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Economic Growth and Disparity Issues in Income and Education: A Causal Enquiry on ASEAN Countries

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Abstract: *Using alternative method to the standard Granger causality approach, this paper intends to shed light on causality relationships which have not been explored before, as well as provide rigour to some pre-established causal linkages. In particular, this paper lends empirical insight to the literature by examining causal linkages among economic growth, income inequality and education inequality. Data for several ASEAN countries are analysed using Toda-Yamamoto Granger Causality test. Several lag specifications were considered and the appropriate model was selected based on various diagnostic measures. The results revealed a unidirectional causality from income inequality to economic growth. Test procedures failed to find any evidence of causality between economic growth and education inequality as well as between education inequality and income inequality despite various empirical findings in other studies suggesting some form of connection among the variables.*

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JEL classification: I2, O1

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1. Introduction

Efficient policy making requires profound comprehension of socio-economic issues. Appreciation for such societal issues as efficiency and equity has underscored scientific enquiry on these concerns in modern economic literature. A rigorous examination of society's historical behaviour for instance, enables scientists to understand how social agents respond to policy changes and recommend appropriate actions that will

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result in the desired outcome. Moreover, advances in this area of study have been driven by enhancement of data analysis, and thus improvement of research capacity.

In retrospect, sustaining economic growth has long been a pivotal interest among policy makers as it is the most desirable state of any economy. A feeble growth performance may lead to a rise in political tension, asserting pressure on leaders to ensure a stable growth. This is manifest as history has seen premiers ousted in times of poor economic performance, such as what has transpired during Indonesia's Suharto leadership.

Economic downturns inadvertently pose significant social risks. A decline in aggregate output will induce firms to ease their respective outputs, in response to weak demand. A rational profit maximising firm will respond to this by reducing its inputs which includes labour. Downsizing labour is therefore a natural adjustment for firms, particularly those in the private sector. In an aggregate sense, this is reflected in an increase in unemployment, which in turn will induce strain on governments as support services like unemployment benefits are required in such times. The need for support services is essential as unemployed persons are more likely to fall into a spiral of unproductive activities that are potentially harmful to society (Yan, 2012). The will and resources of governments however, can only stretch thus far.

The importance of growth has led researchers to debate on various models and theories that are able to explain and thus, predict economic performance. The intent of this paper however, is not to delve in this particular arena. This paper on the other hand, intends to offer some empirical evidence on a specific issue and the social dimension that surrounds growth concerns. Gearing towards an inclusive economic development requires improvements beyond output growth. Increment in national output does not necessarily translate to improvement in standard of living for the masses. In the case of American economy for instance, despite growth over the past four decades, the top one per cent of household earnings have increased from less than 10% to over 20% of overall national income (Saez & Zucman, 2014). The fact that benefits of economic growth are only accrued to certain segments of society suggests increasing disparity in income. This invariably acts as impediment in achieving optimal growth trajectory as suggested in the literature. In developing economies, the need for ensuring equal distribution of income is ever more pressing as the proportion of poor household tends to be higher than in advanced economies. Income distribution is therefore a dimension of economic development which deserves as much attention as efficiency.

Another crucial dimension of socio-economic consideration is education. The value of education has long been acknowledged by academics and policy makers alike. Accumulation of knowledge and its dissemination by mankind across generations has been a crucial success factor of our society. Naturally therefore, economists pay particular attention to human capital development, a result of investment in education, in the development process of societies. Ideally, every agent in the society should have access to some form of formal education. The minimum level of education for citizens varies across countries, adhering to their respective systems. At the very least however, education is a recognised internationally to be essential, as evident in article 26 of the Universal Declaration of Human Rights (United Nations, 1948).

While importance of education is acknowledged, it is unfortunate that in reality, not all have equal opportunity to basic education, particularly in developing countries. Various factors such as geographical composition as well as policy formulation may inhibit optimal progress in education. With over 50 million students, the populous archipelago nation of Indonesia for instance, ranks fourth in the world in terms of the size of education system. This presents challenges that are unique to the country. About 30% of the adult population in Indonesia attained primary education while 43% attained secondary and tertiary education (ASEAN, 2013). This leaves 27% of its citizens above 25 years of age completely without any form of formal educational background. Prospects for improvements in educational system throughout the region is therefore, encouraging.

In retrospect of preceding arguments, this paper places emphasis on inequality issues in income as well as education in the midst of growth concerns. Exploration of these socio-economic concerns of economic growth is done through the lenses of causality which is a concept that has found its way across a multitude of disciplines, economics included. Scientific enquiry on the basis of causality thrived when Granger (1969) formulated a formal method that enables researchers to determine causal directions. Various implications can be derived from such studies. Evidence of causality that runs from foreign direct investment to economic growth in Sub-Saharan Africa for instance, will encourage relevant authorities to ramp up initiatives that encourage FDI inflow (Adams, 2009). Likewise, discovering the causal linkages between growth and inequality will provide important information on the proper treatment of the two seemingly incongruent objectives.

The prime concerns stipulated in this paper rest within the context of ASEAN nations. In what began as a five member club, the association now comprises 10 countries in the Southeast Asian region. Although not akin to economic institutions like the European Union, ASEAN strives to strengthen economic ties through international collaboration and

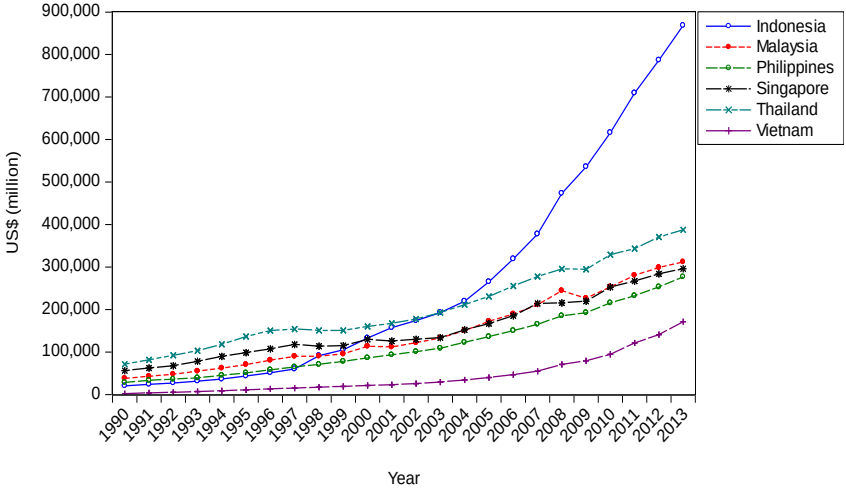
encouragement of trade linkages with less friction. The formation of ASEAN Free Trade Agreement (AFTA) in 1992 for instance, is a testament to this (Okabe & Urata, 2014). Under the Common Effective Preferential Tariff (CEPT) agreed by member countries, import tariffs are targeted to be in the zero to five per cent band. As CEPT implementation gathers momentum, ASEAN economies are expected to reap the benefits of lower trade restrictions in the form of reduced international business transaction costs.

Encouraging progress towards a more integrated ASEAN is also ongoing. Through the Declaration of ASEAN Concord II, the committee has agreed to establish an ASEAN Economic Community (AEC) by 2020, which was then expedited to materialise in 2015 (ASEAN, 2003). By 2011, 67.5% of measures required for the establishment of AEC have been implemented by member countries (Xianbai, 2014). The ambitious AEC aspires for a single market and production base with unhindered movement of factors of production, goods and services as well as investments across the region. This will accelerate developments as nations utilise the advantages of free market in a unified geo-economic climate. Concerns of equity are also addressed in AEC as an equitable economic development has been stipulated as one of the committee's prime objectives. Considering the fact that level of cross-country development within the region is diverse, prospects of integration and further regional development are promising.

2. Developments of Economic Growth and Inequality

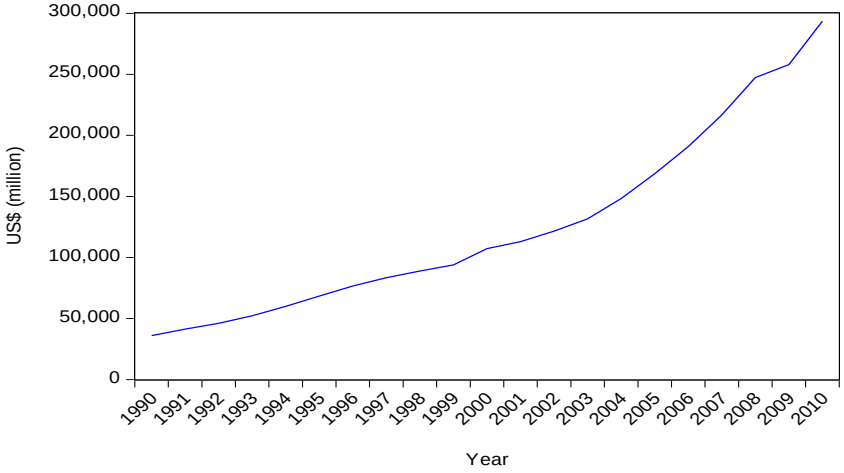
In order to gain a decent understanding of the subject matter of this paper, it would be useful to sketch an overview of developments in growth behaviour as well inequality in income and education in ASEAN economies. As highlighted in Figure 1, members of the association recorded steady increment in national output over the period of more than two decades since 1990. A salient feature of the trend is that significant gaps between the countries are increasingly evident particularly at the turn of the century. While Indonesia has emerged as the rising star of the region, recording substantial growth in late 1990s onwards, Vietnam lagged over the years. The rapid economic growth experienced by Indonesia may be explained by liberalisation and diversion of resources into more efficient economic activities. This particular trend coupled with inflow of investments has fed the economy with funds, which in turn generate activities and income. The reverse may explain the situation in Vietnam. On average however, ASEAN's GDP has seen an encouraging growth over the years, as depicted in Figure 2.

Figure 1: Real GDP of selected ASEAN countries



Source: World Development Indicator, World Bank.

Figure 2: Mean of real GDP for selected ASEAN countries

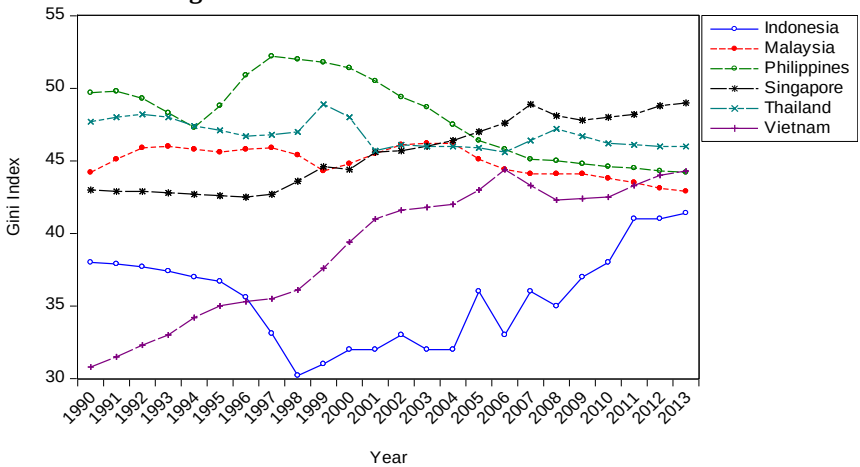


Source: World Development Indicator, World Bank.

Since the purpose of this paper is to examine the relationship between growth and inequality, it would be fitting to study trends of inequality indicators. In particular, we focus our discussion on income inequality and education inequality measurements to capture socio-economic development dimensions. Moreover, growth without equity is a sign that benefits of economic activities are not shared equally by the population. Lack of

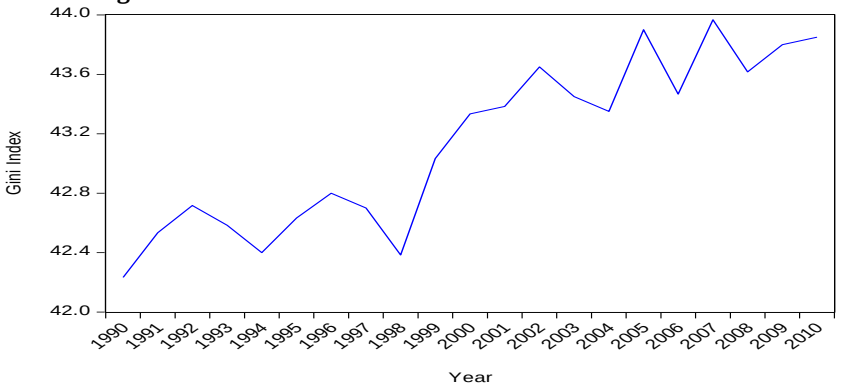
distributional functions of the government may explain this particular situation. Argument for the extent of government involvement in such functions however, is an ongoing debate. Ideally, Gini indices which measure income inequality, should decline over years of economic development. As evident is Figure 3, improvement in income inequality only occurs in certain countries. Even then, progress is limited. In some countries, income inequality has in fact worsened over the years. Vietnam records increment in Gini indices from 30.8 in 1990 to 44.3 in 2013. Indonesia made encouraging progress in late 1990s but relapsed into a spiral of worsening inequality in the post 1997 Asian financial crisis. Generally, countries that are considered in this paper, which represent more than half of ASEAN, recorded Gini indices of greater than 40 in recent years. If one were to single out Indonesia for instance, the observation is that the country has managed to increase its national output significantly, but failed to tackle growing income inequality. It seems that there is inverse connexion between efficiency and equity. This supposition however, requires extensive statistical analysis to be accorded any significance, something which this paper intends to offer. Figure 4 which shows the mean of Gini indices for the region suggests an upward trend in income inequality. Thus, initial observation indicates presence of correlation between economic growth and income inequality for our sampled countries.

Figure 3: Gini Indices of selected ASEAN countries



Source: World Development Indicator, World Bank.

Figure 4: Mean of Gini Indices for selected ASEAN countries



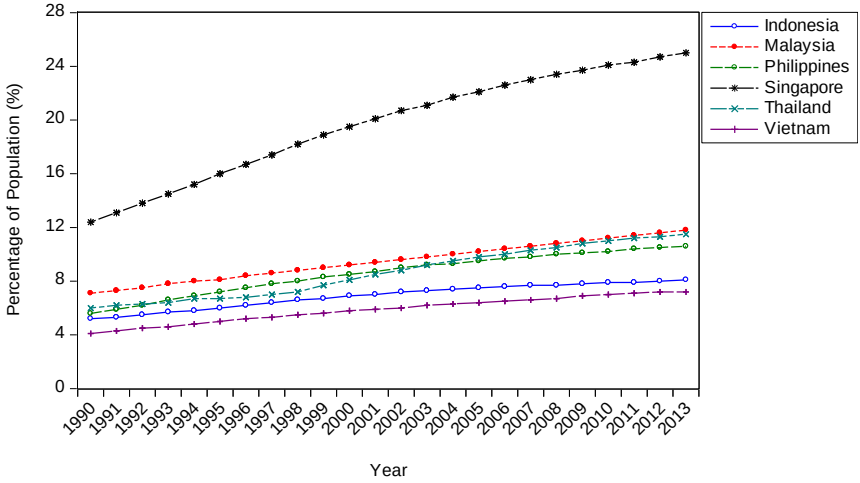
Source: World Development Indicator, World Bank.

Another interesting feature of data depicted in Figure 3, is inter-country gaps. Generally, levels of income inequality among countries included in the sample differ quite significantly from one another in early 1990s. The Gini index for Philippines for instance, is 50 while the index value for Indonesia is approximately 31 in 1990. As ASEAN members in question improve their national output position over the years, income inequality measurements of the same sampled economies seem to be on a convergent path, centring on the 40 to 50 band. The Gini indices for both Philippines and Indonesia by 2013 is approximately 44. This raises the question of whether regional output growth has led to significant reduction of inter-economy gaps in income inequality. An answer to this concern will indeed guide policy makers so as to strike a balance between growth and income disparity.

Issue of equal opportunity in education is another matter which is worth the attention of policy makers and academics alike. An educated labour force is essential for an economy to thrive. Skilled labours for instance, are able to produce output more efficiently and are compatible with capital-intensive production processes. As more capital is employed, workers who are laden with technical knowledge are able to utilise this capital to their full advantage and thus produce at optimum. At the core of creating such labour force is of course, equal access to education.

Access to tertiary education in particular, will determine a nation's high-skilled human capital stock. Singapore excels in this area by ensuring almost approximately a quarter of its labour force are equipped with tertiary education by 2013, as seen in Figure 5. Its universities are doing well globally as well. Although other ASEAN countries are considerably behind Singapore, human capital stock with higher education is on a steady, albeit slow rise.

Figure 5: Percentage of population above 15 years old with tertiary education

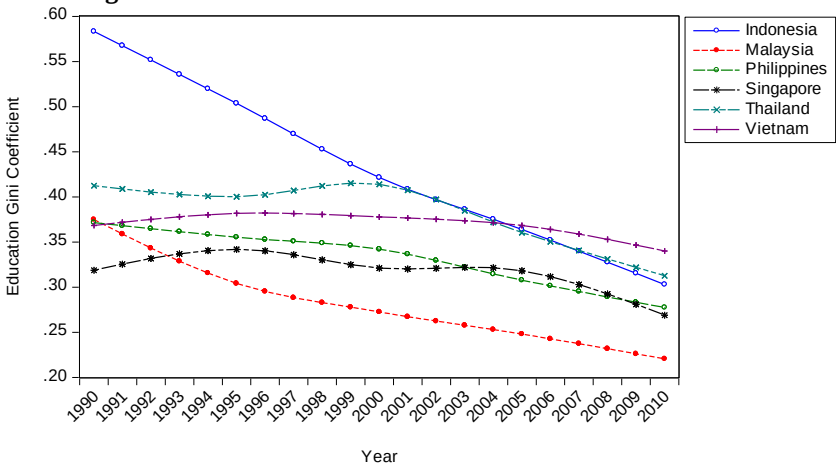


Source: World Development Indicator, World Bank.

This paper highlights in its analysis, the causal effects of income inequality to educational attainment in the sampled countries. Hence, it would perhaps be fitting to consider the education Gini coefficients as shown in Figure 6. The general development of this particular indicator indicates improvements in education inequality over the years. A country which perhaps has experienced stark improvement is Indonesia. With education Gini coefficient of over 0.55 in 1990, various efforts at increasing access to formal education for the masses have reduced Indonesia's educational inequality to just below 0.35 by 2010. Education Gini coefficient for other ASEAN countries has seen a declining trend over the sample period as well. Taking an average of the coefficients of aforementioned countries, it is clear that education inequality has significantly declined over the years, as depicted in Figure 7.

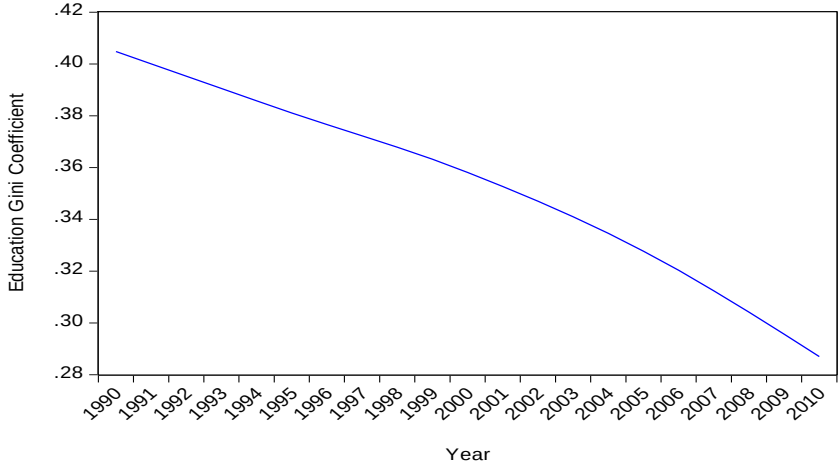
To offer more insight into the possible relationship among the variables, we examine graphical correlation of mean data. Figure 8 plots Gini indices against real GDP. A regression fit line suggests a positive relationship between the two, i.e. the greater the GDP, the greater the income inequality, suggesting a trade-off between efficiency and equity. The distribution of data along the regression line however, is rather dispersed which indicates a weak relationship. Figure 9 on the other hand suggests a strong negative correlation between education Gini coefficients and real GDP. This is consistent with our earlier argument that low education inequality or greater education equality is in sync with greater output growth.

Figure 6: Education Gini Coefficients of selected ASEAN countries



Source: World Development Indicator, World Bank.

Figure 7: Mean of education Gini Coefficients for selected ASEAN countries



Source: World Development Indicator, World Bank.

Figure 8: Plot of Gini Indices against real GDP

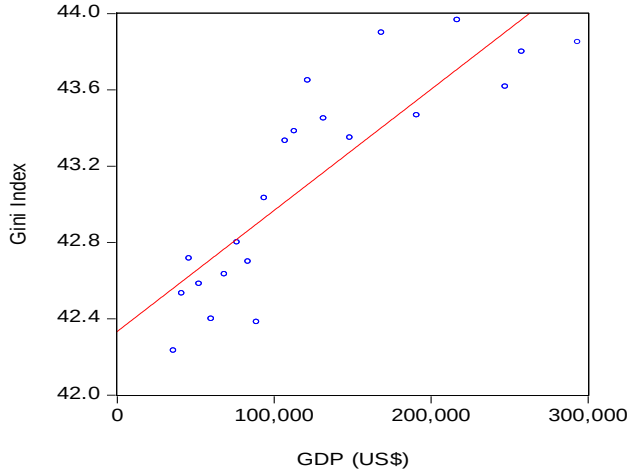
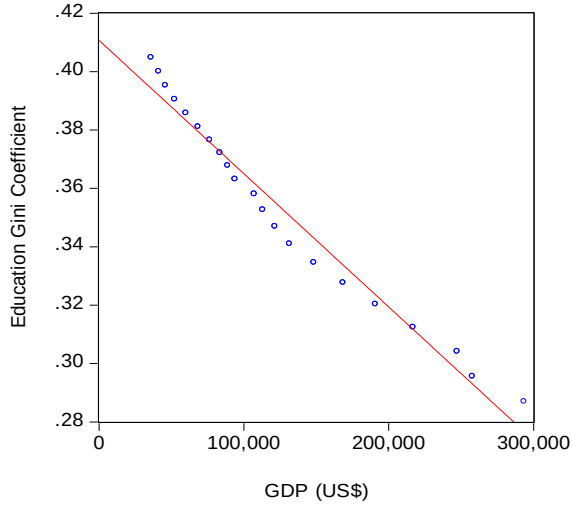
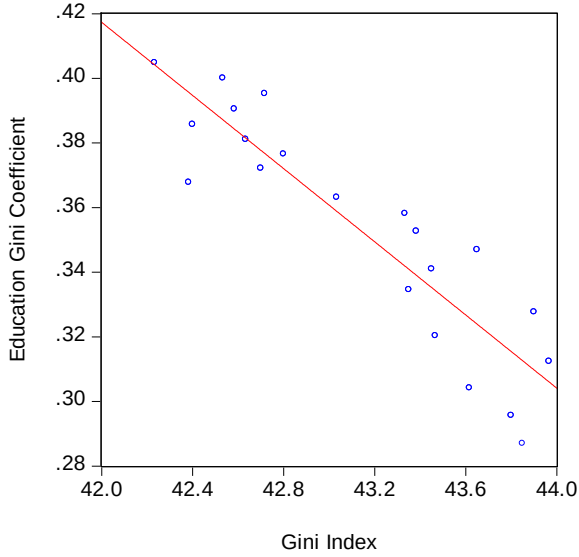


Figure 9: Plot of education Gini Coefficients against real GDP



Counterintuitively, Figure 10 indicates a negative relationship between income inequality and education inequality. This would suggest that the more unequal society is in terms of income, the less unequal it would be in terms of educational attainment. However, data dispersion is high, which suggests a weak correlation between the two. Hence, it would not be productive to dwell on this data plot.

Figure 10: Plot of education Gini Coefficients against Gini Indices



A superficial examination of data has brought into focus some intriguing questions surrounding the growth-equity nexus. This paper intends to investigate the causal directions between economic growth, income inequality and education inequality in the context of ASEAN, By applying contemporary technique in causality testing, this paper contributes empirical evidence to the vast and growing literature on the question of causality among the aforementioned variables.

3. Discussions on Inequality and Growth

Before discussing the analytical procedures, a review of literature on the issues explored in this paper is in order. Theoretical as well as empirical discussions on the subject of economic growth are extensive. Aligning to the motive of this particular paper, discussions on growth are couched in the context of income inequality and education inequality. Interplay between the two inequalities is also discussed.

3.1 Income inequality

Given the undesirable social consequences of income inequality, researchers strive to find a cause and effect connection and suggest viable solutions to this prevailing phenomenon. Mukhopadhaya (2013) for

instance, offers empirical evidence which support the notion that income differential is dependent on income composition of the household. The author finds that a large wage share of income leads to widening income disparity. Households which depend on wage income are subject to unreliable income stream as opposed to those dependent on salary income which is associated with constant income flow and various occupational benefits. Given such conditions, corrective measures such as transfer payments are viewed as an effective tool in reversing income inequality. Historical incidence has also been cited as one of the causes of unequal income distribution, particularly with regards to inter-ethnic disparity. The general lack of opportunity for African-Americans were attributed to social status of blacks in the community (Bertocchi & Dimico, 2014). While similar inference may be made on some ASEAN countries which are ethnically diverse, it should be noted that the impact of such historical influences may be muted out over the long-run. Moreover, there is increasing evidence of such factors as economic volatility to be a determinant of increasing income inequality (Huang, Fang, Miller, & Yeh, 2015).

While factors that may lead to income inequality are numerous, the literature is not short on evidences of growth-inequality nexus. More precisely, there is sufficient interest in academia with regard to the relationship between national output and income inequality. The well-known Kuznets hypothesis has perhaps, to a certain extent, influenced the advancements in income inequality research. As an economy progresses from a low income country to a higher income one, income inequality will increase. Further progress however, will eventually lead to a decline in income inequality. Empirically however, this notion does not prove to be robust. As such, the growth-inequality relationship is still very much an active research area, laden with various theoretical and empirical views. One such example is a theoretical position that predicts a positive relationship between growth and income inequality, offered by García-Peñalosa and Turnovsky (2005). A positive movement in income inequality in the paper however, is an outcome, rather than cause of growth. The authors argue that inequality in capital endowments exacerbates income inequality where capital abundant agents obtain positive returns. In this context therefore, growth is expected to lead to greater income inequality. This view however, may not be generalisable to all economies.

A panel data study shows that inequality may have negative relationship with growth in less developed countries while a positive relationship prevails in economies on the higher income spectrum (Barro, 2000). This serves as a clear contradiction to the Kuznets curve hypothesis. Additionally, this empirical evidence is backed by a theoretical position argued by Shin (2012), in a heterogeneous agent growth model. The model

postulates that even at the early stage of development, a positive connection between growth and inequality is as possible as a negative link. The decisive element is whether the economy is near steady state. Meanwhile, Glomm and Kaganovich (2008) offers an interesting theoretical framework on income inequality-growth nexus. Their model shows that increment in government expenditure on education will reduce income inequality while maintaining a positive effect of economic growth for countries with relatively low social security backing. For countries with relatively high social security funding, further increment in expenditure on education will consequentially reduce income inequality but with negative effect on growth.

An empirical evidence on the causal nexus front, is offered by Assane and Grammy (2003). Their paper proves unidirectional causality that runs from growth to inequality. This finding is also echoed in a Granger study on Turkey (Elveren, Örnek, & Akel, 2012). These findings suggest that economic growth is in fact a cause of income inequality. National output growth in some countries therefore, does not necessarily result in betterment of the whole society. Given the country-specific nature of causal links however, more empirical proof is necessary, particularly one that is within the ASEAN context.

3.2 Education inequality

The importance of access to education is frequently highlighted in the literature. In regions where educational inequality is persistent like in certain areas of Pakistan, efforts to increase access to education play an important role in improving welfare of its citizens (Rehman & Cooper, 2013). This is particularly true in instances where certain segments of the community are significantly deprived of equal access to education. Government resources channelled for the purpose of improving educational reach is therefore productive.

Delving deeper into the literature, one would discover discussion around the issue of education and disparity in income distribution. The relationship between the two is both intuitive and substantiated by empirical studies. In China for instance, empirical evidence indicate the existence of a long-run relationship between education and income inequality (Yan, 2012). Therefore, it is unsurprising that Granger causality study reveals unidirectional causality from education to real income in China (Kumar Narayan & Smyth, 2006). This seems to suggest that improvements in income inequality may stem from educational advancement, which is rather intuitive. On the other hand, Blanden (2004) offers empirical evidence, that there is a causal link that runs from income to education attainment in the United Kingdom. Specifically, family income of the concerned individuals

are found to be an important determinant of their education attainment. This implies therefore, that rising income inequality would result in worsening educational inequality as those who cannot afford higher education in particular, will be left with limited social mobility. Moreover, there is a strong correlation between the two inequalities, as found in a study utilising micro data (Rodríguez-Pose & Tselios, 2008). These differing observations may be a result of different space specification in the respective studies.

The importance of studying socio economic behaviour in different settings is crucial. Despite overwhelming support for the relationship between education and income inequality in the literature, there are a few evidences that undermine this link, which cannot be simply discounted. A two-stage least-squares analysis on non-OECD countries with regard to inequality in income and education inequality fails to find conclusive evidence of any significant relationship (Földvári & van Leeuwen, 2011). This is in contrast to several empirical evidences of a connection between income and education in other studies such as those by Yan (2012), Blanden and Machin (2013) as well as Rodríguez-Pose and Tselios (2008). Further, the Földvári and van Leeuwen (2011) analysis on OECD countries reveals that a positive relationship exists between income inequality and education inequality. Hence, worsening inequity of educational opportunity translates into income inequality in OECD countries. These discrepancies are the result of data sensitive measurements as evidently noted by the authors. It would hence be a productive inquisition to examine the nature of linkage between income inequality and education inequality in ASEAN, an object of which this paper seeks to uncover.

There is also the issue of education and economic growth relationship. Neoclassical growth theory highlights the effect of human capital formation on economic growth. Policy makers too, promote advancing educational services as a means of national economic development. In the spirit of scientific inquiry, researchers scrambled to find evidence of statistical relationship between the two variables. A study within the VECM framework has clarified that unidirectional causality runs from education to economic growth in Malaysia (Li, Mahmood, Abdullah, & Chuan, 2013). Empirical evidence also confirms significant relationship between education and economic growth in the African region, which has ample space for improvement in its educational sector (Seetanah, 2009). The causal link between economic growth and education however, is not common across countries. Causality runs from education to growth in Sweden, United Kingdom Japan and France while there is no evidence of causal interaction between the two in Italy and Australia (Meulemeester & Rochat, 1995). These differing conclusions point to the need of country-

specific empirical evidence. Furthermore, this paper also acknowledges that different conclusions are possible when utilising a different set of data.

Another country-specific evidence with regard to education and economic growth is offered by Jalil and Idrees (2013) through a non-linear two stage least squares instrumental variable estimation in Pakistan. Within a neoclassical growth model, the authors included education as a separate input in the typical Cobb-Douglas production function, as done by several previous authors such as Rao and Vadlamannati (2010) and Zhang and Zhuang (2011). Applying appropriate data to the model confirms that education is indeed beneficial to economic growth. Moreover, it is worth highlighting that the paper finds that in less developed provinces, increase in access to primary and secondary education benefits the region the most while increase in access to tertiary education will largely benefit relatively developed areas. The general conclusion of the paper is echoed in another study utilising Pakistani data. Using the Autoregressive Distributed Lag (ARDL) model, data indicates existence of a long run relationship between education and economic growth, with tertiary education again highlighted as the most significant determinant (Afzal, Rehman, Farooq, & Sarwar, 2011). Further analysis in the study reveals a causal interaction, where greater tertiary education enrolment leads to greater economic growth.

The nature of relationship between growth and education is commonly found to be positive, such as that of Vogel and Keen (2010). The authors however did so through a micro framework, examining investment expenditure by State University of New York on the state's growth. The evidence that mounts for education as a propeller of growth is encouraging. However, there is a grave question about those who are not incorporated in the fast-paced advancement of educational services. Various reasons may lead to unequal opportunity in education, effects of which need to be investigated. Economic crisis for instance, may lead to increasing trends of educational inequality (Torche, 2010). While previous studies have investigated issues of access to education or expenditure on public programmes relating to educational services, there is still a need to empirically estimate the relationship between growth and disparity in education with greater precision. As will be discussed in the following section, this paper contributes in terms of appending educational inequality measurement to a relatively recent technique of causality investigation.

4. Theoretical Foundation

Theoretical considerations are essential so as to serve as a solid foundation for the latitude of discussion. The following framework therefore, lends support to the empirical exercise embarked in this paper.

4.1 Income inequality

Fawaz, Rahnama, and Valcarcel (2014) provide a clear and lucid discussion on the empirical and theoretical fronts of the relationship between income inequality and economic growth. Their model distinguishes between a high income developing country (HIDC) and a low income developing country (LIDC), where national income of the former exceeds the threshold aggregate income level $\tilde{Y}$. Assuming N number of firms where firm j owns $k_{0,j}$.

initial units of capital at $t = 0$, the firm obeys the following production function:

$$y = \bar{A}k_j^{\alpha} \tag{1}$$

The capital stock accumulation is described as:

$$K_{t+1} - K_t = sY_t - \delta K_t \tag{2}$$

where s and ∂ are exogenous savings and depreciation rates and Y_t is the aggregate level of output where $Y_t = \sum_{j=1}^{N} y_j$. Key to the model is the collateral endowment of a firm, φ, which may be described as:

$$\varphi = uy_j \tag{3}$$

with $u > 0$ as the proportion of income to be held as collateral by the firm. More importantly, the behaviour of φ is defined such that collateral denigrates for subpar firms. Thus:

$$\varphi = \begin{cases} > 0 \; if \; y_j \geq \tilde{Y} \\ = 0 \; otherwise \end{cases} \tag{4}$$

This arrangement suggests that HIDC will be endowed with higher collateral and better capital market facilities. In essence therefore, firms may only employ capital in excess of its initial endowment only if it has collateral to begin with. Firms without collateral on the other hand, may only employ the amount of capital it owns or less and lend the remaining capital to the market, yielding market rate, $r > 0$. Firms in this model therefore, face the following problem:

$$\max_{k_j} \bar{A}\, k_j^{\alpha} - r(k_j - k_{0,j} - \varphi) \tag{5}$$

In the case of LIDC where endowment of capital is relatively low and national income is below threshold, $\tilde{Y}$, the optimal level of capital, k_j^* would be an increasing function of capital share and factor productivity and decreasing function of borrowing cost:

$$k_j^* = \left[\frac{\alpha \bar{A}}{r}\right]^{\frac{1}{1-\alpha}} \tag{6}$$

Aggregating the level of capital stock gives $K_t = \sum_{j=1}^{N} k_j$. Within this framework, aggregate level of income for a given country would mirror that of the standard AK model adopted in economics text books. This fact coupled with equation (2) would yield the following output and capital stock growth rates:

$$g_y = g_k = \frac{K_{t+1} - K_t}{K_t} = sA - \delta \tag{7}$$

By reasoning, in the absence of borrowings, output growth would be less than obtained in equation (7). For the case of HIDC, where collateral is non-zero and national income is in excess of the threshold, $\tilde{Y}$, the optimal level of capital would be:

$$k_j^{**} = \left[\frac{(1 + r\mu)\alpha \bar{A}}{r}\right]^{\frac{1}{1-\alpha}} \tag{8}$$

By comparison, it is clear that $k_j^{**} > k_j^*$. Therefore, since the level of collateral in HIDC is higher than in LIDC, it follows that capital accumulation in HIDC exceeds that of LIDC. Hence, income inequality in the presence of high capital accumulation may in fact be beneficial for economic growth. Alternatively, income inequality in a LIDC would dampen economic growth.

4.2 Education inequality

As discussed in section 3.2, economic theory supports the notion that education enhances economic growth. Increased investments in education would translate into human capital growth. A model specification in Jalil

and Idrees (2013) for instance, defines the Cobb-Douglas technology as follows:

$$Y_t = A_t K_t^{\alpha} (H_t \times L_t)^{1-\alpha} \tag{9}$$

Where Y is output, A is knowledge stock, L is employment level and H is human capital. Expressed in per worker terms, Equation (9) could be reformulated as:

$$y_t = A_t k_t^{\alpha}. \tag{10}$$

It follows that the steady state level of output is

$$y^* = \left(\frac{s}{d+g+n}\right)^{\frac{\alpha}{1-\alpha}} A \tag{11}$$

and that the growth rate is

$$\Delta ln y^* = \Delta ln A = g \tag{12}$$

Where α is share of profits, s is savings rate, d is depreciation, g and n are output and population growth rates respectively. Aggregating terms will yield:

$$\frac{Y}{L} = \left(\frac{s}{d+g+n}\right)^{\frac{\alpha}{1-\alpha}} A \times H \tag{13}$$

Computing the effects of human capital stock on output is rather straight forward:

$$\frac{\partial Y}{\partial H} = \left(\frac{s}{d+g+n}\right)^{\frac{\alpha}{1-\alpha}} A \times L \tag{14}$$

Equation (14) suggests that education which enhances human capital stock would induce a positive shock on output. The effects of inequality in education attainment however, have not been explicitly modelled in the literature. The inclusion of education inequality therefore hinges on the model described in the preceding section where difference in collateral may affect capital accumulation in a Cobb-Douglas technology. It is therefore postulated that this may influence human capital stock accumulation as

well. The formal modelling of this condition however, is left to other researchers who intend to explore this in-depth.

5. Methodology

Procedures in this section will be applied on variables which have been chosen to aptly represent issues that this paper seeks to discuss. Summary of the variables is presented in Table 1. Gini index which ranges from 0 to a 100 measures income distribution, where a high index number reflects high income inequality. Similar interpretation is applied to education Gini coefficient. Gross Domestic Product or GDP, the standard measurement for national income, have been discounted to constant 2013 prices.

Each of the variables constitutes country level data for Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. This paper acknowledges the limit of data availability, particularly concerning Gini indices of income inequality and educational attainment which are not monitored rigorously by other ASEAN countries. Hence, as many countries as possible are included to best represent the ASEAN region. Specifically, 60% of ASEAN is represented by the sampled countries in this paper.

Table 1: Description of variables

Variable Name	Description
GDP	Gross Domestic Product; Value of goods and services produced in the economy. Measured in constant 2013 prices at fixed 2013 US$ Exchange Rate.
GINI	Gini Index; Measures income inequality based on the Lorenz curve, of which value ranges from 0 to 100.
EDGINI	Education Gini Coefficient; Measures education inequality, of which value ranges from 0 to 1.

5.1 Measurement of income inequality

This paper uses the standard reference to income inequality through Gini indices. The common Lorenz curve, describing income share as a function of fraction of population, may be represented by:

$$Y = L(X) \tag{1}$$

Where Y is cumulative share of income and X is cumulative share of population. To account for unequal income distribution, the following integral is considered:

$$G = 1 - 2\int_0^1 L(X)\,dX \tag{2}$$

Equation (2) essentially captures the ratio of the Lorenz curve which describes income distribution of the population. Operationally, a Gini index value of zero indicates perfect income equality where the entire population has the same income level while an index value of one hundred shows a completely unequal society where one person owns the entire income of the economy and the rest of the population has none.

Alternatively, Gini index may be calculated directly from population data using Equation (3). Where $y_i < y_{i+1}$.

$$G = \frac{1}{n}\left(n + 1 - 2\frac{\sum_{i=1}^{n}(n+1-i)y_i}{\sum_{i=1}^{n} y_i}\right) \tag{3}$$

Albeit conceptually simple, this method is effective in terms of capturing income inequality in the economy. Other methods of inequality measurement such as the Theil index which enables investigators to assess income distribution among various groups within the society are also available. For the purpose of this study however, Gini index is deemed to be appropriate.

5.2 Measurement of education inequality

This paper adopts the education inequality measurement introduced by Thomas, Wang, and Fan (2001), which is described in Equation (4).

$$E = \left(\frac{1}{\mu}\right)\sum_{i=2}^{n}\sum_{j=1}^{i-1} p_i|y_i - y_j|p_j \tag{4}$$

Where μ is the average years of schooling for the entire population, y_i and y_j are years of schooling at different levels of education and p_i and p_j are the corresponding proportions of population.

Interpretation of education Gini coefficient is similar to that of income inequality Gini coefficient. A coefficient value of zero shows a situation where the entire population attains the same level of education, while a

coefficient value of one indicates that a person in the society has the only access to education and the rest of the population has none.

5.3 Investigating causality

In assessing the causal linkages between variables, the common approach and most widely used in the literature is a method introduced by Granger (1969). The method may be illustrated in a two-variable framework.

$$x_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i x_{t-i} + \sum_{i=1}^{k} \beta_i y_{t-i} + \mu_t \qquad (5)$$

Note that variable x_t is said to be related to lagged values of its self, another variable, y_t and an innovation, μ_t. Statistical significance of parameter β would indicate that variations in variable *x* can be explained by variable *y*. In other words, *y* Granger cause *x*.

Conversely, the following specification would be warranted to verify causal run from variable x to y.

$$y_t = \gamma_0 + \sum_{i=1}^{k} \gamma_i y_{t-i} + \sum_{i=1}^{k} \delta_i x_{t-i} + \nu_t \qquad (6)$$

Granger (1969) noted that the variables need to be uncorrelated white noise series, where $E[\epsilon_t \epsilon_s] = 0 = E[\eta_t \eta_s], s \neq t$ and $E[\epsilon_t \epsilon_s] = 0 \; \forall \; t, s$.

A limitation of the standard Granger test however, is that for variables that are possibly integrated, hypotheses testing on the coefficients that determine causal interactions would not be reliable if the test is applied on level of the series. An integration of order one, *I* (1) for instance, would require the series to be first-differenced before applying Granger causality test. This would mean that prior knowledge on the level of integration of the variables is needed. Various tests are at a researcher's disposal for this purpose. These tests however, require large data observation for them to be free of biases, something that is not always possible in economic studies (Toda & Yamamoto, 1995).

This paper therefore, employs a method developed by Toda and Yamamoto (1995), which enables an investigator to examine causal interactions between variables that are stationary, integrated or cointegrated at a given order without the pre-test biases. The method allows coefficient test on VAR models using Wald criterion, without great emphasis on knowing order of integration of the variables.

Take the model specified in (5). Toda and Yamamoto (1995) proposes the following specification:

$$x_t = \alpha_0 + \sum_{i=1}^{k+d} \alpha_i x_{t-i} + \sum_{i=1}^{k+d} \beta_i y_{t-i} + \mu_t \quad (7)$$

Note that the number of lag included now is $p = k + d$, where d is the maximum order of integration that is expected to exist among the variables. In hypotheses testing however, only the first *k* lags are included in the Wald test and the remaining variables of *d* lags are taken as exogenous. Thus,

$$H_0: f(\phi) = 0 \quad (8)$$

Where $\phi = (\beta_1, \dots, \beta_k)$. Rejection of null hypothesis indicates that there is unidirectional causality from variable *y* to *x*. Similarly, if the converse causality relationship is in question as in (6), the following specification is warranted:

$$y_t = \gamma_0 + \sum_{i=1}^{k+d} \gamma_i y_{t-i} + \sum_{i=1}^{k+d} \delta_i x_{t-i} + \nu_t \quad (9)$$

Which is subject to the following restriction:

$$H_0: f(\omega) = 0 \quad (10)$$

Where $\omega = (\delta_1, \dots, \delta_k)$, and a rejection of null hypothesis would indicate a unidirectional causality run from variable *x* to *y*.

Also note that there is a need to determine the number of *k* lags to be included in the model. Criterion that are used for this purpose include Akaike information criterion (AIC) or Schwarz criterion (SC). This is commonly done by choosing the model which yields the lowest values of AIC and SC.

Note that aforementioned framework is a simple two variable system. Abandoning earlier notations, a Toda-Yamamoto Granger causality setup within this paper's framework to examine causality that runs toward GDP would be:

$$GDP_t = \alpha_0 + \sum_{i=1}^{k+d} \alpha_i GDP_{t-i} + \sum_{i=1}^{k+d} \beta_i GINI_{t-i} + \sum_{i=1}^{k+d} \gamma_i EDGINI_{t-i} + \mu_t \quad (11)$$

Where the null hypotheses are:

$$H_0: f(\delta) = 0 \quad (12)$$

$$H_0: f(\zeta) = 0 \quad (13)$$

Where $\delta = (\beta_1, \dots, \beta_k)$ and $\zeta = (\gamma_1, \dots, \gamma_k)$. Rejection of hypothesis in (12) indicates a Toda-Yamamoto Granger causality run from $GINI$ to GDP while a rejection of hypothesis in (13) would translate into causality run from $EDGINI$ to GDP.

Following is a set up to for Toda-Yamamoto Granger test on causal run to $GINI$:

$$GINI_t = \theta_0 + \sum_{i=1}^{k+d} \theta_i GINI_{t-i} + \sum_{i=1}^{k+d} \iota_i GDP_{t-i} + \sum_{i=1}^{k+d} \kappa_i EDGINI_{t-i} + \varepsilon_t \quad (14)$$

The null hypotheses are:

$$H_0: f(\lambda) = 0 \quad (15)$$

$$H_0: f(o) = 0 \quad (16)$$

Where $\lambda = (\iota_1, \dots, \iota_k)$ and $o = (\kappa_1, \dots, \kappa_k)$. Rejection of hypothesis in (15) would indicate a Toda-Yamamoto Granger causality run from GDP to $GINI$ while a rejection of hypothesis in (16) would translate into causality run from $EDGINI$ to $GINI$.

The following is a set up for Toda- Yamamoto Granger test on causal run to $EDGINI$:

$$EDGINI_t = \rho_0 + \sum_{i=1}^{k+d} \rho_i EDGINI_{t-i} + \sum_{i=1}^{k+d} \varsigma_i GDP_{t-i} + \sum_{i=1}^{k+d} \sigma_i GINI_{t-i} + \nu_t \quad (17)$$

The null hypotheses are:

$$H_0: f(\tau) = 0 \quad (18)$$

$$H_0: f(\varphi) = 0 \quad (19)$$

Where $\tau = (\varsigma_1, \dots, \varsigma_k)$ and $\varphi = (\sigma_1, \dots, \sigma_k)$. Rejection of hypothesis in (18) would indicate a Toda-Yamamoto Granger causality run from GDP to $EDGINI$ while a rejection of hypothesis in (19) would translate into causality run from $GINI$ to $EDGINI$.

6. Results

Prior to engaging in the analytical procedures of causal investigation, information on descriptive statistics as well as order of integration is necessary. Table 2 summarises the descriptive statistics. Mean of total GDP for the selected ASEAN economies within our sample period is US$125,867 million with a standard deviation of US$104,146 million. Gini indices record a mean of 43.13 with standard deviation of 5.53. The mean for education Gini coefficient is 0.35 and its standard deviation is 0.07. Skewness for all three variables are within the [-2, 2] interval, which indicates normal distribution (George & Mallery, 2010). Panel unit root test summarised in Table 3 shows that most of the variables are conclusively non-stationary at level with the exception of education Gini indices. The variable EDGINI is stationary under the intercept and trend specification and is non-stationary under the intercept only as well as no intercept and trend specification. Since an examination of data suggests that the appropriate underlying assumption is with intercept and trend, EDGINI could thus be concluded as *I* (0).

Table 2: Descriptive statistics

Statistics	Variable		
	GDP	**Gini Index**	**Education Gini Index**
Mean	125867	43.133	0.353229
Median	104092	44.9	0.349519
Maximum	616333	52.2	0.583239
Minimum	2004.3	30.2	0.220427
Std. Dev.	104146	5.5255	0.066102
Skewness	1.8219	-0.788	0.922838

Table 3: Unit Root test at level

Variable	**Presence of Unit root**	**Method**	***p*-value**	**Conclusion**
GDP	with intercept	Levin, Lin & Chu	0.0915	series is stationary*
		Im, Pesaran & Shin W-stat	0.9767	series has unit root
		ADF - Fisher Chi-square	0.9922	series has unit root
	with intercept and trend	Levin, Lin & Chu	0.9114	series has unit root
		Im, Pesaran & Shin W-stat	0.6787	series has unit root
		ADF - Fisher Chi-square	0.7802	series has unit root
	without intercept and trend	Levin, Lin & Chu	1.0000	series has unit root
		Im, Pesaran & Shin W-stat	-	-
		ADF - Fisher Chi-square	1.0000	series has unit root
Gini Index	with intercept	Levin, Lin & Chu	0.1003	series has unit root
		Im, Pesaran & Shin W-stat	0.4722	series has unit root

Table 3: (Continued)

	with intercept and trend	ADF - Fisher Chi-square	0.5375	series has unit root
		Levin, Lin & Chu	0.3400	series has unit root
		Im, Pesaran & Shin W-stat	0.5460	series has unit root
	without intercept and trend	ADF - Fisher Chi-square	0.3922	series has unit root
		Levin, Lin & Chu	0.6392	series has unit root
		Im, Pesaran & Shin W-stat	-	-
		ADF - Fisher Chi-square	0.9224	series has unit root
Education Gini Coefficient	with intercept	Levin, Lin & Chu	0.9791	series has unit root
		Im, Pesaran & Shin W-stat	1.0000	series has unit root
		ADF - Fisher Chi-square	1.0000	series has unit root
	with intercept and trend	Levin, Lin & Chu	0.0000	series is stationary***
		Im, Pesaran & Shin W-stat	0.0001	series is stationary***
		ADF - Fisher Chi-square	0.0000	series is stationary***
	without intercept and trend	Levin, Lin & Chu	1.0000	series has unit root
		Im, Pesaran & Shin W-stat	-	-
		ADF - Fisher Chi-square	1.0000	series has unit root

Note: The scripts *, ** and *** denote statistical significance at 10%, 5% and 1% respectively.

The variables are then further subjected to panel unit root tests at first differences, of which results are summarised in Table 4. As may be inferred by the presented results, all variables with the exception of EDGINI are stationary at first differences and thus integrated at order one, I (1). This information is vital in Toda-Yamamoto Granger test as the order of highest integration is needed in the test specification, specifically, $d = 1$.

Table 4: Unit root test at first difference

Variable	Presence of Unit root	Method	*p*-value	Conclusion
GDP	with intercept	Levin, Lin & Chu	0.0023	series is stationary***
		Im, Pesaran & Shin W-stat	0.0004	series is stationary***
		ADF - Fisher Chi-square	0.0014	series is stationary**
	with intercept and trend	Levin, Lin & Chu	0.0302	series is stationary**
		Im, Pesaran & Shin W-stat	0.0928	series is stationary*
		ADF - Fisher Chi-square	0.0517	series is stationary*
	without intercept and trend	Levin, Lin & Chu	0.0075	series is stationary***
		Im, Pesaran & Shin W-stat	-	-
		ADF - Fisher Chi-square	0.1121	series has unit root
Gini Index	with intercept	Levin, Lin & Chu	0.0000	series is stationary***
		Im, Pesaran & Shin W-stat	0.0000	series is stationary***
		ADF - Fisher Chi-square	0.0002	series is stationary***
	with intercept and trend	Levin, Lin & Chu	0.0001	series is stationary***
		Im, Pesaran & Shin W-stat	0.0008	series is stationary***
		ADF - Fisher Chi-square	0.0024	series is stationary***
	without intercept and trend	Levin, Lin & Chu	0.0000	series is stationary***
		Im, Pesaran & Shin W-stat	-	-
		ADF - Fisher Chi-square	0.0000	series is stationary***

Table 4: (Continued)

Education Gini Coefficient	with intercept	Levin, Lin & Chu	0.0000	series is stationary***
		Im, Pesaran & Shin W-stat	0.0003	series is stationary***
		ADF - Fisher Chi-square	0.0007	series is stationary***
	with intercept and trend	Levin, Lin & Chu	0.0000	series is stationary***
		Im, Pesaran & Shin W-stat	0.0000	series is stationary***
		ADF - Fisher Chi-square	0.0000	series is stationary***
	without intercept and trend	Levin, Lin & Chu	0.0494	series is stationary**
		Im, Pesaran & Shin W-stat	-	-
		ADF - Fisher Chi-square	0.0383	series is stationary**

Note: The scripts *, ** and *** denote statistical significance at 10%, 5% and 1% respectively.

Cointegration test was conducted on the series to obtain signs of existence of any causal relationship between the variables. Table 5 presents cointegration test results with trace statistics and Table 6 with maximum eigenvalue. The first column indicates the hypothesised number of cointegrating relation, r. The number of cointegrating relation is determined by testing progressively on $r = 0$, $r = 1$, …, $r = k - 1$ until the null hypothesis fails to be rejected. Failure to reject null hypothesis at $r = k - 1$, would indicate k number of cointegrating relations. Since the null hypothesis is rejected by at most one cointegrating relation in both test statistics, it could be concluded at 95 confidence level that there is one cointegrating relation between variables in the model. This particular result is imperative in this study. The existence of cointegration serves as a cross-check measure on causality testing. If series included in the model are cointegrated, then there must also be a consequential Granger causality relationship among the variables.

Table 5: Unrestricted cointegration rank test (Trace)

Hypothesised Number of Cointegrating Relations	Eigenvalue	Trace Statistics	Critical Value	Probability
None *	0.315326	40.72748	29.79707	0.0019
At most 1	0.125598	13.453	15.49471	0.0992
At most 2	0.051271	3.789503	3.841466	0.0516

Note: Significant at 1% level.

Table 6: Unrestricted cointegration rank test (Maximum Eigenvalue)

Hypothesised Number of Cointegrating Relations	Eigenvalue	Max-Eigen Statistics	Critical Value	Probability
None *	0.315326	27.27448	21.13162	0.0060
At most 1	0.125598	9.663497	14.2646	0.2350
At most 2	0.051271	3.789503	3.841466	0.0516

Note: Significant at 1% level.

Since cointegration test results point to the possibility of causal linkages, it would hence be valid to construct a VAR model. Prior to specifying the VAR, there is a need to determine the appropriate number of lag, *k* to be included in the specification. Table 7 summarises the criterion used in arriving at lag length decision. Four of the criterion, namely Sequential modified LR test statistic, final prediction error, Akaike information criterion and Hannan-Quinn information criterion, indicate that the appropriate number of lag is eight while Schwarz information criterion suggests four lags are used.

For conclusiveness, suitability of both cases are considered by examining serial correlation under both lag specifications. The serial correlation LM test statistics with four lags of exogenous variables are summarised in Table 8. The results clearly indicate that at five per cent significance level, null hypothesis of serially uncorrelated series is rejected. Table 9 summarises test statistics with eight lags. The results indicate that at five per cent confidence level, null hypothesis of serially uncorrelated series fail to be rejected. These results suggest that the most appropriate number of lag to be used is eight.

Table 7: Lag length selection

Lag	Sequential Modified LR Test Statistic	Final Prediction Error	Akaike Information Criterion	Schwarz Information Criterion	Hannan-Quinn Information Criterion
0	NA	0.000194	-0.034753	0.05589	0.001533
1	1030.243	2.20E-10	-13.72619	-13.36362	-13.58104
2	148.7645	3.41E-11	-15.59069	-14.95619	-15.33669
3	109.137	8.64E-12	-16.96488	-16.05845	-16.60202
4	64.01897	4.09E-12	-17.71902	-16.54066*	-17.2473
5	7.466066	4.60E-12	-17.60867	-16.15839	-17.0281
6	16.90268	4.41E-12	-17.66439	-15.94218	-16.97495
7	21.22287	3.86E-12	-17.8126	-15.81846	-17.01431
8	36.08046*	2.52e-12*	-18.26259*	-15.99653	-17.35544*

Note: The script * indicate suggested lag based on the respective criterion.

Table 8: Serial correlation test statistics with four lags

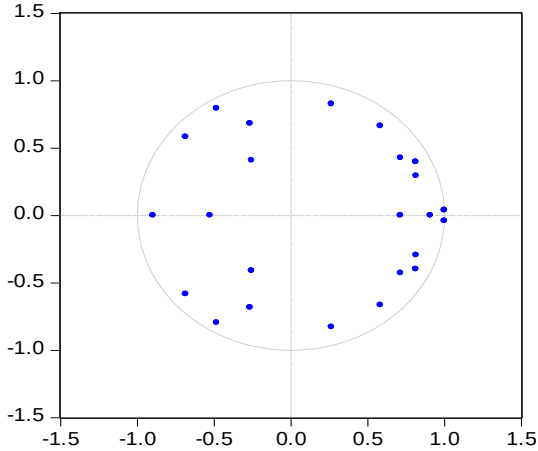
Lags	Serial Correlation LM Test Statistics	Probability
1	2.178513	0.9883
2	9.006754	0.4367
3	19.2825	0.0229
4	19.21717	0.0234
5	19.65741	0.0201
6	25.86079	0.0022
7	17.13417	0.0467
8	12.08383	0.2086

Table 9: Serial correlation test statistics with eight lags

Lags	Serial Correlation LM Test Statistics	Probability
1	16.04902	0.0659
2	15.45594	0.0791
3	18.68289	0.028
4	9.756064	0.3706
5	9.813657	0.3658
6	14.03768	0.121
7	29.06516	0.0006
8	12.47062	0.1881
9	26.22535	0.0019

Subjecting this inference to further analysis, the inverse roots of AR characteristic polynomial is examined. The result depicted in Figure 11 indicates that the model with eight lag is stable as all AR roots lie inside the unit circle. The process is then covariance stationary and this paper concludes that it is viable to proceed with this specification of VAR model. Additionally, while multicollinearity may be of concern in a multivariate regression model, it is not an issue in a VAR system as in this paper. Even in the presence of severe multicollinearity, estimated coefficients are still unbiased (Voss, 2005). Moreover, since our focus is on causality and not on the marginal effects of exogenous variables, multicollinearity is a non-issue.

Figure 11: Inverse roots of AR characteristic polynomial graph



Using the Toda-Yamamoto approach, a VAR model of $p = k + d$ lag is specified. Results of Granger test in this specification is summarised in Table 10. At 10% significance level, there is evidence of causal run from income inequality to output. There is no evidence of any causal runs at higher confidence levels. Existence of causality between income inequality and economic growth is substantiated in the literature (Assane & Grammy, 2003; Barro, 2000; Elveren et al., 2012). The direction of causality however, is in contrast to that in Assane and Grammy (2003) and Elveren et al. (2012). While those authors find evidence of causality which runs from economic growth to income inequality, this paper finds the opposite. This could be explained by the developmental level of economies being investigated. Structural compositions of economies are different, depending on their level of development. This would result in a contradictory empirical behaviour as noted by Barro (2000). Distribution of income may affect economic growth of ASEAN economies as there may be a substantial gap between current and potential output. Presence of income inequality therefore, would render economic agents deprived of their individual capacity and thus, affect aggregate output. Absence of reverse causality between income inequality and output would stem from the fact that ASEAN economies have not reached the threshold level for this to materialise (Ray, 2006).

The fact that this study finds no evidence between income inequality and education inequality as well as between education inequality and economic growth is rather surprising. One reason may be the fact that this study structures data in a pooled regression setup. Results derived from this study may differ to that of empirical studies done on individual countries in isolation. Moreover, it could be inferred that the structural setting in ASEAN economies do not allow for aforementioned nexuses. For education inequality to significantly affect economic growth for instance, labour market should function well enough to capture the differentials in education standard. Employment of overqualified workers for example, tends to understate national output, which in turn is an effect of economic activity in that region, which in its own right, a structural condition.

Table 10: Toda-Yamamoto granger causality test

Exogenous Variables	**Endogenous Variables**		
	GDP	**Gini Index**	**Education Gini Coefficient**
GDP	-	0.9449	0.7776
Gini Index	0.0641*	-	0.4149
Education Gini Coefficient	0.1028	0.2562	-

Note: The scripts *, ** and *** denote statistical significance at 10%, 5% and 1% respectively.

7. Concluding Remarks

Using an alternative method to the standard Granger causality approach, this paper intends to shed light on causality relationships which have not been explored before, as well as provide rigour to some pre-established causal linkages. The ASEAN panel data utilised in this study shows that income inequality unidirectionally causes economic growth. This is in contrast to findings by Assane and Grammy (2003) as well as Elveren et al. (2012) which reveal causality runs from growth to income inequality. Moreover, this particular observation answers a concern raised earlier in this paper where economic growth does not explain income inequality behaviour. The reverse relationship is however true. Inequity in income distribution may thwart growth by impeding an economy from reaching its full potential. Alternatively, this causal direction could be the result of policy responses by public bodies to rising income inequality. As efforts to reduce inequality in income distribution may include investments in human capital development, evolution of growth may to a certain extent be influenced by income inequality.

A survey of the literature with respect to issues explored in this paper finds that there are compelling evidence of a relationship between economic growth and education such as found by Jalil and Idrees (2013), Seetanah (2009) as well as Zhang and Zhuang (2011). Arguments for a relationship between income disparity and education are offered by Yan (2012), while Rodríguez-Pose and Tselios (2008) offer evidence of strong correlation between income inequality and disparity in education. As such, it was expected that some causal interaction between income inequality and education inequality as well as economic growth and education inequality may exist. Toda-Yamamoto Granger causality test however, fails to find any conclusive evidence of aforementioned causal interactions for the ASEAN region. This serves as a stark reminder that causal interactions are region-specific. As has been discussed in the previous section, this may be a result of structural issues. This paper has contributed to literature by documenting these findings which have been subject to rigorous empirical scrutiny.

The implication of our findings is twofold. On the policy front, it lends credence to the campaign for improving income inequality, which may be used to rationalise tax increases on top income earners. Detractors often cite the need to encourage productivity to minimise taxation on the wealthy. With this empirical evidence however, the case for increased taxation and its use as a redistributive tool to improve income inequality is justified. The level of taxation nevertheless, needs to be calibrated so as to remain accommodative for growth. On the theoretical front, this paper provides motive to formally develop a growth model which explicitly

incorporates education inequality. We argue that this is an important consideration to be able to fully comprehend the nexus between education inequality and economic growth. In such a framework, it would be viable to assert the conditions in which education inequality negatively affects economic growth, hence making it possible to campaign to tackle those conditions.

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