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Economic implications of domestic natural gas allocation in Indonesia

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Abstract

Purpose – The purpose of the paper is to provide to a better scientific understanding of Indonesia's domestic gas allocation policy and its effects on the national economy and to answer the question of what best priorities can be set in allocating the natural gas for the domestic market to maximize the benefits for the national economy.

Design/methodology/approach – The authors apply a Computabled General Equilibrium (CGE). The Social Accounting Matrix 2008 is used to calibrate the CGE Model. There are two scenarios proposed, each is simulated with certain percentage of gas supply curtailment (50 MMSCFD, Scenario A), (100 MMSCFD, Scenario B).

Findings – It is confirmed that government's current policy to give priority to oil production is not the optimum way to maximize added value of natural gas to Indonesian economy. While oil production generates state revenue, it is industry and petrochemical sector that induces high economic impacts because of strong backward and forward linkages.

Research limitations/implications – Due to the limited data availability, it is assumed that the data on the SAM 2008 are valid for describing the structure of Indonesian economy.

Practical implications – The paper provides recommendation to the government to revise gas allocation policy by changing the rank of consumers' priority.

Originality/value – This paper provides instruments to measure the impact of Indonesia's domestic gas allocation policy. Finding the best hierarchy of consumer priorities is essential for maximizing added value of natural gas for the national economy.

Keywords Policy, Input-output tables, Modelling, Resource management, Natural gas, General equilibrium models, Social accounting matrix

Paper type Research paper

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1. Introduction

Indonesia is endowed with substantial natural gas resources. The country has been exported gas since early 1980s, mostly to the neighboring countries. Refocusing natural gas policy in 2001 affects the prospects of Indonesia as gas-exporting country. It has changed the direction from export to a domestic market orientation, representing a significant shift, as prior to this Indonesian gas policy has been dominated by an export orientation, almost from the very beginning of the country's natural gas production. However, the change in orientation will be difficult to implement because it is not supported by current and future gas production. The gas production used to be based on long-term export contracts; thus, the short-term need of gas supply for domestic market cannot be covered wholly. As the supply for domestic market cannot be fulfilled entirely, it cannot support the growing domestic demand.

The Indonesian Government became aware of this problem and tried to solve it by means of gas allocation policy. The Ministry of Energy and Mineral Resources (2010) issued a policy on natural gas allocation for domestic market through the Ministerial Regulation No. 3 to give legal grounds for natural gas allocation to domestic consumption. Prior to Ministerial Regulation concerning gas allocation that was issued in 2010, gas supply was not regulated; every consumer can contest to get the gas, and gas producer would sell the gas to highest bidder. This condition was undesirable because key sector that has low purchasing power such as petrochemical industry, for instance, was less likely to get gas supply. The regulation aims to prioritize the allocation of natural gas in four of Indonesia's largest domestic gas processing industry sectors of petroleum operations, fertilizer production, power generation and other industries. The Regulation that manages natural gas supplies for the domestic market must be allocated hierarchically by prioritizing first to the petroleum sector, followed to fertilizer sector, and so on. At the time of the enactment of the Regulation, it was assumed that this approach to allocation was a good instrument to manage natural gas shortage on the domestic market.

However, the rationale of the priority order of the four sectors has never been fully analyzed. Natural gas is expected to back up the economic development and foster prosperity of Indonesia. This reason is used to legitimatize the gas allocation instruments. According to official reasoning, the sector that supports the national economy most should have priority in the national gas allocation. However, the economic linkages that actually determine the chosen priority order of the sectors have not been proven.

The analysis provided by this paper attempts to make a contribution to this knowledge gap. The objective of the paper is to provide a profound basis to comprehend Indonesia gas allocation policy and its impacts on the national economy by answering the question on what is the best hierarchical order of domestic gas consumer to optimize the ripple effect for the economy. This study applies Computable General Equilibrium (CGE) model as this methodology enables to analyze quantitatively the economic impact of policy changing.

The structure of the paper will be as follows. Following the introduction in Section 1, Section 2 will present a brief overview on natural gas market in Indonesia and the current gas allocation. Indonesia allocates the natural gas available for the domestic market in a certain priority order that provides some sectors with more gas than others. Then, it briefly explains the details of the current natural gas allocation policy in Indonesia. Furthermore, discusses the CGE methodology that has been used for the economic analysis of the effects of gas allocation and also scenarios. Section 3 discusses the results, followed by Section 4, which discusses the research findings. Section 5 summarizes the findings and draws conclusions.

2. Materials and methods

2.1 Indonesia's natural gas market

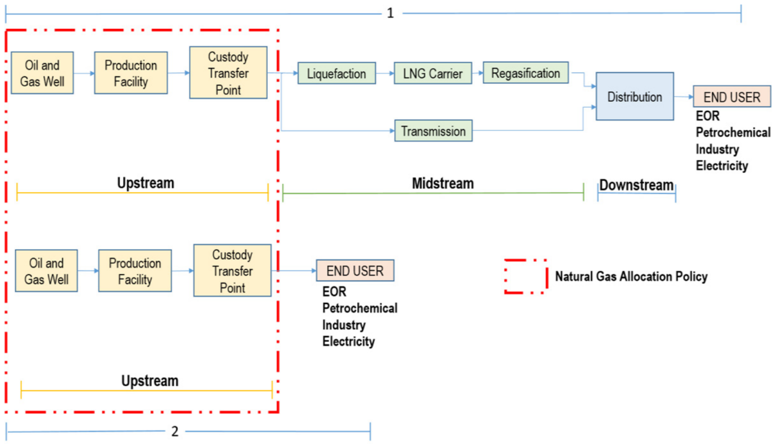
Oil and gas sectors in Indonesia are regulated by the 2001 Oil and Gas Law. The oil and gas sector comprises upstream and downstream activities (Figure 1) which are separately regulated and organized. Extracted oil and gas remains owned by the State until it passes the custody transfer point. This concept is the embodiment of constitution 1945, article 33 paragraph 3, which asserts that land, water and the natural resources contained therein shall be controlled by the state and used for maximum prosperity of the people (Constitution of the Republic of Indonesia, 1945). This implies that the government has full control over oil and gas resources management, either to sell it for export or domestic use, including the decision about the buyers, price and quantity. This law is largely focused on the upstream side and is less concerned to the midstream and downstream development due to the country's natural resource management approach (Purwanto, 2016). The division between upstream and downstream segments of Indonesian gas chain is regulated under two types of gas contract:

(1) The first one is upstream scheme where end-users directly buy the gas from the producers (number 2) requiring them to provide the infrastructure to transport the gas.

(2) The second type is downstream scheme where end-users buy the gas from gas shippers or gas transporters.

For both schemes, the government decides which consumer will buy the gas through natural gas allocation policy, which is the characteristic of Indonesian centrally planned economy that shapes the energy sector management. Indonesian gas market is a transition from a central planning to market based where it liberalizes the downstream part of the gas chain. However, downstream market development to some extent is affected by the government policy in the upstream and the government masterplan of gas infrastructure.

Theoretically, by taking into account the experience of developed countries advancing their natural gas industry, the development of downstream structure of the natural gas



Source: Directorate General of Oil and Gas, Ministry of Energy and Mineral Resources (2018)

Figure 1. Indonesia gas industry

industry can be modeled into three groups (Gracia, 2002). The first model is a transition model where a gas producer sells gas to an integrated company that controls transmission, distribution and services. Second model is an open access; in this model, the producer sells gas to the transmission company which then is sold to the distribution company. Subsequently, the distribution company sells the gas to small consumers and large consumers. The third model is open access/full liberalization. In this model, the gas producer sells the gas to the transmission company which resells the gas to the distribution companies. Large and small consumers are free to choose the service providers they like. This model has been applied in several industrialized countries.

Indonesia is in a transition phase from the vertical integration structure where most of gas networks is owned by the state own company; PGN controls 80 per cent of the grid (IEA, 2008) to open the access model. Table I pictures the comparison of gas condition in several countries. Many studies suggest that a combination of privatization, regulatory reform and liberalization will enhance economic efficiency and improves service standard in energy sectors (Megginson and Netter, 2001; Pollitt, 2002; Jamasb *et al.*, 2014). This has been the subject of various studies on gas market (Capece *et al.*, 2013; Price and Weyman-Jones, 1996; and Lee *et al.*, 1999). The discussion about downstream side of Indonesia gas market has been the subject to some scholars, e.g. Nugroho (2004) and Purwanto *et al.* (2016), who came out with a similar conclusion that Indonesia is still far away from the basic of downstream gas market regulation requirements (IEA, 2009, 2012; Spanjer, 2008; and Hutagalung *et al.*, 2011); and the serious consequence of this lag of implementation is the lack of infrastructure development in midstream and downstream (Hutagalung *et al.*, 2017).

Nonetheless, the focus of this paper is not on the downstream part of gas market, but on analyzing the upstream part concerning the government policy over gas management. Unlike developed countries that liberalize their gas market, in Indonesia, liberalization can only be implemented in downstream side of gas market; while the upstream side is controlled by the government as planned economy as it is mandated by the constitution. Hence, the issue is how to optimize the utilization of natural resources to benefit the country.

2.2 Natural gas allocation policy

Developing countries apply central planning methods and strategies in their economic planning as attempts to develop the national economy (Munasinghe and Meier, 1993). To support these mechanisms, Munasinghe (1980) and Munasinghe *et al.* (1989) recommended a hierarchical structure, the "Integrated National Energy Planning," that requires the linkage analysis of energy input and the impacts on the national economy. In this context, a wide range of policy instruments are suggested to initiate the economic development. The most

Country	Status of gas industry
Belgium	National Gas Company, Distrigaz, has been privatized. Belgium is European Gas Hub
France	Gas de France, state owned company monopoly
Germany	Private sector
Italy	Managed by government, SNAM is the national gas transporter company, AGIP, national oil and gas producer
Netherlands	Gasuni, monopoly
UK	Privatization and liberalization
Japan	Rely on LNG import and industrial development around LNG terminal

Source: Juris (1998)

Table I. Status of gas industry in developed countries common instruments are physical control of resources, policies that affect investments, technical methods, policies on subsidy, tax, pricing and other incentives (Munasinghe and Meier, 1993). These scholars suggested that physical control would be the most appropriate and effective instrument to be applied in a state of lack of energy, whether in the short or long terms.

In natural gas sector, this physical control is applied into the natural gas allocation policy. Allocation policy is a system of prioritizing allocation among the consumers/sectors in which the higher allocation-rank consumers will have the opportunity to fulfill their gas demand. The objective of gas allocation is to manage the gap well between demand and supply in the case of shortage of gas supply. This allocation policy is not to be confused with gas capacity allocation mechanisms, which is the technical rule related to how transmission system operators distribute capacity allocation of pipeline.

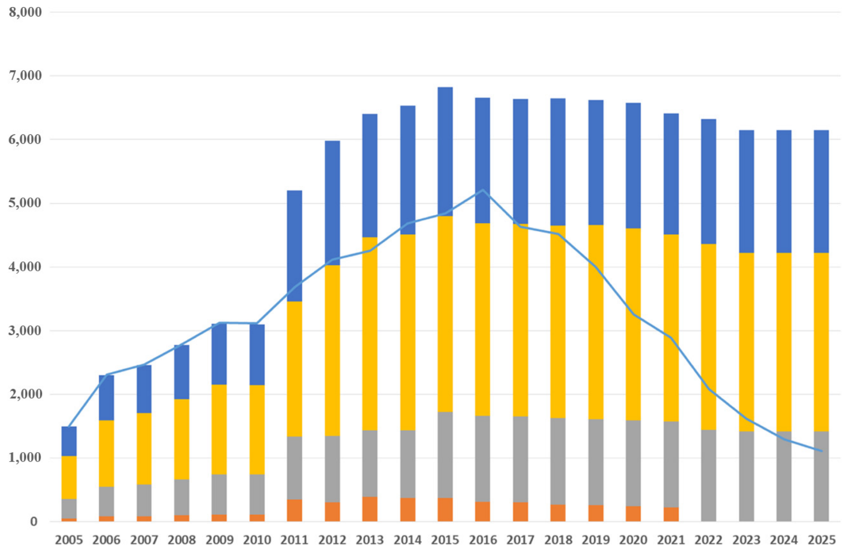
Some countries have implemented this particular policy, such as India (Jain and Sen, 2011), Pakistan (Ministry of Petroleum and Natural Resources Government of Pakistan, 2005) and the USA (Koplin, 1955). In Pakistan and India, as in Indonesia, the top ranking of natural gas allocation is directed to the fertilizer and electricity industries. Fertilizer industry is important for agriculture and food production in India; the electricity production is also prioritized (Jain and Sen, 2011). While in Pakistan, commercial sector becomes their top priority besides fertilizer and electricity sectors. The three countries make priority determinations in allocating natural gas without cost and benefit analysis on the impacts of applying different priority decisions.

Indonesia started gas allocation policy in 2010. This policy was structured as a strategic plan related to the low supply of natural gas so that the supply shortage can be allocated efficiently and effectively to support the national economic interests (MEMR, 2010). The arrangement of priority order was considering the assumption of natural gas requirement for economic sectors. Indonesia's domestic natural gas consumption is dominated by the industrial sectors, with the small portion of household use. The main energy mix in Indonesia, in 2006, was dominated with oil, natural gas and coal, accounting for about 50 per cent of oil and about 25 per cent natural gas (MEMR, 2012). Natural gas is expected to grow its share to 30 per cent by 2025. Though it appears to be a manageable improvement, in reality, it is a big challenge, given the overall growth of primary energy needs.

Figure 2 shows the projection of natural gas supply and demand in Indonesia up to the year 2025. The balance in the chart was computed by subtracting the demand from existing supply. The production forecast is based on volume simulation data from gas producers in every gas field in Indonesia. Gas demand data are based on contracts on sales and projected domestic gas demand. Domestic demand can be broken down into four sectors: oil production by enhanced oil recovery (EOR), fertilizer and petrochemical industry, electricity and other industries.

The increasing gap of natural gas supply and demand on the domestic market is clearly shown on the figure. One of the obvious solutions for this problem is increasing natural gas production. However, this is not a feasible alternative in the period until 2025 for several reasons (Hutagalung *et al.*, 2011).

As diesel subsidy or high-speed diesel (HSD) being removed for the industrial sectors in Indonesia, the demand of natural gas began increasing in 2005. The removed solar-subsidy initiated significant changing; industrial sectors turned from diesel to natural gas, leading to gas shortage in domestic market and sharp price increases. The abrupt rising demand was hard to fulfill by increasing supply, simply because all gas production was already contracted for export. Consequently, gas shortage has become a serious problem since 2011 because it endangers the functioning, performance and continuation of crucial economic



Notes: The blue line in the figure depicts gas supply while vertical bar depicts gas demand sourced from oil production by EOR (orange bar), fertilizer and petrochemical (grey bar), electricity (yellow bar) and other industries (blue bar) from 2005-2025
Source: Adapted from Directorate General of Oil and Gas - Ministry of Energy and Mineral Resources (2011)

Figure 2. Forecast of natural gas supply and demand (in MMSCFD)

sectors in Indonesia, which depends heavily on constant availability of natural gas. The main economic sectors in which natural gas is an important source are:

2.2.1 Oil production by enhanced oil recovery. In addition to natural gas, Indonesia also produces substantial volumes of crude oil. In the oil industry, increasing oil production is done by utilizing EOR. Heat is injected from the combustion of natural gas into the oil reservoir. It is done to lessen the oil viscosity. The production of EOR crude reached more than 50 thousand barrels per day and the natural gas needed for the heat source equal to 250 MMSCFD[1]. Because of the characteristics of oil field and Indonesian oil specifically, there is no alternative for gas as a heat source. But the 50 thousand additional barrels of oil produced by EOR also bring in additional state revenues.

2.2.2 Fertilizer and petrochemical industry. Natural gas is an important resource to produce fertilizers which are necessary to the life of agriculture in Indonesia. No back-up feedstock is on hand. The increased demand for fertilizer has resulted in increased domestic demand for natural gas; so new facilities are needed to support increased production. In 2011, about 11 per cent of the total domestic gas supply is consumed by fertilizer industry in Indonesia. (Directorate General of Oil and Gas - Ministry of Energy and Mineral Resources, 2011). Nowadays, resurgence of aged fertilizer factory, as well as investments in new ones, is planned. If all these plans are implemented, the natural gas demand for fertilizers will increase to 300 MMSCFD and the volume of fertilizer production to more than 4 million tons a year between 2013 and 2030.

2.2.3 Electricity. The share of natural gas in the fuel mix of electricity production is significant, but not dominant. The general expectation is that the current share of

17 per cent natural gas will continue until 2020; but keeping this share assumes significant increase of gas supply for the electricity production sector. This supply increase will be difficult to achieve in the coming years. Coals are expected to continue as influential fuel position in the production of electricity in the upcoming decades (Directorate General of Electricity – Ministry of Energy and Mineral Resources, 2008).

2.2.4 Other industries. This group covers all gas consuming industries besides the fertilizer and petrochemical industries, including food and other beverages, paper, textile, glass, ceramics, cement and metal industries. In 2011, the total gas demand of other industries was 1,522 MMSCFD, with the metal (including manufacturing) and paper industries taking the largest shares (60 per cent and 16 per cent respectively), followed by the ceramics industry for 9 per cent and glass industries for 4 per cent. Gas demand in the other sectors is negligible (Yusgiantoro, 2012).

This overview demonstrates the severe gas dependence of crucial economic activities in Indonesia and their significance for Indonesia's gross domestic product (GDP). For instance, the manufacturing industry belonging to the metal industry, contributes 24 per cent to Indonesia's GDP (BPS/Indonesian Central Agencies of Statistics, 2012). It has been indicated above that the increased domestic gas demand is hard to fulfill by additional production and the next few-year supply. Therefore, an appropriate policy reaction is needed to lessen negative economic impacts due to the shortage of natural gas in domestic market. The policy's response, in this case, is the government control in allocating the natural gas.

In the current ranking, the petrochemical industry, in particular oil and fertilizer productions are prioritized in gas allocation. The rationale behind this ranking is unclear and has never been officially explained. The privilege of petroleum operation to be in top priority has drawn criticism from industrial and energy expert (Tempo.co, 2012) who stated that the need of natural gas in petroleum operations is only to increase the production of oil to escalate state revenues, and not for its more general contribution to the national economy. According to these experts, the national economy would benefit more if industrial production (other industries) instead of crude oil production had priority in gas allocation. The controversies over economic effects of the priority order have been debated since establishment of Indonesia's gas allocation policy and the debate goes to the core of resource management in developing countries.

There is only one attempt in scientifically grounding Indonesian gas allocation for the domestic market, which is a master thesis that is not yet published, written by Wibowo (2008). The study applied input-output (I-O) analysis to analyze the economic effects (Wibowo, 2008). In the study of Wibowo (2008), the output multiplier of each gas consumer was calculated and then was used to rank the priorities. The priority order suggested is chemical industry, fertilizer industry and electricity production. Although this is a unique attempt in examining the economic impacts of allocating gas nationally, the method is actually not well suited for this kind of research because I-O analysis is unable to include dynamics of the economic system into the analysis. Moreover, I-O analysis assumes a linear correlation between economic activities and it cannot analyze short- or long-term economic effects. Applying the Computable General Equilibrium (CGE) model makes it possible to overcome these limitations and to get a better idea of real economic effects of national gas allocation policy in Indonesia. The next section explains the methodology in detail.

2.3 Methodology: the computable general equilibrium model

CGE model is able to examine the effects of policy variables modifications across multiple markets. The parameters used shall be price-based such as taxation and subvention or quantity base (restricted on demand/supply) where the analyst may exogenously specify the worth (Wing IS, 2004). The expediency shall be assessed based on the exactness and realism of the assumed model after comparing the pre and post shift equilibria (Wing IS, 2004). CGE model serves a counterfactual analysis in which it predicts various possible conditions that might happen without any particular policy or when a certain expediency is performed. CGE has a strong micro-economic bottom and a full economic depiction with the direct and indirect influences of expediency modifications. It has been broadly executed and has become an accepted policy analysis on energy and environment (Chi *et al.*, 2014).

CGE model is an ideal tool for this case study as it is able to analyze the wide impacts of policy on overall economic growth, sectoral growth, employment and energy consumption. CGE model is extensively used in policy studies in developing countries. It is unlikely to use econometrics models as it requires extensive time series data which is not available; besides considering the policy in question has just been implemented in less than eight years. Several researcher on energy applying the CGE among others are Lin and Jiang (2011) who studied the impacts the energy subsidy in China, Seddighi (1985) who used CGE for optimal country-level planning in oil production, and by Naqviu (1998) who used CGE for energy supply and demand modeling. Most of CGE model case studies are investigating the impacts of changes in pricing and not in physical quantity. However, the CGE application in simulating the physical quantity can be found in the study of Qin (2011), who studied water allocation with CGE; Hatano and Okuda (2006) investigated how allocating water affects the national economy. Juana *et al.* (2006) conducted a similar study for inter sectors water reallocation. This paper is developed on analogue scenario to examine the effects of gas allocation to the national economy. For analytical purpose, gas accounts are extracted from corresponding primary energy composite account which is the input factor in production function. The similar technique was used in the study of water allocation. The CGE model used in this paper is a dynamic model that enables the forecasting of policy impact scenarios year by year. The production structure of the model is displayed in Figure 3.

Several blocks of equation in the CCGE model are structured as follow:

- the production block with equations reflecting the structure of production and producer behavior;
- the household block with equations reflecting the behavior of households and institutions[2];
- market clearing blocks, which ascertains the conditions of market clearing for goods, labor and services in the economy; and
- inter Temporal Block representing the dynamic capital and labor supply function over the years.

The data analysis in this study is presented by social accounting matrix (SAM). SAM presenting the economic data of a country is a comprehensive data framework, in the form of a quadratic matrix, with each account represented by rows and columns. Payments from a column account to a row account are shown in each of its cells. SAM Indonesia year 2008, which is the latest SAM published by the Indonesian Bureau of Statistics (BPS), is applied to this study as a database for the CGE model. Indonesia's SAM is released every five years by BPS, started in 1975. The SAM's validity and reliability are discussed in previous studies; some of which are in studies of Hartono and Resosudarmo (2008), Lewis (1991), Thorbecke (1992), Azis (2000), Clements *et al.* (2007), Endriana *et al.* (2016), and Hartono *et al.* (2017). These studies indicate that the Indonesian SAM is a reliable and valid data source.

The classification of SAM on the Indonesian economic sectors used in the analysis is described in production sector classification:

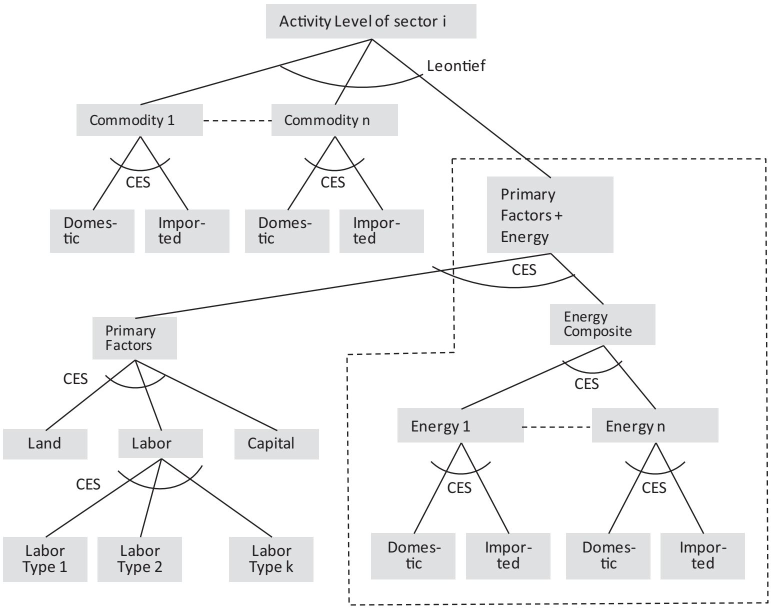


Figure 3.
Structure of CGE model

Notes: This model reproduced from Hartono and Resosudarmo (2008) with constant elasticity of substitution function (CES) as main function

(1) Food Crops;
(2) Estate Crops;
(3) Livestock;
(4) Forestry;
(5) Fishery;
(6) Metal;
(7) Coal Mining;
(8) Crude Oil (Crude);
(9) Natural Gas (Nat-Gas);
(10) Geothermal;
(11) Other Mining;
(12) Food Processing (Foodproc);
(13) Textile and Leather (Textile);
(14) Wood Processing (Wood);
(15) Paper and Machinery (Paper);
(16) Petrochemical;
(17) Bio-Ethanol;;

(18) Bio-Diesel;
(19) Other Refinery;
(20) Gasoline;
(21) Bio-Gasoline;
(22) Kerosene;
(23) High Speed Diesel Oil (HSDO);
(24) Bio-HSDO;
(25) Non-Subsidized Gasoline;
(26) Subsidized LPG;
(27) Non-Subsidized LPG;
(28) Liquefied Natural Gas (LNG);
(29) Subsidized Electricity (S-Electricity);
(30) Non-Subsidized Electricity (NS-Electricity);
(31) Hydro;
(32) Urban Gas;
(33) Clean Water;
(34) Construction;
(35) Trade;
(36) Restaurant and Hotel (Restaurant);
(37) Train;
(38) Land Transportation;
(39) Air-Water Transportation and Communication;
(40) Supporting Services;
(41) Bank and Insurance (Bank);
(42) Real Estate;
(43) Public Service; and
(44) Other Service (Source: BPS, 2008).

For analytical purposes, the original SAM is modified through the disaggregation of sectors of energy sources: natural gas, coal, crude oil, mining and geothermal. Modifications also include the separation of the petrochemical sector from the general, the discrepancy between electricity, gas and urban water. This needs to be done because the study focuses on the energy-intensive economic sector. In total,44 economic sectors are analyzed to achieve reliable and valid statistical results. Combining all households in one type is done as a modified form in the household segment.

The Armington number is used as elasticity parameter. This parameter expresses the elasticity of substitution across goods. The export demand value elasticity requires the export commodities' response on international market price changes, and finally the value-added elasticity, indicating the elasticity of substitution between capital and labor. The GTAP database[3] provided the elasticity data for the analysis.

The system in CGE model is square, where a number of equations are required to be equal to the number of endogenous variables. As consequence, a "closure" is needed, that is the choice of some exogenous variable to close the model. The model in this research used long run closure, where the supply of factors of production is able to move across sectors. As part of the closure, some variable such as tax tariff, various transfer and technology parameters are set as exogenous variables, whereas nominal exchange rate choice as the numeraire[4].

2.4 Scenarios for gas allocation

The simulation is started by developing several scenarios in which the allocation of natural gas varies, which enables us to assess the economic implications. First, a baseline scenario is developed for the period of 2008-2025 on economic growth without any changes in gas allocation. The GDP increase over the years is included as real growth for the years 2008-2011 and projects growth for the rest of the period. Table II gives an overview of the growth rates assumed in the analysis.

Then several scenarios are developed in which the availability of natural gas for the four economic sectors in gas allocation policy varies. These four sectors are oil production, petrochemical industry in particular fertilizer industry, electricity production and other industries.

The simulation compares the impacts appeared due to lowering the consumption of gas to all consumers proportionally; with reducing the same amount of gas consumption from each of the four sectors alternately. Equal amount of reduction is important to investigate how the same amount of gas curtailment from different sector affect the rest of the economy differently base on how strong its interlinkage with other sectors. The stronger the impact, the more important the sector, hence restriction of gas consumption should be avoided, and it places the sector in a higher rank of gas allocation priorities above the other gas consumer. Decreasing the consumption of gas lessen the sectors' output, which in the model plays as an exogenous variable. Different assumptions are applied on each sector to determine the output elasticity[5] of gas consumption. This is due to different characteristics owned by each sector in consuming gas. The assumptions are:

- Directorate General of Oil and Gas – Ministry of Energy and Mineral Resources (2011) claimed an increase in the production of oil by 6,500 barrels per day for every ten MMSCFD of gas consumption. For simulation purposes, the loss of oil amount is transformed from a physical unit into a monetary unit.
- The elasticity basis of the electricity sector utilizes the heat rate equation amongst HSD and natural gas. Reduction in gas usage will change the major energy origin of natural gas into HSD as an alternate for energy, but shall not lessen the electrical output. Heat rate of 1 L HSD is equivalent to 38,887.7193 BTU[6] of natural gas. The increase in HSD consumption for every one MMSCF gas supplies that has been cut can be calculated from this conversion rate.

Years	GDP Growth (%)
2008	6.01
2009	4.63
2010	6.2
2011	6.46
2012-2014	6.4-7.5
2015-2025	8-9

Source: Coordinating Ministry for Economic Affairs (2011)

Table II.
GDP Growth 2008-2025

- As there are no data available for petrochemical and other industries, output multiplier is used as a proxy for output elasticity.

For each of the four sectors, two scenarios are simulated: A1: a reduction of 50 MMSCF and A2: a reduction of 100 MMSCF annually for each of the four sectors. Table III gives an overview of the impact of these gas cuts in output of the four sectors.

The first three columns indicate the two gas cut scenarios in absolute and relative numbers. The relative number of gas cut was needed for calculating the output reductions. The other columns give the percentage of output reduction resulting from the 50 and 100 MMSCF cuts per sector. The choice of 50 and 100 MMSCF were made because those are substantial amount of gas consumption. As an illustration, 50 MMSCF of gas is adequate to run one unit of fertilizer or gas power plant.

The first row of the table shows that the 50 MMSCF gives an output reduction of 4.67 per cent of the petrochemical industry and a 3 per cent output reduction of electricity production. The output decreases per sector have been put into the CGE model as an exogenous variable with continuous models.

3. Results

Simulation results are elaborated and analyzed to seek three different effects of:

(1) macroeconomic on Indonesia's GDP, employment, consumption and investments;

(2) output of economic sectors; and

(3) national energy consumption.

3.1 Macroeconomic effects for Indonesia

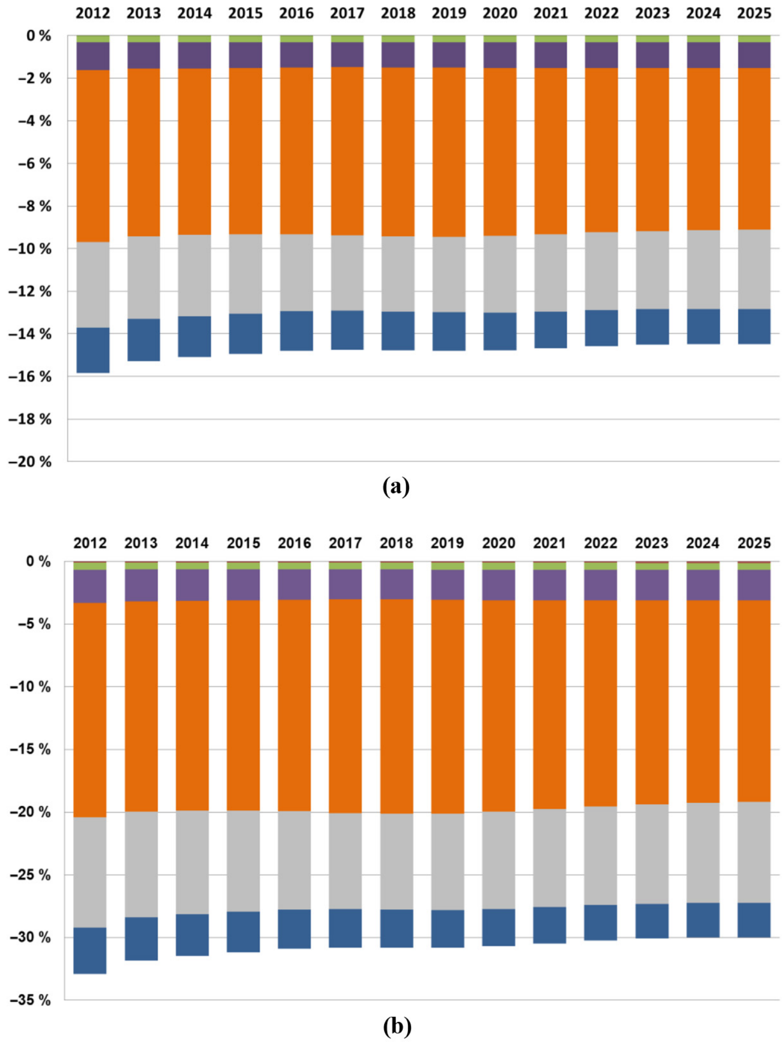
3.1.1 Gross domestic product. Two scenarios of gas reduction on GDP would be analyzed: gas decrease of 50 MMSCF for each sector (A1) and gas decrease of 100 MMSCF (A2). Figure 4 shows the decreases of the two gas sectors and their effects on the GDP. The effects occurred are the diversion of the baseline scenario in which the intervention of policy does not take place. In food sector, for example, a decline in GDP of 7.8 per cent occurred in 2012, due to a reduction of 50 MMSCF of gas.

Gas supplies limitation to crude oil and electricity production causes GDP decline of less than 1 per cent. However, different things happen in the petrochemical sector, food processing, textile and paper. A national economic downturn of more than an average of 7 per cent occurs, if the gas supply for food processing is cut, followed by a decrease in the paper sector by 3.6 per cent and textiles by 1.8 per cent. This is because of its high added value in the industry per volume of gas utilization is not the same as in EOR and power generation sector (BPS, 2008). Curtailment of gas supply lower sector output and GDP. By

	Gas					Industry (%)		
Sim	level	Proportional (%)	Crude (%)	Petrochemical (%)	Electricity (%)	Textile	Food processing	Paper
A1	50	2	4	4.76	3	12	10	12
A2	100	4	8	9.51	6	24	20	25

Source: Author's calculations

Table III. Two reduction scenarios with sectorial output effects



Notes: Images shown in (A) and (B) depict author's calculation results of the impact on real GDP from scenario A1 and A2, respectively. For each picture, vertical bar represents GDP deviation from baseline (in percent) derived from natural gas (red), crude oil (green), petrochemical (purple), electricity (light blue), food processing (orange), paper (grey) and textile (blue)

Figure 4.
Impacts on GDP of scenarios A1 and A2

sorting the magnitude of impacts on GDP, Indonesia should set the priority of gas consumer in the following order:

- other Industries (food processing, textile and paper);
- petrochemical sector;

- the Production of Crude; oil; and
- electricity.

3.1.2 Employment. The decline in GDP results in a large decrease in labor in the short term (2012-2015) due to reduced sectoral output and appropriate employment levels. Effects on the national workforce follow the pattern of GDP above. Reduced gas availability for food processing (2.8 per cent), textiles (0.9 per cent), and paper (0.3 per cent), followed by petrochemicals (Figure 5), gave the greatest effect on labor. The sectors absorb a lot of manpower in Indonesia; however, the impact on work is short term. Conversely, there is a long-term potential cross-sector labor movement; the explanation behind lower unemployment rate from 2017 onwards. However, the practical possibility of this is in question as skills of labor cannot easily be transfered across sectors.

3.1.3 Consumption of household. Similar to labor, a negative trend occurs in household consumption. Gas supply reduction in the food processing, textile, paper and petrochemical sectors (Figure 6) results in large reductions in consumption levels. When industries that generate primary consumption needs decreased sectorial output, household consumption declined. In addition, there is an indirect effect of labor decrease on consumption levels. When the labor absorption is low, consumers do not have the income to meet their consumption needs. Then, the spending rate is low.

3.1.4 Investments. Figure 7 shows that changes in gas allocations have an impact on the level of investment. When the GDP falls, the rate of investment goes down. The limitation of gas supply to the petrochemical and paper industries, where these industries are capital-intensive sectors, generates the greatest negative effect. As a result, the level of production and investment in these industrial sectors also declines significantly.

3.2 Sectoral output

The effects on the level of economic sectors will be discussed in this section. The results summary of the A1 scenarios on several Indonesian economic sectors is presented here. It will focus on the sectors most crucial to the national economy. The sectors based on the estimation cover: food crop production, food manufacturing, paper, textile, petrochemical, construction, trade, restaurant, bank, real estate, public service, and other services.

Figure 8 shows that the greatest impact on sectorial output performance is caused by the food and paper sectors. Both sectors have strong economic relationship with other sectors, resulting in a decrease in production of about 4-15 per cent. Textiles suffered an average decrease of 1 per cent and petrochemicals by 0.5 per cent, a moderate rate. Crude oil and electricity are hardly affected by other sectors, as other industries do not consume crude oil. Flexibility of fuel in electricity production also makes the electricity sector unaffected. However, a rise in fuel prices could significantly increase the electricity tariff. High electricity tariff will influence all economic sectors as all industries use electricity. Low use of natural gas in a sector does not necessarily result in a low impact by reducing the supply of this gas. Although the use of gas in the food manufacturing industry is relatively small, it has a significant impact on sectorial output, with a decreasing rate of about 5-10 per cent. The explanation is twofold, first, natural gas is vital component in production structure of food processing industry. Second, food processing industry is a key sector that has high interlinkage and strong impact on the rest of the economy.

Scenario A2 uses higher restrictions in gas consumption, which have larger negative impacts to output performance (see Figure 9); nearly doubling the impacts of Scenario A1. In

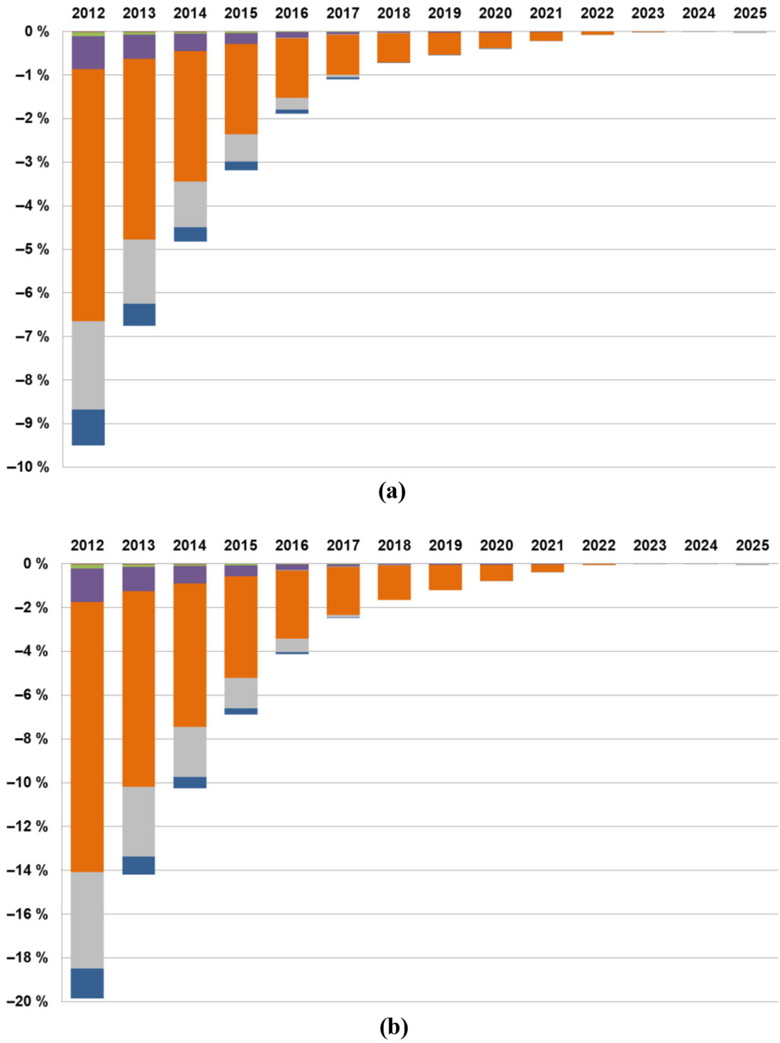
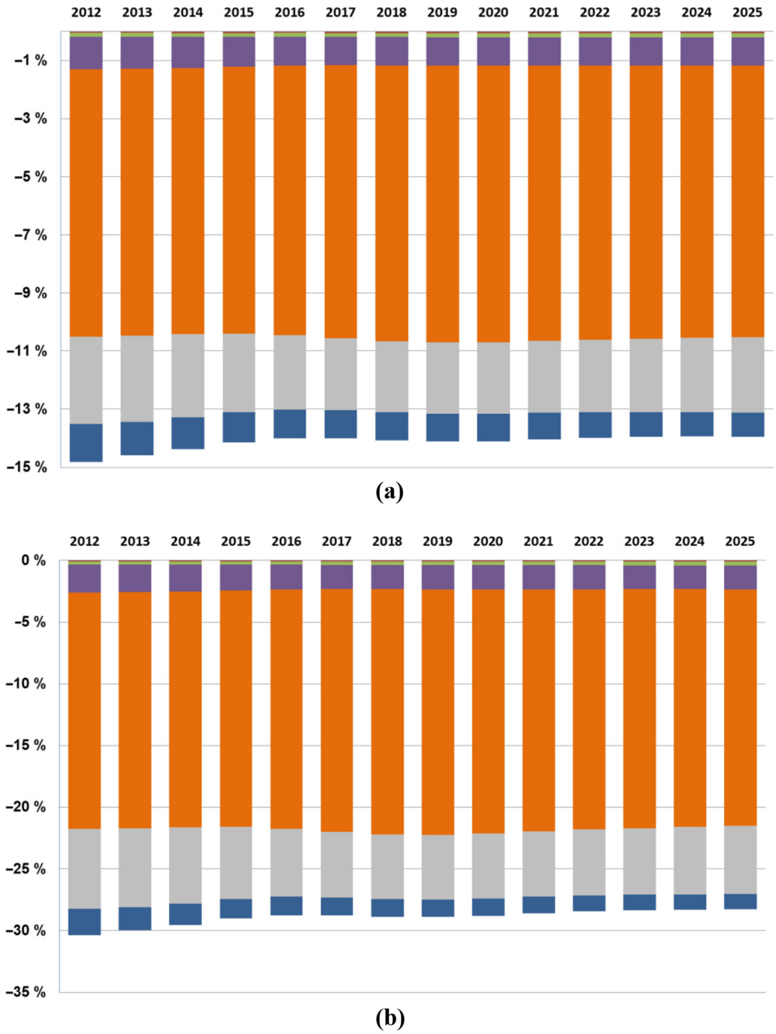


Figure 5.
Impacts on employments of scenarios A1 and A2

Notes: Images shown in (A) and (B) depict author's calculation results of the impact on employment from scenario A1 and A2, respectively. For each picture, vertical bar represent employment deviation from baseline (in percent) derived from natural gas (red), crude oil (green), petrochemical (purple), electricity (light blue), food processing (orange), paper (grey) and textile (blue)

the food manufacturing and paper scenarios, there is a decrease in sector output of about 11-27 per cent; and textiles show an average of 2.5 per cent decline and a 2 per cent petrochemical decline. Compared with the A1 scenario, in the A2 scenario, crude oil is affected slightly higher at 0.2-0.4 per cent.



Notes: Images shown in (A) and (B) depict author's calculation results of the impact on household consumption from scenario A1 and A2, respectively. For each picture, vertical bar represents household consumption deviation from baseline (in percent) derived from natural gas (red), crude oil (green), petrochemical (purple), electricity (light blue), food processing (orange), paper (grey) and textile (blue)

Figure 6.
Impacts on household consumption in scenarios A1 and A2

3.3 Substitution of energy resources

Table IV presents the impacts of substituting the natural gas due to the restriction policy. It shows that changing it with alternative fuel is quite simple (Columns 2 and 3), this implies that gas consumption is hardly substituted by other energy sources. The median changes of

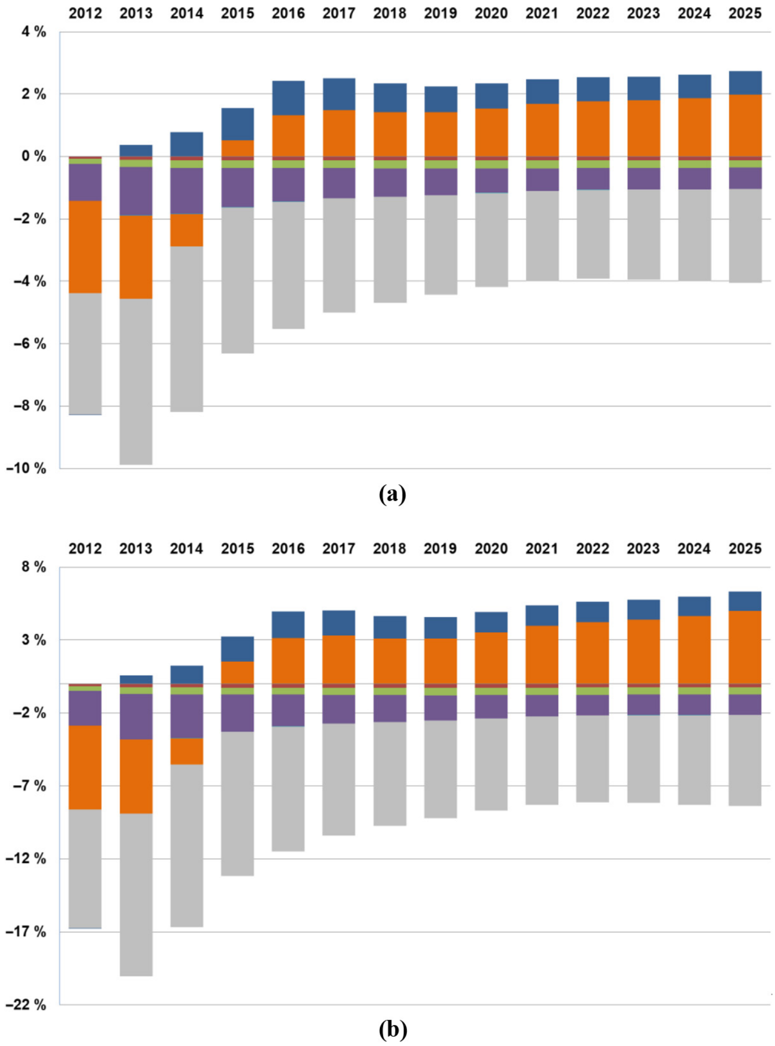
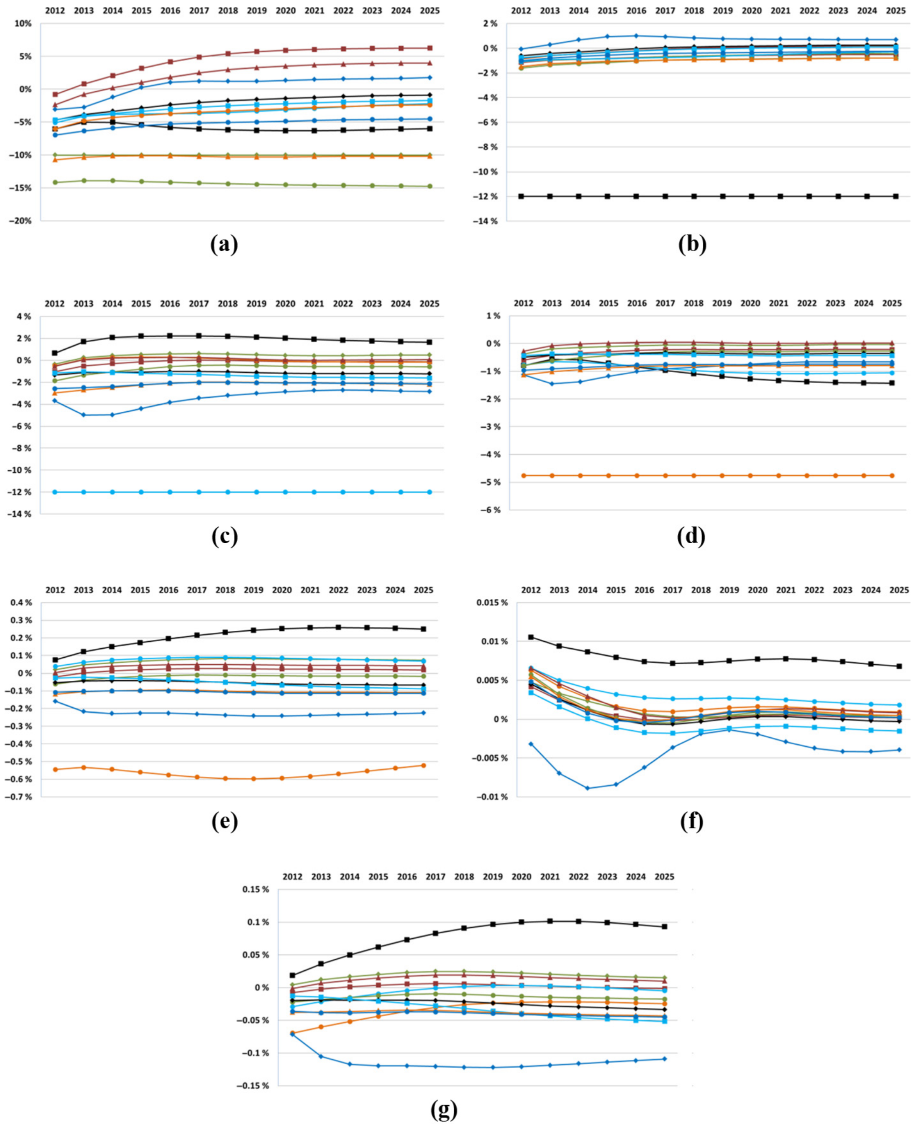


Figure 7.
Impacts on investment in scenarios A1 and A2

Notes: Images shown in (A) and (B) depict author's calculation results of the impact on investment from scenario A1 and A2, respectively. For each picture, vertical bar represents investment deviation from baseline (in percent) derived from natural gas (red), crude oil (green), petrochemical (purple), electricity (light blue), food processing (orange), paper (grey) and textile (blue)

the use of gas are presented in the table for both A1 and A2 scenarios, in the period of 2012-2025.

It hints the escalation of other energy source consumption as spurt of restriction of gas utilization, the effect falls within range 1-2 per cent.



Notes: Image (A) depicts author's calculation result of food processing scenario while image (B) depicts textile scenarios; (C) paper scenarios; (D) petrochemical scenarios; (E) crude scenarios; (F) electricity scenarios and (G) gas scenarios on sectoral performance. For clarity, placement of color line in each images corresponding to the impact based on sector's type in which food crops sector represented by square-red line, petrochemical (round-orange), bank (diamond-black), food processing (diamond-green), construction (diamond-blue), real estate (square-light blue), textile (square-black), trade (triangle-red), public service (triangle-orange), paper (round-light blue), restaurant (round-green) and other service (round-blue)

Figure 8.
Impacts on sectoral output for Scenario A1

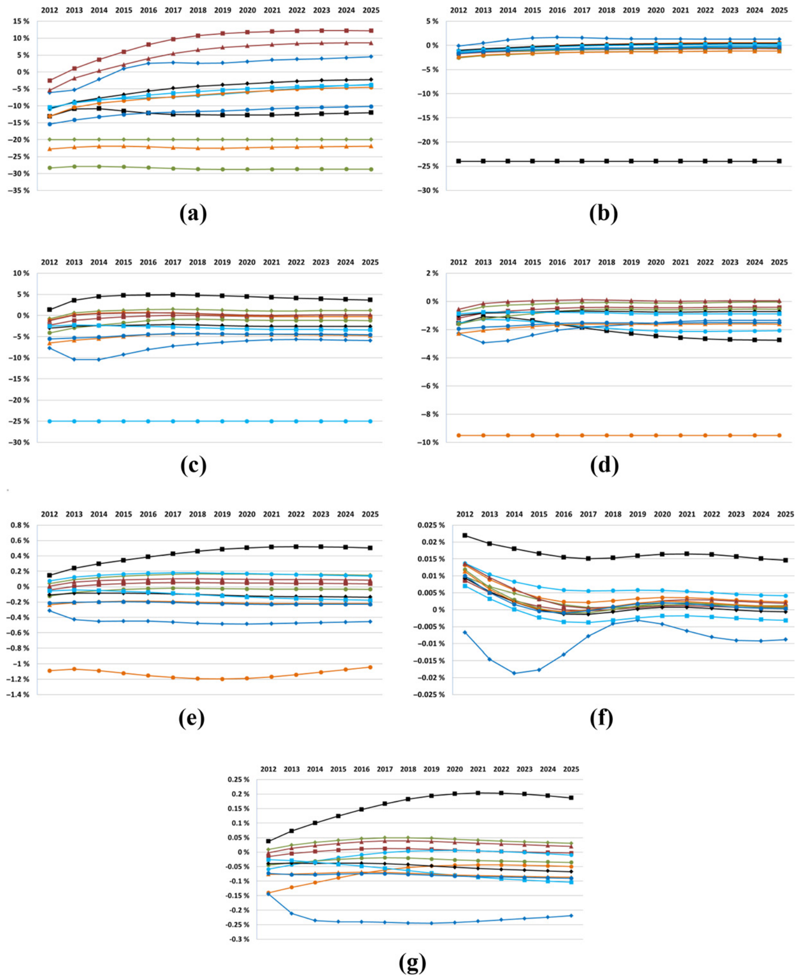


Figure 9.
Impacts on sectoral output for scenario A2

Notes: Image (A) depicts author's calculation result of food processing scenario while image (B) depicts textile scenarios; (C) paper scenarios; (D) petrochemical scenarios; (E) crude scenarios; (F) electricity scenarios and (G) gas scenarios on sectoral impact. For clarity, placement of color line in each images corresponding to sector's type in which food crops sector represented by square-red line, petrochemical (round-orange), bank (diamond-black), food processing (diamond-green), construction (diamond-blue), real estate (square-light blue), textile (square-black), trade (triangle-red), public service (triangle-orange), paper (round -light blue), restaurant (round-green) and other service (round-blue)

Natural gas is the main fuel in the petrochemical sector. Coal as a substitute fuel plays a minimal role, because not all parts can use replacement fuel. The use of HSD in the food and textile industries has increased slightly. HSD price that is relatively more expensive than natural gas can spur production costs. High product prices can reduce consumer purchasing power, resulting in cutting sector output.

4. Discussion

Overall, this study analyzes the main impacts of the policy on limiting the natural gas supply to industry toward the economy. The CGE model is used to simulate scenarios of gas curtailment in different sectors and examine the impacts through three indicators: macroeconomics, sectoral output and energy consumption. Based on findings in each indicator, the rank of gas consumer priority is set. The result (Table V) is consistent for macroeconomic and sector output where they lead to the same rank of priority; as for energy consumption, there is no priority that can be set because there is no substantial differences

Scenario	Natural gas	Crude oil	Petrochemical	Electricity	Food	Paper	Textile
Gas	−2	−0.77	−0.09	0.01	−0.89	−1.07	−0.17
Coal	0.08	0.16	0.34	−0.002	−1.51	−0.68	−0.45
Geo	−0.02	−0.46	−1.14	−0.06	−4.13	−1.62	0.33
HSD	−0.02	−0.21	−1.63	0.00	0.08	−1.88	0.04

Source: Author's calculations

Table IV. Average change in energy consumption (2012-2025)

Indicators	Findings	Rank of priority
Macroeconomic effects (GDP, Employment, Consumption and Investments)	Curtailment of gas supply to other industries leads to the worst impact in four macroeconomic indicators compared to other consumer sectors. As illustrated, GDP declines by 7.8%, and national employment drops by almost 3%. The second worst impact of macroeconomic indicators is showed by gas curtailment in petrochemical sector, followed by crude production and electricity	Other Industry Petrochemical Crude Oil Production Electricity
Sectoral Output	Curtailment of gas supply to other industries leads to the worst impact on sectors output compared to other consumer sectors. It leads to 4-15% output drops of other economic sectors. The second worst impact is showed by petrochemical, crude production and electricity	Other Industry Petrochemical Crude Oil Production Electricity
Energy Consumption	Curtailment of gas supply to other industries and electricity causes the energy consumption switch to HSD; while the gas supply curtailment to petrochemical and petroleum sector leads to Coal consumption. However, the spillover impact is limited to average of 1%. The rank of priority based on the result of energy consumption indicators cannot be set. The explanation is that with the electricity exception, the other consumer sectors cannot easily replace gas with other energy sources. Therefore, the consequence is to cut down the output leading to various economic impacts as showed in macroeconomics and sectoral indicators	–

Table V. Summary of findings

in result between scenarios. To get the intuition behind the result, the characteristics of each consumer sectors need to elaborate.

The first cluster is other industries or manufacture industries (food, textile, paper, metals and every industry other than petrochemicals); these are the main industries supporting the Indonesian economy. These industries have a high dependence on other industrial sectors as their raw material suppliers, which makes them have a high backward linkage. On the other hand, the industries also play an important role in supplying other industrial raw materials, which makes them have high forward linkage. Having high forward and backward linkages makes these industries potentially rise multiplier effects on the economy. The policy of limiting gas in one sector will reduce the output in that sector, which then affects the associated economic wheels. A strong level of linkage plays a role in this; the higher the linkage, the more negative the generated impacts. This explains why gas consumption reduction in this sector creates the worst economic impact compared to other sectors.

Petrochemical sector is generally defined as an industry that use petroleum and gas products as its raw material (Ministry of Industry, 2014). In Indonesia, gas-based petrochemical industry is limited, which includes methanol, ammonia and urea, which are the feedstock to produce fertilizer. As an agriculture country, fertilizer industry has an important role to support the agriculture sector; this is a labor-intensive sector which has strong forward linkage and impacts on national employment. It will not be a surprise that curtailment of gas supply to this sector cause the second worst economic impact.

Most of Indonesia's crude oil production is exported so that the oil sector has no high relation to other industrial sectors. The oil production sector contributes to state revenues but has no direct impact on the domestic economy. Curtailment of gas supply will reduce the oil production (if there is no substitution to other energy). Nevertheless, considering that oil sector does not have strong forward or backward linkage to other economic sectors, its major economic impact is a cutback in the state revenue. Intuitively, the loss of state revenue is less significant compared to the loss of multiplier effects if the gas supply to other sectors is cut; the result of simulation confirms it.

Electricity sector has a high degree of relevance to other industries and other economic sector as electricity is used by almost every sectors, while natural gas contributes to 25 per cent of energy mix for power plant. However, the use of natural gas in the electricity sector can be replaced by other fuels. This fuel replacement affects the level of energy subsidy in Indonesia. Similar to the case of oil production sector, the impact of additional subsidy is overcome by multiplier effects.

The aforementioned analysis can be refined into two points. First, the simulation has showed a consistent result that the rank of gas allocation priority is the same for various macroeconomic and sectoral indicators. Second, the characteristics of each sector have provided the arguments behind the result. Thus, it is proposed that based on this impact analysis, the priority of national gas allocation should be arranged as follows (from highest to lowest priority):

- other industry[7];
- petrochemical sector;
- crude oil production; and
- electricity.

Government's current policy deviate from the suggested result, where the top priority is given to enhance oil recovery (crude oil production). The selection of this priority can be assumed because crude oil production affects state revenues, so the government chooses it as a priority considering the country needs revenues from this sector. It is also worth noting that production in only one oil field is given priority – the Duri Oil Field; while other production sites do not depend on natural gas. The government decides that the second priority of natural gas allocation is given to the petrochemical sector, for the need of fertilizer production. Electricity and industrial production are not prioritized in natural gas allocation because they are considered flexible enough to switch to alternative fuels. While the research shows, from a macroeconomic perspective, these industry sectors have strong backward and forward linkages, so the government's natural gas allocation policy needs to be reconsidered.

5. Conclusions

This study analyzes the challenges faced by Indonesia due to natural gas allocation policy; suggestions related to problems are presented to address them. The main discussion is to answer the question: *What is the best priority that Indonesia can set to allocate natural gas to the domestic market to maximize the national economy*?

The CGE model is applied to quantitatively measure the economic impact of gas curtailment in several economic sectors. The most prioritize sectors in natural gas allocation are determined base on macroeconomic effects. The sequence of the priority is: other industry, petrochemical, crude oil production, and electricity.

The allocation priorities suggested above are different from the current policy applied by the government. Petrochemical industry is prioritized by the government to support fertilizer production. Meanwhile, the research result suggests that industrial sector should be prioritized as the high macroeconomic impacts may rise when the gas supply is restricted in this sector. It is known that restricting gas supply for one month in 2011 in industrial sector due to the cessation of gas supply from PGN (the state-owned company), resulting in big noxiousness of US$500m (Teguh, 2011). Imposing new gas allocation policy is not that simple, as substituting gas use with coal in the fertilizer sector needs a massive amount of investment (approximately US$400m) as claimed by the Ministry of Industry (2007). Unavailability of funds does not allow policy changes in the short term.

There are two points of implication in this paper. First, most of academic literature about natural gas focus on market performance after liberalization; it seldom discusses from the perspective of government policy in central planning system to optimize the natural resources management. In central planning system, policies are fundamental tools to reach the goals of socioeconomic growth; thus, estimating the policy measure effectiveness is necessary for a pre-fixed establishment before fully implementing it (ex ante). To gain insights on a policy impact during the decisions making process, an adequate tool is needed. The only study about natural gas allocation is Jain and Sen (2011), who descriptively analyzed the choices of government priority on gas utilization. This paper contributes in providing a wide impact analysis of such policies under different policy options using an economic model concerning the economic indicators. Furthermore, studies on Indonesian energy policy, especially natural gas, are still very limited.

Second, it contributes to public policy practice. In the context of policy-making in Indonesia, a policy measure often lacks of significant factors, explanation and facts that can create more effective energy policies in overcoming the social and economic matters (Muliadireja, 2005). The Government of Indonesia acknowledges this reality and seeks to improve evidence and analysis for effective energy policy-making. Every policy or regulation has to be backed up by academic studies – documents that elucidate the objective of a certain policy and the possible impacts of it. However, the limited time pushed the government to carry out a narrow cost and benefit analysis with limited data and information. Some policy trials were taken place resulting the regulation had to be revised even in just few months after it had been implemented, whenever a deeper analysis was done. This paper shows that there is room for improvement in gas allocation policy.

Unfortunately, the research could only use data from the Indonesian SAM of 2008. It would be possible to reanalyze with more recent data by applying more scenarios to bring additional perspectives to the Indonesian gas allocation and its economic implications. Further research might be developed using different scenarios, such as the policy impacts to different types of household or regional impact analysis. The input data can be modified as well by using econometric data to determine the elasticity of gas consumption and economic output as an input for CGE model. Due to the data limitation, such analysis cannot be incorporated in this current paper.

Notes

1. MMSCFD = Million Standard Cubic Feet per Day.
2. Institution refers to economic actors in the SAM database, which consist of household, firm (private sector) and government.
3. GTAP is a global data base describing bilateral trade patterns, production, consumption and intermediate use of commodities and services.
4. In order to make the model "square", usually one equation is dropped and one price variable is fixed as numeraire.
5. Elasticity in this context is defined as the amount of output drop because of reduction in gas consumption.
6. 1 MMSCF = 1000 MMBTU, BTU = British Thermal Unit.
7. The government defines, the industry category comprise food processing, textile and paper, although for technical analysis purpose it is broken into separate sectors. The three "subsectors" reveal the strongest economic impact that given them the first priority in government policy.

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