TOWARDS A COHERENT ENERGY POLICY IN ASEAN USING ECONOMETRIC AND STRUCTURAL EQUATION MODELS

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ABSTRACT

The ASEAN Economic Community is an emerging regional market with people experiencing an aggregate output growth which drives them to increase their energy consumption. With the imminent integration in the region, energy consumption in each of the member countries varies in details and dimensions defined by the internal experiences inherent to the country. This study aims to articulate the coherent energy policy in ASEAN which is a significant step towards the formulation of explanatory parameters for the regional bloc and eventually identify possible policy implications. This paper examines the impact of regional trade, direct investment, public investment, and per capita income on the energy consumption of the 10 ASEAN member countries. Drawing information from the Asian Development Bank, World Bank, and BP World Energy Statistics Review databases, panel data sets were subjected to a sequence of econometric tools prior to the utilization of the structural equation model through AMOS version 19. Data specifications and diagnostic tests were completed to verify the acceptable good to fitness of the data as well as the model itself. Two classified classes of fit indices were employed and these are the discrepancy functions and comparative tests between target and null models. The discrepancy functions are exemplified by chi square test and the root mean square error of approximation. While the comparative tests between target and null models are defined by the normal fit index, goodness of fit index, and comparative fit index. The results from the study manifest that (1) public investment, per capita income, and regional trade has a significant impact on the ASEAN energy consumption, (2) direct investment has no substantial effect on the region's energy consumption, and (3) there is a sizeable correlation between direct investments with its co-explanatory variables.

Key Words: *energy consumption, policy, trade, investment*

Introduction

Energy is perennially associated with progress and development in any country's quest for a higher quality of life for its citizenry. A citizenry that is constantly clamouring for more energy to consume as the economy achieves an ascending increment in the aggregate output. Such economic phenomena reflect the neoclassical thoughts of a higher disposable income lead to further consumption of any preferred goods or services available in the market. Energy for one is a commodity highly regarded in the power market, and is a component to aggregate output. Energy's ubiquity is apparent to every industry's operation and productivity, thus, one can never discount its immense impression towards an economy. Energy plays a major role in the robust economies prevailing in the ASEAN region, with energy consumption rising by 13% on the average for the last ten years (Asian Development Bank, 2012). Such average rise of energy consumption in ASEAN is accompanied by an average economic growth rate of 6.84% (World Bank, 2012) in the last ten years, a decade of economic performance clamouring for more power commodity.

As an emerging regional market with people experiencing an aggregate output growth which drives them to increase their energy consumption, the ten country members has acknowledged the importance of a gradual economic integration. For more than a decade, the governments of the ten country member have crafted the ASEAN Economic Community (AEC) which is expected to be in placed by 2015. The existence of the AEC is well articulated in its blueprint stated as:

> *"the AEC will establish ASEAN as a single market and production base making ASEAN more dynamic and competitive with new mechanisms and measures to strengthen the implementation of its existing economic initiatives; accelerating regional integration in the priority sectors; facilitating movement of business persons, skilled labour and talents; and strengthening the institutional mechanisms of ASEAN. As a first step towards realizing the ASEAN Economic Community, ASEAN has been implementing the recommendations of the High Level Task Force (HLTF) on ASEAN Economic Integration contained in the Bali Concord II" (ASEAN Economic Community Blueprint, 2007, p. 12).*

The AEC is the springboard for the ASEAN integration to become one sizeable market and a strong base for productivity and growth. Moreover, *the AEC comprises five core elements that include free flow of goods, free flow of services, free flow of investment, freer flow of capital, and free flow of skilled labour* (ASEAN Economic Community Blueprint, 2007, p. 6). Given the changing economic landscape of the South East Asian region, demands for energy will definitely be defined by the extent of integration being aimed at, not only in 2015, but also beyond. It is imperative to elucidate possible explanatory variables that significantly affect energy consumption in each of the ten member country and ASEAN to a larger extent as seen in the vernacular of per capita income, pubic investment, direct investment, and the volume of intra-

regional trade. As free mobility of services, goods, and investments transpires in the region, it is essential to articulate the relationship of the identified explanatory variables to energy consumption in the impending economic integration.   Currently, there are voluminous of literatures about energy consumption but most of these studies are done in the light of cointegration and causality with economic growth.   Such relevant recent researches were expound clearly in the works of Ozturk, Aslan, & Kalyoncu (2010); Balcilar, Ozdemir, & Arslanturk (2010); Bartleet, & Rukmani, (2010).   These research outputs differs from the research pursued by the proponent, in several dimensions: (1) there is scarcity of study done equating energy consumption with public investment, direct investment, and regional trade; (2) the study determines the explanatory variables implication towards a coherent energy consumption as the region integrates through AEC; (3) none or limited usage of the structural equation model in establishing the significant relationship of the identified parameters as compared to previous studies made; (4) the paper deviates from the usual cointegraton and causality nexus between energy consumption and economic growth.

This study aims to articulate the coherent energy policy in ASEAN a significant step towards a formulation of explanatory parameters for the regional bloc and its possible policy implications. This paper examines the impact of regional trade, direct investment, public investment, and per capita income on the energy consumption of the ASEAN member countries in the context of the AEC core elements towards a coherent energy policy. Relevant literatures were integrated to provide better dimensions on the topic, accompanied by methodology using econometric and structural equation models, to extract the information required for clarification and discussion. The paper ends with the articulation of the results with the subsequent conclusions.

Literature Review

The appraisal of the relevance of the literatures is presented on the clustering of the ideas and thoughts as per the defined parameters in the research. Each literature is dissected in the vernacular of the course taken in the study.

Integration and Regional Trade

Umbach (2010) showed that coherence in the energy policy in the European Union is possible through a sufficient strategy to cope with the challenges emanating from the new global and geopolitical order. It was clear in the study that sufficiency in strategy is in the form of a declared common energy (foreign) policy. The author articulated that the approach to address the changes brought by the inter-linkage of globally designed traditionally security concepts and domestic as well as regional political stability requires new thinking with a larger understanding of the new global order, such thoughts are similar in the research of Neto, Perobelli, Bastos (2014). Economies that are veered towards integration must assume structural adjustments that must reflect the changing global arrangement. Such structural changes are necessary especially if several countries that are part of the integration are not at par with the other co-members. The

study of Tsani (2010), points that there are countries that are less endowed with natural resources even in the generation of energy. Greece was the example made that must address its energy import dependence through policy implications and to adopt structural policies that affects energy consumption. Such structural polices need to affect the demand side of energy and improvements should be done to make it efficient. Energy dependence is a common scenario in ASEAN. There are countries that are not energy resource endowed, example of which is the Philippines.

China's economic performance was put under inquiry in the research paper of Crompton & Wu (2005) to assess its long-term implications towards future trade and investment strategies to ensure the country's security of energy supply. The interest to diagnose the significance of energy consumption in the long-term perspective is due to the apprehension of the country's capability to supply the energy requirement of a growing trade and investments. ASEAN as it integrates creates an economic situation where in trade and investments increases that demands an appropriate energy prerequisite. On the other hand, based on the findings from the study made by Lorde, Waithe, and Francis (2010), there is a reason to look into the possibility of liberalizing the electricity market to reflect the real prices and this would encourage efficiency and innovation in any of the three stages of the energy industry. Such policy may also untie the hands of the government from financial constraints as it affects the energy sector. Both the service and manufacturing sectors are essential to energy consumption. It was revealed that too much emphasis in service sector affects the energy demand inversely as noted in the works of Mulder, de Groot, and Pfeiffer (2014). The same perspective was taken by Voigt, De Cian, Schymura, and Verdolini (2014) especially, on the heterogeneity of the sectors and regions.

In the context of regional trade, it was illustrated in the findings of Korsakiene, Tvaronaviciene, and Smaliukiene (2014) that an increasing energy prices have not affected international competitiveness of the exporting industrial sectors. This has policy implications in the mobility of commodities within an integrated economic region.

Investments

Turner & Hanley (2011), hypothesized that as a country attains further wealth, the country can now afford to spend more on research and development which may lead to more advanced and environmentally-friendly production techniques. They established the relationship between capital and energy efficiency, and such finding has an apparent consequence to consumption. Investments regardless it's public or direct would have repercussions to energy consumption through increased demands from economic activities generated by more investments. Frondel, Ritter, Schmidt, and Vance (2010), demonstrate the significant outcome of efficient public investment in the promotion of renewable energy technologies. Such decision in public expenditures in renewable energy done in Germany have benefitted the consumers through an environmentally benign, abundant and cost-effective energy source. The German experience in public expenditures in energy brings out the optimal output if allocation of funds is not

misplaced or challenge incentives to the energy market and the providers. Public investments are critical toward energy generation and consumption as the government leads the path for growth and progress. As the market base expands due to economic integration, there is a need to develop a number of transmission infrastructures to accommodate the impending growth, thus, it was articulated by Delucchi, and Jacobson (2011) to allocate further investments to such energy projects. Investment is essential whatever the nature of it, public or direct, in order to expand greatly the transmission infrastructure to accommodate the new power systems. Notable in the study is the substantial investment requirement in the provision of transmission infrastructure, but energy is not only a matter of transmitting the power commodity, it also requires the generation and distribution phases, which again requires investments.

It is noteworthy that allocation of public investment was the centre-piece of the research work done by Lin & Jiang (2011). The study explored the dent of energy subsidy towards the level of energy consumption and emissions, and the authors further conclude to adopt offsetting policies that certain part of the subsidies are transferred to support other sustainable development measures of the Chinese government. In order to accomplish the required 3.5% average economic growth in Asia by 2020, according to Umbach (2010), conservative estimates of development costs and investment needs will go up to as high as US$4.4 trillion of oil infrastructure alone. Thus, investments either public or direct in nature are an essential component to secure the stability of energy supply in Asia.

Gross, Blyth, and Heptonstall (2010), construed that energy policy normally depend upon investment. This investment is mostly diverted towards technologies or categories of technology in generating, transmitting, or distributing the energy commodity. The study also mentioned that in UK electricity sector, investment is spearheaded by private companies because these firms are motivated by expected returns. One of the explanatory variables considered to affect energy consumption in ASEAN is direct investment   Financial development, economic growth and energy consumption were determined to have a causal and cointegration relationships as expounded in the work of Jalil and Feridun (2011). Through their study it evidences were found to exist between financial development and foreign direct investment. This only illustrates the link between investment and energy consumption. Such linkage confirmed the previous work of Ang (2008a, 2008b) where in it was pointed out that financial deepening in Malaysia leads to higher foreign direct inflows.

In the findings of the article of Mishra, Smyth, and Sharma (2009), it was suggested for countries taken as a panel or as a whole should adopt if not craft a multi-pronged strategy to increase energy infrastructure investment, with a simultaneous regulatory reforms to enhance the delivery of an efficient and continuous promotion of alternative sources of energy. This is the policy implications of their work. However, enticing investments to come in, the national government should initiate reforms, because according to the study of Erdogdu (2013), Napp, Gambhir, Hills, Florin, and Fennell, (2014), Craig, and Allen (2014) reform progress is highly correlated with investment flows. The appropriate political and economic environment is essential to attract a

number of investors to the country or region and to inculcate best practices to achieve energy efficiency, the same result were founded by Lee and Leal (2014).

Per Capita Income and Energy Consumption

To validate the credibility of the explanatory variables chosen in the present study, energy consumption through nuclear activities and oil usage the dynamic interrelationship with real income and urbanization's effects towards energy consumption were examined through the research imparted by Lee and Chiu (2011), Wang, Q. (2014) respectively. The studies established the evidence of unidirectional causality between real income and nuclear energy consumption in Japan wherein the directional flows emanates from real income and China respectively. The study also reveals the presence of causality from oil consumption towards nuclear energy consumption in several industrialized countries such as Canada, Japan, and the UK. With different study but the same authors, Wolde-Rufael and Menyah (2010), Akhmat and Zaman (2013), they were able to determine the causal relationship between nuclear energy consumption and real GDP for nine developed countries. Common to the present study is the inclusion of several countries defined by the ASEAN member countries and establishing the relationship of energy consumption with other explanatory variables but not in the context of causation and cointegration evidences.

Saving and investment were both used to establish the link between energy consumption and economic growth as expounded in the study made by Ang (2007), Herrerias, Joyeux, and Girardin (2013), Wang (2014). Moreover, in another study of Ang (2009), he concluded that in China's case the more energy use, the higher income and greater trade openness tend to cause more CO2. Although the dependent variable is the CO2, the fact that energy use, income and trade openness were disclosed to be part of the equation to explain the phenomena, it gave weight to the decision to include those parameters to the present study, such perspective was also recognized in the study made by El Anshasy and Katsaiti (2014), Samuelson (2014). However, if panel data sets consists of several countries taken as aggregate and individually, the relationship between energy consumption and real GDP that there is no consensus either on the existence of such relationship or not conclusive in one cluster or establishes strong relationships if taken individually and these are manifested in the works of Balcilar, Ozdemir, and Arslanturk (2010), Halicioglu (2011), Ozturk, Aslan, and Kalyoncu (2010), Narayan, P.K., Narayan, S., and Popp (2010), Shahbaz, Khan, and Tahir (2013), Yalta (2011), Zhixin and Xin (2011). The marginal value of energy is influenced by the willing to pay of the users as stated in the study of Brennan and Palmer (2013), Thompson (2014) which has an implication to the relationship between per capita income and energy consumption in terms of price elasticity.

Research Methodology

A descriptive and quantitative approach was utilized to empirically treat the information at hand. Such design is appropriate to articulate and substantiate the possible results that were yield from the research. Varied illustration form such as graphs, tables, and pies are basic means for presentation coupled with econometric tools to extract sound information from the secondary data.

Regression Analysis

The model was used to determine the extent of significance of the set of variables that explain the significance among energy consumption, direct investment, public investment, intra-regional trade, and per capita income for each ASEAN country. The model assumes that there are linear relationships among the parameters as reflected by the following functional equations:

$$EC_{tc} = a_{t0c} + \beta_{t1c}DI_{t1c} + \beta_{t2c}PI_{t2c} + \beta_{t3c}RT_{t3c} + \beta_{t4c}PCI_{t4c} + \mu \qquad \text{(Eq. 1)}$$

The functional equation (1) pertains to energy consumption (EC) with the determinants such as direct investment (DI), public investment (PI), intra-regional trade (RT), and per capita income (PCI). To test the reliability and stability of the model, it requires the following procedures (Gujarati, 2003):

1. compute for the value of $F = \dfrac{(ESS_{new} - ESS_{old})/NR}{}$
      i. $RSS_{new}/n\text{-}k$
2. find the ordinary least square estimation that would comply with the rule of
      a. $RSS_R › RSS_{UR}$
      b. use the usual t-test in acceptance or rejection of the null hypotheses if $\beta^* = 0$
      c. inference be done by the figure that represent R^2 with F-test and a significance level of 0.05

Structural Equation Model

This model was to test and estimate the causal relationships of the articulated dependent and independent variables. The model is capable to combine both statistical data and qualitative causal assumptions. The model was preferred to confirm and explore the theory being developed in the study.   Under the structural equation model the regression was separated into for causal equation, such as (Byrne, 2004):

$$EC = DI + error1 \qquad \text{(Eq. 2)}$$
$$EC = PI + error2 \qquad \text{(Eq. 3)}$$
$$EC = RT + error\ 3 \qquad \text{(Eq. 4)}$$
$$EC = PCI + error\ 4 \qquad \text{(Eq. 5)}$$

Data Specifications and Diagnostic Tests

Empirical treatment of panel data sets requires to meet several specification and diagnostic tests to minimize if not totally eradicate the presence of misspecifications of the defined parameters and to validate the goodness to fit of the model to articulate the economic phenomena under scrutiny with a high degree of certainty.

Chi-Square Test

One of the fit indices available and is integral part of the structural equation model, which is also known as discrepancy function. The test provides justification to the worthiness and fit to goodness of the model and how extensive the discrepancy between the target and null models to validate the hypotheses. The test shows the degree of significance of the target model with that of the null model. The value of the chi-square should yield a significant value to make the model unacceptable (Byrne 2004).

Root Mean Square Error of Approximation (RMSEA)

RMSEA is a supplementary mechanism to determine the fit of the data to the model. A value less than 0.05 reflect the data fitness to the model and can therefore validly explain the causal relationship between and among parameters (Hooper, Coughlan, and Mullen, 2008).

Other Indices Comparing the Target and Null Models

To further fortify the possibility of non-misspecifications of data and the spuriousness of the model several indices were employed to compare the target and null models. According to Hooper, Coughlan, and Mullen (2008), the following fit indices are respectable indicators to keep safe the assurance of acceptable specifications of data and the model: [1] under the Normed Fit Index (NFI) the value should not exceed 0.90; [2] for the Goodness of Fit Index (GFI) the requirement is for the value not exceed 0.90, and [3] lastly, the Comparative Fit Index (CFI) value should not be more than 0.93.

Research Results

Energy Consumed in ASEAN

In the last 22 years, each ASEAN country members continues to experience an ascending demand for power, electricity, or energy. Fig. 1 illustrates the directional trend of the amount energy being consumed for the last two decades due to economic growth which transpired in the region during the covered period.

Indonesia's energy requirement was comparatively the largest among the region's member countries which registered an average 102.54 million tonnes of oil equivalent (MTOE) with Thailand comes in second with an average of 71.48 MTOE consumed energy. The two strongest

economic performers in the region, Malaysia and Singapore, posted an average energy utilization of 50.31 and 44.46 MTOE respectively. The Philippines which started its independence far distant with Vietnam had an equal level of average energy consumption of 24.09 MTOE. This is to consider that the latter went through a political turmoil aggravated by American initiated war. It only reflects the tenacity and formidable character of Vietnam as it brush itself from the ashes of varied conflict towards a highly potential economic opportunities and growth.
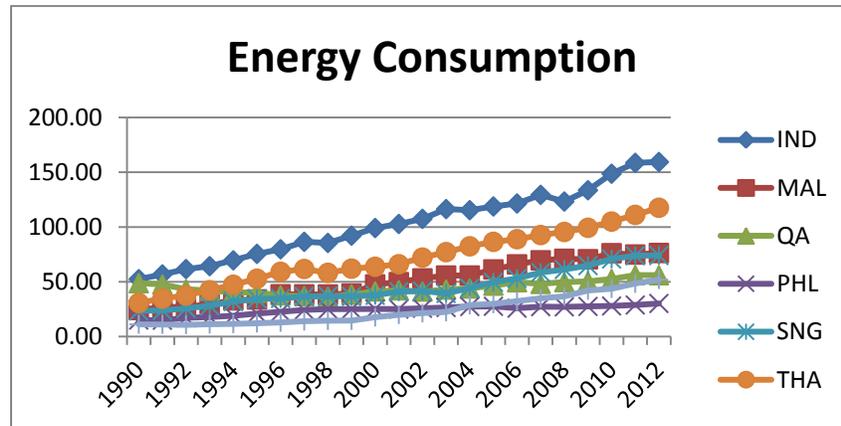

Figure 1: Energy Consumption Profile of Each ASEAN Country Members

Source: BP World Energy Statistics Review

Aggregately, the consumption of energy is expected to increase in the near future which is likely to further accelerate with the imminent integration of the ASEAN region in 2015 and beyond.

Causal and Correlation Framework

Based on the empirical treatment employed, the results articulate the significant impact of the explanatory variables to the energy consumption in the ASEAN region. Using as yardstick the standard 0.05 level of significance, and given the extracted p-values of public investment (0.006), per capita income (0.010), and regional trade (0.000) it could be inferred that public investment, per capita income, and regional trade has a significant impact on the ASEAN energy consumption. However, direct investment has no significant impact on the ASEAN energy consumption because the p-values yielded an integer greater than the standard and signified level of significance. This poses a greater comprehension and logical expression of such relational or non-causal phenomenon between direct investment and energy consumption in the region. The information built states a clear non-relationship among direct investment and energy consumption in the ASEAN region; however, such non-causality does not hinder a strong presence of a significant correlation among the explanatory variables.

Empirical results illustrate correlation between direct investment with public investment with p-value of 0.003 and estimated correlations at 0.245. Direct investment has a significant

correlation with regional trade with p-value of 0.000 and an estimated correlation at 0.538; on the other hand, it also has a considerable correlation with per capita income with a p-value of 0.004 and an estimated correlation at 0.237.

There is a significant link among public investment and energy consumption in ASEAN as reflected by a p-value of 0.006, a value still within the set level of significance. Both ASEAN energy consumption and public investment are positively related with an estimated coefficient of 0.22. It is clear that there is a significant relationship between regional trade and energy consumption in ASEAN with a p-value of 0.000 with an estimated coefficient of 0.381 and both parameters are positively correlated. Moreover, in the context of per capita income and energy consumption in ASEAN the association is significant with a p-value of 0.010. However, the coefficient is -0.190, but this does not mean there is an inverse relationship existing between two parameters.
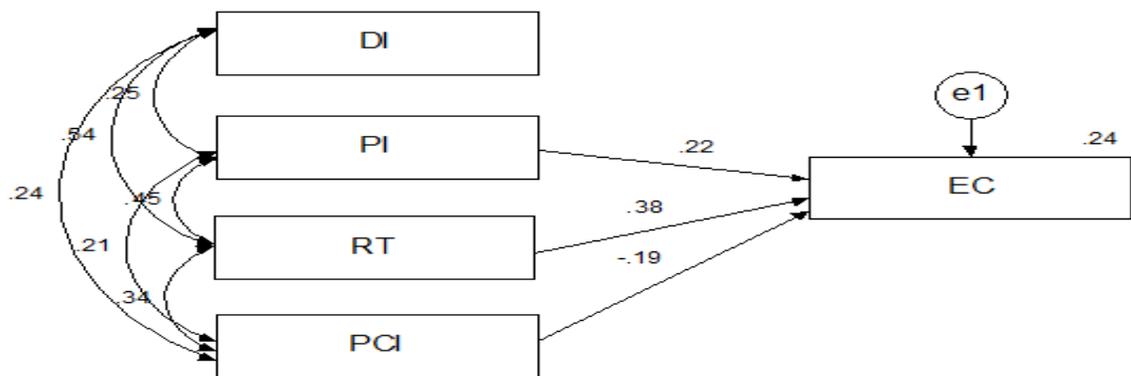

Figure 2: Structural Relationships and Correlations

The regression weights estimates show a significant relationship present between per capita income and energy consumption in ASEAN with a p-value of 0.010. However, the coefficient is – 0.190, but this does not mean there is an inverse relationship existing between two parameters. There are strong correlations among the explanatory variables as manifested by the covariance's' p-values compliance to the lever of significance. Correlations coefficient estimates are well defined among the explanatory variables that provide a good measurement of such correlations.

Discussion

The chi-square value (through the CMIN) justifies the robustness of the model goodness of fit to accommodate the empirical treatment of the data. Moreover, all the good to fitness indices indicates favourable outcome for non presence of misspecifications in the data. The integration of the ASEAN region as an economic bloc raises the demand for energy in each member country as they simultaneously moves towards spurring the growth and development in the area. As the integration intensifies energy consumption is expected to further increase in the region. However, clear platforms are essential to identify from where economic progress can emanate

and where policy implications may be derived. It is accepted that public investment, regional trade, and per capita income are significantly and positively related to energy consumption. As the government expenditures increases, regional trade becomes vibrant and per capita income improve consequently each of the explanatory variables significantly affects the consumption of energy in the ASEAN regional economic bloc. Conversely, direct investment failed to qualify as a strong explanatory parameter for the energy consumption's increments. But the structural equation model asserts the strong correlation of the direct investment with the other explanatory variables that has a significant impact to energy consumption. A possibly good articulation is the strong correlation between direct investment and public investment, this correlation justifies the option of the government in the ASEAN region on the policy regarding Private-Public Partnership (PPP) investment initiative.

If the intention is to provide a clear platform to make a coherent energy policy in ASEAN, it is noteworthy to look into the public investment, regional trade, and per capita income of the member country. All policies pertaining to each of the explanatory parameters should be reviewed to identify areas for adjustment and restructuring to yield the necessary outcome appropriate to realize the objectives of the EAC not only in 2015 but also beyond.

Conclusions

The aim towards a coherent energy policy in ASEAN requires definitive areas of concern to commence the essential adjustments or restructures prerequisites for integrating economies. Such definitive areas must be identified as the platform to initiate the necessary policies that has implications to energy consumption. The study arrives on the following conclusion:

1. The platforms or definitive areas to achieve a coherent energy policy in ASEAN are public investment, regional trade, and per capita income.
2. Although direct investment is insignificant, the presence of strong correlation between direct investment with the other significantly related parameters would have an indirect impact toward energy consumption.
3. ASEAN through EAC would experience a high consumption of energy beyond 2015 as it starts to integrate.

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