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Causality-in-mean and causality-in-variance among electricity prices, crude oil prices, and yen–US dollar exchange rates in Japan

Tadahiro Nakajima^{a,1}, Shigeyuki Hamori^{b,*}

^a *The Kansai Electric Power Company, Incorporated 6-16, Nakanoshima 3-chome, Kita-Ku, Osaka 530-8270, Japan*

^b *Faculty of Economics, Kobe University 2-1, Rokkodai, Nada-Ku, Kobe 657-8501, Japan*

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ABSTRACT

In this study, we test the Granger-causality-in-mean and Granger-causality-in-variance among electricity prices, crude oil prices, and yen-to-US-dollar exchange rates in Japan using a cross-correlation function approach. We find Granger-causality-in-mean from neither the exchange market nor the oil market to the power market; the same was true of Granger-causality-in-variance, although both the exchange rates and oil prices greatly influence power generation costs in Japan. We suspect the efficiency of this market is at play.

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1. Introduction

Since the end of the twentieth century, the electric-power industry in Japan—like its counterparts in the United States and the industrialized nations of Europe—has undergone deregulation. However, until recently, the regional monopoly over power generation, transmission, and supply, which was under the control of 10 regional power utility companies, had been legally permitted for a number

* Corresponding author. Tel.: +81 78 803 6832; fax: +81 78 803 6832.

E-mail addresses: nakajima.tadahiro@a4.kepco.co.jp (T. Nakajima), hamori@econ.kobe-u.ac.jp (S. Hamori).

¹ Tel.: +81 6 6441 8821.

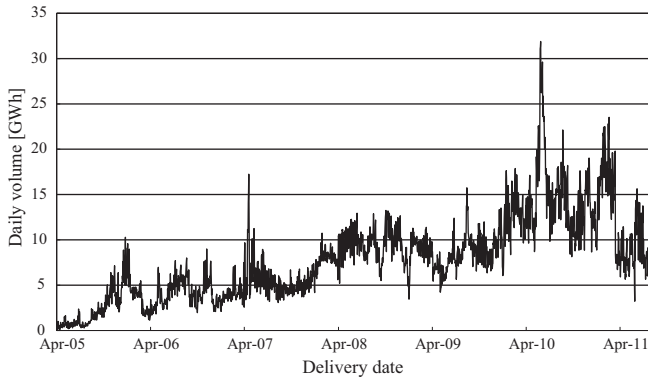


Fig. 1. Time-series plots of the trading volumes of the [Japan Electric Power Exchange](#).

of years. With the amendment of the Electricity Utilities Industry Law in 1995, new entrants were permitted to conduct electric power generation activities in Japan, and businesses began supplying electric power to power utility companies as wholesale traders. In 1999, the Electricity Utilities Industry Law was revised once again to permit the partial liberalization of the power retail supply for extra-high voltage users of 20,000 V or more and a usage scale of 2000 kW or more. The Law was repeatedly reformed in 2003, and the scope of liberalization was expanded twice by enforcing the Law once in 2004 and subsequently in 2005 through a usage scale of 500 kW or more and 50 kW or more, respectively. As liberalization policies evolved, the [Japan Electric Power Exchange](#) was established, and trading in wholesale electric power was initiated in April 2005. The purpose of this endeavor was to ensure fair competition and invigorate the business of transmitting and distributing electric power on a nationwide basis. As shown in [Fig. 1](#), trading activity has gradually increased, with the total contract volume (5501 GWh) in fiscal year 2010 (April 2010 to March 2011) exceeding that (938 GWh) in fiscal year 2005 (April 2005 to March 2006) by 5.9 times. Spot and forward markets have been established at this exchange.²

The futures price for Dubai–Oman is considered the benchmark in the Asian crude oil market. However, since this crude oil is unsuitable for fueling electric power plants, Japan imports light sweet crude—which is appropriate for this use—from Indonesia, Vietnam, Sudan, and Gabon. In the North American market, the key crude oil price indicator is the futures price of West Texas Intermediate (WTI) crude oil, and in the European market, the price of Europe Brent crude oil is considered the benchmark; both types of oil are light sweet. WTI crude oil spot prices reflect demand, supply, and savings in the United States, because WTI’s full volume is consumed domestically. In contrast, Brent crude oil is exported, and so the economic conditions of not only Europe but those of Asia and Africa influence Brent spot prices.

According to the survey conducted by the [Federation of Electric Power Companies of Japan](#), during fiscal year 2009 (i.e., April 2009 to March 2010), the types and proportions of primary energy sources used by Japan’s electric utilities (general and wholesale) for generating electricity were as follows: hydro power, 8%; oil, 7%; natural gas, 29%; coal, 25%; nuclear, 29%; and geothermal and new energy, 1%. This means that approximately 90% of Japan’s power was produced from imported fuels. Moreover, nearly all imports of fuels for power generation were denominated in US dollars through long-term contracts, while the oil fuel was often procured through the spot market.

In the United States, the United Kingdom, Belgium, and the Netherlands, the price of natural gas is determined according to the hub approach, under which prices are based on demand and supply conditions. In contrast, Japan links the prices of natural gas to a crude oil benchmark; this practice

² In this section, information pertaining to Japan’s electricity consumption and related policies has been obtained from [Nakajima \(2010\)](#), the website of the [Federation of Electric Power Companies of Japan](#), and the website of the [Japan Electric Power Exchange](#).

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