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A Decade of Reforms in the Philippine Power Sector: A Price-Concentration Analysis on the Whole Sale Electricity Spot Market

John Lourenze S. Poquiz
University of Santo Tomas, Manila, Philippines
johnlorenzp@gmail.com

The Philippines has one of the highest power rates in Asia, second only to Japan. This remains true even though it has been more than ten (10) years since the country engaged in a comprehensive liberalization of the power industry, through the legislation of the Electric Power Industry Reform Act (EPIRA). The rationale for the EPIRA is to introduce competition in power sector by selling the assets of the National Power Corporation (Napocor). It was expected that competition would bring about efficiencies in the power industry and ultimately ease the price of electricity. Majority of the Napocor assets have been sold to private firms since the signing of the EPIRA but whether or not privatization was able to lower power rates remains questionable. This paper uses the structure-conduct-performance paradigm to evaluate the price effects of privatization. Regression analysis was used to determine whether changes in market concentration had a significant effect of the price of power in the Whole Sale Electricity Spot Market (WESM) from 2006 to 2010. The Herfindahl-Hirschman Index (HHI) was estimated for each month covered by the time period of the studied and the market concentration was assessed using the HHI. The results suggest that the changes in market concentration had no significant effects on electricity prices from 2006 to 2010. The study also concludes that situations wherein the supply of power is tight could allow prices in the WESM to rise.

JEL Classifications: D00, L12, L13, L41, L52

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A study by International Energy Consultants placed the country's average residential power rates at $0.18 per kWh, higher than the rates of Japan at $0.17 per kWh, Singapore's $0.16 per kWh, Thailand's $0.09 per kWh, Malaysia's $0.07 per kwh, Indonesia's $0.06 per kWh, and Vietnam's $0.04 per kWh (Mercado, 2011). Because of high power rates, foreign investors have been reluctant to invest in the country. The Philippine Exporters Confederation, Inc. said in a report that investors would rather put up their manufacturing facilities and business centers in countries like Thailand and Vietnam where electricity rates are lower to save operating costs. This remains true even though it has been 12 years since the country engaged in a comprehensive power sector reform aimed at improving industry competitiveness.

Most countries have liberalized their electricity markets. In a liberalized power sector, the private firms control most, if not the whole, market. The selling point of these reforms is the promise of lower electricity rates as a result of competition and continues private sector investments (Swadley & Yücel, 2011). Usually, the reforms involve the unbundling of the whole power system, privatization of the transmission grid operator, establishment of a regulatory body, and the creation of a wholesale electricity spot market, where generators can trade the "*uncontracted*" electricity they generate. The goal of the reforms is to introduce competition so that efficiencies could set in, incentivizing firms to produce close to marginal cost, and effectively result into a more competitive industry. Chile in 1972 was the first country to liberalize its power industry. Other Latin American countries followed the trend (Nagayama, 2007). Developing countries in Asia and Arab nations were relatively late in the implementation of reforms (Joskow, 1997; Nagayama, 2007; Jamasb & Pollitt, 2005; Hattori & Tsutsui, 2004).

The Philippines found it necessary to restructure its electricity supply sector to keep up with international power industry trends and resolve the government's financial difficulty in maintaining a capital-intensive business. The Electric Power Industry Reform Act (EPIRA) was signed in 2001. The law was intended to address: 1) the absence of consumer choice; 2) relatively high electricity rates; 3) a highly fragmented distribution sector; 4) uncertainty of funding resources; and 5) lack of incentives for investors to operate more efficiently (Villameron-Mendoza, 2008). One of the major goals of the EPIRA is to break down the monopoly of government in the electricity sector and introduce competition. The Power Sector Assets and Liabilities Management Corp. (PSALM) was created to sell the state's power assets and relinquish the market dominance from the government. It was believed that in a competitive private sector-led electricity industry, efficiencies would set it and ultimately result to a downward pressure on power rates.

The liberalization of the power market does not always result to cheaper electricity. The United Kingdom is among the first European countries to liberalize its power industry in the mid 1990s. Studies have shown that England and Whales encountered several problems because of market power in the generation sector (Green & Newbery, 1992; Joskow, 1997 Wolfram, 1999; von der Fehr & Harbord, 1993.) According to the studies, the UK spot market was highly concentrated even after the reform, allowing the three power generators to exercise strong market power, resulting to generally high power rates.

This study seeks to find out whether the changes in market concentration, as a result of privatization, had a significant effect on electricity prices in the Luzon Wholesale Electricity Spot Market (WESM). The level of privatization in Luzon and Visayas is at 85% (Department of Energy, 2011). As of 2006, the year when WESM started commercial operations, majority of power generation was under the control of

the government through PSALM and National Power Corporation. Because of privatization, by the end of 2010, the market share jointly held by PSALM and Napocor shrunk to only 21%, considerably lower compared with the 78% in 2006. It can be assumed that market concentration has significantly eased since 2006. This study evaluates whether the change in market concentration had a significant effect on power rates, particularly in the wholesale level.

The study uses time-series data from 2006 to 2010. The only existing electricity spot market in the Philippines during the time that would be covered by the study is the Luzon WESM. Even though WESM-Visayas is currently running, the commercial operations of that said market only started in December 26, 2009. The maturity of WESM-Luzon provides enough data to assess the result of the power market reforms in the country.

THE RATIONALE FOR POWER INDUSTRY REFORMS

Before the 1980s, power generation was a business almost exclusively handled by the governments through state-owned enterprises (Sioshansi, 2005; Nagayama, 2007) and the whole power supply chain was vertically integrated (Nagayama, 2007). The power supply industry can be functionally segmented into three parts: generation, transmission, and distribution. The generation sector is where power is produced using fuel sources like running water, nuclear fission, wind currents, and petroleum combustion among others. Distribution is the segment that delivers electricity to household and industrial end-users through low-voltage lines. Transmission, meanwhile, entails the delivery of power from the power generators to distribution utilities through high-voltage cables. The vertical integration of generation and transmission was seen to have its benefits (Nagayama 2007; Sioshansi, 2005).

The dominance of state-owned enterprises in electricity industries caused problems worldwide. In the 1970s, national debts from the development of power infrastructures began ballooning and inefficiencies started to plague electricity supply networks. Power companies who enjoy the benefits of monopoly were rewarded through a return-on-rate-base scheme. Under this mechanism, utilities gain incentives in the form of rate increases and collections for the investment they pour into their assets. This led to over investment or "gold plating," unless prevented by regulators (Sioshansi, 2005). State-owned enterprises have also been criticized for being heavily influenced by political pressure. This led to subsidies causing price discrepancies in some countries. It became hard to determine the cost components in unbundled power systems (Sioshansi, 2005).

According to Sioshansi (2005), major breakthroughs in technology and organizational innovations paved the way to the restructuring of electricity supply industries, thus solving the dilemmas earlier mentioned. Gas turbines made it easier for the private sector to invest in power generation. Investors can put up small generating units with little risk involvement. The generation sector, which used to be dominated by large-scale, capital intensive assets, welcomed the entry of scalable power producers, who can come in to the industry even without long-term contracts. Regulators around the globe also made it easier for private firms to enter the industry, with more lenient policies. With the cost-efficient technology and the regulatory framework in place, independent power producers started emerging and began to compete with the incumbent (Sioshansi, 2005).

THE STATUS OF ELECTRIC POWER INDUSTRIES

A study by Fehr and Harbord (1993) showed that reforms implemented by the UK during the 1990s were not able to push down power rates in Britain's spot market. According to the study, the presence of strong market concentration held by three firms in the UK spot market allowed the generators to sell power significantly above marginal cost. The power producers typically choose bids above marginal cost.

Sarvi (2007) devised a conjectural variation model for the Nordic electricity market. The model analyzed some scenarios using 2006 data. According to the study, electricity prices tend to decrease and supply tends to increase when there are more firms in the power market. Competition is estimated to be the highest in Finland and lowest in Denmark. Shukla and Thempy (2011) hypothesized that market power is the reason why price levels at the wholesale electricity spot market in India rose after industry liberalization. The study points out that market concentration in India was highly concentrated based on US standards. The study also shows that each generator in India functions as pivotal suppliers, which would allow the firms to exert market power. A pivotal supplier is a unit that is necessary to run in order to meet the system's demand at any given time. Functioning as pivotal supplier would allow generation companies to exert market power. According to the study, price-cost markup of generating firms increased from 2004-2005 to 2006-2007, an evidence of the market power exercise. The study suggests that the Indian government divests its power assets since majority of power generators in the region is still controlled by the government (Shukla & Thempy, 2011).

Borenstein, Bushnell, and Wolak (2002) used data from 1998 to 2000 for the examination of market power in California. The study computed for an expected perfectly competitive price of the California spot market and compared it with actual market prices. The research found the estimated marginal cost of generation was above the actual market prices by June 1998, when the market was still in its third month of operation. Between the months June 1998 and October 2000, margins were 33 & above the competitive levels. According to the study, market power is greater when power demand is high (Borenstein, Bushnell, & Wolak, 2002).

Nagayama (2007) analyzed the relationship between power industry reforms and efficiencies. His study examines the impact of the restructuring taken by 83 countries, 20 from Latin American, 26 from the former Soviet Union and Eastern Europe, 11 from developing economies in Asia, and 26 developed countries. The study tried to determine the price effects of the presence of wholesale and retail competition, the establishment of independent regulators, and the presence of IPPs, the unbundling of the power system, and the privatization from the period 1985 to 2002. Nagayama (2007) found that the presence of IPPs resulted in the lowering of industrial power prices in countries in the former Soviet Union. The result is not the same for Asia and Latin American countries. Nagayama (2007) theorized that since IPPs forced governments to engage in expensive long-term contracts, the end result is an increase in the price of power. The study also showed that the introduction of a wholesale power market caused residential power prices to go down in the Soviet Union and European countries. However, in Latin American and developing countries, the wholesale market caused prices to go up. The study showed that retail competition caused both residential and industrial power prices to go down in the Soviet Union and European countries but it raised industrial electricity prices in Latin America. Nagayama's (2007) study showed that the unbundling of the generation and transmission segments of the industry resulted in an increase in electricity prices in the Soviet

Union and developed countries, contrary to the expectation of the research. According to the study, privatization resulted in the lowering of industrial prices in developed countries and residential prices the Soviet Union. Meanwhile, the privatization was shown to increase residential prices in developing countries.

Hattori and Tsutsui (2004) used panel data to assess the impact of regulatory reform for 19 member countries in the Organization for Economic Co-operation and Development (OECD). The study found out that retail competition is likely to reduce industrial power prices. At the same time, this variable created a disparity between the price of power being sold to the industrial sector and residential end users. The study also found out that the unbundling of the generation and transmission sector does not have a significant effect on power prices. The study further found that the establishment of a WESM does not have a negative impact on power prices, and may actually increase rates (Hattori & Tsutsui, 2004). Steiner (2000), who also used a panel data analysis on 19 OECD countries, tested the regulatory environment, the degree of vertical integration and private ownership, and their impact to efficiency and power rates. The study found out that there is no significant relationship between unbundling and on price levels. Coefficients for competition were found to be significant in affecting prices. The study also found out that the existence of the WESM can result in lower prices.

THE PHILIPPINE POWER INDUSTRY REFORM MODEL

The Electric Power Industry Reform Act of 2001, the first bill signed into law by President Gloria Macapagal-Arroyo, is perhaps one of the most sophisticated reform policy legislated in the Philippines. It involves the unbundling of the of the Philippine power supply network, the creation of an independent regulator—the Energy Regulatory Commission—the privatization of the government's transmission and generation assets, the setting of market caps to prevent the market dominance of firms, the establishment of a wholesale electricity spot market, and a provision for open access and retail competition. The goal of the reform is to reduce the role of the government in the power business to market monitoring. The ERC was put into place to ensure a leveled playing field and to protect consumer welfare from the potential abuses of private firms (Santiago & Roxas, 2010; Villamejor-Mendoza, 2008; Valderrama, 2007).

Prior to the signing of the EPIRA, the debt burden carried by Napocor, the state-owned power utility that used to hold the monopoly in power generation and transmission, stood at P672 billion. With such a level of financial liabilities, the government is unable to carry out the expansion of its generating facilities. By selling Napocor's generation and transmission assets, the government aims to generate enough funds to pay the utility's debts (Santiago & Roxas, 2010).

It was believed that once competition is introduced in the electricity sector, efficiencies would set in and ultimately put a downward pressure on power prices (Mendoza, 2008). The EPIRA also created provision for establishment of competition in both the wholesale and retail levels. Competition was theorized to result into improved operating efficiencies and ultimately lower power rates. The law also created the WESM, where electricity can be traded. All distribution utilities were required to source at least 10% of their power requirements from the WESM. To safeguard against the abuse of monopolistic behavior, the EPIRA set a market cap (Santiago & Roxas, 2010). The law prohibits any company or related group from owning, operating, or controlling more than 30% of the installed generating capacity of a grid and/or 25% of the national installed generating capacity. Napocor plants and those managed by

the PSALM were exempted from the limits on concentration of ownership, operation, or control of installed capacity at this time the said plants are being privatized (Danao, 2009).

THE WHOLESALE ELECTRICITY SPOT MARKET

At the heart of the EPIRA is the WESM. WESM is a venue where electricity made by power-producing companies are centrally coordinated and traded like any other commodity in a market of goods in a level playing field. Prices are driven by supply and demand from buyers with the objective of giving the best price for consumers of electricity including the end-user (Baillo, Ventosa, Rivier, & Ramos, 2004). The pool was created to introduce competition in the generation subsector of the power industry (Danao, 2009). All generators are required to sell power to the spot market and all suppliers (distribution utilities) are required to source at least 10% of their power requirements from it. Distribution utilities are allowed to source up to 90% of their power supply from bilateral contracts with generators (WESM Rules, n.d.). This system allows power distributors to hedge against price volatilities through negotiated supply contracts (Danao, 2009).

PRICE DETERMINISM SCHEME AT THE WESM

The generators would be made to offer volumes and price the "uncontracted" electricity they generate. Trading sessions are done every hour. The market operator forecasts the peak demand for every session while the generators offer output at a set price. The dispatch of electricity would be arranged in terms of prices (merit order). The generator with the lowest offer price would be dispatched first followed by the generator with the second lowest offer price, and so on, until the demand is met by the offers. The last price to enter the market is the "market clearing price," or the price to be taken by all participants for the trading session. This mechanism aims to incentivize generators to produce efficiently, or at the lowest cost, in order for the power they have generated to be dispatched. Trading participants are price takers in the WESM (Danao, 2009; Baillo, Ventosa, Rivier, & Ramos, 2004; WESM Rules, n.d.).

MARKET POWER IN THE PHILIPPINE COMPETITIVE POOL

Market power has been the main argument for many anti-trust legislations. It is believed that the exercise of market power could lead to excess profit for firms and burdens consumers with high prices. In the Philippines, the EPIRA provides that no firm could control 30% of the installed capacity of any of the regional grids (Luzon, Visayas, and Mindanao) and 25% of the installed capacity in the national grid, or either, (Epira IRR, 2002) to avoid the exercise of market power. But the effectiveness of this market cap in preventing market power exercise has yet to be empirically evaluated. There has been very little research aimed to evaluate the exercise of market power in the Philippine power industry.

Valderrama (2007) used 2004 installed capacity data, instead of actual sales, to estimate the market concentration in the Luzon, Visayas, and Mindanao grids. The study also computed for the supply margins and compared it to the market's surplus capacity above peak demand for each grid. The study suggests that when the supply margin is low, some firms tend to function as pivotal suppliers and exercise market power. The Luzon and Mindanao grids were unconcentrated and the Visayas grid was moderately concentrated, based on standards used by the US Department of Justice (Valderrama, 2007). However, the study

used the installed capacity of each generation facility to calculate the market concentration ratio, and did not consider consolidating the market shares of all the power plants owned by the government. Had this been considered, the market concentration ratio during the time of the study could have been higher since the government controlled 90% of the generation capacities at the time period covered by the study. The study also shows that some power plants, particularly the Tongonan Geothermal Plant in the Visayas and the Agus-Pulangi Hydroelectric Power Plants in Mindanao, generate capacities substantially above the supply margins of their respective grids. The study remarks that these plants would have the capacity to exert some degree of market power because their generation output was critically required in order to meet the peak demand (Valderrama, 2007).

In a more recent study, Danao (2009) argued that the market should be regularly monitored to detect the exercise of market power. Danao used the Herfindahl-Hirschman Index to detect the potential for market power exercise in the Luzon grid. His study also used the Pivotal Supplier Indicator to support conclusion that could be derived from the market concentration estimates. According to Danao, as of 2008, the government remains to be the dominant electricity player in the market. About 71% of the capacities registered at the WESM were controlled by the government, through PSALM (55%) and Napocor (16%) as of 2008. The research estimate points to a highly concentrated market. The government has been selling its generation assets since the signing of EPIRA. There were delays in the privatization process, which according to Danao (2009), led to a highly concentrated market at the end of the period covered by his study. The study also points out that large power firms function as pivotal suppliers during peak demand, the time of the day when electricity consumption is the highest. Power plants with large generation capacities such as the Ilijan Gas-Fired Power Plant of the Kepco Philippines Corp. and the Sta. Rita Natural Gas-Fired Power Plant of First Gas Corp. were found to be pivotal suppliers at 53.6% and 53.8% of peak hours in 2007, respectively. When reserve levels are thin, even small power generators like the Masiway Hydroelectric Power Plant can function as a pivotal supplier. The study also reveals that in 2007, only 47% of the average capacity registered at the WESM has been offered in the pool (Danao, 2009). This research raises the question on whether or not the large unoffered capacity had a significant effect on prices.

Many developments have occurred since the study of Danao. About 85% of the government's generation capacity in Luzon and Visayas had been sold to the private sector. Only 19% share of the generating capacity at the national level is still under the control of the government through Napocor and PSALM (Department of Energy, 2011). One can assume that market concentration has changed significantly since the periods covered by the previous studies. EPIRA took a long time to be fully implemented. It took more than 9 years before the Philippine government was able to successfully auction majority of its generation assets. This study aims to find out if the change in market concentration over time affected the price of electricity. Monthly data on WESM prices, and market share from 2006, the time WESM started commercial operation, to 2010 were gathered. The market shares of each IPP were used to compute for the market concentration ratios.

STRUCTURE-CONDUCT-PERFORMANCE MODEL

This study employs the structure-conduct-performance (SCP) paradigm to explain the relationship between the energy price and market concentration in the WESM. The SCP paradigm was first published by Edward Chamberlin and Joan Robinson and was a popular approach in

evaluating competition during the 1940s up to the 1960s (Perloff, Karp, & Golan, 2007) The model was developed by Manson (1939, 1949) and Bain (1956). The SCP approach essentially involves the examination of competitive conditions in an industry by analyzing the market structure and establishing its effects on market conduct and performance (Ahmad & Shamsudin, 2008). It provides indirect evidence to collusive and competitive behavior, or either. The framework has been used to assess the effects of corporate mergers on prices and profitability. Many anti-trust policies were legislated using this theory as empirical basis. The SCP approach has been used to analyze industries such as gasoline (Oxedine, 2005), banking (Shaffer,1994; Liu & Zhang, 2008; Chortareas et. al., 2011), food manufacturing (Lirón-España & Lopez, 2005), hospital markets (Dranove, 1993), grocery retailing (Newmark, 1990), media industry (Fu, 2003), among others.

In the SCP framework, the performance of an industry is assumed to be dependent on the conduct of sellers, which is dependent on the structure of the market. Likewise, the success of the industry in providing benefits to consumers is also dependent on the structure of the market. The theory assumes that market structure determines the conduct of the firms, which in turn determines the performance of the industry (Golan et al., 2007). Usually, the first step in this analysis is to identify measures of market performance and market structure. Second is for the researcher to apply regression analysis on the measures of performance and market structure (Golan et al., 2007). Variations in market performance are assumed to be a function of the variations in market structure measures:

$$\mathbf{MP = f(MS,Z)} \quad (1)$$

Where: MP = measure of market performance
MS = measure of market structure
Z = other factors

Ahmad and Shamsudin (2008) defined market structure as particular organizational characteristics of a market that establish relationship between the buyer and the seller of homogeneous product. Typically, economists summarize the structure of the market by the number of sellers in the market and the size of the firms relative to the size of the market, or either. It is assumed that a firm could exert greater market power when there are less firms competing with it or if the firm's competition hold smaller market shares relative to the market share of the firm. In SCP studies, market concentration, as the function of the market share of some (if not all) firms in the industry, is the most commonly used variable to represent market structure (Golan et al., 2007). The intention of SCP studies is to assess whether market power is exercised by firms on certain industry. The exercise of market power can manifest in two ways: high rates of return and high prices.

Some SCP studies used market returns to represent market performance. The use of market returns as an endogenous variable in an SCP paradigm assumes that firms tend to earn more in a highly concentrated market. A direct relationship is assumed between market concentration and market returns (Golan et al., 2007). Some economists raised concerns about the use of this variable to represent market performance. According to Goldan et al. (2007), estimating the rate of return is usually problematic. Eight reasons were cited on the difficulty of estimating the rate of return: 1) accosting cost is used instead of economic cost; 2) depreciation is measured improperly; 3) the valuation of advertising gains and research and development are often confronted with problems; 4) the rate of return may not be properly adjusted for risks; 5) estimation does not usually involve the cost of money; 6) adjustments to inflation must be made; 7) monopoly profit may be inappropriately included in the calculated rate of return because of the use of book value in the estimations, and; 8) taxes are often not factored in (Golan et al., 2007).

To avoid this problem, most researchers have used price levels to represent market performance (Newmark, 2006; Golan et al., 2007).

It is a widely accepted paradigm of industrial organizations that price and cost are lower in a less concentrated market. Classical microeconomic theory tells us that competition tends to cause prices to dip (Pindyck & Rubinfeld, 2005). In a highly competitive market, firms tend to lower the selling price of their products to match the prices being offered by the other firms they are competing with. Often, firms produce at marginal cost to survive competition. The greater the number of competing firms in a market, the more competitive it is, the greater the pressure for prices to go down (Pindyck & Rubinfeld, 2005; Stiglitz, 2000).

RESEARCH PARADIGM

While it is generally accepted that competition can exert downward pressure on prices, its applications in studies covering electricity markets have rarely been explored. As mentioned in the literature, results from such analysis are not consistent. This study estimates an SCP model to examine the relationship between market concentrations in the WESM against the market clearing prices. The WESM is an excellent area to examine, since in this venue, the most cost competitive generator is hypothetically given incentive to produce by having its output dispatched. The market clearing price in the WESM would be used to represent market performance while the Herfindahl Index, a measure of market concentration, would represent market structure. The variation of market concentration is assumed to be derived from privatization. The other factor that was controlled for would be reserve levels, which, according to the literature, allow power firms to exert market power in a setup such as the WESM. A model is designed to capture the assumptions of the study where the level of prices in the WESM is determined by market concentration and the level of reserves in the grid. It is given as follows:

$$\mathbf{P_w = f(MC, [S\text{-}D])} \quad (2)$$

Where: Pw = wholesale electricity spot market prices
MC = degree of market concentration using the Herfindahl index;
(S-D) = excess supply or reserves

This study will assume a direct relationship between market concentration and electricity prices, so as to be consistent with the SCP theory. Following this logic, the coefficient for market concentration is expected to be positive. Previous studies suggest, even small generators are able to function as pivotal suppliers when reserve levels are thin, which would allow the firm to sell significantly above marginal cost (von der Fehr & Harbord, 1993; Danao, 2009 Shukla & Thempy, 2011). The tightness in electricity reserves during those periods could push the price of power in the WESM upward. To capture this phenomenon, this study incorporated reserve levels (S-D), as a variable which could affect WESM prices. Reserve levels or excess supply would be derived by subtracting the available capacity in the grid with the peak demand. Since, according to Danao (2009), thin reserve levels could raise WESM prices, an indirect relationship between this variable and WESM prices is assumed by this study.

LIMITATIONS OF THE STUDY

This study would have certain limitations which would be as follows:

1. While the EPIRA was put into effect in 2001, the study would employ data from 2006 to 2010 only. The WESM started operations in June of 2006, which is the

reason why data prior to 2006 was not used in the study.

2. The study aims to evaluate the effect of the changes in market concentration to changes in the price of power in the WESM. Other aspects of the reform, like its effect on supply, electricity access, and the reduction of the energy debt, would not be tackled in the study.
3. This study would only examine the effect of the changes in market concentration to the price of power in the WESM. It would not, however, tackle the effect of the changes of market concentration to the total generation charge and the retail rate of electricity.

RESEARCH METHODOLOGY

The study employs three variables. These are market concentration (MC) as measured by the monthly estimates of the Herfindahl index; the monthly average market clearing prices at the WESM, and the monthly average reserve levels. The market share of each of the power generators trading at WESM were collected for the computation of the Herfindahl index, the main exogenous variable for the study. The Herfindahl index is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. The index can be computed using this formula:

$$\mathbf{HHI} = \sum \mathbf{s^2} \qquad (3)$$

Where: HHI = Herfindahl index
s = market share of the trading participants in the WESM

Because of their explicit ability to collude, the market share of generation companies owned or controlled by affiliated groups were combined in the analysis. The Herfindahl index of June 2006 would be compared with the Herfindahl index of December 2010. The time series data needed for this study was sourced from the Philippine Electricity Market Corporation (PEMC), operator of WESM. An empirical model was designed to provide specific answers to the research questions formulated and validate the specified hypotheses. It is given as follows:

$$\mathbf{P_w = \beta_0 + \beta_1 MC + \beta_2 (S\text{-}D) + u} \qquad (4)$$

Where: Pw = wholesale electricity spot market
MC = degree of market concentration using the Herfindahl index;
(S-D) = excess demand or supply
$\beta_0,..\beta_i$ = regression parameters of the model
u = stochastic error term

We incorporated a dummy variable, representing the first three months of 2010, to capture the effects of the El Niño dry spell and other non-recurring events which caused WESM prices to spike. Equation (5) was formulated incorporating the intervention variable (D) to captures the non-recurring events in the first three months of 2010:

$$\mathbf{P_w = \beta_o + \beta_1 MC + \beta_2 (S\text{-}D) + \beta_3 D + u} \qquad (5)$$

Where P_w = wholesale electricity spot market
MC = degree of market concentration using the Herfindahl index;
(S-D) = excess demand or supply
D = dummy variable for the El Nino and other events in 2010
$\beta_0,..\beta_i$ = regression parameters of the model
u = stochastic error term

For this study, the dependent variable (Wp) would be spot market prices while the independent variables are the Herfindahl index and excess supply (S-D). To validate the empirical model presented in Equation (5), the study applies time series multiple regression analysis based on ordinary least squares (OLS) procedure. OLS is a popular method because of its strong theoretical properties derived from Gauss-Markov theorem (Gujarati & Porter, 2010). A battery of statistical tests and procedures were employed to generate parameter estimates and tests of significance as well as other critical diagnostics essential in determining adequacy of the model. The tests would include: 1) Unitroot test for stationarity; 2) Ramsey's RESET Test for specification error; 3) Jarque-Bera Test for the normality of the residuals; 4) Durbin Watson's Test for autocorrelation; 5) White's Test for heteroskedasticity; 6) Chow Test for structural breaks, and; 6) the Johansen Cointegration Test. The formulas for these diagnostic procedures can be found in Appendix 3.

SPIKE IN THE WESM MARKET CLEARING PRICE

WESM prices are spiked in the beginning of 2010. This can be explained by the El Niño dry spell, which hit the Philippines during that period. The high temperature caused the water levels at dams to drop substantially. With low water levels, hydroelectric power plants, which generate some of the cheapest power output, were not able to produce at their maximum capacity. Some hydroelectric power plants were not able to produce power at all during that period because of water protocols, which prioritize domestic water usage and irrigation over power generation. It can also be noted that during that time, a lot of power facilities were on maintenance shutdown in preparation for the election that year. The government required all power generation firms to conduct the maintenance of all their power plants at the start of the year until the summer in order to prevent the possibility of power outages during the elections. The Malampaya Gas Field, fuel supplier of the 1,500-MW Sta. Rita-San Lorenzo Gas-Fired Power Plants and 1,200-MW Ilijan Natural Gas Plants, was also on scheduled maintenance, causing the combined-cycle power facilities to run on condensates instead of cheaper natural gas sourced from Malampaya. All these non-recurring factors contributed to the abnormal spike in WESM prices during that period. It has been reported that power prices at the retail level also peaked during that period (Anonuevo, 2010; Remo, 2010). This study considers the WESM price spike during the first three months of 2010 as an outlier and was controlled for by a dummy variable, which was incorporated in the regression model.

MARKET CONCENTRATION

We acquired data on the market share of each trading participants in the WESM. Data was provided by PEMC. As mentioned earlier, the market shares of generation companies owned or controlled by affiliated groups were combined in the analysis because of their explicit ability to collude. The market concentration ratio was computed using the HHI formula (Equation 3). Table 1 compares the HHI from the first six months of when the WESM started its operations and the last six months of 2010.

Table 1
Market Concentration in 2006 and 2010

Month	2006	2010
July	3,201.3	2,698.1
August	3,308.9	2,859.8
September	3,200.4	2,734.4
October	3,199.3	2,775.1
November	3,055.8	3,002.4
December	3,126.6	3,051.7

It can be noticed that market concentration has generally eased since the last six months of 2006. The market concentration ratio in November and December of 2010 were slightly higher compared to July, August, September, and October. This is because the power facilities controlled by San Miguel Corp., now the largest independent power producer in the country with a market share 28% in Luzon, were temporarily out of commission. Even though market concentration has generally eased since 2006, the HHI estimates points to a highly concentrated industry based on the US Department of Justice threshold (see Table 2).

Table 2
Levels of Concentration Using HHI

Highly Concentrated	1,800 < HHI
Moderately Concentrated	1,000 < HHI < 1,800
Unconcentrated	HHI < 1,000

Source: US Department of Justice

RESERVE LEVEL

The movement of reserve levels is erratic as it is a function of electricity supply and demand. Most of the variations in the supply side were caused by the availability of power plants to produce at their rated capacities. The availability of hydroelectric power plants is a function of temperature. The output of hydro power facilities is dependent on the water level of its reservoir. Unplanned outages caused by the technical and machinery problems could also cause major changes in supply. Demand, meanwhile, is more erratic. Variations in power demand can be caused by the changes in temperature and economic activity. The spike in temperature could cause reserves to sharply drop, which is apparent in summer months.

SUMMARY OF THE DATA

Table 3 shows the summary of the descriptive statistics of the three variables. WESM prices dropped to a low as -P1,824 per MW hour. While the WESM rules placed a cap on the maximum price players could bid in the spot marker, there is no limit as how low WESM prices could drop. This allows firms to bid at negative prices. The rationale for bidding at negative prices is to allow dispatch. There are instances where the opportunity cost of not having the power plants generate electricity is greater than generating power average cost. This is most especially true for hydroelectric power facilities, since they price power based on opportunity cost. At the time when the price of power in the WESM was at its minimum, reserves was 50% higher than its average levels, implying co-movement between the two variables. Market concentration, as measured by the HHI, however, was only 0.8% lower than its average level when WESM prices was at its lowest.

Table 3
Descriptive Statistics

	Prices	*Reserves*	*HHI*
Mean	3,976	1,029	2,908
Min	(1,824)	(370)	1,849
Max	10,959	1,986	3,569
Variance	6,139,609	339,953	200,529
Coefficient of Variation	0.6232	0.5664	0.1540

Power reserves reached a minimum value of -370 MW (code red or a deficit) on April 2010. WESM prices at that time was at P7,327.46 per MW hour, which is 84.3% higher than its average value. When reserves reached its highest level at 1986 MW in September 2008, WESM prices fell to P1,196.27 per megawatt hour, 70% lower than its average value. This further supports the idea that the two variable co-vary and are inversely

related. Market concentration, meanwhile, dropped to as low as 1,849 in September 2009. This was the only time the HHI fell close to *moderately concentrated* as categorized by the US Department of Justice. WESM prices at that time was down to P957.95 per MW hour, 75.9% lower than its average value. Market concentration was highest in March 2008, when HHI was at 3,569. WESM prices at that time was only 6.6% higher than its average value.

Table 4
Correlation Matrix of the Variables

	Prices	*Reserves*	*HHI*
Price	1		
Reservers	-0.773	1	
HHI	-0.091	0.3105	1

Based on the coefficient of variation (Table 3), WESM prices appears to be the most volatile among the three variables. This is not unusual since spot market prices tend to be erratic, being a function of hourly changes in supply and demand. HHI, meanwhile, exhibits the least variability among the three series. This can indicate that there is not much changes in market concentration in the period covered by the study. While WESM prices are generally as variable reserves, the variability of WESM prices is asymmetric with market concentration. The analysis of correlation coefficients (Table 4) shows that WESM prices have a relatively strong, inverse, linear relation with reserves. WESM prices and market concentration are also inversely related but the linear relationship is weak based on the correlation coefficient. While the correlation coefficient was low, the inverse relationship goes against theoretical expectations. Prices are expected to be directly related with market concentration as implied by the SCP framework. The linear relationship between the response variable with the explanatory variables would be validated in the regression.

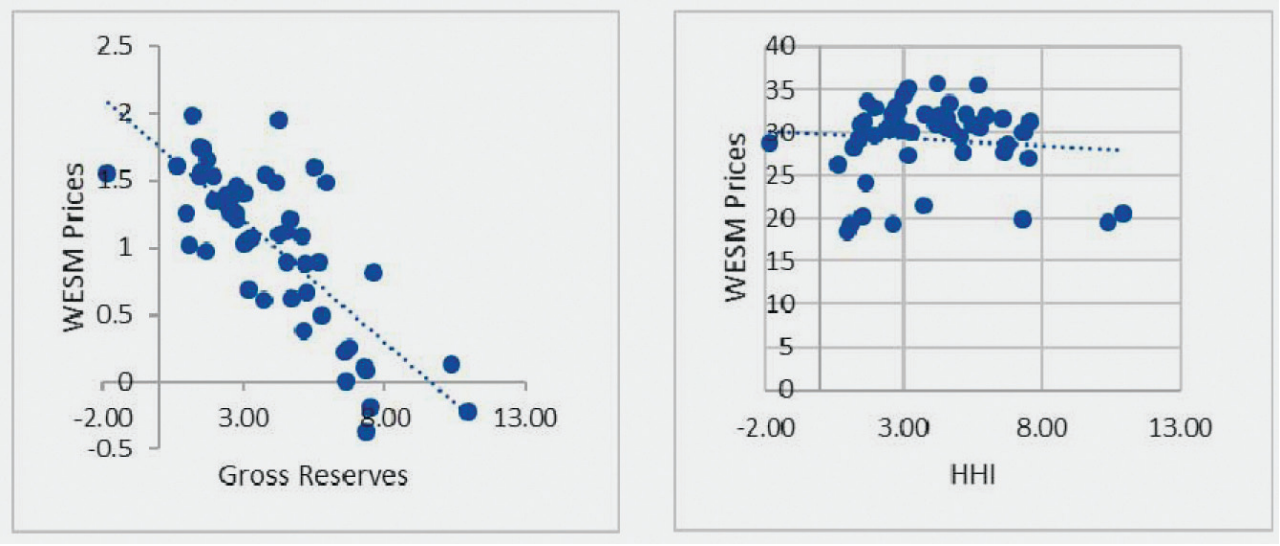


Figure 1.
Scatter plot of reserves and HHI versus WESM Prices

EMPIRICAL RESULTS

As mentioned in the methodology, a unit root test was conducted to assess where the series are stationary in the mean. The test shows that all variables are stationary at the first difference so that we can proceed with regression at levels (Appendix 4).

The regression result is summarized in the equation (t-ratios in parentheses):

$$P_w = 3{,}468.6 + 1.1\ MC - 2.8\ [S\text{-}D] + 2{,}577\ D + 0.37AR \quad (1)$$
$$(1.73) \quad (1.64) \quad (-5.89) \quad (2.46)$$

Table 5 provides a summary of the regression estimates (full regression results can be viewed at Appendix 5) of Model 2 after being corrected for autorcorrelation. Based on the model estimates in Table 5, the coefficient of all parameters were consistent with theoretical expectations. It was discussed earlier that market concentration would have a positive impact on prices. The SCP paradigm assumes that prices tend to rise when markets are highly concentrated. The theory assumes that the greater the market concentration in a particular industry, the higher market prices tends to be. The coefficient for the market concentration in the regression result was positive, consistent with the expectation of the SCP model.

As discussed earlier, the tendency of power generators to exert market power and raise prices when reserve levels are thin is apparent in the case of California, where spot market prices shot up during the summers between 1998 and 2000 (Borenstein et al., 2002). In addition, a study by Danao (2009) asserted that when reserve levels are thin due to high power demand, most generators function as pivotal supplier, meaning the capacity output from those generating firms are necessary to meet the peak demand for that certain period. By functioning as a pivotal supplier, these generators are given the opportunity to exert market power. Taking those in consideration, spot market prices are assumed to be higher when reserve levels are low. The coefficient for reserve levels in the regression result was negative, consistent with the expectation of the study. Earlier, it was discussed that certain non-recurring events in the first three months of 2010, like the El Niño, caused WESM prices to spike during that period. The presence of these events is assumed to have a positive impact on spot market prices. We found it necessary to control these events by incorporating a dummy variable. The coefficient for the dummy variable in the regression result was positive, consistent with the expectation of the study.

Table 5
Summary of Regression Results

Variable	*Coefficient*		
C	3468.57**	***R-Squared***	0.695591
MC	1.07	***Adjusted R-Squared***	0.670224
(S-D)	-2.81*	***S.E. Regression***	1432.217
Dummy	2577.92*	***F-Probability***	0
AR(1)	0.37**	***Durbin-Watson Stat***	1.995872

*Significant at 0.05 level

**Significant at 0.01 level

Table 6
Summary of the Diagnostic Test Results

Diagnostic Test	Test Statistics	Probability
Ramsey's RESET	2.491018	0.093937
Jarque-Bera	0.893845	0.639593
White's Test	1.532036	0.198089
Chow Test	1.064788	0.411948

*Significant at 0.05 level

**Significant at 0.01 level

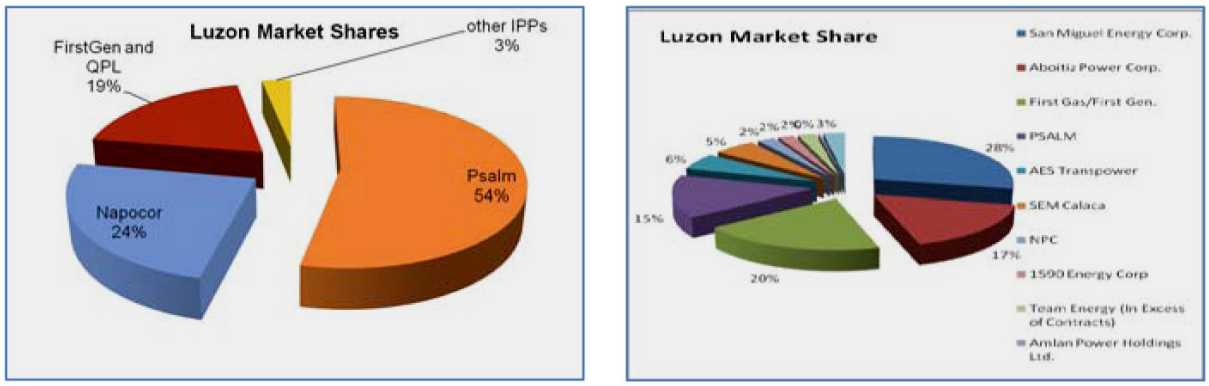
Based on the regression results in Table 5, the coefficient of determination or R-squared was estimated to be 0.695591, while the adjusted R-squaredwas estimated to be 0.670224. This means that about 67% of the variations in the spot market prices from July 2006 to December 2010 can be explained by market concentration, reserve levels, and the events in the first three months of 2010. The RAMSEY RESET ruled out misspecification error, while the Chow Test ruled out the presence of structural breaks. The Jarque-Bera Test showed that the residuals are normality distributed, and the White's Test ruled out the presence of heteroskedasticity. The Johansen Test revealed that that there are at most two cointegrating equations at five percent significance level as the likelihood ratio of the eigen values exceed critical values at this level of significance.

MARKET POWER IN THE PHILIPPINE ELECTRICITY SPOT MARKET

The regression result in Table 5 shows that the only predictor variables that exert significant effects on market clearing prices were reserve levels and the dummy variable. Since the parameter for market concentration is insignificant based on regression, we say that we failed to reject the null hypothesis that the variations in market concentration from 2006 to 2010 had a significant effect on the WESM Market clearing price. The variable representing market concentration was not significant in the regression estimates. The p-value for the parameters of market concentration was computed to be 0.1074, higher than alpha set at 0.05. This means that the changes in market concentration between July 2006 and December 2010 did not have significant effect on WESM prices. The p-value for the parameters of reserve levels was estimated to be 0, indicating that the coefficient is significant at alpha set 0.01. According to the OLS estimates, when reserve levels drop by 1 MW, the price of power in the WESM would tend to rise by P2.813 per MW hour.

By the end of 2010, the price of power at the WESM was 80% higher than its levels in July 2006. Market concentration, as measured by the HHI, was lower compared to its levels in 2006, but only by five percent. Figure 2 compares the 2006 and 2009 market share of each electricity generation company in Luzon. It can be noticed that in the 2006, the year when WESM started commercial operations, majority of power generation is in the control of the government through PSALM and Napocor. Because of privatization, by the end of 2010, the market share jointly held by PSALM and Napocor shrunk to only 21%, considerably lower compared to the 78% in 2006.

While the share of government in electricity generation substantially dropped, market concentration continues to be high. Around 65% of the market is jointly owned by the three major players, namely San Miguel Corp., First Gen Power Corp., and Aboitiz Power Corp. As a result, market concentration remained high, despite the privatization efforts of the government.



Source: Department of Energy 2011

Figure 2.
Comparison between 2006 and 2010 market shares of electricity generation companies in Luzon grid.

CONCLUSIONS AND RECOMMENDATIONS

According to the SCP paradigm, the easing of market concentration as a result of industry liberalization programs such as the EPIRA should have exerted a downward pressure on market prices. The government may have privatized most of its generation assets and abandoned the role as the dominant market player in the generation business, but the regression analysis shows that there is no empirical evidence to reject the hypothesis that market liberalization in power generation had no significant effect on the price of electricity.

The HHI values indicate that the power industry remains to be highly concentrated. The dominance of Napocor and PSALM in the Philippine power generation industry was replaced by the large power companies. This could be an indication of the ineffectiveness of the privatization program to generate significant competition. Perhaps it can be argued that the price-effect of privatization would be felt over the long-run, when the private sector is able to bring in efficiency through their investments.

The researcher recommends that EPIRA and its implementation, or either, be reviewed so that necessary policy changes could be made. Clearly there is room for more competition in the power generation sector. Policy makers should look into the adoption of mechanisms to enhance or stimulate further competition in this sector. The study also found that low reserve levels tend to raise the price of power in the WESM. This is consistent with the findings of previous studies which assert that lower reserve levels would result to high spot market prices. The researcher also recommends that the government allocate substantial resources in protecting watershed and forest areas particularly those along river basins where hydroelectric power generating stations are situated to ensure an adequate supply of level of power reserves to prevent substantially high electricity prices.

This study concludes that there is no empirical evidence showing that competition in the WESM was able to have a significant effect on prices. Future research could quantify the magnitude of the how market power is being exerted by trading participants in the WESM. Future studies could also provide a framework how to improve competition environment in the spot market.

ACKNOWLEDGMENT

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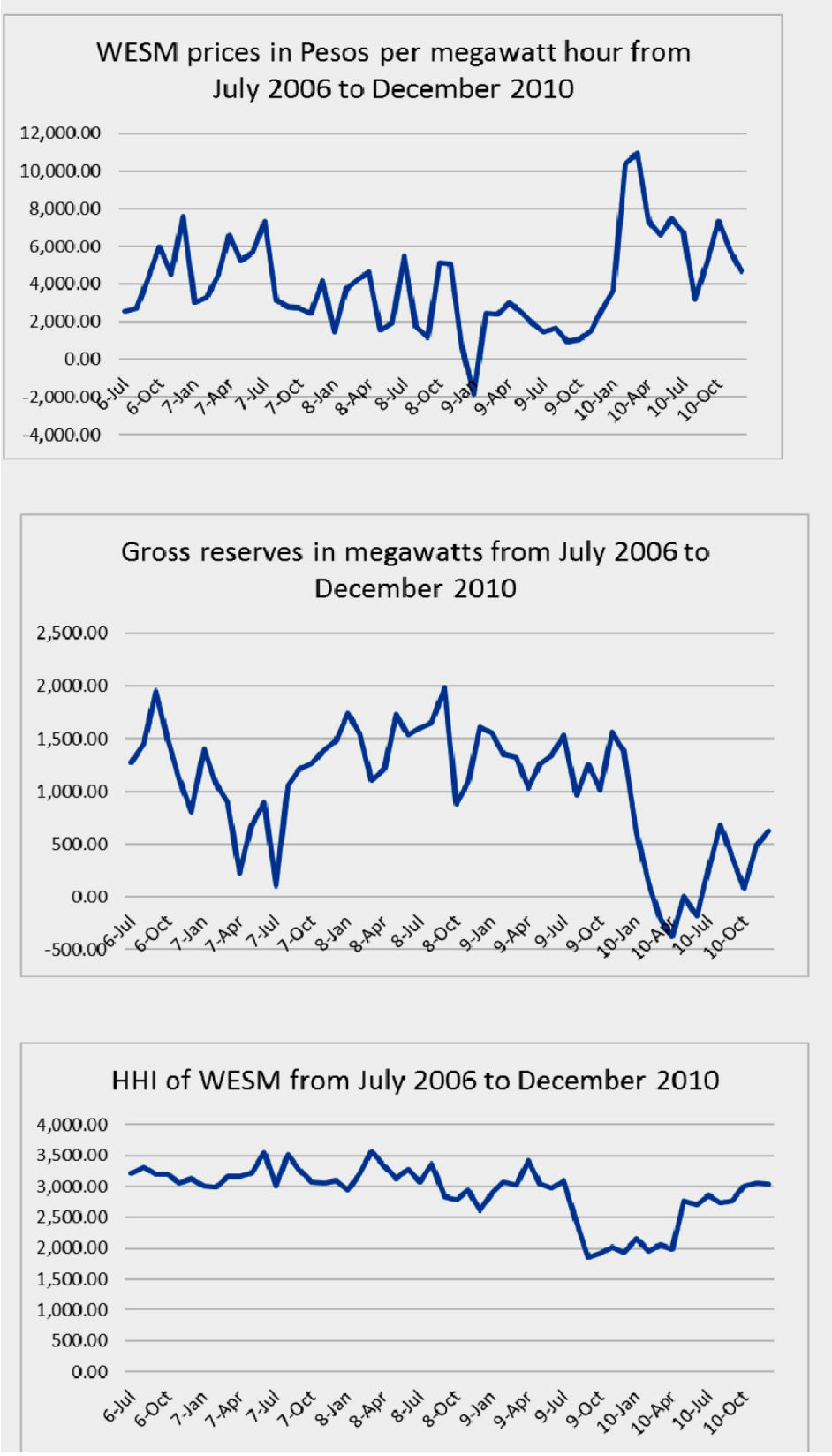
APPENDIX 1: TIME PLOT OF WESM PRICES, RESERVES, AND HHI



APPENDIX 2.1: WESM PRICES FROM 2006 TO 2010

	2006	2007	2008	2009	2010
Jan	NA	3,007.1	1,432.4	-1,824.2	3,708.4
Feb	NA	3,303.2	3,763.0	2,433.9	10,388.4
Mar	NA	4,526.5	4,238.8	2,382.7	10,959.4
Apr	NA	6,609.6	4,634.1	2,998.5	7,327.5
May	NA	5,257.4	1,561.0	2,458.8	6,623.4
Jun	NA	5,685.7	1,938.9	1,963.1	7,513.6
Jul	2,591.6	7,295.2	5,482.2	1,456.2	6,767.3
Aug	2,761.4	3,156.4	1,714.0	1,651.6	3,189.8
Sep	4,268.0	2,775.8	1,196.3	958.0	5,132.0
Oct	5,962.0	2,743.9	5,164.1	1,069.4	7,334.4
Nov	4,549.3	2,438.6	5,058.5	1,520.9	5,779.2
Dec	7,604.7	4,164.2	632.1	2,598.3	4,708.1

APPENDIX 2.2: WESM PRICES FROM 2006 TO 2010

	2006	2007	2008	2009	2010
Jan	–	1,408.1	1,747.6	1,551.5	606.3
Feb	–	1,076.3	1,543.7	1,353.6	133.3
Mar	–	890.4	1,102.9	1,326.5	-216.4
Apr	–	224.2	1,210.5	1,036.1	-369.5
May	–	670.5	1,734.2	1,262.3	3.7
Jun	-	897.2	1,534.6	1,347.6	-186.6
Jul	1,278.8	107.1	1.602.8	1,530.6	260.6
Aug	1,458.1	1,050.1	1,651.8	968.0	683.5
Sep	1,957.6	1,216.2	1,986.2	1,259.2	378.8
Oct	1,490.1	1,262.8	887.6	1,017.3	88.1
Nov	1,116.3	1,393.1	1,084.4	1,566.4	490.7
Dec	808.9	1,485.4	1,611.5	1,383.6	626.2

APPENDIX 2.3: WESM PRICES FROM 2006 TO 2010

	2006	2007	2008	2009	2010
Jan	NA	3,017.0	2,935.6	2,885.5	2,155.5
Feb	NA	2,999.6	3,211.7	3,077.0	1,957.8
Mar	NA	3,166.9	3,569.0	3,033.3	2,051.5
Apr	NA	3,159.3	3,332.0	3,424.1	1.989.4
May	NA	3,218.3	3,123.3	3,042.8	2.763.8
Jun	NA	3,551.8	3,279.2	2,970.9	2,698.1
Jul	3,210.3	3,002.3	3,082.8	3,098.5	2,859.8
Aug	3.308.9	3,513.3	3,360.9	2,416.7	2,734.4
Sep	3,200.4	3,256.0	2,831.1	1,849.4	2,775.1
Oct	3,199.3	3,083.1	2,778.9	1,927.7	3,002.4
Nov	3,055.8	3,060.0	2,947.9	2,014.0	3,051.7
Dec	3,126.6	3,097.5	2,623.0	1,931.9	3,042.8

APPENDIX 3: FORMULAS FOR THE DIAGNOSTIC TEST PROCEDURES

Ramsey's RESET:
Test for Specification Error

$$F_{(M;N-k-1)} = \frac{(SSR_{\hat{Y}} - SSR_{\hat{Y}^2})/M}{SSR_{\hat{Y}^2}/(N-K)} = \frac{(SSR_R - SSR_{UR})/M}{SSR_{UR}/(N-K)}$$

Where SSRs = the sum of squared residuals for the respective regressions;
M = number of restrictions;
N = number of observations;
K = number of parameters estimated in the unrestricted equation

Jarque-Berra Test for Normality

$$JB = \frac{n}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right)$$

Where n = is the number of observations (or degrees of freedom in general);
S = sample skewness, and
K = the sample kurtosis.

White's Test for Heteroskedasticity

$$F = \frac{R_u^2/k}{(1-R_u^2)(n-k-1)} \sim F_{k,n-k-1}$$

Where n-k-1 = degrees of freedom

Durbin Watson Test for Autocorrelation

$$DW = \frac{\sum_{t=2}^{T}(u_t - u_{t-1})^1}{\sum_{t=1}^{T} u_t^2}$$

Where T = the number of observations;
u = *stochastic error term;*
DW = 2 indicates no autocorrelation

Unitroot Test

$$\Delta Y = \rho Y_{t-1} + \gamma t + \sum \beta \Delta Y_{t-1} + v_t$$

Johansen Cointegration Test

$$\Delta Z_t = \Gamma \Delta Z y_{t-1} + \Pi Z_{t-1} + \varepsilon_t$$

Where $\mathbf{\Delta Z_t}$ = vector of endogenous variables;
$\mathbf{\Pi}$ = vector of error correction term;
$\mathbf{Z_{t-1}}$ = vector of stationary, *I(0),* exogenous variables including deterministic components, i.e. constant and trends.

The rank of the matrix **Π** would indicate the number of cointegrating vectors in the model

APPENDIX 4: SUMMARY OF UNIT ROOT TEST

			McKinnon Critical Values		
		Levels	*1%*	*5%*	*10%*
MC	Levels	-1.99	-4.14	-3.50	-3.18
	1st Difference	-5.56	-4.15	-3.50	-3.18
S-D	Levels	-2.63	-4.14	-3.50	-3.18
	1st Difference	-6.79	-4.15	-3.50	-3.18
Pw	Levels	-3.45	-4.14	-3.50	-3.18
	1st Difference	-7.85	-4.15	-3.50	-3.18

APPENDIX 5: FULL REGRESSION RESULTS GENERATED FOR EQUATION 3

Dependent Variable: Pw
Method: Least Squares
Date: 02/15/12 Time: 13:14
Sample(adjusted): 2006:08 2010:12
Included observations: 53 after adjusting endpoints
Convergence achieved after 8 iterations

Variable	**Coefficient**	**Std. Error**	**t-Start**	**Prob**
C	3468.569	2004.512	1.730381	0.09
MC	1.073236	0.654219	1.640486	0.1074
S-D	-2.807363	0.530043	-5.29649	0
DUMMY	2577.92	1046.013	2.46452	0.0174
AR(1)	0.371142	0.134819	2.752901	0.0083

R-squared	0.695591	Mean dependent var	4.002.128
Adjusted R-squared	0.670224	S.D. dependent var	2494.017
S.E. of regression	1432.217	Akaike info criterion	17.46142
Sum squared res	98459804	Schwarz criterion	17.6473
Log likelihood	-457.7277	F-statistic	27.4207
Durbin-Watson	1.995872	Prob(F-statistic)	0

Inverted AR Roots	0.37

APPENDIX 6: SUMMARY RESULTS OF THE JOHANSEN COEINTIGRATION TEST

Test assumption: No deterministic trend in the data
Series: PR MC S-D DUMMY
Lags interval: 1 to 1

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.349014	57.25601	53.12	60.16	None*
0.331764	34.93415	34.91	41.07	At most 1*
0.171224	13.9722	19.96	24.6	At most 2
0.077705	4.2063	9.24	12.97	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level

L.R. test indicates 2 cointegrating equation(s) at 5% significance level