Energy Consumption and Current Account Balance: Empirical from Asian Countries

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ABSTRACT

This study examines the effect of energy consumption on current account balance of 15 Asian countries. The analysis in this study was carried out using panel data with the simultaneous equation method. Research data from 1998-2022 in 15 Asian countries (Bangladesh, China, India, India, Japan, Jordan, Korea Republic, Kuwait, Kyrgyz Republic, Malaysia, Oman, Saudi Arabia, Singapore, Thailand and Vietnam) are sourced from the World Development Indicator, World Bank. The simultaneous equation method was chosen to provide more comprehensive results in conducting complete research and interpretation. The results of the study indicate that fossil fuels, gross domestic product (GDP) per capita and population have a significant effect, while the current account balance, access to electricity and broad money do not have a significant effect on energy consumption. Energy consumption and net exports have a significant effect, while the exchange rate and foreign direct investment do not significantly impact the current account balance. These findings have important implications for policy makers in Asian countries policies that encourage energy efficiency and diversification of domestic energy sources. More proactive policies in the development of renewable energy can not only reduce the current account balances deficit but also national energy security.

1. INTRODUCTION

In recent decades, countries in Asia have experienced rapid economic growth, making it one of the most dynamic regions in the world. This growth has been driven not only by industrial expansion but also by a significant increase in energy consumption. High energy consumption is one of the important factors supporting infrastructure development, urbanization, and improving living standards in many countries in Asia. However, the heavy dependence on energy, especially energy imports, also poses challenges to macroeconomic stability, especially in terms of the current account balance. Many countries in Asia, especially the rapidly developing ones such as China, India, and the Arab region, are experiencing increasing energy needs to support industrialization and economic development [1].

Dependence on energy, especially fossil fuels, coal and other energy sources, puts pressure on their trade balances due to the increasing demand for oil, gas and sufficient electricity for industrial needs. This makes the relationship between energy consumption and the current account balance increasingly relevant, given the importance of the current account balance as an indicator of a country's economic stability. The current account balance reflects all economic transactions between a country and the outside world,

including exports and imports of goods and services, as well as capital flows. A deficit in the current account balance is often a sign that a country is dependent on foreign capital or foreign loans to cover the gap between its exports and imports. When the deficit is associated with high energy imports, it can make the country vulnerable to fluctuations in global energy prices, thus affecting its economic stability [2].

Energy is necessary to support a country's economic operations, both for production and consumption in many economic sectors. As part of natural resources, energy must be maximized for the benefit of many parties through sustainable management. From the supply perspective, energy comprises both nonrenewable and renewable resources. Currently, however, energy exploration is more focused on nonrenewable resources, while renewable energy sources remain underutilized. This condition limits the availability of energy, as the emphasis on fossil fuels has increased. Therefore, it is necessary to accompany this focus with innovation to expand the scope of energy utilization [2, 3].

The characteristic of natural resources and the environment is the presence of various ecosystems that are capable of supporting the lives of humans and other living creatures. The utilization of natural resources, essential for prosperity, must be carried out responsibly and in accordance with the carrying capacity of these resources, prioritizing sustainability and the

preservation of environmental functions for sustainable development. Insightful spatial planning is essential in development planning to ensure that the use of natural resources. To manage natural resources, proper structuring is required through environmental protection, environmental law, and environmental communication. These measures are necessary to support elements that interact with each other in harmony and maintain balance and diversity. All these elements must function according to their roles, with the flow of information being used to advance scientific knowledge aimed at sustainable development [4, 5].

Osano et al. [6] and Onafowora and Owoye [7] explain that population growth poses serious threats to the environment, including floods, landslides, deforestation, erosion, and other issues. These challenges must be addressed to ensure that natural resources remain available for human use, thereby guaranteeing the fulfillment of human needs through a reciprocal relationship with nature. As economic growth continues, energy demand will also increase, necessitating that supply be maintained to maximize energy availability. If this is not addressed, achieving net zero emissions by 2050 and preventing temperature increases becomes crucial to reducing energy use and transitioning to renewable energy. This research focuses on energy consumption patterns in households are influenced by changes in household income. Increased energy demand for household needs leads to higher energy consumption overall.

Rehman [3] the relationship between energy consumption and current account balance often explored how energy use affects a country's economic position in the context of international trade and capital flows. High energy consumption often has a significant impact on a country's current account balance, especially through its impact on the balance of trade and capital flows. Overall, energy consumption plays an significant role in defining a country's economic stability and current account balance. Polat [5] countries that depend on energy imports usually have larger trade balance deficits due to high energy import costs. For example, an increase in international oil prices could worsen the current account balance deficit for oil importing countries. Factors such as dependence on energy imports, investment in the energy sector, and energy efficiency all contribute to the complex and interconnected economic impacts of energy consumption and the current account balances. Investment in the energy sector, especially renewable energy, can attract foreign capital and improve the current account balances through direct investment flows. A strong and sustainable energy sector can increase foreign investor confidence, thereby increasing foreign direct investment (FDI) flows which contribute positively to the current account balances. Countries that invest in efficient energy infrastructure can attract more foreign investment, which in turn strengthens the current account balances by increasing foreign capital inflows. This shows that sustainable development of the energy sector can increase investment attractiveness and long-term economic stability.

Olubusoye and Musa [8] and Okoro et al. [9] explain other factors such as developments in information technology and demographics also contribute to the increase in energy consumption. On the other hand, the general trend in demand for fossil-based energy is increasing, in line with rapid economic growth. There are many negative impacts of fossil energy, where decreasing availability could threaten dependence on energy consumption. If this happens, strategic resources are needed to develop and save energy order to avoid negative impacts in the future.

The goal of this research is to assess the state of energy consumption and current account balance, specifically in Asian countries. One of the reasons for this research was to observe the development of Asian countries such as China and India, as well as Arab countries in maintaining world energy supplies through oil and gas. On this basis, the study carried out has a strong foundation so that the research results are in line with expectations. By understanding how energy consumption affects the current account balance, policymakers can design more effective strategies in managing energy dependence, reducing the current account deficit, and maintaining long-term economic stability. This is also relevant to ensuring that economic growth in the Asian region can continue without creating risky external imbalances. Figure 1 explains the condition of energy consumption.
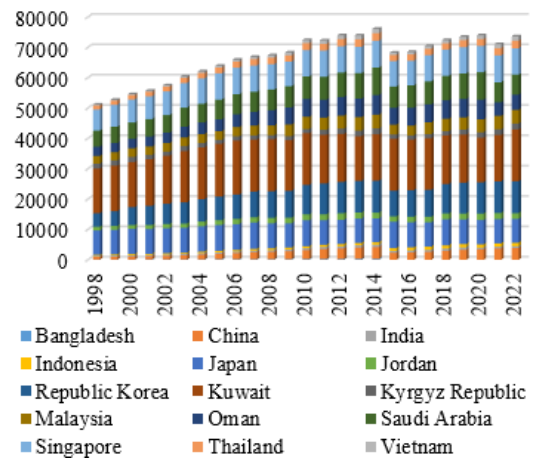

Figure 1. Energy consumption Asian countries (1998-2022)
Source: World Bank, 2023

Figure 1 energy consumption conditions with the electricity power consumption indicator. Japan had the highest energy consumption of any other country in 2007 amounting to 8710.026 kwh, and Republic Korea in 2022 amounting to 10496.51 kwh. This also indicates that energy consumption for the population in both countries has reached 100% of the population. Meanwhile, Bangladesh had the lowest energy consumption in 1998 at 87.62331 kwh and Thailand at 235.9441 kwh. Countries with energy production from the Arab Region such as Jordan, Oman, Kuwait and Saudi Arabia also have high energy consumption levels from countries in the East Asia, South Asia and Southeast Asia regions. In addition, Arab countries are known as the largest producers of oil and natural gas in the world, reflecting the massive energy exploration carried out in these countries.

The current account balance is a macroeconomic issue that has been extensively studied by academics and empirical researchers. An unmanaged current account deficit is the most critical challenge that many governments face. This can generate a huge and sustained current account deficit, resulting in an economic crisis, increasing foreign debt, and decreased foreign exchange reserves [10]. There is widespread agreement that the sustainability of the current account balance is critical for macroeconomic policy changes and decisions. Countries that use current account balances as macroeconomic indicators must react to changes in economic conditions, due to the position of economic variables such as savings, investment, and the state budget [11, 12].

From a structuralist macroeconomic perspective, the role of current transactions shapes macroeconomic developments in open economy countries, which are often triggered by balance sheets leading to economic instability. Therefore, a current account deficit can be temporarily offset by capital flows. When the deficit as a percentage of GDP exceeds a threshold value, countries may face barriers to capital flows, as noted by Vedia-Jerez et al. [13-16]. Policies aimed at mitigating current account balance issues have been extensively analyzed, including monetary policy, fiscal policy, and the reduction of money flows into the economy. It is important to recognize that while these policies are regarded as helpful in reducing the current account deficit, they all potentially have a negative impact on economic growth. First, an expansion of private credit can boost GDP, which may result in an increased current account imbalance. Moreover, tight monetary policy can slow economic development and exacerbate the current account deficit. Second, fiscal policies might also restrict economic growth. To view current account balance data for Asian countries, refer to Figure 2.
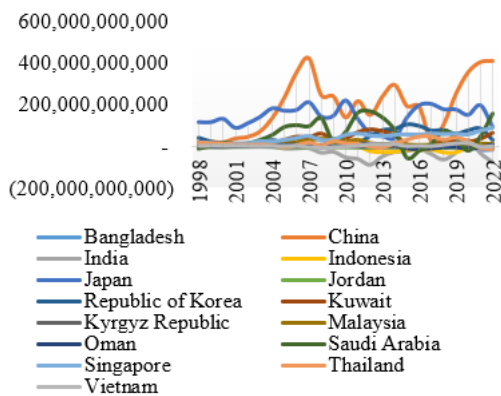

Figure 2. Current account balance Asian countries (1998-2022)
Source: World Bank, 2023

From Figure 2, the current account balance experienced fluctuations from 1998-2022. Like other countries, China achieved the highest current account balance in 2022 at 407.857.023.848 and Bangladesh the lowest in 2003 at 131.637.632. he economies of these two countries are highly unequal in terms of production capacity, both nationally and globally. At the beginning of the research year, China, Japan, Kuwait, Malaysia, Republic of Korea, and Singapore experienced both current account deficits and surpluses. This condition implicitly suggests that their trade activities in goods and capital are balanced. In contrast, India, Jordan, and the Kyrgyz Republic have been facing serious issues with current account deficits over the past 10 years, which have widened the gaps in capital and goods flows, reduced state income, and affected monetary instruments. The depreciation of their exchange rates is often a key factor, leading to cheaper imported goods and facilitating production for households and companies.

2. LITERATURE REVIEW

Lin and Kueh [17] investigate how exchange rate devaluation can drive countries to intentionally hold their currency values below the equilibrium level in order to obtain a competitive advantage, a behavior known as "competitive devaluation." If the exchange rate is lower than that of the importing country, demand for imported goods grows, making it difficult for the current account balance to shift towards a surplus. Shah [18] many governments have tracked exchange rate movements in order to improve export competitiveness and attract foreign direct investment, resulting in a better current account balance. In theory, exchange rate depreciation becomes a tool for managing current account balance concerns by increasing internal and foreign competitiveness. Building a theoretical framework from previous research is crucial for understanding the problems being researched. Ben Jebli et al. [19] state that equal access to electricity requires substantial energy reserves to ensure availability for households. It is a significant responsibility for the government to bridge the electricity gap, aiming to provide economic and social benefits to the community. Salman and Hosny [20] shows the significant impact of acces to electricity on energy consumption. As a priority, energy availability must meet the country's electricity needs by maximizing the use of resources to provide electricity, thereby improving the quality of life and increasing economic capacity.

Stockhammer et al. [16] show that fossil fuel consumption is positively correlated with carbon emissions and overall energy use in developing countries. They found that increasing use of fossil fuels goes hand in hand with increasing emissions and energy consumption due to high dependence on non-renewable energy. This condition is not the same as that experienced in developed countries described by Vedia-Jerez and Chasco [13] highlight that developed countries have lower dependence on fossil fuels compared to developing countries. However, energy consumption remains high due to energy-intensive industry and a large transportation sector, much of which still relies on fossil fuels.

Khan et al. [21] reveal that excessive use of fossil fuels can cause long-term environmental damage. While fossil fuels are essential for electricity production, many mining operations do not adhere to legal procedures. Therefore, the use of fossil fuels must be regulated by a sustainable energy transition policy.

Broad money refers to the circulation of financial instruments used for various transactions related to goods and services in economic activities. It has a significant influence on energy consumption, encompassing economic transactions that reflect large-scale monetary flow. High levels of energy consumption can be achieved when money circulates through productive economic sectors [22]. Broad money provides a comprehensive picture by highlighting high levels of energy consumption in developed countries, such as oil and natural gas usage. This condition reflects the substantial impact of a growing economy moving towards an era of high consumption, focusing on energy-intensive activities, making energy availability a primary concern for policymakers [23, 24]. GDP per capita significantly affects energy consumption, with the premise that rising incomes enhance economic levels. This reality explains the increase in household energy consumption, particularly for electricity, which supports productivity and welfare in microeconomic activities [25, 26]. Amidst the threat of climate change, energy consumption is now a central issue. The country's economy reflects GDP per capita as an indicator of prosperity. The higher the income, the more dynamic the transactions for goods and services, such as household electricity needs, which must be met. Furthermore, developing countries increasingly require more electricity each year to meet the population's needs [27].

A study by Zahonogo [11] found a strong positive correlation between GDP per capita and energy usage, indicating that countries with higher GDP per capita tend to have higher energy consumption due to improved living standards and greater access to energy-intensive technologies. Altayligil and Çetrez [12] supported this finding, explaining that economic growth, as measured by GDP per capita, is often accompanied by an increase in energy consumption, particularly in the industrial and transportation sectors. This increase is driven by the need for energy to support economic activity. Furthermore, they discovered that countries with high GDP per capita tend to have a more diversified energy structure, with a greater proportion of renewable energy compared to countries with lower GDP per capita. Therefore, this research necessitates further examination of the relationship between GDP per capita and energy consumption patterns.

Erdiwansyah and Zaki [28] and Pegkas [29] discovered evidence that demographic variables, notably population size, had a positive and considerable impact on energy usage. Population data can explain factors such as age and economic behavior. Younger people tend to consume more of their household income and save more than older folks. Nasir and Jackson [30] assert that population growth positively affects energy consumption. Different population characteristics determine energy needs, especially the availability of electricity for households, which the government provides to harmonize electricity needs and energy consumption. Recently, dynamic population activities have increased the exploitation of fossil energy sources for power generation, highlighting the need for solutions in conservation and appropriate technological innovations to positively impact energy consumption levels.

Hadush et al. [31] research examines the implications of monetary policy in regulating exchange rate movements. The study findings suggest that the exchange rate can push the current account balance into surplus if international trade flows are stronger in exports than imports, resulting in current account stability. The presence of oil price shocks and aggregate demand dominates a country current account balance management problem, preventing it from becoming entirely surplus. Stable macroeconomic circumstances, such as exchange rate appreciation and monetary growth, were crucial determinants in attracting foreign direct investment to emerging nations and achieving a current account balance surplus.

Insela and Kayıkçı [32] investigates the relationship between the exchange rate and current account balance. An appreciation of the exchange rate leads to stability in the current account balance, which is caused by household requirements in economic activity. This conventional preference is considered effective in suppressing external shocks provided that the exchange rate appreciation is in the long term. Ighodalo Ehikioya et al. [33] consider the relationship between the exchange rate and the current account balance. They discovered that exchange rate depreciation influences the rate of return on foreign assets and obligations, which can lead to capital outflows from a country.

Hope [34] show that international commodity prices, especially in developing countries, have a negative relationship with the current account balance. Their research suggests that trade openness leads to uncontrolled commodity flows over time in 106 countries, negatively impacting the current account balance. Pistoresi and Rinaldi [35] look into the relationship between net exports and current account balance. Their findings indicate that exports can bring the current account balance toward equilibrium and assist keep it within the threshold of a surplus. Fraj et al. [36] there was evidence that net exports were negatively correlated with current account balances. In the era of globalization, cross-border trade has flowed readily without policy barriers. The flow of imports in a country is a necessity where the commodities needed can become a driving factor for domestic production.

Goldbach et al. [37] examined the impact of net exports on Europe current account balance. The fluctuations in the current account balance have a negative impact on exports but a positive one on imports. Competitiveness is an issue for European countries due to a lack of balance between exports and imports. Examines the relationship between the current account balance and net exports in Europe. The execution of trade policy has progressed to a point where it is more consistent with exchange rate appreciation, which is regarded a resilient macroeconomic condition for maintaining the current account balance.

Gogmenoglu et al. [38] examined the effect of foreign direct investment on the current account balance. The study findings suggest that foreign direct investment has a beneficial impact on the current account balance. This is a positive response to the narrowing in the trade imbalance between goods and capital. Ayele [39] discovered that the macroeconomic impact, particularly foreign direct investment, has a positive correlation with the current account balance, with the appreciation of the exchange rate causing more stable foreign capital flows into a country with the guarantee of policies that are adaptive to global economic conditions. Xuan [40] stated that the current account balance experiences stability if foreign capital flows are high in channeling capital to the productive sector. Khan et al. [21] analyzes the current account balance which is closely related to foreign direct investment. The existence of competition in economic activities means that the government must be more careful in stimulating the level of foreign investment as a form of support for the effectiveness of policies that emphasize the importance of capital in the economy. Eita et al. [10] investigated the effect of foreign direct investment on the current account balance. Capital flows drive the income elasticity of per capita income which implicitly becomes a determining factor in increasing capital flows in a country.

3. RESEARCH METHOD

3.1 Data and model

The author focuses on scientific objectivity in analyzing energy consumption and current account balance. Data obtained from the World Development Indicator, World Bank for 25 years (1998-2022) in 15 Asian countries (Bangladesh, China, India, Indonesia, Japan, Jordan, Republic Korea, Kuwait, Kyrgyz Republic, Malaysia, Oman, Saudi Arabia, Singapore, Thailand, Vietnam). Independent variable in this research is access to electricity, fossil fuel, broad money, GDP per capita, population, exchange rate, net export and foreign direct investment.

The use of data from 1998 to 2022 was chosen for several important reasons. *First,* the 1997-1998 Asian Economic Crisis covers the post-1997-1998 Asian economic crisis

period, which had a significant impact on the economic structure of countries in Asia, including changes in energy, trade, and financial policies. Using data since 1998 provides an overview of how Asian countries have recovered and adapted to new challenges, including fluctuations in global energy prices. *Second*, global economic developments cover a variety of important events, such as the increase in world oil prices, the 2008 global financial crisis, and economic transformations in developing countries in Asia. This period reflects the study can see how energy consumption and the current account balance react to major changes in the global arena. *Third*, technology and renewable energy there are major changes in technology and diversification of energy sources, especially with the increasing use of renewable energy in Asian countries. By using data until 2022, this study can identify more recent and relevant changes to the dynamics of energy consumption.

3.2 Simultaneous equation analysis

A simultaneous equation model consists of multiple interconnected equations that establish a causal relationship between endogenous and exogenous variables. This setup allows for a variable to be identified as either endogenous or exogenous in different equations within the system. In a system of simultaneous equations with two or more equations, it is possible to determine the numerical values of each parameter in each equation, as the equations are either indistinguishable through observation alone or are very similar. The method for testing the identification of a simultaneous equation is detailed in Eq. (1).

$$K–k \geq m–1 \qquad (1)$$

where,

M: the number of endogenous variables in the model

m: denotes the number of endogenous variables in the equation

K: represents the number of preset variables in the model

k: represents the number of preset variables in the equation.

With criteria:

This equation is identified, when $K–k=m–1$. It is followed by simultaneous equation estimation using the indirect least squares (ILS) approach.

This equation is overidentified, when $K–k>m–1$. The two-stage least squares (2SLS) approach is then used to estimate equations simultaneously.

This equation is remains undermined, when $K–k<m–1$. The simultaneous equation system may solve an equation whose order conditions are identified and overidentified.

The model of simultaneous analysis is explained in the econometric equation below:

$$Y_{1t} = \alpha_0 + \alpha_1 Y_{2it} + \alpha_2 X_{1it} + \alpha_3 X_{2it} + \alpha_4 X_{3it}$$
$$+ \alpha_5 X_{4it} + \alpha_6 X_{5it} + \mu_{it} \qquad (2)$$

$$Y_{2t} = \beta_0 + \beta_1 Y_{1it} + \beta_2 X_{6it} + \beta_3 X_{7it} + \beta_4 X_{8it} + \mu_{it} \qquad (3)$$

The model of simultaneous analysis is explained in the econometric equation below:

$$K\text{-}k \text{ » } 8\text{-}5 = 3$$
$$m\text{-}1 \text{ » } 2\text{-}1 = 1 \ (3 > 1, \text{ overidentified}) \qquad (4)$$

$$K\text{-}k \text{ » } 8\text{-}3 = 5$$
$$m\text{-}1 \text{ » } 2\text{-}1 = 1 \ (5 > 1, \text{ overidentified}) \qquad (5)$$

The assumptions taken into account in the simultaneous equation method are as follows:

Identification assumption

To ensure that the equations in a simultaneous system can be estimated, it is necessary to ensure that the system is identified. There are two main conditions: overidentified (there is more information than the estimated parameters) or just identified (the amount of information is the same as the parameters). If the system is not identified, parameter estimation cannot be done correctly, so that the research results are invalid.

Endogeneity

In the simultaneous equation method, endogenous variables are correlated with errors (error terms). If the assumption that exogenous variables are not correlated with errors is violated, the estimation results will be biased and inconsistent. If endogeneity is not handled properly (for example, by using the right variable instrument method), the research results will not represent the true causal relationship. This error can provide a false picture of the effect of one variable on another.

Linearity assumption

The simultaneous equation method assumes that the relationship between variables is linear. If the true relationship is non-linear, the estimation results based on linear equations can be wrong. If the relationship between variables is not linear but is forced into a linear form, the research results will fail to capture the complexity of the relationship and make inaccurate predictions.

Simultaneous equations guarantee that there is a relationship between endogenous variables that influence each other an effort to provide a broader picture of the importance of exploring endogenous variables in the same model. With this model, researchers to compare the results of two equations when endogenous variables are included in different models so that the research results become more varied (Table 1). This condition is very beneficial for cross-country studies where economic characteristics differ between the countries studied.

Table 1. Operational definition variable

Variable	Indicator	Unit
Energy Consumption (Y_1)	Electric Power Consumption	KWH Per Capita
Current Account (Y_2)	Current Account Balance	BOP Current US$
Access Electricity (X_1)	Access to Electricity	% Population
Fossil Fuel (X_2)	Fossil Fuel Energy	% Total Energy
Broad Money (X_3)	Broad Money	Current LCU
Gross Domestic Product (X_4)	GDP Per Capita	Current US$
Population (X_5)	Population	Person
Exchange Rate (X_6)	Exchange Rate	Nominal
Trade (X_7)	Net Export	BOP Current US$
Investment (X_8)	Foreign Direct Investment	% of GDP

Energy usage accompanied with indicators The production of power plants, as well as combined heat and power plants, is measured by electric power consumption, which accounts for transmission, distribution, transformation, and own use losses.

The total of net primary income, net secondary income, and net exports of goods and services is the current account balance. Current U.S. dollars are used for data.

The proportion of the rural population that has access to electricity is known as access to electricity, rural.

Coal, oil, petroleum, and natural gas products are examples of fossil fuels.

The total amount of money not kept in banks, demand deposits from sources other than the federal government, and the time, savings, and foreign exchange deposits of non-federal resident sectors are all considered forms of broad money.

The gross domestic product divided by the population at midyear yields GDP per capita. GDP is the total of the gross value added by all producers who are residents of the country, plus any product taxes and minus any subsidies that aren't factored into the product value. It is computed without accounting for the depletion and deterioration of natural resources or the depreciation of artificial assets. Current U.S. dollars are used for data.

Exchange rate is a measurement of currency in US dollars used in international transactions between nations.

Trade is the total of products and services exported and imported expressed as a percentage of GDP.

The net inflows of capital intended to obtain a long-term management stake (10 percent or more of voting shares) in a business that operates in a different economy than the investor is known as foreign direct investment. As indicated by the current account balances, it is the total of equity capital, earnings reinvested, other long-term capital, and short-term capital.

4. RESULT AND DISCUSSION

After carrying out simultaneous analysis, the first equation with the energy consumption model can see the results below.

The results of the simultaneous equation estimation can be shown in Table 2, so that the first equation model is as follows:

$$Y_{1t} = -689.8249 + 3.83E10_{Y2} - 0.010923_{1t}$$
$$+36.06541_{2t} - 1.21E13_{3t} + 0.187826_{4t} - \qquad (6)$$
$$1.03E06_{5t} + \mu_{it}$$

Current account balance has a regression coefficient of 3.83E-10. The results show that there is a positive influence on energy consumption; that is, a 1% increase in the current account balance will increase energy consumption by 3.83E-10. Although there is a positive relationship, the coefficient is

very small (3.83E-10), indicating that the impact of an increase in the current account surplus on energy consumption is quite weak. An increase in the current account surplus may be related to an increase in exports, which can require more energy to produce the goods exported. However, this effect is very small, which may indicate that other factors play a greater role in determining energy consumption in a country.

Access to electricity has a regression coefficient of -0.010923. These results show that there is a negative influence on energy consumption; that is, if 1% increase access to electricity will decrease energy consumption by -0.010923. Economically, this may seem counter-intuitive since increased access to electricity would normally be expected to increase energy consumption. However, a possible interpretation is that countries with higher access to electricity often have more efficient energy infrastructure, allowing for more efficient energy use even though more people have access to electricity. For example, countries with near-universal access to electricity tend to switch to more efficient technologies or cleaner energy sources.

Fossil fuel has a regression coefficient of 36.06541. These results show that there is a positive influence on energy consumption; that is, if 1% increase fossil fuel will increase energy consumption by 36.06541. This is a very strong relationship and makes sense from an economic perspective. Fossil fuels (such as oil, gas, and coal) are the primary source of energy in many countries, especially developing ones. Increased use of fossil fuels means increased energy production, which in turn increases overall energy consumption.

Broad money has a regression coefficient of -1.21E-13. These results show that there is a negative influence on energy consumption; that is, if 1% increase broad money will decrease energy consumption by -1.21E-13. The coefficient of -1.21E-13 indicates a very small effect on a numerical scale, almost close to zero. That is, a 1% increase in broad money will reduce energy consumption, but this decrease is very small and may not be practically significant in an economic context. Economically, this result suggests that changes in the money supply in the economy do not have a large effect on energy consumption.

GDP per capita has a regression coefficient of 0.187826. These results show that there is a positive influence on energy consumption; hat is, if 1% increase GDP per capita will increase energy consumption by 0.187826. This relationship makes economic sense because an increase in GDP per capita indicates an increase in the average income of the population. With higher incomes, people have more purchasing power to use various goods and services, including those related to energy consumption such as the use of private vehicles, household electricity, and other energy products.

Table 2. First simultaneous equation

Variable	Coefficient	Std. Error	t-Statistic	Prob
C	-689.8249	525.6808	-1.312251	0.1903
Y_2	3.83E-10	2.16E-09	0.177706	0.8591
X_1	-0.010923	0.256775	-0.042537	0.9661
X_2	36.06541	6.552963	5.503680	0.0000
X_3	-1.21E-13	8.03E-14	-1.508994	0.1322
X_4	0.187826	0.009943	18.89076	0.0000
X_5	-1.03E-06	3.51E-07	-2.943944	0.0034
R-squared		0.688791		
F-statistic		135.7474		
Prob (F-stat)		0.000000		

Population has a regression coefficient of -1.03E-06. These results show that there is a negative influence on energy consumption; that is, if 1% increase population will decrease energy consumption by -1.03E-06. This coefficient is very small and may not be economically or practically significant. In theory, an increase in population is usually expected to increase energy consumption because more people need energy for everyday purposes such as transportation, electricity, and industry. However, this result suggests that an increase in population may be associated with a decrease in energy consumption.

The result of the first equation proves that from the estimation result of the energy consumption equation, the R-squared value is 0.688791 or 68.87%. Therefore, the probability value (F-statistic) in the current account balance equation is 0.000000 <0.05, it can be said that the current account, access to electricity, fossil fuel, broad money, GDP per capita and population together have a significant effect on energy consumption in Asian countries.

Current account balance has no significant effect on energy consumption. Asian countries, especially the rapidly developing ones such as Japan, Korea Republic, and Arab region are highly dependent on energy imports. Although the current account balance may reflect a surplus (due to high exports of manufactured goods), domestic energy consumption may not change much because most of the energy consumed is imported and is therefore less affected by movements in the current account balance. The current account balance in many Asian countries may be driven by exports of technology, manufactured, or services that use less energy in production, so changes in these may not have a significant impact on overall energy consumption. Arif-Ur-Rahman and Inaba [41] international trade activities should guarantee the availability of the country's needs, especially for the use of energy which is an important product in the economy. The flow of goods and services transactions requires an agreement between countries to complement each other's needs for goods and services, including part of the process of achieving a trade surplus order to avoid deficit conditions. Energy consumption in developing countries tends to be high from fossil fuels, causing volatility in the price of energy raw materials to increase due to high demand on the global market. This condition will worsen current account performance so that import reductions or substitution of energy products must be carried out to avoid excessive increases in import levels which will disrupt the global trade sector.

Dada and Akinlo [42] observed that countries with a surplus in their energy trade balance, such as oil-exporting nations, may experience increased revenues from energy exports. These revenues can be utilized to enhance energy infrastructure and boost domestic energy consumption. To mitigate current account balance deficits, the government may impose taxes on energy imports. Conversely, Fisseha [43] noted that countries facing substantial deficits in their current account balances may encounter higher inflation as import prices, including those for energy, rise. This increase in inflation can diminish people's purchasing power, leading to a decrease in energy consumption. When global energy prices increase, countries that are significant importers of energy will see an impact on their current account balances. These circumstances could prompt adjustments in energy consumption strategies, either through enhancements in energy efficiency or through reductions in consumption.

Access to electricity shows no significant influence on energy consumption. Efficient electricity infrastructure in Asian countries such as Korea Republic, Japan, and Singapore means that even though electricity access is high or increasing, per capita energy consumption does not increase significantly due to the energy efficiency implemented in electricity production. Many Asian countries are turning to renewable energy (such as solar and wind), which are more efficient than fossil fuels. Even if electricity access increases, energy consumption may not increase significantly due to the use of more efficient and environmentally friendly energy sources. Emphasized the importance of households gaining adequate and equitable access to electricity as a form of energy independence. Developing countries tend not to have equal access to electricity, including high electricity prices making it difficult for underprivileged households to get access to electricity. Limited electricity supply, minimal investment in electricity and infrastructure services are obstacles in developing electricity availability which must be accompanied by the availability of raw materials such as fossil energy. For this reason, improving the quality of electricity access is very necessary for households by building networks and increasing electricity capacity so that access continues to increase [44, 45]. The results of other research Hassan and Mhlanga [46] have found that access to electricity contributes to increased energy consumption, especially in the use of household electrical appliances and lighting. Access to electricity also increases economic productivity and quality of life. The results of other research have found that access to electricity contributes to increased energy consumption, especially in the use of household electrical appliances and lighting. Apart from that, access to electricity also increases economic productivity and quality of life.

Fossil fuels demonstrate significant impacts on energy consumption, indicating that the demand for fossil energy will lead to increasingly greater energy needs, provided there are adequate energy reserves. This observation is supported by Al-Ghaili et al. [47], who revealed that available fossil energy is a primary necessity for countries that have not yet initiated renewable energy programs, with its availability serving as a crucial raw material for power plants. Although the formation process of fossil energy is lengthy, it significantly benefits various parties, particularly the industrial sector, by facilitating the processing of products for economic purposes. Energy consumption could be regulated if the availability of fossil materials can reduce the reliance on electricity sources, thereby enhancing the distribution of supplies so that all economic actors, including households and companies, can ensure sustainability and improve quality of life. Conversely, Rehman [3] highlighted a different perspective, emphasizing that a country must achieve energy independence to curb excessive energy use and reduce future carbon emissions. This approach will enable developing countries to reach this stage through the implementation of appropriate policies.

Broad money appears to have no significant impact on energy consumption. In Asian countries undergoing rapid economic growth, the allocation of money to non-energy sectors such as property, services, and technology—sectors that do not require high energy consumption—has absorbed increased liquidity without significantly boosting energy demand. The expansion of broad money may be linked to monetary policies aimed at maintaining price stability or controlling inflation, which, in turn, do not directly correlate with an increase in energy consumption. For instance, even if the money supply increases, without a corresponding rise in

demand for energy goods or services, energy consumption remains unaffected. Asian countries have transitioned from economies reliant on heavy industry, which requires substantial energy, to ones based on services and technology.

This observation is supported by Osano and Koine [6], who noted that a certain volume of transactions involving goods and services in emerging nations is driven by the circulation of money, which is influenced by interest rates. The implications for energy consumption prices will impact the demand for electricity supplies as a means to enhance the economic quality of households and companies in the economic development of developing countries. The circulation of money is indicative of the level of national production capacity, providing insights into the direction of money flows used to meet various needs.

This research evaluates the relationship between broad money and energy consumption in developed countries, as explored by Onafowora and Owoye [7]. The findings indicate that an increase in the money supply significantly boosts energy consumption, primarily due to enhanced purchasing power and heightened economic activity. Expansionary monetary policy and increased money supply tend to escalate energy consumption as economic activity and investment in energy infrastructure grow. An increase in money supply leads to heightened energy consumption through the income effect, where more money in circulation spurs economic activity and elevates energy demand.

GDP per capita reflects the income level within a population and serves as a basis for assessing welfare. In this study, GDP per capita is shown to have a significant impact on energy consumption. Consistent with the findings of Olubusoye and Musa [8], GDP per capita represents the income and expenditure levels of the population, which correlate with the units of goods or services transacted within a specific year. As the population's income increases, basic household needs, including energy consumption, are expected to rise. This is particularly beneficial for underprivileged populations who might otherwise struggle to meet their electricity needs. However, with improvements in quality of life, energy consumption needs can be satisfied, provided that population income is maximized to enhance social status and promote prosperity. A growing economy positively impacts underprivileged communities, facilitating economic improvements that align with stakeholders' expectations. Contrary findings from Ben Jebli et al. [19] suggest that when GDP per capita increases, people do not immediately increase their consumption; some choose to save and invest, reflecting a long-term thinking prevalent in developed countries, as opposed to immediate spending.

Although GDP per capita is increasing, these sectors are less energy-intensive, so the relationship between GDP per capita and energy consumption is weak. Economic growth in many Asian countries has been accompanied by large investments in more energy-efficient technologies. Countries such as Japan are known for their energy efficiency in production and consumption, which can break the direct correlation between GDP growth and energy consumption. Growing awareness of climate change and environmental issues in Asia has prompted public and business policies that support reduced energy use and increased efficiency, even amid rapid economic growth.

The population shows evidence of significant influence on energy consumption. Population characteristics influence the goals and decision-making processes, determining whether actions are productive or consumptive in economic activities.

Studies by Hakim and Sriyana [48] have carefully examined this issue, interpreting how population decisions, driven by productive attitudes, are expected to build household purchasing power and enhance competitiveness for companies. This, in turn, supports the movement of goods and services towards achieving a surplus in the current account balances, which aligns with other macroeconomic conditions such as inflation and exchange rates. Furthermore, population decisions related to saving and investing are closely tied to the availability of capital for financial institutions. If a significant portion of a country's population enjoys access to electricity, the availability of fossil fuels for electricity generation must be increased. This is crucial given the inevitable advancements in information technology, making the maintenance of a steady electricity supply essential.

The results were further elaborated by Fasanya and Olayemi [49], who believe that the characteristics of the population can enable developing countries to achieve widespread energy consumption across all household and corporate sectors. This would be a reflection of the availability of environmentally friendly energy and the assurance that energy needs are met.

Table 3. Second simultaneous equation

Variable	Coefficient	Std. Error	t-Statistic	Prob
C	-1.07E+10	3.86E+09	-2.765290	0.0060
Y_1	2854437.0	561347.2	5.084975	0.0000
X_6	-565709.0	442628.3	-1.278068	0.2020
X_7	0.103475	0.009886	10.46792	0.0000
X_8	0.003511	0.102580	0.034227	0.9727
R-squared		0.622048		
F-statistic		152.2399		
Prob (F-stat)		0.000000		

The outcomes of the estimation can be found in Table 3, and the model for the second equation is as follows:

$$Y_{2t} = -1.07E10 + 2854437.0_{Y1} - 565709.0_{6t} \\ +0.103475_{7t} + 0.003511_{8t} + \mu_{it} \quad (7)$$

Energy consumption has a regression coefficient of 2854437.0. These results show that there is a positive influence on current account balance; that is, if 1% increase energy consumption will increase current account balance by 2854437.0. This relationship reflects that higher energy consumption can boost economic activity, including export-oriented manufacturing and industrial sectors. With more energy available for use in economic activity, production capacity can increase, which in turn improves the current account balance through increased exports or decreased energy imports.

Exchange rate has a regression coefficient of -565709.0. These results show that there is a negative influence on current account balance; that is, if 1% increase exchange rate will decrease current account balance by -565709.0. A higher exchange rate often means that the domestic currency appreciates, making exported goods and services more expensive for international buyers. This can lead to a decrease in exports and a decrease in the current account surplus. Conversely, imports become cheaper, which can increase imports and worsen the current account balance.

Net export has a regression coefficient of 0.103475. These results show that there is a positive influence on current account balance; that is, if 1% increase net export will increase current account balance by 0.103475. Net exports are the

difference between exports and imports. An increase in net exports directly improves the current account balance, since a country that exports more than it imports tends to run a trade surplus. This is an economically sound relationship, where increased exports (or decreased imports) will improve a country's current account position.

Foreign direct investment has a regression coefficient of 0.003511. These results show that there is a positive influence on current account balance; that is, if 1% increase foreign direct investment will increase current account balance by 0.003511. Foreign direct investment usually helps improve the current account balance because FDI can increase domestic production capacity, which in turn can increase exports or reduce dependence on imports. However, its impact is relatively small compared to the other variables in the model, which may indicate that FDI plays a more indirect role in affecting the current account balance.

The result of the second equation proves that from the estimation result of the current account balance equation, the R-squared value is 0.622048 or 62.20%. Therefore, the probability value (F-statistic) in the current account balance equation is 0.000000 <0.05, it can be said that energy consumption, exchange rate, net exports and foreign direct investment together have a significant effect on the current account balance in Asian countries.

After the estimation equation is explained in Table 3, a discussion of the variables is provided in this section. Energy consumption shows evidence of a significant impact on the current account balance. According to Khan et al. [21], global energy needs must be managed through the supply chain of export and import activities because not all countries have fossil energy reserves. Furthermore, energy control policies from the governments of oil-producing countries, concerning prices and availability, can ease the burden on importing countries, ensuring that fossil energy needs are met. The performance of the current account balance is not always enhanced by this trading activity. Rather, it is seen from the perspective of energy consumption, guaranteeing that the country's energy requirements are managed and emphasizing long-term supply maintenance. Different perspective was put forward by Okoro et al. [9] highlighting the significance of energy innovation in developing nations, emphasizing the use of renewable energy as a successful energy transition strategy to reduce carbon emissions while taking into account the larger context of international trade, and concentrating on policies that supply enough energy for the industrial sector.

The exchange rate shows evidence of significant influence on current account balance. The dependence on energy imports makes the relationship between the exchange rate and the current account balance less significant. If the currency weakens, energy imports become more expensive, which can offset or even eliminate the benefits of more competitive exports due to currency depreciation. Asian countries, especially China, hold large foreign exchange reserves which they use to stabilize their exchange rates. This means that exchange rate fluctuations may not have a significant impact on the current account balance because of government intervention in maintaining exchange rate stability. Government Intervention: Some Asian countries such as China actively intervene in the currency market to maintain exchange rate stability, mainly to protect the competitiveness of their exports. This stability reduces the impact of exchange rate volatility on the current account balance because large fluctuations are less frequent.

Dincer and Yasar [50] and Das [51] exchange rate depreciation poses a serious obstacle to international trade flows, requiring government intervention to minimize the domino effect of increased demand for foreign currency. A worsening current account balance is a critical issue for a country as it can lead to various economic problems, such as hindered capital flows, reduced government expenditure, increased state debt, and more. Although the pressure from exchange rate depreciation is often temporary, it can disrupt many economic channels, prompting central banks to implement expansionary policies. High exchange rate swings have the potential to lower foreign investment and raise uncertainty. Due to trade swings and the unpredictability of foreign investment, currency rate appreciation can lead to imbalances in current account balances.

Net exports show evidence of a significant influence on the current account balance. Research by Chitgupi [52] and Freund and Gagnon [53] discovered that although exports are a vital component of a country's current account balances do not considerably affect them. Consequently, efforts to increase the competitiveness of domestic products must be prioritized as a form of sustainable innovation, emphasizing the importance of product diversification and policy measures that aim to achieve international trade benefits. Cota et al. [54] and Bird and Choi [55] state that importing products from other countries can be influenced by a country's weakening exchange rate relative to other nations. This often occurs when aggregate demand for goods and services rises domestically, making import flows more manageable. Policies that regulate the flow of imports by raising import tariffs, giving preference to domestic products, and developing industrial areas that can meet domestic needs can better balance the demand for imported goods and improve the current account balance. These measures will ultimately result in export-oriented growth.

Foreign direct investment shows different results, there is no significant influence on the current account balance. Foreign direct investment in Asian countries is not directed to export sectors, but to domestic sectors such as infrastructure, property and financial services. Investment in these sectors may not directly affect the current account balance because they are not involved in the production of goods and services for export. For example, foreign direct investment in property development or large infrastructure projects in China or India is more focused on domestic consumption than international trade. Foreign direct investment can also create capital outflows in the form of dividends or profits sent back to the investor's home country. This can reduce the potential positive effects of foreign direct investment on the current account balance. Although increases domestic production capacity, the profits generated are often transferred abroad, so the net impact on the current account balance is limited.

Studies by Bedir and Soydan [56] and Batdelger and Kandil [57] suggest that foreign capital flows can lead to exchange rate appreciation at a lower level, which is a determinant of financial transactions. High growth in investment levels reflects a positive value in creating an open environment for sustainable economic prospects and can drive balance in the current account. Additionally, when capital flows positively impact the current account balance, foreign exchange reserves increase. This is consistent with findings by Camba-Crespo et al. [58] and Adekunle et al. [59] who highlight the importance of domestic capital allocation to align with foreign capital needs. The need for gross capital formation provides security

for the middle-class economic sector, which does not have a significant market share in product marketing, especially in export-based markets. This reliance on domestic capital can directly influence asset-side expenditures for sustainable investment. The size of gross capital formation is often affected by interest rates, which facilitate wider capital distribution, ensuring that capital availability for households and companies can increase production levels in the long term, supported by government policy.

5. CONCLUSIONS

This research offers a new policy framework based on a comparative analysis of renewable energy policies in 15 developing Asian countries. The novelty of this research is the development of an adaptive, data-based policy model between countries that allows policy adjustments to the country's specific economic and social conditions. The results of this research provide a new, more holistic and detailed view of the condition of energy needs from renewable energy programs, which allows for more informed and responsible decision making. The study's findings indicate that the first equation for fossil fuel and GDP per capita has a considerable impact, but the population, current account balance, population, and access to electricity have no discernible effects on energy consumption

The current account balance is significantly impacted by the energy consumption and net export, but not by the exchange rate or foreign direct investment. Energy consumption will always be maximized order to meet the need for electrical energy used for economic activities. If this energy continues to be utilized for all needs, efficiency and effectiveness of use can be achieved to support the achievement of energy independence in the long term. For this reason, guaranteed quality and quantity of energy can be obtained from international trade activities, of course based on income characteristics and population as a reference for using available energy. In analyzing the current account balance, the results provide valuable insights into economic conditions in Asia over the past few decades, which can guide policymakers in designing strategies to improve economic stability. For instance, understanding trends in savings, investment, and trade can inform fiscal and monetary policies aimed at addressing external imbalances, promoting sustainable growth, and mitigating vulnerabilities to global economic shocks. It is advisable to focus on foreign direct investment as a means to promote a current account surplus. Balanced capital flows, in conjunction with international trade, can have positive effects on the current account balance. The results for the exchange rate and net exports differ from previous literature.

These findings highlight the variations in research perspectives, which previously assumed that international trade activities such as exports and imports significantly influence the current account balance. Exchange rates, being highly influenced by global sentiment, are sensitive and play a crucial role in ensuring the sustainability of international trade, favouring exports over imports. Generalize the limitations in this research by referring to previous research as a reference in interpreting theories, methods, data, analysis and more comprehensive discussions in order to achieve relevant research results. The policy implications derived from this analysis suggest that governments in each country must maintain control over international trade with the objective of achieving high export value.

Appropriate monetary policies should be in place to regulate exchange rates, thereby encouraging private capital accumulation in productive sectors and enhancing competitiveness compared to products from other countries. The flow of foreign capital should align with exchange rate appreciation, positively impacting the current account balance and contributing to a surplus. Regulate state income and stimulate fiscal policies to address economic challenges faced by the country. With concrete policies, countries can renew energy availability to avoid scarcity and potential energy crises. This approach creates numerous opportunities for innovation, particularly in supporting the use of electricity, which can drive the development of impactful electricity generation infrastructure and positively affect the economic ecosystem.

5.1 Limitations

Asia is a very diverse region with countries at different levels of economic development, ranging from developed countries such as Japan and Republic Korea to developing countries such as Indonesia, Kyrgyz Republic, Thailand and Vietnam. The simultaneous equation model used in this study may not fully capture the structural differences between these countries. The impact of certain variables, such as energy consumption and current account balances, may vary depending on the level of economic development of each country, which is not always represented in the model. Although the simultaneous equation method is chosen to capture the reciprocal relationship between energy consumption and current account balances, it has limitations, especially if the underlying assumptions are not fully met. For example, the assumptions of homoscedasticity and linearity may not hold uniformly across Asian countries. In addition, the method is sensitive to model specification and the choice of instrumental variables, which may affect the robustness of the results. The period 1998-2022 encompasses several global economic crises, including the Asian financial crisis in the late 1990s, the 2008 global financial crisis, and the COVID-19 pandemic. These economic instability can affect energy consumption patterns and international trade, as well as the current account balances, in ways that are difficult to predict. The model may not fully capture the exogenous impacts of these crises, and the results should be viewed with caution.

5.2 Future research

For future research, several directions can be taken to address the above limitations. First, further research can expand the scope of variables, such as including more specific environmental factors and energy policies. Further research can also distinguish between developed and developing countries in Asia to understand the impact of different energy consumption on the current account balances. In addition, more complex models, such as dynamic or panel models, can be used to better capture intertemporal and intercountry variations. Finally, the impact of technological change and the increasingly dominant green energy policies in Asia may also be an interesting topic for future research.

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