CAUSALITY BETWEEN THE PRICES OF MAIN PRODUCT AND BYPRODUCT: METALS USED FOR THIN-FILM PV CELLS

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Overview

Solar power is one of the most promising renewable energy sources. The energy source of solar power is almost limitless and it does not produce much pollution. Among the solar power, photovoltaic cells are devices which convert sunlight directly into electricity. As the concerns related with renewable energy grow, photovoltaic cells are likely to be an important source of electricity. Thin-film cells, also known as second-generation photovoltaic cells, are in growing phase. Unlike currently dominant silicon-based photovoltaic cells, thin-film cells is light and easy to carry. The market for thin-film cells is not mature yet. This situation can work as a chance for high-tech based Asian countries.

Thin-film cells need specific metals according to the types of the cells. For example, CIGS(Copper-indium-gallium-selenide alloy) cells need metals such as copper, indium, gallium and selenium. Cadmium, tellurium and germanium are required to produce other types of thin-film cells. Enen though only small quantities of the metals are included in a cell, they play a critical role. The metals mentioned above are produced as a byproduct, except for copper.

Joint production is a typical feature of mining industry. The results of joint production are main product, byproduct and coproduct according to their economic importance. A main product is the most important, so the price of a main product affects the output of a mine. When two or more metals have influence upon mine output, they are called coproducts. On the contrary, a byproduct has no power on mine output. Supply of a byproduct is dependent upon the main product. That is, maximum amount of a byproduct is restricted by the output of the main product. As a result, supply function of a byproduct includes supply or price of the main product(Tilton, 1985). It is commonly believed that the price of a main product affects supply of the byproduct and have further influence on price

This study analyzes how the price of a byproduct is related with that of a main product using causality model. There are many studies analyzing causality of metal prices. However, there exists almost no empirical study dealing with the relationship of the prices focused on the product type of the metals. This study will provide an empirical result based on the context of joint production.

Methods

Applying regression using OLS to analyze time-series data, spurious regression may occur. Spurious regression is a regression in which significant correlation is found among independent variables. To prevent this problem, stationarity of should be identified in advance. In this study augmented Dickey-Fuller test(Said and Dickey,1984), Phillips-Perron test(Phillips and Perron, 1988) and KPSS test(Kwiatkowski et al., 1992) are conducted to check stationarity. Once a time-series is found to be non-stationary, it is strongly recommended to avoid basic OLS. Even if individual time-series are non-stationary, linear combination may be stationary. In this case, the time series are said to be cointegrated and the cointegration represents long-run equilibrium. When two series are cointegrated, there exists an error correction representation(Engle and Granger, 1987). The system can be written as

$$\Delta y_t = \alpha \ + \gamma(y_{t-1} - \beta x_{t-1}) + \sum \delta_i \Delta x_{t-i} + \sum \theta_i \Delta y_{t-i} + \varepsilon_t$$

where y denotes the price of the byproduct, x the price of the main product. The coefficient on $(y_{t-1} - \beta x_{t-1})$ measures how fast x and y revert to long-run equilibrium.

Expected Results

The price of a byproduct is expected to be caused by the main product. On the premise that demand for byproduct metals does not change drastically, supply would be major factor in price setting. Production of byproduct and main product is closely related. In this context, it is likely that the prices have close relationship, too. Furthermore, prices are thought to change in opposite direction. Higher price of a main product provokes an increase in production. As the production of a main product increases, so does by product. Demand being unchanged, increase in supply would reduce the price.

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