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The Effects of Electricity Consumption on Agriculture, Service and Manufacturing Sectors in Malaysia

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ABSTRACT

This paper aims to examine the effects of electric consumption on three sectors, namely, manufacturing, agriculture and services. The Johansen co-integration model is applied. The results indicate a long-run relationship between electric consumption and three sectors in Malaysia. Vector error correction models shows that it is confirmed that the long run relationship among electric consumption, agriculture and manufacturing in Malaysia. The Granger causality is used, and the results show that electric consumption does not Granger cause manufacturing and services sectors. However electricity consumption does Granger cause agriculture sector.

Keywords: Electricity consumption, Agriculture, Service, Manufacturing
JEL Classifications: Q11, Q43

1. INTRODUCTION

Several studies have explored the effects of electricity consumption on economic growth. Some of them ascertained that economic growth hinges on electricity consumption but others discovered that there is no relationship. This implies that their findings still remain mixed and therefore, the issues come to the fore. The findings bring many arguments over the electricity policy. Most countries exhibit similar trend in electric consumptions. In developing countries, an increase in electric consumption can cause better economic growth compared to developed countries.

It was found that causality relationship from electricity consumption to economic growth exists in China (Yuan et al., 2007), whereas Abosedra et al. (2009) and Chandran et al. (2010) discovered the similar results in Malaysia. Yoo and Kim (2006) acknowledged that economic growth influences electricity consumption without feedbacks. Proper implementation of effective policies for electricity generation enhanced the relationship between electricity generation and economic growth. The results of these studies sustained the conservation hypothesis posited by Shahbaz and Feridun (2012). Electricity is a very important factor in generating economic activities. Economy can be crippled without electricity. Shahbaz et al. (2011) showed the relationship between electricity consumption and economic growth, which implied that electric consumption plays an important role in economic growth. Altinay and Karagol (2005) stated that electricity is important in sustaining economic growth. Ighodaro (2010) believed that energy policy related to electricity consumption should be formulated because it can enhance economic growth. Electricity consumption is also vital in determining the labor force; thus, policy on electrical energy conservation could also affect the labor force (Narayan and Singh, 2007). However, the relationship between electricity consumption and economic growth indicates that electricity conservation policy is complex. Chen et al. (2007) stated that electricity conservation policy through rationing of electricity without affecting the end users can be implemented because it is not associated with economic growth. However, Acaravci and Ozturk (2012) determined that the energy conservation policy of rationing electricity can have an adverse effect on economic growth. Thus, formulating appropriate electricity conservation measures is necessary to ensure that economic growth will not be harmed (Adom, 2011).

Most of the previous studies did not explore the relationship between electric consumption and some sectors in the formulation of policies. Not all sectors are affected by electric consumption. Electricity is not only consumed in manufacturing sector but also in other sectors, such as agriculture and services. An increase in the production of goods and services can trigger an increase in electric consumption. The amount of electricity consumption in each sector varies, and it is dependent on the needs in these sectors. Therefore, this study investigates the causal relationship between electric consumption and the three sectors, namely, manufacturing, agriculture, and services, in Malaysia.

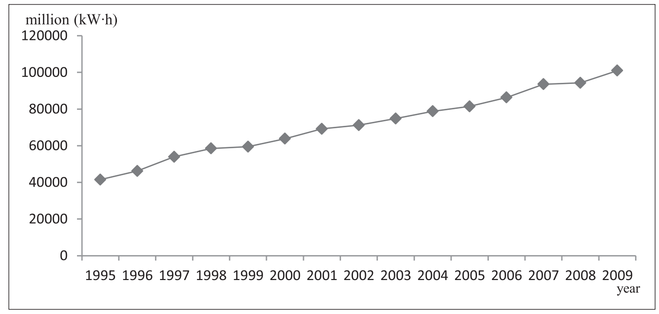
2. TREND IN ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT (GDP) IN THREE SECTORS

Malaysia is the second largest consumer of electricity among ASEAN countries. According to World Bank (2012), electric consumption in Malaysia shows a steady increase, where its recorded consumption was 9,244 million kWh in 1980 and reached 100,996 million kWh in 2009. The consumption is expected to rise in 2021 (Akhwanzada and Tahar, 2012). A rapid increase in electric consumption within 30 years will contribute to economic growth in Malaysia (Endut and Jarji, 2012), even if its consumption showed only a slight increase during the economic crises. Figure 1 shows the trend in electric consumption in Malaysia from 1995 to 2009.

The electric consumption was 41,518 million kWh in 1995, and it increased to 46,220 million kWh in 1996. In 1997, the electric consumption increased by 16.7% and reached 53,923 million. In the following year, the electric consumption increased slightly and reached 58,496 million kWh, and then it increased to 59,478 million kWh in 1999. Afterward, the electric consumption steadily increased for the next 5 years and reached 78,804 kWh in 2004. The electric consumption in 2005 was recorded at 81,460 million kWh, and then it slightly increased to 86,311 million kWh in 2006. In 2007, the electric consumption heightened and reached 93,552 million kWh, and it increased again to 94,277 million kWh in 2008. In the following year, the electric consumption increased slightly and reached 100,996 million kWh. Figure 2 shows the GDP trends by sector (manufacturing, agriculture, and services) in Malaysia from 1995 to 2009.

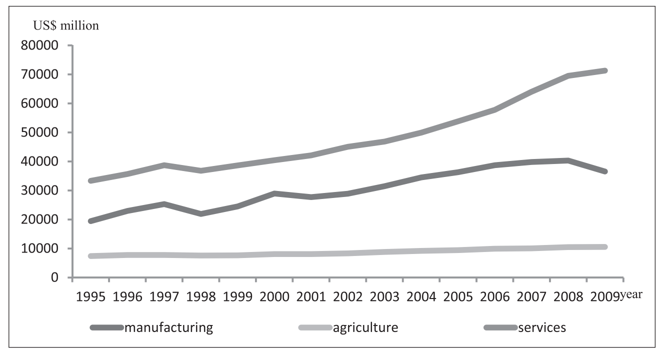
Figure 2 shows the GDP trends of the three sectors in Malaysia from 1995 to 2009. In 1995, the manufacturing sector recorded a GDP of $19,445 million, and it rose to $22,980 million in 1996. The manufacturing sector GDP increased to $25,304 million in 1997 and decreased to $21,909 million in 1998. Afterward, the GDP steadily increased for 2 years and reached $28,947 million in 2000. In 2001, the manufacturing sector GDP dropped to $27,711 million and increased again to $28,853 million in 2002. It steadily increased to $31,497 million in 2003 and to $34,507 million in the next year. The GDP of the manufacturing sector intensified and reached $36,300 million in 2005 and increased to $38,725 million in 2006. In 2007, it hit $39,805 million and then increased to $40,284 million in 2008. The manufacturing sector GDP dropped again to $36,522 million in 2009.

Figure 1: Trend in electric consumption in Malaysia during 1995-2009



Sources: World Bank Report, 2012

Figure 2: Trends of the gross domestic product of the three sectors in Malaysia during 1995-2009



Sources: World Bank Report, 2012

For the GDP in the agricultural sector in Malaysia, in 1995, it was $7,396 million and increased to $7,731 million in 1996. It intensified and hit $7,783 million in the next year and then decreased to $7,568 million in 1998. It increased again to $7,604 million in the following year. In 2000, the GDP was $8,065 million and dropped again to $8,051 million in 2001. It steadily increased for the next 4 years and reached $9,430 million in 2005. It decreased to $9,921 million in 2006 and increased again to $10,047 million in 2007. The GDP increased slightly to $10,480 million in 2008, and then it increased to $10,548 million in 2009.

For the service sector, its recorded GDP was $33,301 million in 1995, which increased to $35,673 million in 1996. The GDP rose to $38,726 million in 1997 and decreased to $36,774 million in 1998. Afterward, it rose to $38,616 million in the next year and increased to $40,405 million in 2000. In 2001, it increased again to $42,074 million and reached $45,083 million in 2002. It rose and hit $46,865 million in the following year and increased again to $49,953 million in 2004. In 2005, the service sector GDP increased again to $53,807 million and slightly increased to $57,758 million in 2006. Afterward, it steadily increased for the next 3 years and reached $71,314 million in 2009.

Electric consumption was observed to have a positive relationship with the GDP by sector (manufacturing, agriculture, and services) in the long term. Based on the trends of the electric consumption and GDP by sector during the recession in 1998, the GDP for all the sectors dropped, whereas the electric consumption still increased. In the other recession in 2009, only the electric consumption in the manufacturing sector decreased, whereas those of the agriculture and service sectors slightly increased.

3. LITERATURE REVIEWS ON THE METHODOLOGY

Basically, the single-country analysis employed the co-integration test and the error correction models (ECM) that estimate the set of data of a single country to test the direction of the Granger causality test (Chen et al., 2007). The several research investigations that used single-country analysis were those by Zachariadis and Pashouortidou (2007), Tang (2008), Lean and Smyth (2010), Ouedraogo (2010), Lorde et al. (2010) and Acaravci (2010).

Hossain (2012) estimated the co-integration and causal relationship between energy consumption and economic growth in Asian countries using the multi-country analysis for the five Asian countries. He stated that the time-series approach is not a powerful approach in the causality studies compared with the panel data that employ panel co-integration and panel-based vector auto-regression (VAR) and vector ECM (VECM). For the multi-country studies, Chen et al. (2007) re-investigated the relationship between electricity consumption and economic growth in China, Hong Kong, Indonesia, India, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. Their results confirmed the co-integration between electricity consumption and economic growth, except in China and Malaysia. The panel Granger causality test reported bidirectional causality between electricity consumption and economic growth in the long term, and economic growth appeared to be related to the Granger-cause electricity consumption in the short term. Yoo (2006) conducted multi-country studies to examine the causal relationship between electricity consumption and economic growth in four ASEAN countries, namely, Indonesia, Malaysia, Singapore, and Thailand. Empirical evidence indicated bidirectional causality between electricity consumption and economic growth in Malaysia and Singapore.

Mainly, researchers used panel co-integration and causality tests to determine the long-term and causal relationship between electricity consumption and economic growth. Narayan and Prasad (2008) stated that unidirectional causality was found to exist from economic growth to electricity consumption in five countries, namely, Finland, Hungary, Korea, the Netherlands, and UK. Ciarreta and Zarraga (2010) determined a unidirectional causality in electricity consumption in the long-term equilibrium relationship among electricity consumption, electricity cost, and economic growth. Recently, Yoo and Kwak (2010) have found out that most of the selected seven South American countries proved a unidirectional causality relationship between electricity consumption and economic growth using the Granger causality techniques. Similarly, a one-way causal relationship was found between economic growth and electricity consumption in Indonesia and Thailand.

Bidirectional Granger causality between economic growth and energy consumption was found in a research conducted by Wolde-Rufael (2006) for Morocco, Egypt, and Gabon. Squalli (2007) investigated the electricity consumption growth in Iran, Qatar, and Saudi Arabia using the bound testing approach for co-integration and the Granger causality test. The test revealed bidirectional causality between electricity consumption and economic growth. Recently, the relationship among electricity consumption, electricity cost, and economic growth has shown a bidirectional Granger causality result between energy cost and economic growth in the long-term equilibrium, as found by Ciarreta and Zarraga (2010). Narayan and Prasad (2008) used the bootstraping causality test to determine the causality between electricity consumption and economic growth in 38 OECD countries. Their findings showed that electricity consumption Granger-cause economic growth in Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK.

Tang and Shahbaz (2011) proposed that alternative energy sources should be considered because these alternatives are more environmentally friendly, such as hydro, wind, and solar power, compared with fossil fuel. The main factor of electricity consumption can also be influenced by the increase in population in a certain country. Another point that should be considered is the financial development, which can also be considered a Granger-cause in economic growth for many countries. As a result, energy consumption should not only be the factor to consider but it must also be complemented with the financial development and population growth factors.

Masuduzzaman (2012) examined the causal relationship between economic growth, electricity consumption and investment in Bangladesh from 1981 to 2011. The study applied the ECM model. Prior to the causality test, the ADP/Phillips-Perron test and Johansen co-integration test were used to examine the stationary property and long-run co-integration. The results from the Johansen co-integration test showed the existence of long run equilibrium among the variables, and the causality results proved that there is unidirectional causal relationship running from electricity consumption to economic growth in the short run.

Mehrara and Musai (2012) examined the causality relationship between electricity use and income in a panel of 11 selected oil exporting countries (Iran, Kuwait, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Algeria, Nigeria, Mexico, Venezuela and Ecuador), applying a dynamic panel framework to capture both inter-country and inter-temporal variation. The panel integration and co-integration techniques were employed for the period of 1970-2010. The results explained that these eleven countries are heavily dependent on oil revenues and enjoying implicit generous subsidies for energy. The findings from Granger Causality within the framework of a panel co-integration model suggested that there is strong causality running from GDP and oil revenues to electricity use with no feedback. Oil revenues have effects on GDP in short run.

Bekhet and Othman (2011) carried out causality tests to investigate the relationship between electricity consumption and total expenditure, consumer price index, GDP and Foreign direct investment (FDI) in Malaysia within 1971-2009. The VECM was used to estimate the causal relationship between electricity consumption with respective independent variables. The results showed that all variables are co-integrated, suggesting the existence of long run relationship between all variables. In addition, there is long run causality from electricity consumption to FDI, GDP growth and inflation, thus indicating that an increase in electricity consumption can affect a major macroeconomics problem such as inflation.

Endut and Jarji (2012) examined the elasticity between residential electricity consumption and economic growth in Malaysia. The study used quarterly time series data for the period of 1985 to 2006 and employed bound testing approach together with newly developed ECM-based F-test in examining the potential long run relation and autoregressive distributed lag model. The results showed that electricity consumption is not co-integrated in the long run with its determinants. The evidence also confirmed that there is no causality running from the residential consumption and economic growth. Alinsato (2009) also used using ADRL to investigate the same relationship between electricity and GDP in two energy integrated countries (Togo and Benin). The study collected annual data on real GDP (in local currency) and electricity consumption for the period of 1973-2006. The results of the co-integration test and the causality suggested that the Benin and Togo economies are less dependent on electricity. The electricity consumption was found not connected with GDP, indicating that electricity demand side management measures can be used to reduce the wastage of electricity.

Most of the previous studies formulated the policy on electric consumption by investigating the relationship between electric consumption and economic growth without finding out which economic sector is affected and not affected. If the findings found that there is no relationship between the variables, the policy to reduce electric consumption is not necessary. Not all of the sectors will be affected and some of the sectors might be affected, therefore considering the specific sectors such as manufacturing, agriculture and services are very important to have a policy on electric consumption reduction.

4. METHODOLOGY

There are several tests, particularly, stationary test, co-integration test, and Granger causality test, that will be employed in this study to investigate the impacts of electricity consumption on manufacturing, service and agriculture sectors. Therefore, data on those variables are collected for the period of 1975-2009. In order to ensure the stationary property of every variable, unit root test is going to be performed. The Unit Root test based on augmented Dickey-Fuller (ADF) will be done. The equation for the test is as follows:

$$\Delta Z_t = \beta_1 + \beta_{2t} + \beta_3 Z_{t-1} + \beta_4 \sum_{i1}^{p} \Delta Z_{t-1} + u_t \quad (1)$$

Where, Z represents the variable, t is the time trend, P is the number of lagged term, u is the error correction term and β is the coefficient. If the results reveal the significant value, it bespeaks the existence of stationarity and no unit root. Therefore, the alternative hypothesis can be accepted. If the results show the insignificancy, the null hypothesis can be accepted. The hypothesis can be written as follows:

$$H_0: \beta_3=0 \text{ (unit root/non stationary)} \quad (2)$$

$$H_1: \beta_3 \neq 0 \text{ (no unit root stationary)} \quad (3)$$

After the unit root test shows that all the variables are non-stationary at level and stationary in first difference. Johansen co-integration can be proceeded. The co-integration test is vital to determine the long term effects of electricity consumption on agriculture, manufacturing and service sectors. Therefore the equation is as follows.

$$Y_t = c + \sum_{j=1}^{p} \Gamma_j \Delta Y_{t-j} + \varepsilon_j \quad (4)$$

If the variables in Y_t are I(1), the VAR in Equation (4) is not stationary. If no co-integration exists, statistical inference is not possible by using the usual tests. Given this condition, the difference of the series should be determined and a first difference VAR of the form should be estimated:

$$\Delta Y_t = c + \sum_{j=1}^{p} \Gamma_j \Delta Y_{t-j} + \varepsilon_j \quad (5)$$

Integration vectors give rise to the stationary variable. If this is the case, the VAR in Equation (5) can be written as:

$$Y_t = c + \sum_{j=1}^{p} \Gamma_j \Delta Y_{t-j} + \Phi Y_{t-1} + \varepsilon_t \quad (6)$$

In Equation (6), Φ is a rank r matrix that can be divided as,

$$\Phi = \alpha\beta \quad (7)$$

Where α is a 3 × r loading matrix and β is a 3 × r matrix of co-integrating vectors, r being the number of co-integrating vectors. Following the Johansen procedure the number of co-integrating vectors were tested by using the co-integrated VAR as in Equation (6).

The Granger causality test is important to determine the directional relationship between two variables. If the P values of the variable Y significantly contribute to forecast the value of another variable X, then Y has a Granger causal relationship with X and vice versa. The test is based on the equation below.

$$Y_t = \beta_0 + \sum_{z=1}^{p} \beta_1 Y_{t-z} + \sum_{i=1}^{q} \beta_2 X_{t-1} + \mu_t \quad (8)$$

$$X_t = \beta_0 + \sum_{z=1}^{p} \beta_1 X_{t-z} + \sum_{i=1}^{q} \beta_2 Y_{t-1} + \mu_t \quad (9)$$

Where Y and X are the selected variables and t is the time period. Z and i are the number of lags. For Equation (8), if the value of probability shows that it is significant, therefore, the null

Table 1: Augmented Dickey-Fuller unit root test results

Variables	Intercept		Intercept+trend	
	Level	First difference	Level	First difference
lnE	2.1554 (0.9999)	−4.0859* (0.0037)	−2.6615 (0.2583)	−4.7543* (0.0035)
lnM	−2.1409 (0.2305)	−4.2482* (0.0021)	−0.0611 (0.9935)	−4.6215* (0.0041)
lnA	−0.1824 (0.3630)	−6.3583* (0.0000)	−2.7193 (0.2356)	−6.2416* (0.0001)
lnS	−0.9118 (0.7718)	−3.4256** (0.0171)	−2.5923 (0.2859)	−4.4818* (0.0097)

Note: *,**,*** Indicate the rejection of the null hypothesis of nonstationary at 1%, 5%, and 10% significance level, respectively

hypothesis will be rejected. It suggests that *X* does Granger cause *Y*. If the value of probability in Equation (9) is significant, therefore, the alternative hypothesis is accepted. It suggests that *Y* does Granger cause *X*. It also can be said that there is bidirectional relationship between *X* and *Y*.

5. FINDINGS

The findings from the tests of the study are discussed. Data from 1975 to 2009 were used in this study for all variables (electric consumption, manufacturing, services and agriculture). Unit root test based on ADF was conducted to measure the stationary property of the time series data. Then, Johansen co-integration was performed to investigate the long run relationship between all variables. Finally, Granger causality was done to identify the direction of the causality relationship.

Table 1 shows that all variables (electric consumption, manufacturing, agriculture and services) are non-stationary in level with the constant trend. However, in the first difference test, the result for all variables indicates that they are significant, which means all variables are stationary. The null hypothesis is rejected, and the alternative hypothesis is accepted. Thus, Johansen co-integration test can be performed.

Table 2 shows the results of the Johansen co-integration test. The Table 2 shows that by using trace test and max-Eigen value test, one co-integrating equation is found at 5% level. Co-integration shows long-run relationships between electric consumption and three sectors (manufacturing, agriculture and services). However, co-integration cannot determine which direction of the relationships. Thus, Granger causality is performed to examine the direction of causality relationships.

On the other hand, the influence of electric consumption on three sectors in Malaysia in the short run and they are determined by VECM. The results from Table 3 show the negative sign of lagged error-correction terms (ECT_{t-1}) which is statistically significant at 5 per cent level. This affirmed that the finding from Johansen (2002) test that a long run relationship among the variables exist and there is also a long run causality running from electric consumption to agriculture and manufacturing in Malaysia. Besides, this study finds that in the short run electric consumption plays an important role in the production of agriculture in Malaysia.

This study used various forms of proxies for energy consumption. Table 4 presents the Granger causality between electric consumption and three sectors (manufacturing, agriculture and services). The results indicate that electric consumption

Table 2: Co-integration test

Lag intervals 1 to 2				
Rank	Max-Eigen statistic	Critical value (Eigen) at 5%	Trace statistic	Critical value (trace) at 5%
r=0*	28.0297	27.5843	50.6439	47.8561
r≤1	10.9180	21.1316	22.6142	29.7970
r≤2	10.1377	14.2646	11.6962	15.4947
r≤3	1.5585	3.8415	1.5585	3.8415

Note: LR test indicates one co-integrating equation at the 0.05 level

Table 3: VECM

Dependent variable: Electric consumption			
	Coefficient	SE	t-value
ECT (t_{-1})	−0.405**	0.145**	−2.800**
ΔlnS (−1)	−0.083	0.293	−0.283
ΔlnA (−1)	−0.008	0.281	0.029
ΔlnM (−1)	0.100	0.149	0.671
C	−0.024	0.030	−0.800
Dependent variable: Services			
ECT (t_{-1})	0.057	0.070	0.819
ΔlnE(−1)	−0.257	0.240	1.067
ΔlnM(−1)	−0.035	0.122	−0.286
ΔlnA (−1)	0.170	0.240	0.700
C	0.050***	0.024***	2.039***
Dependent variable: Agriculture			
ECT (t_{-1})	−0.868**	0.286**	−3.035**
ΔlnS (−1)	−0.026	0.168	−0.153
ΔlnM (−1)	−0.360	0.261	−1.377
ΔlnE (−1)	0.419**	0.181**	2.320**
C	0.163*	0.052*	3.139*
Dependent variable: Manufacturing			
ECT (t_{-1})	−0.453*	0.108*	−4.193*
ΔlnE (−1)	0.315	0.465	0.677
ΔlnA (−1)	−0.591	0.446	−1.325
ΔlnS (−1)	0.557	0.463	1.269
C	0.065	0.047	−1.388

*,**,***Indicate the rejection of the null hypothesis of nonstationary time series data at 1%, 5%, and 10% significance level, respectively, VECM: Vector error correction models, SE: Standard error

does not Granger cause manufacturing and services sectors. However electricity consumption does Granger cause agriculture sector.

6. CONCLUSION AND POLICY IMPLICATIONS

Through an empirical analysis, this paper aims to examine the relationship between electric consumption and three sectors,

Table 4: Granger causality

Null hypothesis	Observed	F-statistic	Probality
lnM does not granger cause lnS	33	2.42904	0.1065
lnS does not granger cause lnM		2.00124	0.1540
lnE does not granger cause lnS	33	1.62300	0.2153
lnS does not granger cause lnE		2.04821	0.1478
lnA does not granger cause lnS	33	1.82400	0.1800
lnS does not granger cause lnA		0.58593	0.5633
lnE does not granger cause lnM	33	0.48859	0.6186
lnM does not granger cause lnE		17.1525	1.E-05
lnA does not granger cause lnM	33	0.94560	0.4005
lnM does not granger cause lnA		0.36095	0.7002
lnA does not granger cause lnE	33	0.94258	0.4016
lnE does not granger cause lnA		6.95237	0.0035

namely, manufacturing, agriculture and services. First, a unit root test, which is non-stationary in level and stationary in first difference, is conducted. The Johansen co-integration model is applied. The results indicate a long-run relationship between electric consumption and three sectors in Malaysia. VECM shows that it affirms that the long run relationship electric consumption, agriculture and manufacturing in Malaysia. The Granger causality is used, and the results show that there is no causal relationship running from electric consumptions to manufacturing and services sectors. Electric consumption is found to contribute to a change in agriculture sector.

This paper can be instrumental in the formulation of policies that will prevent negative effects on manufacturing, services and agriculture. Increasing the price of electric consumption or any policy to reduce its consumption will not influence manufacturing and services sectors. However any policy regarding electric consumption should be reevaluated to ensure that it will not affect the production of agriculture in Malaysia.

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