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Disaggregated energy demand by fuel type and economic growth in Malaysia

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HIGHLIGHTS

- Examines the relationship between disaggregated energy consumption by fuel type and economic growth in Malaysia.
- Diesel is the major contributor to economic growth in the long run in Malaysia.
- The long run elasticity for diesel is 0.4, which is similar to total energy consumption.

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ABSTRACT

We use an augmented production function approach to examine the relationship between disaggregated energy consumption by fuel type and economic growth in Malaysia. The main finding is that diesel is the major contributor to economic growth in the long run in Malaysia. The long run elasticity for diesel is 0.4, which is similar to our finding for total energy consumption. The problem for Malaysia is that diesel is a major cause of acidification and greenhouse emissions and that Malaysia's reserves of oil are depleting. The results for diesel suggest that the challenge moving forward for Malaysia will be to replace diesel with cleaner biodiesel alternatives, while not adversely affecting Malaysia's current high rate of economic growth. The prospects for so doing, and measures taken thus far in Malaysia, are discussed.

1. Introduction

Increasing attention is being given to changing the energy mix in developing countries. The rationale for this attention is predictions by the International Energy Agency that energy consumption will increase by 53 per cent by 2030 and that 70 per cent of the growth in consumption will happen in developing countries [1]. The purpose of this paper is to consider the relationship between disaggregated energy by fuel type and economic growth in Malaysia within an augmented growth model framework. Malaysia is an interesting case for such a study. On the one hand, it has an enviable record of economic growth, which has made it a "poster child" of the East Asian region [2]. However, in terms of depleting fossil fuels, fluctuating oil prices and addressing air pollution, Malaysia is confronting many of the same problems as other developing industrialized countries [3–6].

In Malaysia, high economic growth has been on the back of increasing energy consumption. Malaysia is largely dependent on fossil fuels for energy. Malaysia has one of the highest rates of greenhouse gas emissions in the world with a 7.9 per cent compounded average growth rate over the period 1990–2006. In the fifteen year period from 2005 to 2020, emissions of greenhouse gas in Malaysia are predicted to rise from 189 million tonnes to 382 million tonnes of CO2e [6]. This means that Malaysia is now grappling with how to address climate change.

A common objective of energy policies around the globe has been to ensure secure, diverse and stable supplies of energy in a cost effective manner [7]. In order to address climate change, globally this objective has increasingly focused attention on ways to promote renewable energy sources [8–10]. Malaysia is pursuing similar policies to other countries in terms of attempting to reduce reliance on fossil fuels and promoting renewable and alternative energy sources as a means to alter the energy mix. These policies are reflected in Malaysia's energy development framework via its National Energy Policy 1979, National Depletion Policy 1980 and Fuel Diversification Policy (see e.g. [3–5,7]). While Malaysia is relatively blessed in terms of renewable energy sources – along with Indonesia, the Philippines, Thailand and Vietnam it is one of the few ASEAN countries with most types of renewable energy- renewable energy targets remain small

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relative to fossil fuel consumption. The challenge Malaysia faces to first realize, and then increase, renewable energy targets is similar to other countries in the global community (see e.g. [11,12]).

Some recent research has used panel models to study the relationship between energy consumption and economic growth. Our focus, however, is on a single country. The limitation of using data on a panel of countries is that such studies are unable to account for the issues facing specific countries. Thus, the conclusions drawn can only be of a general nature and are unlikely to be of much practical relevance when formulating policy in specific countries. This applies *a fortiori* when the focus is on disaggregated energy by type. The advantage of focusing on a specific country is that it provides more opportunity to draw policy implications that are of specific relevance to that country. A further obstacle to using panel data with disaggregated energy is that the categorization of different types of energy is likely to differ across countries, limiting the number of comparable energy types.

The addition to the literature to understanding the relationship between energy consumption and economic growth in Malaysia is that we focus on disaggregated energy by type and employ an augmented growth model in the same study. Most extant studies of this sort for Malaysia use aggregate energy consumption, or electricity consumption, and do not use a growth framework [2,13–28]. Lean and Smyth [29] use an augmented growth framework, but not consider disaggregated energy by fuel type. Saboori and Sulaiman [30] use disaggregated energy, but do not use an augmented growth framework. This is the first study on Malaysia to examine the relationship between disaggregated energy by fuel type and economic growth using an augmented growth framework.

Using disaggregated energy by fuel type is important for the following related, reasons. Aggregate data on energy does not take into account the degree to which specific countries utilize a range of different types of energy [31]. With aggregate data, one is not able to examine the extent to which particular types of energy contribute to economic growth [32]. Finding, or failing to find, a relationship between aggregated energy consumption and economic growth, might mask nuanced relationships between specific energy types and economic growth. Knowing the relationship between aggregate energy consumption and economic growth is of little value to policy makers when it comes to thinking about the contribution that different components of the energy mix make to economic growth. At the same time, it is the contribution different types of energy make to economic growth which is important when it comes to thinking about the efficacy of alternative energy sources.

Using an augmented growth framework is important because use of a bivariate framework results in omitted variable bias. To be specific, bivariate tests may fail to detect a relationship between energy consumption and economic growth because of substitution effects between energy consumption and capital and labor as other inputs in production [33,34]. Some studies have attempted to address omitted variables bias by the inclusion of *ad hoc* variables in a multivariate setting. The problem with such an approach, though, is that it is essentially a theoretical as there is no underpinning framework guiding variable selection. The advantage of using a production function approach is that it recognizes disaggregated energy by type as inputs in the production process and allows one to ascertain the marginal effect of each energy type on output, holding other inputs constant [33].

2. Malaysian context

In the mid-1980s the Malaysian government implemented the Industrialization Plan, which moved the country's economic focus from agriculture to manufacturing and services [35]. For the last three decades Malaysia has experienced high rates of economic growth, but it has also had high rates of energy consumption. Fig. 1 shows final energy demand by fuel type in Malaysia from 1980 to 2011. Over this entire period, diesel (29 per cent), motor petrol (22 per cent) and electricity (16 per cent) were responsible for about two-thirds of Malaysia's final energy demand.

Fig. 2 shows final energy demand by sector in Malaysia over the period 1980–2011. The industrial and transport sectors represent almost four-fifths of the final energy demand in Malaysia, with residential and commercial a distant third. The main sector applications/uses for the specific fuel types used in this study are as follows: Aviation turbine fuel (ATF) and aviation gasoline(AV gas) – industrial and transport; coal and coke – industrial; diesel – industrial and transport; electricity – industrial, residential and commercial, and agriculture; natural gas – industrial, residential and commercial; kerosene – industrial, residential and commercial; liquefied petroleum gas (LPG) – commercial, residential, industrial and transport; fuel oil – residential and commercial, industrial and agriculture; and motor petrol – industrial, transport and agriculture.

Fig. 1 masks substantial change in the energy mix over these three decades. At the beginning of the 1980s Malaysia was primarily reliant on oil for its energy supplies. At this time, the Malaysian government made a conscious attempt to move away from its heavy reliance on oil, implementing the four-fuel diversification strategy. As a result, consumption of natural gas and coal has increased at the expense of oil. In 1980, diesel and pol made up almost 90 per cent of Malaysia's energy consumption. On the other hand, coal accounted for just 0.5 per cent and natural gas just 7.5 per cent of energy consumption in Malaysia. This situation had reversed by 2010; coal and natural gas together represented in excess of 90 per cent of energy consumption and consumption of diesel and oil was negligible [1]. Almost all of Malaysia's electricity comes from fossil fuels, with coal, on its own, responsible for generating almost one-third of Malaysia's total electricity consumption [5].

Looking to the future, Malaysia's primary demand for energy is expected to triple by 2030 [36], reflecting growth in living standards – evidenced, for example, in expansion of the ICT and transport sectors – and further expansion of the manufacturing sector [3,37]. Most of the growth in energy consumption is expected to come from fossil fuel consumption, which has raised concerns about the effect of Malaysia's growth on the environment.

This expectation has focused the attention of policy-makers on the viability of alternative energy sources to fossil fuels. The Ninth Malaysian Plan (2006–2010) endorsed the need to consider cleaner

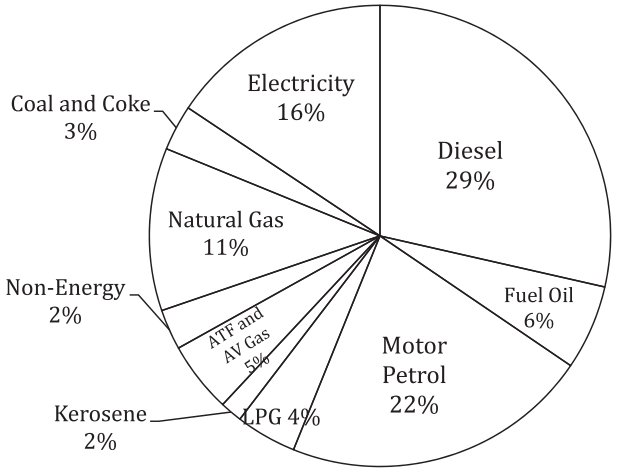

Fig. 1. Final energy demand by fuel type 1980–2011.