists. Trade openness, however, may strengthen pre-existing social, political, cultural, ethnic divides, and thus threaten national unity and social stability. Hence, this issue should not be neglected when considering the outcome of globalization process —which, in this context, has put the focus on the case of ASEAN Economic Integration.

Despite the fact that a rising number of policymakers especially in developing countries have taken this issue into account and been seeking the most appropriate way to promote spatially balanced growth (WorldBank, 2009), studies of how external trade impinge on disparities within country. The association between external trade and spatial inequality in theories and empirics is inconclusive (Brülhart, 2005). This may be because the study on the evolution of within-country spatial inequalities has tended to focus on the internal factors as they are likely to follow Williamson (1965).

External factors have only been playing as a supporting role, and when they are taken into account, the result has been vague (Rodríguez-Pose, 2012).

In addition, literatures concerning the relationship between international trade and spatial disparity tend to concentrate on developed countries because within-country level data are accessible particularly in the case of European Union (e.g.(Barrios, 2009)). The evidence from developing countries is still limited due to the shortage of within-country income data and the disturbance of economic activities in informal sector. This can be implied that the evidence from ASEAN countries, where less developed countries are integrated, does not necessarily have the similar consequences to the developed ones. Hence, the relationship between international trade and spatial inequality is still left inconclusive.

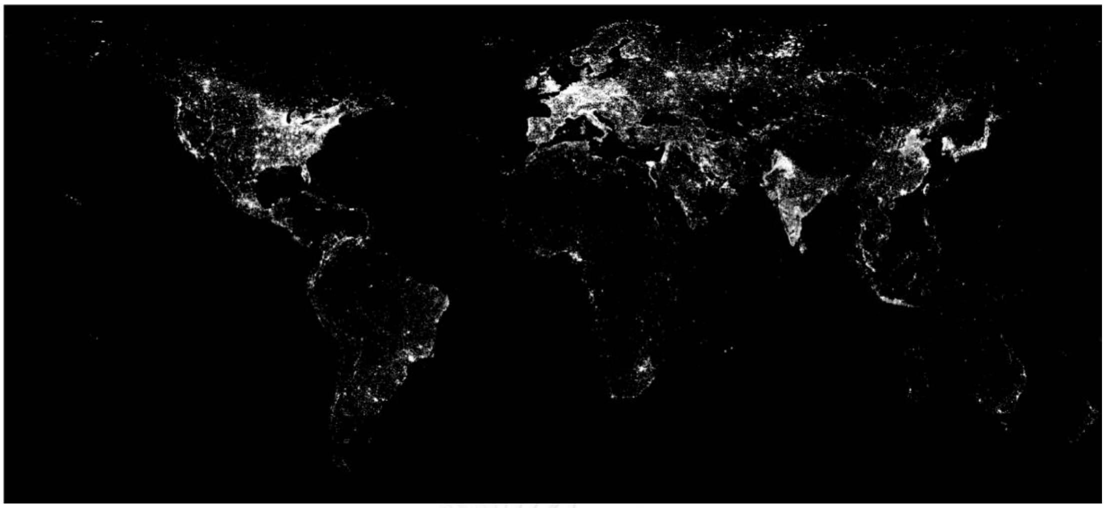
This paper used satellite images of light density at night to provide spatially within-country differences defined as 'nightlight spatial inequality'. Evidence from ASEAN countries has proved that nightlight can efficiently proxy the diffusion of economic activities (Chaiwat, 2013). Area with higher degree of economic activity concentration would have higher light intensity.

Nightlights data (NL) is collected in raster image form by DMSP (Defence Meteorological Satellite Program), Department of Defence program, and provided by NOAA's Earth Observation Group. (Sub-organization of NASA). Figure 3 illustrates the picture of light at night in 2010. Light is dense in the eastern side of the United States of America and Asia, the western side of Europe, the southern side of Africa, and Northern and South west of India. This analysis has clipped image into ASEAN area. The image presents lights in the global level which are mostly generated by human activity, thus light from sunlight, moonlight, aurorae, forest fires, and clouds have been removed algorithmically. The light intensity is a digital number ranging between 0 and 63. Zero represents no light and 63 refers to maximum light. This paper uses nightlights to proxy spatial inequality.

This paper puts forward and tests an alternative conjecture that emphasises on the association between international trade and spatial inequality, using a sample set of nine ASEAN countries (i.e. Brunei, Cambodia, the Philippines, Indonesia, Malaysia, Laos, Thailand, Singapore, and Vietnam). Myanmar is excluded from the analysis due to inadequate data. My thesis raises two questions. The first question is whether openness to international trade has an impact on spatial disparities. The second question is whether the previous association changes in time. Two different measures of inequality are employed; Theil, which analyses inequality both within and between group elements and Gini, which directly compare among units in which size of population is varied. The analysis is estimated by running balanced static and dynamic panel data covering the period between 1992 and 2010 when data availability is the same for all countries.

The analysis is conducted by running balanced static panels with country and time fixed effects to address whether the evolution of trade openness has relationship with the evolution of spatial inequality in short term. The other part of the analysis is devoted to assess whether the association between trade openness and spatial inequality in the previous part changes in long-term. To differentiate the effects of short- and long-term, dynamic panel estimation is resorted. The findings indicate that an increase of an international trade can lead to higher spatial inequality in short run, but trade openness has less association with the impact in a long-run. Hence, it can be interpreted that short-run spatial inequality resulting from changes in trade openness are persistent in the long-run. This conclusive remark may reinforce pre-existing inequality in each ASEAN country.

Figure 3 Satellite Image of the Earth at Night



Source: NOAAs Earth Observation Group, 2010

The first contribution of this study is to overcome the sparsity of within-country income data and the shortage of informal sector information among ASEAN countries. Hence, this paper provides spatially within-country differences, defined as ‘nightlight spatial inequality’. Satellite images of light density at night, available at a fine grid, will be used in this case. Recent studies have shown that luminosity is a strong proxy of development (J. V. Henderson, Adam Storeygard, and David N. Weil, 2009). Additionally, evidence from ASEAN countries has proved that nightlight can efficiently proxy gross- regional output and measure level of growth in each area of interests. Its dispersion can also represent the diffusion of economic activities (Chaiwat, 2013).

Second, to record the association between trade openness and spatial inequalities with each ASEAN country, the analysis is conducted by running balanced static panels with country and time fixed effects to address whether the evolution of trade openness has relationship with the evolution of spatial inequality in short-term. The other part of the analysis is devoted to assess whether this relationship changes with time. To differentiate the effects in short- and long-term, dynamic panel estimation is resorted. The static analysis shows that only in the case of Theil, increases in international trade can be a part of spatial inequality. However, trade openness has less association with spatial inequality in the long-run. This can be interpreted that short-run spatial inequalities resulting from changes in trade openness are persistent in the long-run which may reinforce preexisting inequality in each ASEAN country.

Third, in an effort to shed light on the root of spatial inequality, the exploration of its geographic bases is needed. To be specific, motivated by recent work showing that under a string of NEG models, which concerned with the spatial implication of trade openness, the national geography of production and income is constructed concerning changes in market access affecting the forces of the interplay between agglomeration and dispersion. This determines the dynamic of industrial location across domestic areas. Therefore, I include additional country-specific and geographic related endowment under the market access underpinnings to determine the evolution of spatial disparities (i.e. paved road and railway density). The results suggest that geographic differences across space have a weak association with spatial inequality. This contrasts with what Williamson's path asserted, saying that only internal factors matter for the evolution of spatial disparities, not the external ones.

In a recent review of the literature on the effects of trade openness on spatial inequalities, there are only 11 cross-country studies that has explored the link and all of them concentrate on the effect of trade on urban primacy, rather than whether how trade openness associates with spatial inequalities (Ezcurra, 2014). The limited amount of studies dealing with the relationship between international trade and spatial disparities may be because obtaining data is too expensive, especially when previous works used subnational GDP per capita as a proxy for inequality. It may be available in the advanced economies, but unaffordable in the lagging economies. Undoubtedly, literatures concerning the cross-country analysis have been limited to the integration of European Union (e.g. (Barrios, 2009; Niebuhr, 2006)). Stepping outside the EU case, Milanovic (2005) investigates the connection between international trade patterns and geographical disparities across the five countries including Brazil, China, India, Indonesia, and the United States (Milanovic, 2005). He finds that the result is vague. However, using a sample consisting of 15 developed and 13 emerging countries, Rodriguez-Pose (2012) finds that changes in trade patterns in combination with country specific factors, are significantly associated with the evolution of regional economic trajectories with stronger effect in emerging countries than in developed ones (Rodríguez-Pose, 2012). This is not to forget countries where higher degree of inequalities already exist.

The paper is organized as follows. **Section 2** provides a necessarily brief overview of the theoretical and empirical literature. **Section 3** describes the detail of data and the construction of the spatial inequality measures and presents summary statistics and the basic correlations. **Section 4** provides methodology. **Section 5** reports the results of the static and dynamic analysis associating trade openness with spatial inequality across 9 ASEAN countries. **The last section** summarizes findings and discuss avenues for future research.

Review of literatures

Trade and Inequality

Globalization may either encourage or discourage spatial inequality. The fact that some regions may gain more than others allows external trade to increase spatial inequality. In neoclassical economics, spatial inequality determined by international trade is likely to increase as long as regions have different comparative advantage. Regions that possess natural resources for exports such as coasts, transportation networks, and nearness to rivers are likely to benefit more from international trade than the others. An increasing returns perspective suggest that an increase in spatial inequality may be because some regions remain more dependent on domestic trade whereas the others benefit from increasing returns from international trade.

However, as suggested by Puga and Venables (1999), over time, spatial inequality may be reduced by promoting international trade (Puga, 1999). Once one region is concentrated by industries, wage in such region becomes higher than that of the underdeveloped regions, thus generating wage gap. There will then be migration of industry toward one of the lagging regions. Over time, agglomeration will be economically distributed to lagging regions. In their model, both trade liberalization that discourages tariff and import substitution policy that encourages tariff are mechanism for facilitating industries to migrate to lagging regions. Under the scenario of trade liberalization, however, there is an increasing trend of the levels of welfare.

As shown in Krugman and Livas (1996), international trade may bring about urban inequality. In particular, forward and backward linkages representing as the drivers of urban inequality are counterbalanced by costs of transportation and rents of land (P. Krugman, & Elizondo, R. L. , 1996). The equilibrium is stable at the concentration of industries in primate city. This is due to 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

Research on the factors determining spatial agglomeration has emerged in recent years both in theories and empirics (V. Henderson, & Thisse, J. F. (Eds.). 2004). While theories tend to highlight the micro-foundations of spatial agglomerations, empirics are likely to follow the advancement in empirical tools in which the quality of empirical evidence on industrial agglomeration is greatly elaborated.

The prior determinant of spatial inequality is how firms and households decide to locate. While firms seek for locations that they can maximize profits, households obtain the same decision to maximize the outcomes and utility from job market. Both firms and households care about the quality of their regional and urban environments. However, there is no unified theory of spatial location decision (Berliant, 2007; M. Fujita, & Thisse, J. F., 2002).

Economic geography is divided into two fields: regional and urban economics (S. Kim, & Margo, R. A., 2004). The regional models – which possess a regional-urban perspective – has been discredited because of inadequate strong theoretical foundation. In addition, regional models are fundamentally based on international trade models. In contrast, urban models have no useful dimension for regional location decisions. The classic case appeared in Handerson's model, cities are defined as islands with different scale. The distribution size of cities is still on the discussion among urban economists.

In the revision of economic geography theories, Kim (2008) shows that theoretical advancement in increasing return models in recent years reflects plethora of traditional concepts (S. Kim, 2008). For example, Marshallian externalities (which emphasize on technological spillovers, labor market pooling, assess to non-traded intermediate inputs) and non-pecuniary externalities (which focus on forward and backward linkages and market size) have in turn clarified the forces of spatial agglomeration and dispersion. In other words, spatial inequality is the net result of the balance of forces of concentration and dispersion. The spatial dimension has suggested that the centripetal forces of geographic concentration are natural benefits. High transportation and communications costs bring about the immobility of centrifugal forces of dispersion in factors and goods. The urban perspective has suggested that the most important difference is the addition of new costs of concentration in the form of congestion costs that result from the fixed land supply. Concentration brings about a rise in housing and commuting costs as well as costs caused by crime, pollution, and epidemics.

There are only a few methods to measure regional inequality. The simplest and most widely used measure is the location Gini coefficient (P. R. Krugman, 1991). Its application is like Gini coefficient used to measure household income inequality, but in the dimension of geographic activity concentration. Moreover, Ellison and Glaeser (1997) proposed an alternative measure that corrects for an industry's scale economy (Maurel, 1999). Entropy indices, suggested by Brülhart and Traeger (2005), are decomposable into within-region and between-region components (Brülhart, 2005). For measuring urban inequality, urban productivity and the size distribution of cities are put at the heart. Since wages and productivity are generally positively correlated with city sizes, differences in wages and productivity measure urban inequality. Furthermore, urban inequality is also often measured using the rank-size dispersion of cities. In particular, urban primacy or the concentration of the urban population in the largest cities is often used as a measure of urban inequality. There is unfortunately no existing measure that relates urban inequality with regional inequality.

According to the natures of geography, the development of spatial inequalities is related to neoclassical model and the increasing returns model. The neoclassical model focuses on the role of natural resources and nearness to seaports or rivers. The increasing returns model focuses on the density of human interactions. Economic development allows regions to benefit from the nature of geography, so spatial inequality may be beneficial because productivity increases. Nevertheless, regarding the form of higher concentration in urban areas, spatial inequality can be harmful as congestion costs are not internalized by individuals. Therefore, as suggested by theory, spatial inequality at the optimal level still exists. (S. Kim, 2008).

Evidence on Spatial Inequality in Developing Countries

To conclude regional inequality is quite challenging since studies vary in terms of indices of geographic concentration and geographic units of observation. Moreover, panel analysis either in the urban inequality literature or the household income literature is so rare that it is difficult to construct inequality measures to compare across countries. As a result, the literature on spatial inequality is dominated by country-specific studies. Nevertheless, the review of the various nations in developed and developing nations may facilitate comparisons. Due to the scarcity of reliable data, the evidence for developing countries is often based on survey data. The evidence on spatial inequality is more varied, this may be because of poor data quality or greater variance in the economic circumstances of developing countries. The industrial patterns of spatial localization are fairly similar across many developed countries, even though there are important variations in the level of spatial inequality. In developing countries, country specific geographic and political factors may play an out-of-balance larger role in shaping the patterns of spatial inequality in developing as compared to developed countries. These variations in the patterns of inequality of developing countries represent significant challenges in identifying the causes of spatial inequality.

As Kim (2008) reported, there seem to be the case where spatial inequality had fluctuated and then skyrocketed since the late twentieth century (S. Kim, 2008). Spatial inequality in Mexico, for example, had fluctuated between the period 1970 and 1985, then sharply increased in 1985 until 1990. Once Mexico's government implemented trade liberalization, economic activities are highly concentrated in the US-Mexico border (G. H. Hanson, & Harrison, A. , 1999) rather than in Mexico City. Globalization had been suspected for being the main factors determining income inequalities among labor of different geographic areas. States that had more openness to external trade were more likely to benefit than those with less openness (G. H. Hanson, 2007). Another example is China, whose spatial inequality emerged between 1952 and 1962 during the period of the Great Leap Forward and the Great Famine and dropped once it recovered in 1967.

Urban/Rural Development in developing countries

As reported in the work of Tacoli (1998), it has been debatable on which should be the correct combination of investment between agriculture and industry (Tacoli, 1998). One party might support agriculture sector because it can provide the surplus for industrial and urban development. The other might argue that industrial and urban growth are required for modern and productive agricultural sector.

Modernization through Industrialization and Urbanization

The concept of development in the early 1950s emphasized on the increase in the size of domestic markets and investment inducement. Also, the important part of the process of modernization were industrialization and urbanization. As assumed by Lewis (1954) that minimally marginal productivity would occur in densely populated rural settlements in the Third World, hence, there could be no declines in agricultural productivity when the labor from rural agriculture migrate to urban industry (Lewis, 1954). In the mid-1960s, the settlement of migrated workers and their families in urban areas became permanent. Unfortunately, it became obvious that the level job supply in manufacturing sector was too low to absorb the increasing urban populations. As concern with over-urbanization emerged, the initial studies on the urban informal sector were delivered

Structural Adjustment, Globalization and Decentralization

Export-oriented economy, underpinned by Neo-classical economics which encourage competitive free markets rolled-back governments, are strategies for development for many Third World countries. The primary commodities of export are food. "...local agricultural production will blossom and expand" (Corbridge, 1990). For a number of small individual farmers, agricultural inputs cost and consumer goods increase in a faster rate than the price of agriculture products. With the reduction of government subsidies, farmers cannot buy inputs and sell agriculture products in volume right after harvesting due to high costs of transportation. At best, they can wait and then sell their products. It seems to be challenging to reduce the rural urban income gap and the rates of rural to urban migrants as access to international markets are unequal among producers. This deepens inequality in cities and countryside. Moreover, administrative decentralization plays important role of rural-urban associations in the 1990s to deal with international financial institutions and democracy support. In the term of policy, decentralization has continued interest for planning in regional development.

Research on the factors determining spatial agglomeration has emerged in recent years both in theories and empirics (V. Henderson, & Thisse, J. F. (Eds.). 2004). While theories tend to highlight the micro-foundations of spatial agglomerations, empirics take advantage from the advances in empirical methods which have greatly expanded the quality of empirical evidence on agglomeration economies.

Generally, issues concerning regional and urban inequality are addressed separately. This is because of the difficulties in developing a unified theory of regions and cities in a satisfactory manner. Studies vary greatly in terms of focus and measurement of spatial inequality. The most challenging obstacle for studying is the inadequate data in developing countries.

Theories related to Spatial Inequalities

This part closely follows Kim (2008) to present three theories associated with inequalities across space; spatial inequalities, regional inequalities, and urban inequalities.

Spatial Inequalities in Theories

The first theory is spatial inequalities in which the location decisions of firms and households are the fundamental determinants. In particular, firms maximize profits and households maximize utility through their location choices. All they care about are their environments in either urban or regional areas. Considering spatial location, however, general theory that unified regional and urban location decisions is still unaffordable (M. Fujita, & Thisse, J. F., 2002).

In fact, economic geography is divided into two fields: regional and urban economics (S. Kim, & Margo, R. A., 2004). The regional models which possess a regional-urban perspective has been discredited because of inadequate strong theoretical foundation. In addition, regional models are fundamentally based on international trade models. In contrast, urban models have no useful dimension for regional location decisions. Classically, in Handerson (1974) model, cities are defined as islands with different scale (J. V. Henderson, 1974). The distribution size of cities are still on the discussion among urban economists.

Reviewing the various theories of economic geography, Kim (2008) reported that theoretical innovations in modeling increasing returns in recent years have led to the many traditional concepts such as Marshallian externalities emphasizing on technological spillovers, labor market pooling, assess to nontraded intermediate inputs and nonpecuniary externalities focusing on forward and backward linkages and market size. These have in turn clarified the forces of spatial agglomeration and dispersion. In other words, 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 natural advantages. The centrifugal forces of dispersion are immobility in 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 that result from the fixed supply of land. Concentration leads to increased housing and commuting costs as well as costs caused by greater crime, pollution, and exposure to disease.

Regional Inequality in Theories

There are two categories of models in regional economics (S. Kim, 2008). One is based on the neoclassical assumptions of constant returns to scale and perfect competition. Government involvement is limited to infrastructural investments that influence the mobility of labor, goods, and other factors. The other is based on imperfect competition and increasing returns. In the new economic geography model, government plays an important role. In particular, investments in infrastructure may have significant impact on spatial inequality. This is due to the self-enforcing nature of increasing returns. In addition, markets will reach the optimal level of spatial inequality only when the government intervenes. When increasing returns are from forward and backward linkages rather than market size and internal scale economies in production, then an inverted U-pattern of geographic concentration is likely to occur. Production increased by upstream firms provides positive externalities to downstream firms will encourage forward linkages to exist. Production increased by downstream firms provides positive pecuniary externalities to upstream firms. A decrease in transportation costs of final goods leads to geographic concentration and regional inequality because labors are immobile. When transportation costs fall further, regional inequality declines and the location of manufacturing firms becomes more dispersed. Hence, a policy that significantly lowers the transportation costs of final goods may possibly lead to a long-run reduction in regional inequality. Nevertheless, not only do these models ignore economically structural shift components from agriculture to manufacturing and services, but they are also static. The regional inequality may be limited by the manufacturing firms' ability to recruit workers from the agricultural sector as shown in Puga' work (Puga, 1999). Thus, the labor mobility between two sectors is the main factors for the potential for agglomeration. Also, expenditure patterns of consumers may play as a constraint of spatial inequality level. (Murata, 2002).

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Urban Inequality in Theories

Urban inequality and regional inequality are interdependent. To begin with, the urban-rural wage gap can cause regional inequality in the case that the rates of urbanization bring about differences among regions. Hence, a rise in the wage gap between urban and rural may be resulted in a growing regional inequality. Moreover, in the case that regions consist of different types of cities, spatial inequality may be contributed by a variety of industries concerning what those regions are specialized. Furthermore, regional inequality will be influenced by the size distribution of cities. In particular, the impact of urbanization on spatial inequality may be limited in case that cities are uniformly small. In contrast, urban inequality may have a major impact on regional inequality once cities size is different. The example of this is that the concentration of urban population in few primate cities will lead to regional inequality. Therefore, policies aiming to decrease the important of urban primacy are likely to discourage regional inequality. Urban inequality and regional inequality are theoretically different in the treatment of land.

The most important constrained factor for urban inequality is congestion costs associated with land. Firms and workers concentrate in one urban location to take advantage of agglomeration. The determinations of the optimal city size are the balance of agglomeration and congestion costs. According to Henderson's classic model of the systems of cities, the size distribution of cities is determined by the balance of centripetal forces of Marshallian externalities and centrifugal forces of land rents and commuting costs. The strength of its Marshallian externalities can determine a city specializes in a single industry and its size because externalities are assumed to be industry-specific (locationization economies). Theoretically, an increase in urban inequality will occur when locationalized areas are strengthened in a few industries and tends to decrease if agglomeration forces are less significant than congestion costs. A recent model of cities developed by Abdel-Rahman and Fujita (1990) present that when the centripetal force is changed from Marshallian externalities to the Spence-Dixit-Stigliz-Ethier type of pecuniary externalities, there will be similar consequences in terms of the size distribution of cities (Abdel-Rahman, 1990).

Unlike in Henderson model, the latter model shows the positive association between city-sizes and wages, and the variety of intermediate inputs. Particularly, urban inequality may increase if spillovers from forward and backward linkages are significantly strong and concentrated in a few industries. These two models provide different motivations for why cities may specialize or diversify in different industries. According to Henderson, the types of cities are determined by the nature of Marshallian externalities (J. V. Henderson, 1974). If externalities are specific to industries (localization type), cities will be likely to be specialized. If externalities are specific to cities (urbanization type), cities are likely to be diverse. In contrast, based on the

Spence-Dixit-Stigliz-Ethier type of pecuniary externalities, Abdel-Rahman shows that functions of intercity transportation costs can be defined as the extent of urban specialization or diversification (Abdel-Rahman, 1990). When intercity transportation costs are high, cities become diversified to economize on transportation costs. Nevertheless, when intercity transportation costs are low, cities specialize to take advantage of the agglomeration economies from a greater variety of nontraded inputs. Therefore, urban specialization may be constrained by local congestion costs and intercity transportation costs.

Either the standard models of regional inequality or urban inequality are unlikely to prove adequate guides to comprehend urban inequality in developing countries. Puga asserted that the rural-urban interaction and a structural shift from agriculture in rural areas to manufacturing and services in cities are overlooked (Puga, 1999). Therefore, these urban models were unlikely to connect from the classic urban models of development such as Lewis (1954) and Harris and Todaro (1970) (Harris, 1970; Lewis, 1954). Harris and Todaro (1970) raised the issue that a minimum wage in cities and rural-urban migration that cause the rural to urban migration can lead to unwelcoming outcomes for migrants if they are unable to work in the formal sector, but become unemployed in the informal sector instead.

Rauch (1993), nevertheless, provides a different explanation for the wider wage gap between urban and rural (Rauch, 1993). There are two urban sectors in Rauch's model (i.e. formal and informal sectors), and one rural sector. Earnings are lowest in the informal sector, but highest in the formal sector. If the expected income is higher in the city, a rural worker will migrate to the city, however, worker in the rural areas will benefit only in the case that they work in the former sector. Hence, the wage gap between urban and rural may be contributed by uncertainties in labor search. On the contrary, Rauch agrees with Kuznets (1955) for an inverted-U pattern that urban inequality may follow. In the initial stage of development, population is concentrated in rural areas where wages are lower than those in urban areas. As a result, a higher number of agents in rural areas are likely to be in the informal sector regardless of being risk underemployment for a higher wage in the formal urban sector job. The initial stage of urbanization brings about greater income inequality due to higher income inequality between jobs in the formal and informal sectors. Once the population in rural areas decline with urbanization, the urban-rural wage inequality decrease and urbanization rates drop. Rural agents are less likely to incur the risks of underemployment in the informal sector. This ends up with the narrower gap in income inequality.

Spatial Inequality and Income Inequality

A rise in income inequality may be contributed by a higher spatial inequality. Inspired by the inverted U-pattern of income inequality of Kuznets (1955) that contained a geographic component, Williamson (1965) created inverted U-pattern of regional inequality. Kuznets claimed that the rise in income inequality with development is fundamentally caused by a structural shift in the economy from agriculture to manufacturing industries. Two forces that increase inequality identified by Kuznets are (1) an increase in savings inequality, which lead to increased income inequality and (2) the industrial shift by the logic of industry decomposition identity leads to higher income inequality because income inequality in urban areas which are concentrated by manufacturing is higher than rural areas that are concentrated by agriculture. Kuznets argued that the process of countries' development is contrast to the drivers of income inequality. Governments attempted to decrease the savings of the top rich. This is because the nature of capitalism prefers to accumulate people in the entrepreneurial class (S. Kim, 2008).

Considering long-run income inequality, a supply of workers in agriculture is elastic in the beginning of the industrial revolution (Lewis, 1954). Following that period, there was an increase in skilled labors income as a result of industrialization. Hence, income inequality between skilled and unskilled labor increasingly diverged. Yet, as industrialization became stronger and advanced skills are needed, income inequality decreased.

Spatial Inequality in Urban Dimension

Spatial inequality in urban dimension is mostly measured by wage gap between rural and urban areas. Therefore, urbanization brings about differences in earnings between rural and urban areas. Rosenthal and Strange (2004) report that productivity rises approximately 3 to 8 percent as a city's size doubles, Glaeser and Mare (2001) also find that U.S. workers in cities earn 33 percent more than those in rural areas (Ellison, 1999).

In the case of Africa, however, population in urban areas annually increased by 5.3 percent while GDP per capita decreased by 0.66 percent per year (Fay and Opal, 2000). It might be because of noneconomic factors including ethnic conflict, war, or bright lights rather than urban economic agglomeration (S. Kim, 2008). Kessides (2006) argues that Africa's level of urbanization are insignificantly correlated with industrialization. It seems to be fueled by the growth in the informal service sector (Kessides, 2006). However, Barrios et al. (2006) finds that the rural migrants to cities were pushed out of their rural locations. For example, the inadequate of rain dampened agricultural productivity in rural sub-Saharan Africa. This, then, caused farmers into cities. City sizes also matter for spatial inequality in urban. Once the urban population in urban areas only congested in one primate cities, urban inequality will be greater. There are empirical studies showing that developing countries may encounter higher urban inequality than developed countries may such as the work conducted by Soo (2005) (S. Kim, 2008).

Regional and Urban Spatial Inequality

The information on how the level of spatial inequality develops as the economic development is fundamentally based on cross-country studies. Kuznets curve suggests that spatial inequalities rise when the country started to develop and continue. Overtime spatial inequality will drop as the certain level is reached. Moreover, there also seems to be some evidence of an inverted U-pattern of urban spatial inequality and development. Williamson (1965) finds that the difference in income increases from low- to middle-income countries but then decreases from middle- to high- income countries (Williamson, 1965).

Spatial Inequality and Institutions

A number of scholars believe that institutional factors played a major role in the divergence and convergence of the U.S. North and South (Acemoglu, 2004). Mitchner and McLean (2003) find that institutional impediments associated with slavery had a persistent fatal effect on productivity levels in the twentieth century (Mitchener, 2003). Particularly, institutions highly affect within regions in developing countries in the colonial era. In the case of India, British colonial institutions played a significant role to diverge productivity in agricultural sector during the period 1960 to 1990 (Banerjee, 2005).

There is some evidence showing that decentralized federalism promoted regional and urban equality. In general, developed countries are more likely to have a decentralized federalist system than that in developing countries. In term of politics, developed nations are also more decentralized than developing countries (V. Henderson, & Thisse, J. F. (Eds.). 2004). In addition, fiscal decentralized is positively associated with land area and population size. However, this relationship is in the opposite way in Muslim sample (e.g. Oats, 1985; Epple and Nechyba, 2004). The nature of federalist system is likely to depend greatly on the nature of tax system. There is a great variety in tax systems among rich and poor countries. Developed countries are more likely to impose taxes at the state and local level rather than the national level (S. Kim, 2008).

In the case of China, regional and urban spatial inequality is determined by Houkou system (severe migration restriction) and strong local government (M. Fujita, Mori, T., Henderson, J. V., & Kanemoto, Y. , 2004). Moreover, China has policies namely immigration restrictions and national urban planning that restrict urban growth. As a result, they may cause cities in China to be distributed under sized. Among other developed and developing countries, China possesses relatively tiny and uniform distribution. In the United States, however, decentralized federalist system may have contributed more equality in spatial and urban dimension than that in China (Kim, 2008). In Latin America, the weak local governments and strong federal governments are the players determining regional and urban inequality. As mentioned in Ades and Glaeser (1999), dictatorships and political instability cause an increase in the population concentration in the primate city (Ellison, 1999). More recently, Henderson finds that primacy is positively associated with central government consumption. Countries in Asia, Latin America, and sub-Saharan have higher share of population in primate cities reflecting the essential of political institutions on the urban concentration (V. Henderson, & Thisse, J. F. (Eds.). 2004).

In his conclusion, Kim (2008) raised three questions concerning why spatial inequality arise, and why policymakers should pay attention to spatial inequality.

Why do Spatial Inequality Arise (1)? According to the natures of geography, the development of spatial inequalities is related to the neoclassical model and the increasing returns model. The neoclassical model focuses on the role of resources endowments and geographic proximity to rivers and ports. On the contrary, the increasing returns model focuses on the density of human interactions. Economic development allows regions to benefit from the nature of geography, so spatial inequality may be beneficial because productivity increases. Nevertheless, spatial inequality in the form of excessive urban concentration or urban primacy may be harmful as congestion costs are not internalized by individuals. Therefore, as suggested by theory, spatial inequality has its optimal level (S. Kim, 2008).

Why Policymakers should be Concerned with Spatial Inequality (2)? From an efficiency standpoint, policymakers want to obtain optimal level of spatial inequality. The explanation of the density of human interactions implies market imperfections and inefficient levels of agglomeration, policymakers may want to adopt policies to correct these failures. From an egalitarian standpoint, policymakers may want to reduce the effects unequal spatial development although spatial inequality is beneficial. Finally, policymakers realize that sharp regional divergence in economic fortunes of different regions may lead to political divisions that impose significant social costs.

However, implementing effective policies in reducing spatial inequality is very challenging. This is because economic development often includes major shifts in economic and social structures of societies. A shift from a traditional agriculture based society to modern manufacturing and service oriented society is likely to involve a transition from a traditional small scale society based on personal exchanges to a modern society based in impersonal exchanges. In addition, political elites in many developing countries have no incentives to treat problems associated with spatial inequalities particularly when patronage and corruption offer them high benefits. Therefore, once political institutions are prior factors driving spatial disparity, then solving the problems of spatial inequality should begin with implementing difficult political reforms.

Data and Measurement

This study investigates nine ASEAN countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam. Myanmar is excluded in this analysis due to the unavailability of data. Periods of study are 1992 and 2010 which nightlight data is completely accessible. In addition, I identify a literature-related set of conditioning variables that capture the relationship between international trade and spatial disparity.

Spatial Inequality Measures

Nightlight data

Intensity of night lights reflects outdoor and some indoor use of lights. More generally, however, consumption of nearly all goods in the evening requires lights. As income rises, so does the light usage per person, in both consumption activities and many investment activities. Obviously, this is a complex relationship, and we abstract from such issues as public versus private lighting, relative contributions of consumption versus investment, and the relationship between day time and night time consumption and investment.

Based on Handerson et al. (2012)'s assertion above, although it is still unobvious whether or not light-based inequality indicators can accurately measure consumption or income inequality, light can be the simplest, inexpensive and perhaps coherent mechanism to measure spatial disparities since it can proxy income per capita and wealth. To support this postulation, I find the work conducted on the relationship between light and regional inequality with the assumption that "area with higher population counts in developing countries would be poorly lit and therefore have higher percentages of poor people" (Elvidge, 2009). This can directly implies that the area that lights are poorly lit tends to have low income per capita and thus less wealthy. The assumption is that areas that tend to be highly lit tend to have high income per capita and therefore are relatively wealthier.

Chaiwat (2013) used night light imaginary during 1992-2009 to proxy gross-regional output and measure level of growth in each area of interests. The result reinforces that luminosity of night lights can be a proxy for economic activities. Area with higher degree of economic activity concentration would have higher light intensity.

Nightlights data (NL) is collected in a raster image form by DMSP (Defense Meteorological Satellite Program), the Department of Defense program run by Airforce Space and Missile Systems (SMC), and provided by NOAA's Earth Observation Group. The DMSP's night light satellite imagery covers all of the area of the planet between latitudes 65 degrees N and 65 degree S at the resolution of a 30 second arc, roughly equivalent to an area of 0.81 square kilometer near the equator. In this analysis, I have clipped image into ASEAN area. The image is at the global level of lights generated mostly by human activities thus light from sunlight, moonlight, auroras forest fires, and clouds have been removed algorithmically. The luminosity or light intensity is a digital number between 0 and 63 where 0 represents no light while the top coding of 63 refers to maximum light. Nevertheless, the top coding of 63 is a product of limitations of satellite sensors and it does point to a problem in measuring growth over time, particularly in the densely populated urban regions.

Spatial inequality indices

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

Theil index

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

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

Where $\mathbf{p_{it}}$ represents grid share of level i in country c during year t

$\mathbf{y_{it}}$ denotes average light intensity of level I during year t

$\mu_{ct} = \Sigma p_{it} y_{it}$

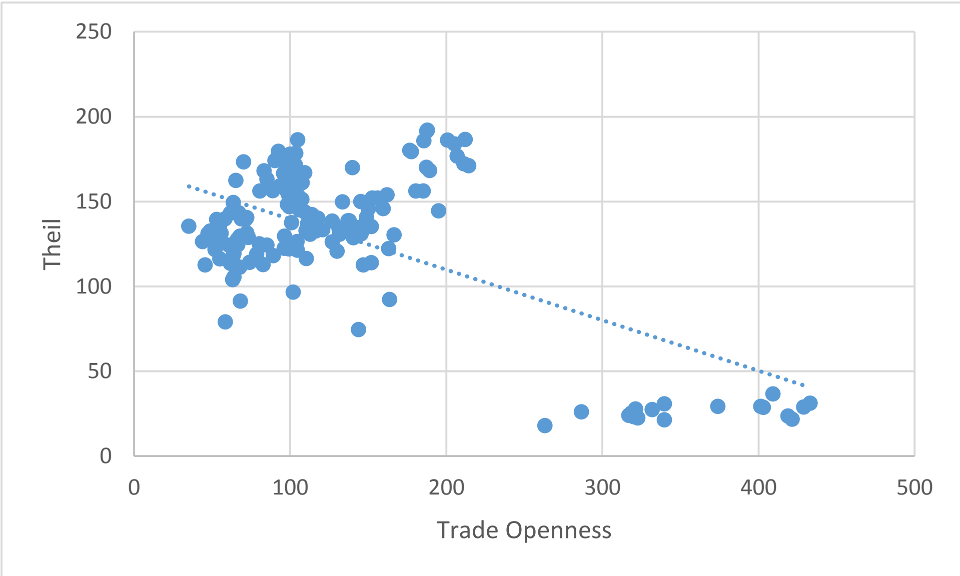
$\mathbf{T(1)_{ct}}$ denotes the Theil index of inequality.

Ezcurra & Rodriguez-Pose (2014) concurred that this measure offers plethora of advantages (Ezcurra, 2014). First, it is independent of scale and population size, and also satisfies the Pigou-Dalton transfer principle (Cowell, 2000). Second, since T(1) is additively decomposable by population subgroups (Bourguignon, 1979; Shorrocks, 1980), it is well recognized by the literature on territorial inequalities (Rodríguez-Pose, 2009). Last, as a matter of fact that omitting population size may immensely misshape the perceptions of spatial inequality (Petrakos, 2005), T(1) takes into consideration the differences in population size across spatial unit, which is always left unnoticed by the work on economic connection that has prospered since the contributions of Barro & Sala-i-Martin, 1992 (Barro, 1992).

The calculation of the Theil first measure of inequality for 9 ASEAN countries is represented as compared spatial inequality and trade openness in sample countries between 1992 and 2010. The majority of the countries in ASEAN experienced fluctuated trend in the inequality over the period of analysis. While Brunei, Malaysia, Philippines, Indonesia, Thailand, and Vietnam encountered a reduction in inequalities during 2008 and 2010, Cambodia, Laos, and Singapore witnessed a rise one. The highest T(1) values among this sample set are found in Malaysia in 2002, implying the greatest level of dispersion in the spatial distribution of economic activities. At the opposite end of the spectrum, I found Singapore.

By considering the evolution of degree of trade openness, most of sample countries experienced a growing trend in trade openness during the period of analysis. Based on a majority of the literature, the degree of trade openness is measured by the ratio between total trade (exports plus imports) and GDP (Dollar, 2004). Thus, the interpretation of the trade openness indicator is affected when the different countries in the sample adopted trade liberalization initiatives. Countries such as Malaysia, Vietnam, and Thailand abandoned their traditional import-substitution development models in favor of export-oriented one since 1997 (Ezcurra, 2014).

Figure 4 The preliminary relationship between trade openness and spatial inequality



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.

Gini index

The Gini coefficient is the simplest and most widely used measure for measuring spatial inequality (P. R. Krugman, 1991). Its locational counterpart measures the extent to which geographic activity is concentrated since it used to measure household income inequality (S. Kim, 2008).

The Gini index is defined as follows

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

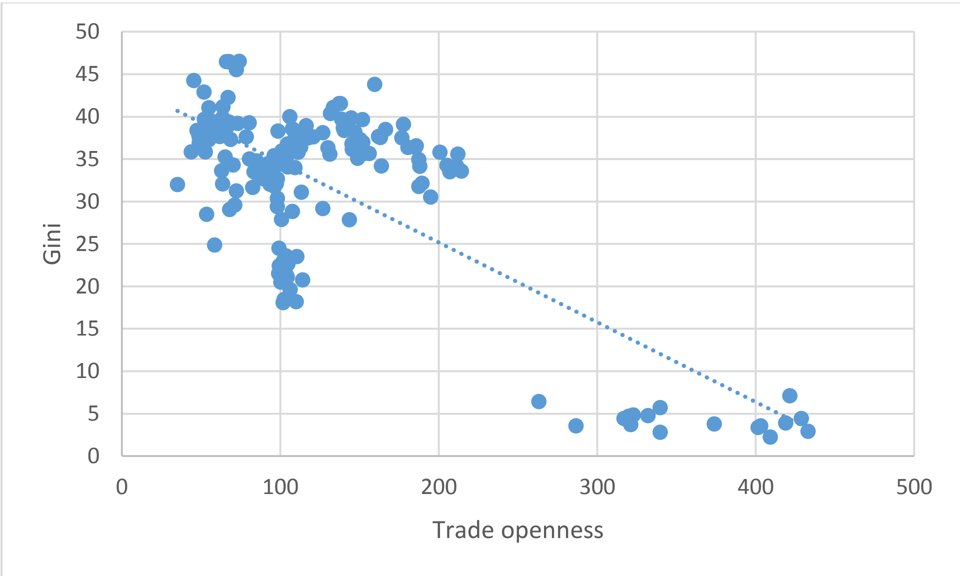
Where p_i and p_j represent grid population share of level i and j respectively in country c during year t

y_{it} and y_{jt} denote average light intensity of level i and j during year t

$\mu_{ct} = \sum p_{it} \, y_{it}$

Gini denotes the Gini's index of inequality.

Figure 5: The preliminary relationship between trade openness and spatial inequality



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.

Figure 4&5 displays the bivariate relationship between trade openness and spatial inequality in ASEAN countries using Theil and Gini's index of inequality respectively. The slope of the regression line points to a negative link between two variables for the pooled data. This implies that the selected countries with higher level of trade openness tend to register a lower degree of spatial inequality. Hence, this preliminary result suggests that the openness of national economies to international trade may have spatial implications and affect the level and the evolution of regional disparities within ASEAN countries. This may be due to neoclassical economics suggesting different comparative advantage among regions. In other words, regions containing naturally export facilitations namely coasts, transportation networks, and nearness to river are more likely to benefit from external trade than lagging regions. In addition, an increasing return perspective suggest that this phenomenon comes from the fact that some region remains more reliant on autarkic trade while others gain increasing returns from trade openness. However, there are also specific characteristics within certain countries that the literature identifies as determinants enhancing or diminishing the impact of trade openness on regional inequality as presented in table 1 (appendix). Hence, the deeper detail is to be examined in the next section.

The control variables

In the literature, specific characteristics within certain countries have been identified as determinants enhancing or diminishing the impact of trade openness on regional inequality

Urban Population (+) A switch from rural locations to cities, 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, implying that trade is a primary factor of spatial inequality. Urban population is expressed as percentage of the total population living in urban areas. The higher the percentage of urban population leads to the less the spatial distribution of benefits of international trade. Hence, urban population encourages spatial inequality. Source: World Development Indicators.

Polity2 (-) The inefficient institution caused by rampant corruption and pervasive rent seeking by durable local elites are barriers to diffusion of wealth from international trade. Polity2 is expressed as the revised combined Polity score of Polity IV databases (Marshall, 2005), which combines 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. The more democratic institutions leads to the smaller impact of trade openness in spatial dimension. Thus, polity2 decreases spatial inequality. Source: Polity Project.

Government Size (-) Government with a greater social and territorial redistributive capacity through public policies will stand in a stronger position to transfer benefits of international trade from prosperous regions to the lagging one, leading to smaller impact on spatial inequality. Government size is defined as total government consumption as a percentage of national GDP. The variable is expressed at 2005 constant prices. The higher percentage of government expenditure leads to the greater spatial redistributive capacity, thus decreases spatial disparities. Source: Penn World Tables 7.1.

Life expectancy (+) Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. The differences in the distribution of human capital can be envisaged that the greater the spatial differences leads to the greater the impact of trade openness in spatial dimension. Source: CEIC database.

GDP in Purchasing Power Parity (+) GDP per capita bases on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. The 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 value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. This is because the GDP in ASEAN countries has been mainly driven by industrialization in urban areas. As a result, migration occurred from rural to urban areas and the rate of urban population is higher than the rural population rendering rapid urbanization with a widening of rural-urban income disparities and worsening intra-urban income disparity, both of which in theory cause nationwide inequality. Therefore, the higher GDP in purchasing power parity leads to the greater effect on spatial disparity. Source: Penn World Tables 7.1

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

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

Paved Road and Railway Density (-) Based on a New Economic Geography (NEG) framework, the 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 this paper, accessibility to foreign market is determined as two factors. The first factor is the paved-road density, which is calculated by the fraction of total length of paved road over total area of the specific country, and the latter is the railway density, which is approximated by the fraction of total length of railway over total area of the country considered. The higher density of paved road and railway leads to the lower spatial inequality. Source: National Statistic Offices.

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

Methodology

As mentioned in Rodriguez-Pose (2012)'s work, the spatial inequality is bound to be a time persistent phenomenon with a high degree of inertia. To tackle this potential inertia, I completely follow Rodriguez-Pose (2012) to formulate a dynamic model with the past levels of spatial inequality on the dependent variables side. By using dynamic panels, we can see the effect of both short- and long-run (Rodríguez-Pose, 2012).

$$\mathrm{INQ}^*_{ct} = \alpha + \beta \mathrm{TRADE}_{ct} + \phi X_{ct} + \varepsilon_{ct} \qquad (1)$$

Where $\mathbf{INQ^*_{ct}}$ is the level of inequality in country i at time t

X_{ct} is a vector conditioning the spatial distribution of wealth in given country c at time t

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

$$\mathrm{INQ}_{ct} - \mathrm{INQ}_{ct-1} = \lambda(\mathrm{INQ}^*_{ct} - \mathrm{INQ}_{ct-1}), \quad 0 < \lambda < 1 \qquad (2)$$

Where $\mathbf{INQ_{ct}}$ - $\mathbf{INQ_{ct-1}}$ ratio is the actual observed change of the spatial configuration

λ is the speed of adjustment ranging between 0 and 1. If λ is close to 1, the adjustment is almost instantaneous and the relationship between the theoretical determinants X_{ct} and the actual observed spatial consequences $\mathbf{INQ_{ct}}$ is static. If λ is less than 1, the difference between the observed spatial outcome and their inertia-free theoretical counterpart $\mathbf{INQ^*_{ct}}$ becomes significant, creating the need to control for partial adjustment in a dynamic model. Rearranging and substituting for $\mathbf{INQ^*_{ct}}$, I get

$$\mathrm{INQ}_{ct} = \lambda\,(\alpha + \beta \mathrm{TRADE}_{ct} + \Sigma \phi X_{ct} + \varepsilon_{ct}) + (1-\lambda)\mathrm{INQ}_{ct-1} \qquad 0 < \lambda < 1 \qquad (3)$$

The equation (3) shows the basic specification following in the dynamic panel regressions. The dependent variable that represents the observed inequality is on the left side of the equation. 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 $\mathbf{INQ_{ct-1}}$, the short-term effect of any independent variable X_{ct} is given by its revealed regression coefficient when running this equation. Conceptually, this coefficient represents the product $\lambda\boldsymbol{\beta}$. The assumption for the long run is that a country's spatial configuration reaches a stable equilibrium, making the current and previous year's inequality levels close to identical. Setting $\mathbf{INQ_{ct-1}}$ equal to $\mathbf{INQ_{ct}}$ in this equation, the long-term effect of any independent variable on the spatial configuration can thus be obtained by dividing the observed regression coefficient $\lambda\boldsymbol{\beta}$ by the speed of adjustment parameter λ.

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

$$\begin{aligned}INQ^*_{ct} = \alpha + \beta TRADE_{ct} + \phi_1 UrPop_{ct} + \phi_2 Polity2_{ct} + \phi_3 Govt_{ct} + \phi_4 LifEx_{ct} + \phi_5 GDP_{ct} \\ + \phi_6 \ln(Pop_{ct}) + \phi_7 Agglomeration_{ct} + \phi_8 Road_{ct} + \phi_9 Railway_{ct} + \varepsilon_{ct} \quad (4)\end{aligned}$$

In static analysis, I estimate equation (4) by running static OLS 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.

Empirical Results

Static Analysis

This section attempted to assess whether trade openness has impact on spatial inequality. The static analysis presents the results of estimating equation (4) with the different specifications. Table 1, Theil index is used as a dependent variable, showing that there is a significant association between trade openness and evolution of spatial inequality. This finding does not coincide with the outcomes of other works (e.g. Rodriguez-Pose and Gill 2006, Rodriguez-Pose 2012). However, when considering trade as a free standing variable, this significant association does not exist. This lack of association is not affected by the inclusion of additional explanatory variables. Yet, there are cases in model 5 and 8 where trade openness becomes positive and highly significant. Model 5 indicates that a 0.15 percent increasing in the Theil index of spatial inequality is associated with a 1 percent increasing in trade openness. Not all the coefficients of additional variables have the expected sign. Rises in within-country spatial inequality are associated with (1) higher percentage of the total population living in urban areas. The rural/urban composition of the country is a crucial factor for geographical differences. A switch from rural locations to cities, associated with a shift from agricultural to manufacturing and services sectors, will cause the concentration of infrastructure, (2) the lower number of democratic institutions. The lagging regions are likely to suffer from inefficient institution caused by rampant corruption and pervasive rent seeking by durable local elites which are obstacles to diffusion of wealth geographically, (3) the lower government consumption as a percentage of national GDP. Government with a weaker social and territorial redistributive capacity through public policy will stand in a poor position to transfer benefits from prosperous regions to the lagging ones. Interregional transfer programs and social expenditures are linearly related to the level of government expenditure in the total GDP. In many countries, this leads to territorial distribution of investment, (4) the lower average life expectancy which reflects lower human capital. Technological changes and external challenge will bring about the fact that skilled-worker will benefit more than those who have less.

Model 8 suppressed life expectancy variables and add GDP in purchasing power parity, population, and agglomeration. The results show that spatial inequality is also associated with (5) lower GDP in purchasing power parity. Since GDP in ASEAN countries has been driven by industrialization in urban areas, lower GDP can cause uncompetitive skilled workers unemployed and migrating back to their origin with less satisfactory pay; (6) lower number of total population. Areas where people are relatively less concentrated will less likely to have dense economic activities. Moreover, there is a (7) higher percentage of urban population living in the largest city of the country leaving other areas less dense and less developed, since it is documented that government income from tax is collected the highest in the largest city. Interestingly, the variables derived from an NEG model (paved road and railway density) are not significantly associated with the spatial inequality. This can be implied that human-built infrastructure is not matter for the evolution of spatial inequality.

To check whether these results are robust to differences in inequality indices, I replace Theil index with Gini index since each index has a different way of aggregating information. Using Gini index to measure inequality, the previous findings do not hold. The coefficients of trade openness in all regression are positive and most are not statistically significant at 1 percent level. This indicates that international trade and spatial inequality are weakly associated. The greater degree of trade openness cannot bring about the greater dimension of within-country spatial inequalities. This results oppose the previous estimation where Theil index is an independent variable. This weak relationship is not affected by the inclusion of additional explanatory variables, namely urban population, polity2, government size, population, road density, and railway density. Nevertheless, in model 8, where life expectancy and GDP in PPP are included, the coefficient of trade openness becomes insignificant suggesting that there is no correlation between trade openness and spatial inequality. This is completely in contrast to the previous result that used Theil index as a dependent variable. When suppressing life expectancy and GDP in PPP, however, the result confirms its robustness, and shows that the effect of international trade on spatial inequality is a true correlation from the omission of relevant variables. Interestingly, while conditioning variables from the NEG model (i.e. paved road and railway density) do not matter for the evolution of spatial inequality, the government size has the strong impact on the disparity regardless of which kind of inequality indices used.

To sum up, the correlation between trade openness and spatial inequality in static analysis is not uniform according to inequality indices that have been used. To be specific, trade openness has a weak relationship with Gini index, which sheds light to Rodriguez-Pose (2012) that increases in trade per se do not lead to greater territorial polarization (Rodríguez‐Pose, 2012). In contrast, rises in trade are found to be positively related to Theil index. More openness to trade may create opportunities, but aggravate within-country spatial inequalities. Some new jobs growth could be in service sectors, such as medical and financial services which locate in prime cities. The demand for high skill workers will increase faster in primate areas leaving unskilled workers in trouble finding jobs in such cities. Those who are from suburban areas are likely to migrate back to their home accepting relatively lower income. This phenomenon concentrates wealth in large cities which allow the governments to earn more from tax revenue. The governments are likely to invest more in public infrastructures in such areas leading to more differences between urban and rural.

Table 1 Trade Openness and Spatial Inequality (Theil Index: Static Analysis)

The impact of trade openness on spatial inequality: static analysis

Dependent variable:Theil	1	2	3	4	5	6	7	8	9	10	11	12	Full set
tradeopenness	0.0338	0.035	0.0212	0.235	0.1455**	0.0656	0.0573	0.1943***	0.061	0.0662	0.0253	0.0294	0.209***
urbanpopulation		-0.0283	0.2551	0.6522	1.2809***	0.6307	0.8246	1.971***	0.8043*	0.7748*	0.8028*	0.6193	1.8398**
polity2			-0.8735*	-0.9631**	-0.8149*	-0.886*	-0.954**	-1.1233**	-0.9167**	-0.9421**	-1.021**	-0.9891**	-0.976*
governmentsize				-2.4837***	-1.7615**	-1.9128**	-1.9353**	-1.7919**	-1.529*	-1.4883*	-2.0221**	2.4378***	-1.1624
life_expectancy					-2.69***								-0.9128
gdp_in_ppp_log								-18.9489**					-14.697
population_log						-7.5149***	7.5752***	-6.482***	7.4187***	7.3496***			-6.0099***
agglomeration							0.2268	0.1551					-0.1568
road&railway dense									-0.2691	-0.271	-0.2856*		-0.2972
Constant	124.6466***	5.8208***	14.882***	20.663***	6.6209***	5.7721***	0.4015***	73.051***	5.4034***	0.4472***	7.6108***	6.8386***	318.2951***
R-sq: within	0.0034	0.0035	0.0243	0.0835	0.1328	0.1494	0.151	0.1853	0.1648	0.1724	0.1094	0.0922	0.2044
Observations	162	162	162	162	162	162	162	162	162	162	162	162	162
F-test	0.471	0.7697	0.2957	0.0109	0.0007	0.0002	0.0004	0.0001	0.0002	0.0002	0.0084	0.013	0.0001

Table 2 The impact of trade openness on spatial inequality: Theil and Gini

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

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 1 percent level of significant when using Theil index, however there is no significant association between trade openness and evolution of spatial inequality by using Gini index. This is because Theil index can calculate inequality both within group and among groups while Gini cannot. In other words, Theil index can calculate inequality more precisely than Gini index. The implication of this is that a 1 percent increase in trade openness may result in 0.21 percent increase in spatial inequality. Regions or areas that have comparative advantage in infrastructure such as the 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. In addition, while some regions gain from increasing returns that openness to international trade offers, the others still rely on trade within countries. Hence, the result that international trade can lead to higher spatial inequality in short run satisfies both neoclassical economic or increasing returns theories.

Dynamic analysis

This analysis is devoted to assess whether the relationship between trade openness and spatial inequality changes with time. By using the xtabond command in STATA to correspond to the first difference Arellano-Bond GMM estimation (Arellano, 1991), the results into short- and long-term can be differentiate which the latter one is emphasised in this part.

With the inclusion of lagged level on the right-hand side of equation (4), I found that all of the differences in 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 impact of international trade irrelevant or less relevant than in the static analysis in either using Theil or Gini index as a dependent variable.

As a free standing variable in either inequality index, trade openness is not significantly associated with spatial inequality. This indicates that international trade does not matter for the evolution spatial inequality in long-term meaning that short-run spatial inequalities resulting from changes in trade openness are persistent in the long-run. According to Krugman and Elizondo, a giant metropolis is promoted by forward and backward linkages under a protectionist trade system using import substitution policies. Forward linkage is that the market is made in the core city because the prices of product are lower than in peripheral regions due to saving in transportation costs. Backward linkage emerges in the core city in relation to a supply of labor for manufacturing production to save the cost of workers commuting so that firms can pay higher wages (if land rent in a large city is not so expensive).

In effect, the giant metropolis is an unintended by-product of import substitution policies. There are two ways for the role such giant metropolis to be broken. One is by rising congestion costs while population increases. More importantly, second is the change in trade policies from import substitution to export oriented. Manufacturing center seeks foreign markets and lead industries to border areas. The giant metropolis is broken and new industrial regions emerge. Like other ASEAN countries, Thailand introduced import substitution policies in order to industrialize after World War II, and shifted to export oriented policies in the late 1980s. Bangkok used to have most manufacturing. The share of Bangkok peaked at 54.1 percent in 1977, and continued to decrease gradually to become below 40 percent in 1995 and was as low as 1.4 percent in 2010. The neighboring provinces of Bangkok still raised their share after 1970s. Samut Prakan Province, for example, raised its share from 12.4 percent in 1975 to 15.8 percent in 1990. The share of the eastern region was stable at around 10 percent until 1990, then rose to 35.8 percent in 2010. Rayong Province, whose share in 2010 was at 10.9 percent which is the third highest in the country, had only a 0.1-0.2 percent share of manufacturing production before 1980. Its share rose gradually during the 1980s and accelerated from the 1990s, exceeding 10 percent from 2005. On the contrary, Chon Buri Province, which belongs to the eastern region but is located very close to Bangkok, followed a different pattern from either Bangkok or Rayong Province. The share of manufacturing was as high as 8.5 percent in 1975, and reached 10.1 percent in 1980. In 1980s it fell until the early 1990s and from the mid-1990s it rose again to 13.1 percent in 2010 (Nozaki, 2014).

Table 3 Trade Openness and Spatial Inequality (Theil Index: Dynamic Analysis)

The impact of trade openness on spatial inequality: dynamic analysis

Dependent variable:Theil	1	2	3	4	5	6	7	8	9	10	11	12	Full set
Lagged Theil	418.61***	431.95***	426.68***	387.7***	381.67***	316.13***	332.66***	324.1***	282.85***	282.51***	362.42***	388.46***	293.1244***
tradeopenness	-0.0745	-0.0433	-0.0552	-0.00969	0.0697	-0.0691	-0.0426	0.1871*	-0.0722	-0.0693	-0.0971	-0.0921	0.1797*
urbanpopulation		-0.4577	-0.2646	0.3527	1.2169**	0.3636	-0.3228	1.5048*	0.5441	0.5273	0.4982	0.3232	1.4775
polity2			-0.6458	-0.7658	-0.7166	-0.739	-0.5735	-0.8248	-0.6743	-0.6874	-0.7182	-0.7757	-0.68
governmentsize				-2.1511***	-1.5621*	-1.9337**	-1.8548	-1.4947*	-1.7153**	-1.6799**	-1.9309**	-2.093***	-1.1952
life_expectancy					-3.2544***								-0.7709
gdp_in_ppp_log								-26.2155***					-21.7877
population_log						-3.2975	-2.901	-2.2452	-3.5583	-3.5477			-2.1926
agglomeration							-0.8299	-0.6101					-0.8468
road_dense									-0.215	-0.2164	-0.199		-0.2526
railway_dense										-1421.12	-1452.01	-1428.63	
Observations	144	144	144	144	144	144	144	144	144	144	144	144	144

Table 4 The impact of trade openness on spatial inequality: Theil and Gini

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

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%

To sum up, with the inclusion of lagged level on the right-hand side of equation (4), I found that all of the differences in 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 impact of international trade irrelevant or less relevant than in the static analysis in either using Theil or Gini index as a dependent variable. Kuznets (1955) and Lucas (2000) suggested that spatial inequality should rise when the 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 (Kuznets, 1955; Lucas, 2000). This means that a decline in spatial inequality come with the condition of spillover effect to transfer benefit from trade and technological advancement to the poorer areas. Although the empirical studies from developed countries reveal that external trade led- development causes smaller gap between urban and rural inequalities, this finding confirms that it might not be applicable for the case of developing countries. Poor countries do not possess as effective process to transfer trade benefits from the primate city to the lagging ones as in developed countries.

Conclusion and Policy Implication

The aim of this paper is to put forward and test 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 paper provides spatially within-country differences, in term of 'nightlight spatial inequality' from satellite images of light density at night. Two different measures of inequality are employed: Theil and Gini indices.

Using static and dynamic panel data analysis to separate short- and long-term results, the findings indicate that an increase of international trade can lead to higher spatial inequality in the short run, but the impact of trade openness are less relevant on spatial inequality in the long run. It can be interpreted that short-run spatial inequalities resulting from changes in trade openness are persistent in the long run. This conclusive remark may reinforce pre-existing inequality in each ASEAN country.

The result may be specific to ASEAN countries due to types of exports and imports. Considering the case of Thailand. Table 5 represents main exports and imports of Thailand in 2013. Vehicles, computer and electronic equipment, and oil are among the top either in imports or exports. Naturally, these products are concentrated in some specific areas and not distributed to other areas. People in suburban areas have immigrated in the city to find plenty of jobs. Since this economic activity is not distributed to other areas, and agriculture sector is left behind as a result of export-oriented structure of economy, growth diffusion has become poor. Hence, trade openness leads to spatial inequalities due to (1) international trade in industrial commodities and (2) inefficient income distribution mechanism to lagging regions.

Table 5 Main exports and imports of Thailand in 2013

Exports	Imports
1. Vehicles	1. Crude Oil
2. Computer and electronic equipment	7. Vehicle parts
3. Oil	9.Computer and electronic equipment

Source: Thai Customs Department

The fact that knowledge and technology spillovers will drive economy forward encourages government to support export-oriented economy and leave agriculture sector behind. However, only some processes of production are transferred such as car assembly in which lower skill is required. This is due to cheap labor resulted from low grain prices and cheap food, thus reflect relatively low cost of living.

Therefore, Thai government should pay more attention to the lagging regions. In particular, in agriculture sector since it is a main player to provide welfare to country. Consequently, increases from international trade will not lead to further territorial disparities. This can be done by implementing policies such as grain prices insurance, universal health coverage service, unemployment insurance, education and skill development, and risk insurance.

Instead of focusing on the urban development, policymakers should pay much more attention on rural development. In other words, government should put agricultural sector as the heart of development. A percentage of employment in Thailand in agricultural sector is 35 to 50. Hence, a majority of workers is in this sector. Moreover, in the context of international trade in globalization era, agriculture plays as global food stability. Agricultural sector will survive when farmers survive, therefore, there should be ‘grain prices insurance’. This is unlike the case of developed countries such as the United States where farmers are capitalist. Farmers in developing countries need the government intervention to help set grain prices so that farmers will be able to carry on their lives in agriculture. The development of the quality of grain should also be supported. Furthermore, once a number of workers are concentrated in some agricultural area, wages in that particular area will decrease. As a result, government should encourage a variety of duties in agriculture. In addition, due to ageing society, the government should provide universal health coverage services 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 workers in industry should have more opportunities in education and skill development so that they can contribute more to the industry sector instead of just assembly in the factories. Academic curriculum or vocational schools should also be based on which comparative advantages certain areas have. For example, if the area has comparative advantage in growing corn, government may build up educational institutions, which providing the most efficient way to grow corn in the curriculum, in that area. This is because people whose family or ancestors are specialized in growing corn will be automatically or easily familiar with growing corn. Once they engage, perhaps, in technology advancement in corn production, they can highly benefit from this occupations and society as a whole can benefit from the relatively lower price of corn as a result of economies of scale, and the better quality of corn products as a result of technology advancement. This solution is, I believe, much better than encouraging students in rural areas to migrate to primate city to receive higher education in the field that they have no ideas which direction they would go after they graduate. They would not be determined by multinational corporations which skills they should possess such as the skill in the assembly line which mostly require no thought provoking action. Government’s job is to find which area is best at which field or jobs, then seriously support them.

This analysis provides a more complete understanding about the relationship between international trade and within-country spatial inequality in ASEAN countries where the income data is inadequate and uncompleted. It is interesting that further studies pay attention to the different sample using nightlight spatial inequality as a proxy for inequality, and also other potential inclusion of additional control variables. Pursuing this analysis provides a more complete picture of the association between trade and spatial inequality.

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APPENDIX

APPENDIX

Table 5 A set of Control Variables Derived from the Literature

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 largeast city of the country	+	World Development Indicators
Paved road and Railway density	the fraction of total length of paved road and railway over total area of the specific country	-	National Statistic Office

Table 6 Descriptive Statistic table

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 PPP)	162	293772.8	377578.5	5627.46	1900000
Population (log)	162	9658.924	26029.4	0.27133	97976.6
Agglomeration	162	34.74657	27.26842	7.31846	100
Road density	162	79.86069	135.4578	9.170608	473.6

VITA

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