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Innovation Factors and its Effect on the GDP Per Capita of Selected ASEAN Countries: An Application of Paul Romer's Endogenous Growth Theory

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Abstract – *Romer's endogenous growth theory highlighted the importance of intentional actions and efforts made by firms to cultivate a culture of innovation and ideas and its eventual effects on economic growth. This study aims to measure whether there is a positive relationship between innovation using Urbanization (URB), research and development (R&D), and human capital (HC) on economic growth. Innovation will be represented by the URB rate per percentage in total population, research and development (R&D), and HC will be assessed using its Global Innovation Index ratings. Economic growth will be measured using the Log of Gross Domestic Product (LGDP) per capita. This study will utilize a panel data regression, Pooled Ordinary Least Square analysis, to determine the relationship in the selected Association of Southeast Asian Nations countries (Indonesia, Malaysia, Philippines, Vietnam) between the years 2013-2020. Results show that URB and HC significantly impact LGDP per capita, while R&D is insignificant. The insignificance found in this study can be explained by the fact that the countries selected are developing countries and that it would take time for R&D to impact their economic growth. Despite the insignificant impact of R&D activities, they should still be actively promoted in these countries, as it will gradually increase the level of innovation with time as explained in the long-run increasing returns of scale and the endogenous growth theory, thus proves Romer's theory is present in Indonesia, Malaysia, Philippines, Vietnam.*

Endogenous Growth, Technological Change, Innovation, Long-run Growth Model

I. Introduction

The key to sustainable economic growth has been a subject of debate over many years. Rostow (1959) has claimed that economic growth is linear, which can be characterized in different stages, along with Harrod (1939) and Domar (1946), who believed that economic growth is a result of an increase in saving, which increases the amount invested in the accumulation of physical capital. From these ideas, Solow (1956) developed the Solow-Swan Model that output depends on the state of technology of a country controlled by the changes in population growth rate – or the number of workers in an economy, and savings rate, hence the exogenous growth model. However, a problem that arises in the long run is that it is subject to diminishing returns to physical and labor capital. Eventually, building on the theory of his precursor, Romer (1990) developed his endogenous growth theory, which highlights three key assumptions.

First, technological change lies at the heart of economic growth. This implies that technological change is an incentive for both physical and HC accumulation (Lucas, 1988), thus increasing output per worker and increasing the amount and quality of goods being produced around the country. Second, efforts and intentional actions made by people responding to market incentives fuels a large portion of technological change. This means that innovation and ideas are gained through the endogenous efforts of the country. Private firms will seek innovation as it gives them the upper hand regarding the effectiveness and efficiency of capital they are using, thus increasing production and quality. Public expenditures on R&D will create positive knowledge spillovers that the community can use for generating ideas and innovation. Third, and perhaps the most crucial premise, is that the ideas for innovation are a non-rival and partially excludable good, i.e., once a cost of creating new instructions has been incurred, it can be used over and over again without additional costs (Romer, 1990).

Achieving sustainable growth has been a subject of debate over the years, whether based on classical or contemporary growth theories, but perhaps the timeliest theory lies within Paul Romer's endogenous growth model. Over the years, the technological level has allowed us to gain more traction in speeding up innovation in the economy. People learned to rely on technical and digital devices to ease production. Zemtzov (2020) concluded that by 2030 about half of the jobs in the world would need to adapt due to an increase in automation and the fourth industrial revolution. Technological change and innovation are at a pace higher than before. Unprecedented in its pace, scope, and impact (UNCTAD, 2020). Through these developments, questions regarding innovation and economic growth arise. Countries are creating policies that would stimulate a culture of ideas and innovation. The endogenous growth theory is becoming more relevant than in earlier years. A question remains, as innovation seems to be at a pace faster than ever before, can it bring with it economic growth?

The development of a country can be measured through various indicators or factors. This study would like to investigate significant relationships between economic growth and innovation. To measure economic growth, the proponents used GDP per capita to assess the rate of development. GDP per capita is used since it exempts external factors outside a country, which would be a better indicator of how much a country develops on its own and consistent with Romer (1990) measuring the output per person. Furthermore, the paper would like to investigate the effect of innovation on the GDP per capita. To measure innovation, URB, R&D, and HC were used.

Previous articles mainly concluded that there is a positive relationship between innovation and economic growth regarding innovation and economic growth. For instance, Pece et al. (2015) stated a positive relationship between economic growth and innovation. Another study claims a long, long-run relationship between innovation and per capita economic growth in most countries (Maradana et al., 2017). Studies also show a long-run relationship between HC and innovation capacity for the economic growth of Indonesia and Thailand. This study also found no long-run relationship between HC and innovation capacity in Malaysia (Muhamad et al., 2018).

The Association of Southeast Asian Nations (ASEAN) comprises ten (10) countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. Brunei and Singapore are the wealthiest among ASEAN countries (Vu, 2020) and rank 8th and 33rd respectively, while Cambodia and Myanmar are the poorest and rank 110th and 129th respectively among 131 economies in the Global Innovation Index (2020). The problem arises when countries have low investments in innovation, which creates barriers to economic growth and makes them unable to adapt to globalization.

The purpose of this paper is to determine if there is a significant positive relationship between innovation proxied by URB, R&D, and HC, and economic growth, which is proxied by GDP per capita. This paper also shows if the endogenous growth theory presented by Romer (1986, 1990) applies to ASEAN countries.

This research aims to contribute to the existing knowledge about applying the endogenous growth theory within ASEAN countries. Furthermore, the findings of this study could help policymakers, development economists, and government leaders to foster an environment that would facilitate the creation of new ideas and inspire a culture of innovation among its people. Using the results of this research, the proponents also strive to aid future researchers in their endeavors regarding innovation and economic development.

II. LITERATURE REVIEW

GDP per capita is a measure of economic growth that can measure how countries develop over time. While countless factors can affect GDP per capita, following Romer’s (1990) endogenous growth model of Paul Romer, this study investigates if there are significant relationships between innovation and GDP per capita and how URB, HC, and R&D affect innovation.

2.1. Innovation on Economic Growth

Economic growth is said “to be seen as an increase in the capacity of an economy to produce goods and services, compared from one period of time to another" (Raisová & Ďurčová, 2014, p. 01). This can be measured by the Gross Domestic Product (GDP) or /Gross National Income (GNI), considering that other factors measure and affect economic growth. In this study, GDP per capita was used to measure economic growth since it explicitly measures the development within a country with no external influence. Moreover, GDP also measures human well-being and progress (Brinkman & Brinkman, 2014).

Preceding journals studying the effects of innovation on economic growth have been inconclusive. Pece et al. (2015) concluded that innovation positively impacts economic growth among Central and Eastern European (CEE) countries. Along with this, some studies have also identified that there is indeed a relationship between innovation and per capita economic growth using cointegration techniques (Maradana et al., 2017). In Latin America, Avila-Lopez et al. (2019) identified that although the results may vary depending on the region and indicators used, there is still a significant relationship between these innovation indicators and the country's economic growth. These findings show that although the relationship between economic growth and innovation is significant, the effect and extent of the relationship still vary widely.

A study conducted in Beijing, China, by Zhang (2012) used foreign direct investment, patent application, and the sum of business transactions in market technologies as a proxy for scientific innovation and economic growth proxied by GDP from 1991-2010. The study showed a long-term equilibrium relationship between scientific innovation and economic growth. However, the patent application played a more critical role in improving the technology and productivity of Beijing, which further enhanced their economic growth. On the other hand, the two remaining indicators needed more time to be able to contribute to GDP.

Similarly, (Cavdar, 2015) also found a long-term relationship between scientific innovation using the variables R&D expenditure, patent applications, residents, health expenditure, GNI per capita, the share of women employed in the non-agricultural sector, internet users, and scientific and technical journal articles have significant impacts on technological development and innovation of Turkey from 1991-2011, resulting in a rise in innovative activities.

2.1.1. URB on innovation

Chaolin (2020) defined URB as increasing the number of people residing or living in urban areas. URB is also often related to modernization, industrialization, or globalization. Paul Romer emphasized the importance of cities in the generation of ideas and innovation, mainly due to population density and agglomeration. Fuller & Romer (2013) urges policymakers, academics, entrepreneurs, & social reformers to bring attention to URB as they believe that nothing else would provide the number of opportunities for social and economic growth that the process of URB contains. The high concentration of people at a particular location allows ideas to move freely from person to person; people in urban areas are more willing to interact and communicate with strangers they have weak ties with than in rural areas (Sato & Zenou, 2015). This makes it easier for people to share their ideas with other people of the same interests.

Knowledge spillover is essential for the development of firms as it affects how they conduct their business models and their overall performance (Trachuk & Linder, 2019). Furthermore, Lyu, L., Sun, F et al. (2019) emphasized the role of the cumulation of highly skilled migrants in urban areas to development, especially in the capital cities of China. However, research conducted by Assmann and Stiller (2019) suggests that, at times, educated individuals tend to narrow down their interactions, making it inefficient because it is also assumed that interactions from people with different backgrounds are necessary for innovation and growth.

The abundance of large firms and state-of-the-art technology in urban areas is also a factor of innovation. In a study conducted by (Allgurin, 2017), he concluded that being a member of a corporate group can significantly influence the capacity of firms to innovate, as it allows all the members of the group to use the knowledge that they have attained amongst themselves. Furthermore, metropolitan cities provide advantages in density, high education, and broadband that are significant in formulating innovation and ideas (Allgurin, 2017). However, some primary researchers argued that the main force behind the geography of innovation lies in a country's shape of settlement structure, availability of knowledge sources like universities and public research institutions, and finance (Fritsch & Wyrwich, 2020).

Few kinds of research have been conducted to assess the innovative capabilities of cities. A preceding journal pointed out that a city size provided a considerable advantage in creative activities during most of the 20th century but receded as time passed (Packalen & Bhattacharya, 2015). Cinnirella & Streb (2017) also supported that a larger population and a higher URB rate facilitate more innovation. Moreover, according to a study, cities with high shares of creative industry employment can serve as a beacon or sites of new content generation and production of new ideas (Lee & Rodriguez-Pose, 2014), further solidifying the importance of URB and cities in fostering innovation. The study expects a significant positive relationship between URB and innovation.

2.1.2. Research & Development on Innovation

R&D shows us the amount of money spent on applying different R&D circulating in the country. Mayfield (2011) detailed the importance of R&D on firms; he determined that firms use R&D in generating new products, new processes in producing products, and internal procedures to increase the overall performance of the firm and its goods. This process involves two kinds of innovation processes, technological innovation, and non-technological innovation. Technological innovation consists in introducing new types of machinery and product developments. In contrast, non-technological innovation includes a firm’s organizational innovations such as new or improved organizational structures, systems, or processes, including systems like total quality management, six sigma, and business process reengineering (Green et al., 2015).

Several journals have been published regarding the importance of research work on firms and innovation for their growth. Some findings suggest a significant positive relationship between things like business, public and higher education R&D and innovation, among which business R&D shows the highest positive relationship to innovation (Pegkas et al., 2019). Voutsinas et al. (2015) concluded in their article that total and private R&D expenditure boasts a positive relationship with total and business innovation. Blanco et al. (2015) proved that positive linkages between R&D and production growth exist in the economy. Likewise, Karahan (2015) supports the notion that business R&D is essential for improving the high-tech sector, especially in Europe. In their study, Jaffe & Le (2015) have also claimed that government actions such as R&D grants almost doubles the ability of firms to create new goods and services. R&D subsidies are also shown to induce a company's R&D efforts which increases their innovation outcomes in the form of increased patent applications and new product launches (Afcha & Lucena, 2020). Akıncı & Utlu (2015) determined that some companies do not realize their technological change due to either the owners' lack of education or R&D awareness and innovation culture.

A study also discovered that eight of the most innovative countries are also within the top ten investors regarding the development of R&D sectors in their country (Savrul & Incekara, 2015). Bobowski & Dobrzanski (2019) has published their study regarding ASEAN countries and their use of R&D funds. The authors used the constant returns to scale approach and a variable return to scale approach. The constant returns to scale approach has revealed Hong Kong and the Philippines as the most efficient nations among the given. Singapore and the Philippines are also identified to be the most efficient in R&D spending when applying the variable returns to scale approach.

Other journals also directly imply the effects of R&D expenditure on economic growth. For example, Ildırar et al. (2016) have discovered that in their study among selected OECD countries, an increase in R&D expenditure of business enterprises by one percent prompts the GDP to increase by .1%., while an increase in government intramural expenditure increases GDP by .02%. The study also concluded that the relationship between R&D expenditure and economic growth is significant. Gumus & Celikay (2015) also came up with the same results, adding a strong positive relationship between R&D expenditure and economic growth in both the long-run and short-run when it comes to developed countries.

Using these statements, one can hypothesize that R&D expenditure helps us improve our ways of living and working. This makes it easier for us to be more efficient and productive when creating goods and services, which can also potentially cause economic growth.

2.1.3. HC on Innovation

The exogenous growth theory in Solow (1956) highlighted the importance of capital accumulation and technological progress. This was assumed that physical capital and labor were in full employment. Solow (1956) highlighted that output is the sum of all physical capital (e.g., machines, plants, buildings), and labor is the number of workers in the economy and that technology is dependent on the amount of physical capital and labor in the economy. Solow showed in his model that there are constant returns to scale and that output is a function of capital and labor, i.e., when the scale of operations (physical capital and labor) are doubled, the output will also double. However, the model cannot explain the long-run growth because it assumes a production with constant returns to scale. With constant returns to scale, there will be diminishing returns to capital. Consequently, the economy will enter a steady state where total investments equal total depreciation, which stops output growth.

However, contrary to Solow (1956), the paper Increasing Returns and Long-Run Growth (Romer, 1986) presented the increasing returns model that posted a positive equilibrium rate resulting from an endogenous accumulation of knowledge. Romer argues that HC, developed through education, R&D investments, and other knowledge-intensive activities, is important in economic growth. This assumes that knowledge is input in production and is subject to increasing marginal productivity (Romer, 1986). In Romer's (1986) model, the rate of investment and the capital return increases over time rather than decreasing. In this endogenous model, output per worker depends on physical and HC, and the accumulation of these capitals depends on the investment in physical capital and education and training for HC (Lucas, 1988; Mankiw et al. 1992; Romer, 1986, 1990). In this case, the accumulation of HC through investments in knowledge is the driver of long-run growth. Knowledge is an essential key to growth. It is assumed to have positive external effects on production since knowledge can be shared. Knowledge can be shared and utilized for profit maximization, exhibits increasing returns, and subjects itself to increasing marginal product. Knowledge will continue to grow because of positive knowledge spillovers.

In his paper, Romer (1990) emphasized the importance of non-rivalry goods, which means that the supply of ideas is not affected when people use more of them. In this paper, Romer proves that growth is about new ideas produced intentionally by the investment of for-profit firms, and HC contributes to the comparative advantage. He further points out that discovering ideas and knowledge is vital to economic growth. Furthermore, ideas also create spillover effects; even in a monopolistic setting where an individual or a firm holds a patent, ideas can still be helpful and do not subject themselves to diminishing returns. Knowledge is the result of the process of learning through education (Lucas, 1988), people create new knowledge through experimentation, and with that comes their experience, which later will contribute to the body of knowledge in a particular field, and ideas generated by individuals will likely be subject to knowledge spillover (Lattacher et al., 2021; Wu, 2021). Following Romer's ideas, Huňady (2014) verified the relationship between innovation through research & development and growth to have a positive correlation, higher investments in innovation activities in a country would cause development and higher productivity and would translate to higher GDP per capita, holding to the new growth theory presented by Romer(1986, 1990).

In this modern age, societies are on a continuous search for new ideas that will contribute to the growth of our country – this tells us that new ideas are scarce and that people are always in pursuit of better ideas. However, existing ideas are not scarce and can be used, which is why Romer stated in his paper that ideas are subject to increasing returns to scale, which is naturally followed by growth. Contrary to the exogenous growth model where the center of growth is the accumulation of traditional economic capital, the endogenous growth model placed ideas at the center of growth, which focused more on the indicators that contribute to idea building, such as education, R&D, education, and, literacy to achieve technological change, a country's investments in HC is needed to engage in innovation (Wu, 2021).

In comparing both growth models of Solow and Romer, Sharipov (2016) used the following independent variables for exogenous factors: geography, institutions, demographic trends, social- cultural factors, and political factors; and used the following independent variables for endogenous factors: accumulation of physical capital, HC, R&D, economic policies and macroeconomic conditions, and openness to trade. The countries examined are selected EU's EaP countries and Central Asian countries: Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine; Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, respectively. To determine the relationship between the dependent variable GDP per capita. The result shows a positive correlation between all variables in the EU's EaP countries, except the endogenous variables linked to economic policies and macroeconomic conditions (except Moldova). Trade openness, particularly exports, another endogenous indicator, had a strong positive correlation for Georgia and a strong negative correlation for Moldova and Ukraine. For the central Asian countries, results show a strong correlation between HC, physical capital, and exogenous demographic trends, geography, institutions. The author suggests that, for these countries, steps on shifting to knowledge-based from resource-based economy should be the primary focus to strengthen the determinants of economic growth for the long run.

Also comparing both exogenous and endogenous growth models, Whalley & Zhao (2013) examines China's growth from 1978-2008 and found that economic growth is still present despite China's reliance on capital accumulation and labor productivity. However, in 1999, HC increased because of the increasing college enrollment in China. The authors found that the contribution of HC to growth is 38% higher, which is an increase from exogenous factors alone. However, Total Factor Productivity (TFP) was a -7%, authors suggest that there has been a misallocation of physical and HC inside China's economy, making the country inefficient. Despite the situation in China, where it relies more on capital accumulation, the authors are still firm on improving HC for China because it is an enhancer for technological growth, innovation, and productivity.

Essentially, Romer tied the knot and provided a new perspective on how economists should view growth, correcting the shortcoming of neoclassical growth models highlighting the importance of HC elements like education and intangible assets such as innovation, R&D, and ideas, and reminds us that sustained growth requires sustained technological progress.

Cinnirella and Streb's (2017) paper showed that the importance of R&D departments in science- based innovation created a significant positive impact at the end of the 19th century. During the first industrial revolution, formal education was limited, secondary and tertiary education was underdeveloped (Lee, & Lee, 2016). In European countries, literacy had no relationship with HC growth, where inventors were more independent in their researches. Somehow during the second industrial revolution came the transition period where more HC was needed, and it was only at the end of the 19th century where most independent creations were almost gone, a period where education started to play a positive role in the productivity of HC on innovation and creating value for economic growth. As the HC improves globally with the help of positive knowledge spillovers (Wu, 2021), advancement in science and technology shaped our modern-day, making us more productive and making industries efficient. This development in technological innovation led to economic growth (Cinnirella et al., 2017).

Globally, on a regional level, education is the means of attaining higher HC and positively impacts workers' education and the development of entrepreneurs, which increase the output per person in the economy (Gennaioli, et al., 2013). Universities, particularly every professor, will play an essential role in providing and developing students' knowledge and will play an essential role in providing and developing students' knowledge that will soon be a part of the HC of a country (Gofman & Jin, 2020). Furthermore, entrepreneurs and innovation are complements that will lead to growth, entrepreneurs are the product of their experimentation using their stock knowledge, and their experience in their focused field will push their understanding further that would also add to their knowledge (Lattacher et al., 2021; Romer, 1990). Similar results were seen on the manufacturing firms, that formal training (that creates experience and knowledge) provided by the firm increases the likelihood of employees to be more innovative (Uden, 2017).

For example, in Indonesia and Thailand, the tertiary enrolment and the government's expenditure on education led to an increase in the patent application and high-technology exports. This also positively affected their economic growth from 1985-2015 and positively affected their economic growth from 1985-2015 (Suriyani et al. 2018). Similarly, South Korea’s increasing educational attainment of the population led to the growth of HC, which led to their economic growth (Han & Lee, 2020).

The early investments to improve the children’s HC, such as education, played a role in making people more educated. It would also explain the complementary benefits of investments in HC such as primary, secondary, and tertiary education (Lucas, 1988) training on the development of high-technology innovation and the development of high-technology innovation the output per person. As more people get educated, the transfer of knowledge or spillovers will quickly develop or push the boundaries of our current innovation as ideas are considered non-rival (Cinnirella & Streb, 2017; Diebolt, 2018; Marvel et al., 2020; Romer, 1986, 1990). Furthermore, firms that have a highly educated stock of HC show that they are more capable of breaking the barriers of innovation and are responsible for the growth of startups (D’Este, 2012; Gofman & Jin 2020; Sun
X. et al., 2020) and the country’s investments in HC will also affect the economic policies that the government will be making (Islam et al., 2016).

Hypothesis
H_0: There is no significant relationship between innovation and GDP per capita

Synthesis
HC and R&D should increase output per worker and, eventually, economic growth as these factors are seen as direct, intentional input to innovation. Using (Fuller & Romer, 2013) as the primary basis, URB should also positively affect economic growth, as unique opportunities are being made by the rapid growth in the urban population, including social and economic progress.

Theoretical Framework
The study is based on Paul Romer’s work on Endogenous Economic Growth Models, which emphasizes the importance of intentional efforts to achieve technological change. In his study (Romer, 1990), he identified HC and R&D as means to increase the technological level of the country. His study defined HC as a practice in growth accounting applications that considers the changes in quality that the labor force had acquired due to their level of education or experience. R&D is also deemed necessary in the study as most designs result from a firm's R&D efforts. He claimed that the innovation in production would boost the of goods and services being created in the country's economy, as output per worker would increase.
The endogenous growth model’s aggregate production function (Romer, 1990) is given as:

$$Y(H_1, L, x) = H_1^a L^\beta \int_0^\infty x(i)^{1-a-\beta} di \qquad (1)$$

$$Y(H_1, L, x) = H_1^a L^\beta A\underline{x}^{1-a-\beta} \qquad (2)$$

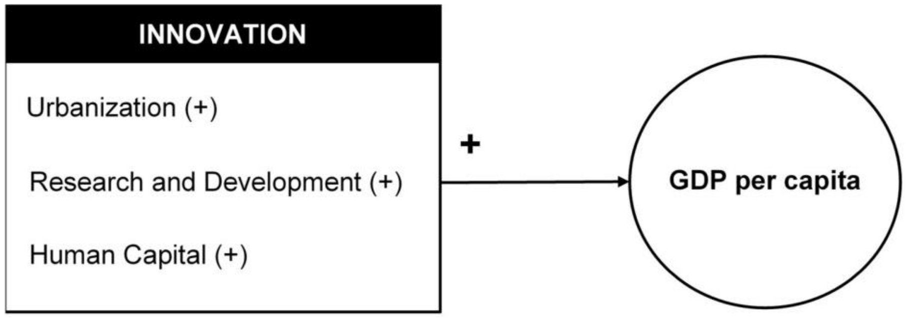
$$Y(H_1, L, x) = H_1^a L^\beta [\frac{K}{\eta A}]^{1-a-\beta} \qquad (3)$$

$$Y(H_1, L, x) = (H_1 A)(LA)^\beta (K)^{1-a-\beta_\eta a+\beta-1} \qquad (4)$$

Where:
Y = output
K = stock of capital
A = stock of knowledge
L = labor
H = HC

Furthermore, the study applied the Marshall-Arrow-Romer (MAR) spillover, which claims that the concentration of firms in a city helps create knowledge spillovers between firms to other firms and employees to other employees, a concept developed by Glaeser, et al. (1992).

Simulacrum



III. METHOD

$GDP = \beta_0 + \beta_1 URB + \beta_2 R\&D + \beta_3 HC + \epsilon$

Where:

GDP = Log of Gross Domestic Product per capita

- GDP per capita is gross domestic product divided by midyear population. GDP is measured by the real GDP divided by the total population. Data are constant 2010 U.S. dollars.

URB = Urbanization Rate per percentage of the total population

- The ratio of United Nations urban population to World bank estimates the total population.

R&D = Research & Development GII score

- Ratio of researchers; gross expenditure on R&D, % GDP; global R&D companies average expenditure top 3; QS university ranking, average score top 3.

HC= Human Capital GII score

- It is broken into two parts, education and tertiary education ratio.
- Education: ratio of expenditure on education, % GDP; government funding/pupil, secondary, % GDP per capita; school life expectancy, years; PISA scales in reading, math, & science; pupil-teacher ratio, secondary.
- Tertiary education: tertiary enrolment, % gross; graduates in science & engineering, %; tertiary inbound mobility, %.

The research study conducted a historical quantitative analysis in which a systematic empirical regression is applied. The proponents opted to use this method to observe the cumulative effect of the variables associated with innovation on economic growth over time. The study also employed cross-country analysis to compare and contrast the effectiveness of the variables in their different countries with growth.

There is limited study regarding innovation in the ASEAN region, mainly using the used variables. So, this study focused on the selected ASEAN countries: Indonesia, Malaysia, the Philippines, Vietnam. These countries were chosen based on their homogeneity in GDP per capita. Furthermore, the period covered by the study was from 2013-2020 because this was the available data for the indicators to be used.

The ASEAN has both developed and developing countries. This study decided to investigate how URB, HC, and R&D affect the GDP of developing countries. The proponents chose ASEAN countries to compare other nations that had already done extensive research into the effects of innovation on economic growth. The data for URB and the countries' GDP came from the World Bank. In contrast, R&D and HC came from the Global Innovation Index Publications by the World Intellectual Property Organization (WIPO).

	COUNTRY	**LGDP**	**URB**	**R&D**	**HC**
2013	INDONESIA	8.178447	51.955	11.8	30.5
2014	INDONESIA	8.214191	52.635	11.6	28.45
2015	INDONESIA	8.249124	53.313	11.9	30.5
2016	INDONESIA	8.286023	53.989	8.6	30.35

2017	INDONESIA	8.323716	54.659	8.1	30.5
2018	INDONESIA	8.36282	55.325	9.4	27.3
2019	INDONESIA	8.400803	55.985	8.4	27.7
2020	INDONESIA	8.369239	56.641	10.2	26.35

Table A. Indonesia's LGDP, URB, R&D, and HC

	COUNTRY	**LOG OF GDP**	**URB**	**R&D**	**HC**
2013	MALAYSIA	9.216491	72.93	21.3	48.85
2014	MALAYSIA	9.261419	73.577	31.1	46.8
2015	MALAYSIA	9.297632	74.213	32.4	43.7
2016	MALAYSIA	9.327595	74.84	33.7	48.05
2017	MALAYSIA	9.370501	75.447	33.3	46.15
2018	MALAYSIA	9.403578	76.036	36.7	49.55
2019	MALAYSIA	9.432417	76.607	38.5	46.95
2020	MALAYSIA	9.361975	77.16	37.4	50.25

Table B. Malaysia's LGDP, URB, R&D, and HC

	COUNTRY	**LGDP**	**URB**	**R&D**	**HC**
2013	PHILIPPINES	7.823119	45.903	9.9	22.15
2014	PHILIPPINES	7.868199	46.093	10.5	17.55
2015	PHILIPPINES	7.913955	46.284	11	16.65
2016	PHILIPPINES	7.967938	46.475	8.1	29.95
2017	PHILIPPINES	8.020499	46.682	7.4	29.8
2018	PHILIPPINES	8.068024	46.907	7.4	33.15
2019	PHILIPPINES	8.113766	47.149	6.2	33.9
2020	PHILIPPINES	7.999684	47.408	6.2	32.8

Table C. Philippines' LGDP, URB, R&D, and HC

	COUNTRY	**LGDP**	**URB**	**R&D**	**HUMAN CAPITAL**
2013	VIETNAM	7.317097	32.429	0	37.1
2014	VIETNAM	7.364675	33.115	0	36.3
2015	VIETNAM	7.418884	33.809	2.1	38.3
2016	VIETNAM	7.468799	34.51	1.1	44.65
2017	VIETNAM	7.524499	35.213	4.1	44.5
2018	VIETNAM	7.582923	35.919	4.5	42.8
2019	VIETNAM	7.641201	36.628	7.4	42.95

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2020	VIETNAM	7.6608	37.34	7	35.55

Table D. Vietnam's LGDP, URB, R&D, and HC

The study used secondary data to observe the trends of the indicators and their effects on the countries' economic growth. The indicators chosen by the proponents that would be used to test URB are URB rate per percentage in the total population. While HC and R&D would be represented using the HC and research pillar from GII (Global Innovation Index). Economic growth would be measured through GDP per capita in constant 2010 dollars. Furthermore, dummy variables would be used as representatives of given countries.

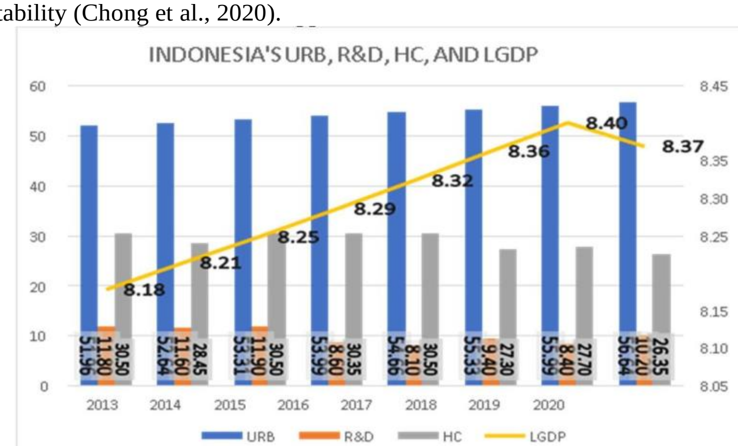
The proponents opted to apply panel regression data to subject multiple countries on a set timeframe from 2013-2020. Panel Data analysis is also used by (Hunady & Orviska, 2014) when they decided to determine the relationship between R&D expenditure, Innovation, and Economic Growth. (Woolridge, 2010) also advised pooled OLS (POLS) to be applied for multiple samples for a given timeframe. To correct multicollinearity on our data and control unobserved heterogeneity, proponents used fixed and random effect models, respectively. The panel data modeling considers three models: the common pooled data, Fixed Effect Model, and Random-effects model. The Hausman test is employed to show the best model to use between the models. The paper focused on determining the relationship between the URB rate and the Global Innovation Index scores on HC and research on the economic growth, assessed using its GDP per capita.

The use of GII scores to assess countries' HC and R&D performances poses several challenges to the study. However, due to the inconsistencies in collecting data that determines a nation's HC and research scores, movements unrelated to the actual performance may happen.

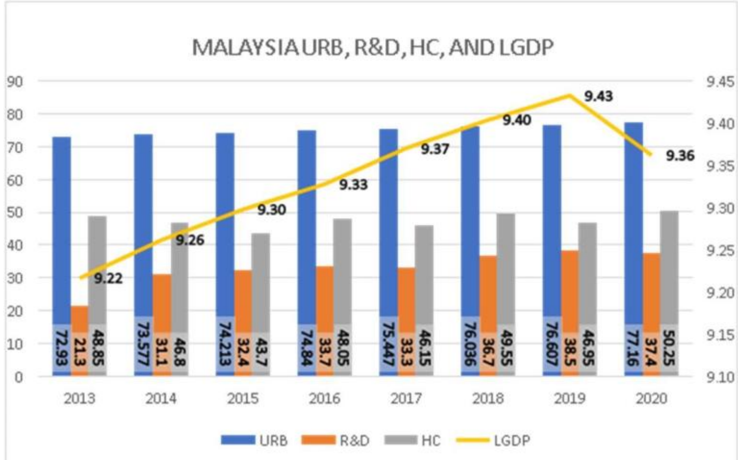
IV. RESULT AND DISCUSSION

This research aimed to answer the following questions: First, is there a significant positive relationship between innovation on economic growth using the variables URB rate per percentage of the total population; R&D GII score; HC GII score; and GDP per capita, respectively, in years 2013-2020? Second, Is there a significant positive relationship between selected ASEAN countries and Paul Romer's endogenous growth theory? It will be using panel data regression analysis to determine the relationship between innovation and GDP per capita. To avoid omitted variable bias or multicollinearity, we ran the fixed effect model; and to control the unobserved heterogeneity, we used a random-effect model. We ran the Hausman test to help us choose between the ideal or best model to use.

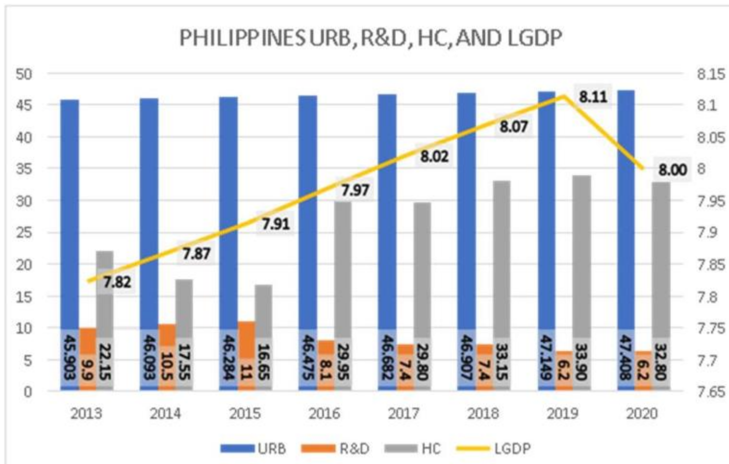
The trends presented below are the graphical representation of each independent variable with the dependent variable. The logs of GDP in the three ASEAN countries show a sudden downtrend explained by the COVID-19 pandemic in late 2019. In the Philippines, strict lockdowns imposed by the government to prevent the virus's rapid spread caused substantial economic losses. Although the government tried to launch subsidy programs and other expansionary fiscal policies to support households and businesses, it was not enough to offset the negative impacts of the pandemic. Furthermore, some industries got hurt, such as education, construction, food services (including tourism), and manufacturing; and some industries benefited like power and energy, information and communication technology, and real estate (Shinozaki, S. L. N. Rao, 2021). Also, because of the said pandemic, it is expected that ASEAN countries will have negative growth rates. They were mainly caused by the decrease in trade volume in the ASEAN trade bloc that led to job loss, leading to small tariff income, which may add pressure on unemployment and government fiscal stability (Chong et al., 2020).



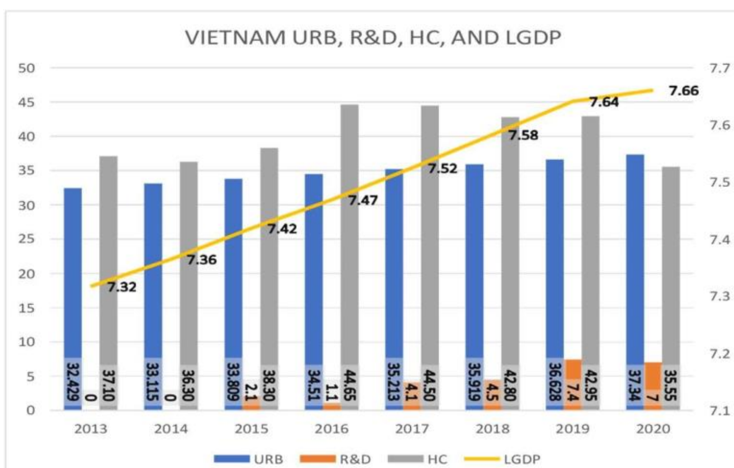
Graph A. Indonesia's LGDP, URB, R&D, and HC



Graph B. Malaysia's LGDP, URB, R&D, and HC



Graph C. Philippines' LGDP, URB, R&D, and HC



Graph D. Vietnam's LGDP, URB, R&D, and HC

For Vietnam's R&D (Graph D), in an eight-year time period, they manage to increase their score on R&D due to the following reasons. First, in the last 20 years (1999-2019), the government made structural and human resource policies to initiate research development in the country, such as granting autonomy to universities which allowed it to create its research development policies. The establishment of the National Foundation for Science and Technology Development (NAFOSTED) focuses on increasing the number of published research in ISI-covered journals for

Vietnamese authors and the release of rules and regulations to maximize the potential in research investment. Second, the government also made sure to develop Vietnamese talents in research. The government launched three projects (projects 322, 911, and 89), a national strategy to improve its academic workforce. Third, it trained and developed R&D staff who have masters or doctoral degrees to supply the demand of Vietnam's goal of modernization and industrialization. Finally, it also focused on training doctoral graduates for higher education institutions in Vietnam. This led to Vietnam achieving the fastest growth rate during 2011-2019, averaging 22% growth annually; although, most of its production of research output relies on international collaboration. It also allowed Vietnamese universities to climb the top university rankings globally. However, Vietnam still lagged behind its neighboring ASEAN countries in terms of articles produced and its number of researchers. It is safe to say that Vietnam is still building its way to improve its academic workforce, particularly in the R&D department (Nguyen, H. T. L., 2020).

Table 1. Panel Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob
Constant	5.756731	0.075411	76.33774	0.0000
URB	0.044102	0.001565	28.18101	0.0000
R&D	0.000789	0.002115	0.373290	0.7117
HC	0.005079	0.001050	4.838954	0.0000

R-squared	0.996461	Mean dependent var	8.275314
Adjusted R-squared	0.996081	S.D. dependent var	0.691207
S.E. of Regression	0.043268	Akaike info criterion	-3.326323
Sum squared resid	0.052420	Schwarz criterion	-3.143106
Log-likelihood	57.22117	Hannan-Quinn criter.	-3.265592
F-statistic	2627.702	Durbin-Watson stat	0.971645
Prob(F-statistic)	0.000000		

Table 1 presents the panel least-squares of innovation (URB, R&D, HC) to economic growth. URB Rate per percentage of total population (URB) and HC (HC) is significant with a p-value ≤ 0.05; p = 0.00 and p = 0.00 respectively. While R&D (R&D) is insignificant with a p-value ≥ 0.05 (p =0.7717). The coefficient of the independent variables showed that for every one unit of increase in URB, LGDP increases by 0.044102; 0.000789 with R&D; and 0.005079 with HC.

Table 2. Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob
Constant	5.039812	0.304997	16.52413	0.0000
URB	0.057243	0.006346	9.020343	0.0000
R&D	-0.000356	0.002730	-0.130385	0.8973
HC	0.006185	0.001873	3.302675	0.0029

R-squared	0.997317	Mean dependent var	8.275314
Adjusted R-squared	0.996673	S.D. dependent var	0.691207
S.E. of Regression	0.039867	Akaike info criterion	-3.415915
Sum squared resid	0.039734	Schwarz criterion	-3.095285
Log-likelihood	61.65463	Hannan-Quinn criter.	-3.309635
F-statistic	1548.961	Durbin-Watson stat	1.399529
Prob(F-statistic)	0.000000		

To fix the multicollinearity problem and to avoid variable bias in our data we now used a fixed effect model. Table 2 now presents the fixed effect model of innovation to economic growth. All the variables are now insignificant with

URB having its p-value ≥ 0.05 (p = 0.3917); R&D p-value ≥ 0.05 (p = 0.8930); and HC p-value ≥ 0.05 (p = 0.5715). The coefficient tells us that for every 1 unit increase in URB, LGDP increases by 0.018977; and 0.001600 with HC. However, an inverse relationship can be seen with R&D with a -0.000337 decrease in LGDP for every unit on the increase in R&D.

Table 3. Random Effect

Variable	Coefficient	Std. Error	t-Statistic	Prob
Constant	5.756731	0.069483	82.85141	0.0000
URB	0.044102	0.001442	30.58561	0.0000
R&D	0.000789	0.001949	0.405141	0.6885
HC	0.005079	0.000967	5.251847	0.0029
Effects Specification				
			S.D.	Rho
Cross-section Random			2.46E-07	0.0000
Idiosyncratic Random			0.039667	1.0000
Weighted Statistics				
R-squared	0.996461		Mean dependent var	8.275314
Adjusted R-squared	0.996081		0.691207	0.691207
S.E. of Regression	0.043268		Sum squared resid	0.052420
F-statistic	2627.702		Durbin-Watson stat	0.971645
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared			Mean dependent var	8.275314
Sum squared resid			Durbin-Watson stat	0.971645
Unweighted Statistics				
R-squared	0.996461		Mean dependent var	8.275314
Sum squared resid	0.052420		Durbin-Watson stat	0.971645

To fix the heteroskedasticity of the model, the random effect model will be used to control for unobserved heterogeneity. Table 3 now shows that URB and HC are now significant with a p- value ≤ 0.05 (both p = 0.000). However, R&D shows no significance with a p-value ≥ 0.05 (p = 0.6885). Coefficients tell us that for every 1 unit of increase in URB, LGDP increases by 0.044102; 0.000789 with R&D; and 0.005079 with HC.

Hausman Test

The Hausman test will be used to choose the best model to use between the two (fixed and random effect). To check the results, we looked at the test summary and checked the probability; if the p-value is ≤ 0.05, then reject the null hypothesis and accept the alternate hypothesis. The null hypothesis is that the preferred model is random, while the alternate hypothesis is that the model to be used is a fixed effect.

Table 4. Hausman Test

Test Summary	Chi-Sq Statistic	Chi-Sq. d.f.	Prob.

Cross-Section Random	7.982168	3	0.0464

Cross-Section random effects test comparisons:

Variable	**Fixed**	**Random**	**Var(Diff.)**	**Prob.**
URB	0.057243	0.044102	0.000038	0.0335
R&D	-0.000356	0.000789	0.000004	0.5490
HC	0.006185	0.005079	0.000003	0.4903

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
Constant	5.039812	0.304997	16.52413	0.0000
URB	0.057243	0.006346	9.020343	0.0000
R&D	-0.000356	0.002730	-0.130385	0.8973
HC	0.006185	0.001873	3.302675	0.0029

R-squared	0.997317	Mean dependent var	8.275314
Adjusted R-squared	0.996673	S.D. dependent var	0.691207
S.E. of Regression	0.039867	Akaike info criterion	-3.415915
Sum squared resid	0.039734	Schwarz criterion	-3.095285
Log-likelihood	61.65463	Hannan-Quinn criter.	-3.309635
F-statistic	1548.961	Durbin-Watson stat	1.399529
Prob(F-statistic)	0.000000		

From the table above, the test shows that the preferred model to use is the fixed effect model, as the test summary shows a p-value ($p = 0.0464$) $\leq$ 0.05. Therefore, we accept the alternate hypothesis.

Fixed Effect with Dummy Variable

Using a dummy variable, we will be able to use a single regression equation and show multiple countries' significance with the dependent and independent variables simultaneously.

Table 5. Fixed Effect with Dummy Variable

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
Constant	4.752692	0.421387	11.27869	0.0000
URB	0.057243	0.006346	9.020343	0.0000
R&D	-0.000356	0.002730	-0.130385	0.8973
HC	0.006185	0.001873	3.302675	0.0029
DUM_INDO	0.260809	0.112767	2.312813	0.0292
DUM_PH	0.386983	0.153487	2.521277	0.0184
DUM_VIET	0.500688	0.220862	2.266972	0.0323

R-squared	0.997317	Mean dependent var	8.275314
Adjusted R-squared	0.996673	S.D. dependent var	0.691207
S.E. of Regression	0.039867	Akaike info criterion	-3.415915
Sum squared resid	0.039734	Schwarz criterion	-3.095285

Log-likelihood	61.65463	Hannan-Quinn criter.	-3.309635
F-statistic	1548.961	Durbin-Watson stat	1.399529
Prob(F-statistic)	0.000000		

Table 5 is the fixed effect model with dummy variables (Indonesia, Philippines, Vietnam) (DUM_INDO, DUM_PH, DUM_VIET), respectively. We used Malaysia as the base year with the highest GDP per capita among the selected countries. We can see that Indonesia (p = 0.0292), Philippines (p = 0.0184), and Vietnam (p = 0.323) have a p-value ≤ 0.05, showing that the relationship between the dependent and independent variables for these countries is significant. Coefficients tell us on the per-country basis using dummy variables, for every one unit of increase in innovation (proxied by URB, R&D, HC), LGDP increases 0.260809 for Indonesia; 0.386983 for the Philippines; and 0.500688 for Vietnam.

With a Prob (F-statistic) of 0.000000, the multiple regression concludes as statistically significant. All independent variables are also statistically significant, except R&D. Contrary to the claims presented in the related literature, R&D has shown no significant relationship with GDP per capita growth. However, researchers like Kacprzyk (2017) have claimed that his study on the matter resulted that the relation between innovation and growth is not as straightforward as it may seem, opposed to the endogenous growth model predictions. The study concluded that there is no statistically significant relationship between total R&D outlays and economic growth. Furthermore, a study by Tuna et al. (2015) stated that relationship between R&D expenditures and economic growth due to the empirical tests applied.

Similarly, the insignificance of R&D in this study can also be explained that the selected ASEAN countries are developing countries. Although, according to Tuna (2015), R&D activities are a long- term investment, the results of these activities can only be seen after 20 to 35 years of continuous R&D activity in the country. Given the short period of our data, results show that R&D is insignificant, however, based on Romer's (1986) theory, growth from R&D (knowledge base on his original paper) will increase over time, and it is the long-run growth that we should look forward to.

Like other cited studies, the URB rate has significantly correlated with GDP per capita growth. Revealing a 0.057243 increase in GDP per capita as the URB Rate increases by a unit. HC has also shown a significant positive relationship with GDP per capita growth, as GDP per capita increases by 0.006185 for every unit of increase with HC level. As per the dummy variables, Indonesia, Philippines, and Vietnam are significant using Malaysia as the base country. Indonesia has shown a 0.260809 increase in GDP per capita growth compared to Malaysia. The Philippines inhibited an increase of 0.386983 more than Malaysia's GDP per capita growth. Moreover, Vietnam has 0.500688 more GDP per capita than the base year.

V. SUMMARY, CONCLUSION, AND POLICY IMPLICATIONS

This research aimed to use Paul Romer's endogenous growth theory to determine whether there is a positive relationship between innovation using URB, R&D, and HC on economic growth. The proponents used ASEAN countries, namely, Indonesia, Malaysia, Philippines, and Vietnam, in years 2013-2020 to compare the results of the variables and their significance. Using panel regression analysis, fixed effect, and panel data analysis, the proponents found out that URB and HC significantly affect GDP per capita. However, R&D has shown no significant relationship with GDP per capita growth.

Conclusion

The researchers hypothesized that there is a significant relationship between innovation and economic growth, which is measured by URB rate per percentage of total population (URB); R&D GII score (R&D); and HC GII score (HC), and economic growth, measured by GDP per capita (LGDP), respectively, in the years of 2013-2020. Results shown from the fixed-effect model, URB and HC had a significant relationship with LGDP, while R&D was insignificant and had an inverse relationship with LGDP. Therefore, the null hypothesis is rejected based on URB and HC results. While R&D may be insignificant, it will require more time to show an impact on the economic growth of the selected countries. It is also important to note that even though R&D is insignificant in the results, R&D activities for these countries should continuously be actively expanding as this will contribute to the long-run growth of an economy in the future. Therefore, endogenous growth theory is present in the selected ASEAN countries.

Policy Implications

The results regarding URB may provide further support for the claims around the MAR spillover that the knowledge spillovers in the city, caused by a concentration of firms, allow for information and skills to flow, thus fueling innovation, then eventually economic growth. The study also supports Romer's claim that the development of HC through education and other forms of knowledge-intensive activities are essential for economic growth—noting the use of HC and the existing stock of knowledge to produce new knowledge in the research sector. Moreover, the use of those designs and capital for production in the immediate goods sector boosts the number of producer durables to process final goods.

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