

Energy Poverty and Market Structure Characteristics: Determining the Energy Access for Rural Households in Developing Countries

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Abstract: The paper analyses the household energy consumption patterns and income allocation for different energy sources in urban and rural parts of Pakistan. Not surprisingly, there is difference in energy mix used by different income groups in urban and rural parts, however rural rich are more inclined towards using energy sources similar to that of rural poor. The paper highlights a non-conventional rationale (particularly income) of market structure to understand the different access levels that households, particularly rural households have for energy sources.

Keywords: Energy poverty, Market structure, Energy access, Rural households, Rural community

1 Introduction

With the passage of time, developing countries have realized the importance of rural energy for mainstreaming their national development efforts, due to large rural populations without modern energy services in these countries. This becomes more striking as these populations struggle for energy to meet their household affairs, especially cooking and lighting (Karekezi, 2002a; Noim-Uddin et al, 2007). The most immediate energy source for these household is traditional *biomass*, including *fuelwood*, animal and plant waste, which is not only common in rural households with lower incomes but also those with higher incomes (Ghaffar, 1995).

Like urban population, rural populations also have different demographics within their communities, allowing one to distinct them into lower, middle and upper classes based on their incomes. However even households with higher disposable incomes are often left with no option other than to use traditional biomass, fuelwood, kerosene, diesel or LPG (liquid petroleum gas) to meet their domestic demands for cooking, lighting and heating.

The paper will adopt two-pronged approach to analyze the *energy poverty* in rural households. In the first part, an illustration of *household survey of Pakistan* for year 2004-05 will be provided, by analyzing the income expenditure patterns of rural households with different income levels. Whereas in the second part, a different approach to analyze the household energy access will be given, using the *rural energy market structure* approach. A relationship between household energy sources and the rural market structure shows that household energy access is also dependent on the prevailing market structure conditions. What we meant by rural market structure will be discussed in later section, however before that, an overview of energy poverty will be given in the following part.

2 Energy Poverty: Poverty of Energy Access?

Before going into details of how *energy access* is important for energy poverty, it is important to define *energy poverty*. The concept of *energy poverty* has several definitions in the literature, but since we will relate the concept to energy access, following definitions will be more important. First, energy poverty can be defined as *the state of insufficient energy resources for basic living – a state where the energy requirements for satisfying basic human needs range between 1.0 to 1.3 TOE¹ per annum* (Pokharel, 2006).

Another definition which provides explanation based on household consumption level is that of Department of Trade and Industry (DTI), Government of United Kingdom. According to DTI, *a household*

¹ TOE refers to One Ton of Oil Equivalent per capita per year energy needed to guarantee an acceptable level of living as measured by Human Development Index (HDI) of 0.8 (Pokharel, 2006).

is considered to be energy poor when it has to spend more than 10 percent of its income on energy (DTI, 2002). Whereas according to Reddy (2000), an absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign energy services to support economic and human development.

The concept of *energy poverty* has been associated with ‘*deprivation*’ of choices to access certain materials, goods, capabilities, freedoms and opportunities (Pachauri et al, 2004). Rural households, especially poor ones, deprived in terms of not only having inadequate financial means for accessing efficient, reliable and sustainable energy sources (Karekezi, 2002a), but are also limited in terms of their access to markets (Sen, 1999). Due to this significant characteristic, but not limited to, along with rural poor, rural rich also have to opt for the similar energy sources, though in different combinations (Davis, 1998). Given a range of energy alternatives, a strong financial or income factor dictates the choice energy source or combination of sources used to meet the energy requirements at household level (Fankhauser and Tepic, 2007).

The absence of reliable, efficient and sustainable energy resources not only severely impact the economic well-being of the rural communities, but also lead them to improper health facilities resulting from smoke, sanitation and non availability of clean water. Usually, the main victim tends to be women and children engaged disproportionately in finding, collecting and blazing of traditional biomass.

In certain cases, the electric grid and network are in reach to most of the population, however still a large proportion lacks electricity connection. According to World Energy Outlook (2002) estimates, there are 580 million people without electricity in India. Though electricity network is technically within reach of 90 percent population, but still only 43 percent are actually connected as many poor people cannot afford the cost of connection and utility. Even where incomes are high enough, households are often discouraged from connecting to the grid because of poor quality of service, including frequent blackouts and brown-outs². For instance in Mumbai, lightning is responsible for roughly 27 percent of India’s evening peak load, which overstresses the grid and is often responsible for rotating blackouts, which in turn hamper the economic output and competitiveness of industries working in the area (WEO, 2002).

2.1 Rural Households and Energy Sources

Most of the energy poor of the rural populations in the developing countries are also financially poor, which inhibits their energy consumption and choices for energy sources. In countries where 75 percent of the population lives below the poverty line (\$2 a day), the per capita energy consumption is by average four times lower than in the countries where less than 5 percent of the population is poor (World Energy Outlook, 2002). More than half of the population below poverty line lives in extreme poverty – earning less than \$1 per day, hence making it difficult to meet their energy demands. Therefore to cope with the energy poverty, rural households in particularly the poor ones, tend to diversify their use with various energy sources (Hosier and Kipyonda, 1993; Martins, 2005). The choice of energy source varies with the appliance, which makes the difference in the quantity of source required for functioning of the appliance (Howells et al, 2005).

2.2 Analysis of Household Energy Expenditure

This part of the paper will provide the analysis of household expenditure on energy in urban and rural areas of Pakistan.

2.2.1 Household Integrated Economic Survey (HIES, 2004- 05)

Federal Bureau of Statistics (FBS) of Pakistan, in year 2004 conducted Household Integrated Economic Survey (HIES), which provides household income and expenditure data. The original survey has categorized household into 5 different quintiles based on their incomes, with 1 representing the lowest income group and 5 representing the highest income group.

2 A situation where voltage supplied from the main grid is less than the normal voltage.

As explained in report published by FBS, household are examined across 5 standardized per capita consumption expenditure quintiles. Each quintile contains 20 % of the total sample households. For instance, in the first quintile contain lowest twenty percent of the total households and in the second quintile the next better of twenty percent of the total households and so on in the fifth quintile it contain the richest 20 % of the total households. For our better understanding, incomes quintiles from the survey are re-alias accordingly in the paper into five income categories: *lowest income group*, *lower income group*, *middle income group*, *upper-middle income group* and *upper income group*.

Energy poverty in these households can be translated by analyzing their energy expenditure and its breakup. According to the survey results (2004-05), 6.76 and 7.84 percent of household income is spent on energy in urban and rural households respectively (see Table 1 and Table 2). Table 1 shows that in urban areas, lowest income groups spends highest portion of their income on energy expenditure, which is 8.54 percent as compared to highest income group. It is important to note that this level of energy spending by urban households is highest in the group.

On other side, the same income group (lowest income) spends 7.94 percent of their income as energy expenditure, whereas highest income group in rural areas spends just over 7 percent. However, in contrast to lowest income group in urban areas, the highest energy spending in rural areas is done by middle income group which is equal to 8.50 percent of their household income. Though in percentage, the energy expenditure decreases with increase in income in urban and rural areas, however in absolute terms, the amount spend by the higher income group is still higher than the lower income groups.

Table 1 Monthly Household Energy Expenditure in Different Income Groups of Urban Pakistan (2004-05)

	Average monthly income	Average monthly expenditure per household (Rupees)	Income spent on energy (%)
Urban (mean)	13,371.00	904.00	6.76
Income Groups:			
Lowest Income	6,203.00	530.00	8.54
Lower Income	7,239.00	604.00	8.34
Middle Income	8,549.00	682.00	7.98
Upper Middle Income	10,462.00	805.00	7.69
Upper Income	19,233.00	1,169.00	6.08

Source: Federal Bureau of Statistics, Pakistan

Table 2 Monthly Household Energy Expenditure in Different Income Groups of Rural Pakistan (2004-05)

	Average monthly income	Average monthly expenditure per household (Rupees)	Income spent on energy (%)
Rural (mean)	7,929.00	622.00	7.84
Income Groups:			
Lowest Income	5,466.00	434.00	7.94
Lower Income	6,588.00	536.00	8.14
Middle Income	7,104.00	604.00	8.50
Upper Middle Income	8,273.00	665.00	8.04
Upper Income	12,658.00	897.00	7.09

Source: Federal Bureau of Statistics, Pakistan

2.2.1.1 Electricity

Despite the fact that electricity has still not fully penetrated in Pakistani households, it still captures the main portion of total household energy expenditure for urban as well rural households. In developing countries, the main use of electricity is lighting and entertainment, which includes watching television, using video or CD player, running computer etc. By average, 63.05 percent and 41.66 percent of total energy expenditure is spent for electricity in urban and rural parts of Pakistan respectively (See Table 3 and Table 4). As already understood by the energy ladder phenomenon, higher incomes groups tend to spend more on the most modern fuel type, i.e., electricity, as compared to the lower income groups due to abandoning the use of traditional energy sources like fuel wood, animal dung and plant waste and shifting towards higher electricity consumption.

In lowest income group of urban areas, approximately 50 percent of energy expenditure is for electricity as compared to only 36.23 percent for the same group in rural areas (see Table 4). Even the highest income group of rural areas is still not able to cross 50 percent of their energy expenditure for electricity and thus has to rely on non-conventional and traditional sources like firewood, animal and plant wastes.

2.2.1.2 Gas (Piped and Cylinder)

For cooking purposes, rural households also utilize natural gas, apart from other available energy sources. In consumption and expenditure patterns of natural gas, there is enormous difference between urban and rural households. Urban households, due to relatively developed infrastructure, rely more on piped gas as compared to rural ones, which rely more on gas available in cylinders. Table 3 shows that by average, more than 20 percent of the energy expenditure is spent for piped natural gas, whereas rural households only spent 1.42 percent of their total expenditure on piped gas (see Table 4).

2.2.1.3 Firewood/Fuelwood

Not surprisingly, more than 34 percent of energy expenditure of lowest group in rural areas is allocated for firewood, used mostly for cooking purposes. Moreover in rural areas, by average 28.36 percent of energy expenditure in firewood is reported in upper income group, which is mainly due to unavailability of natural gas in most rural parts. However in urban areas, the firewood usage goes down dramatically with the increase in income and only 2.49 percent of energy expenditure is spent in highest income group.

Table 3 Break-up of Energy Expenditure in Urban Pakistan (2004-05)

Household Energy Spending in Pakistan (Urban 2004) Income Groups							
	Total	Rural (Mean)	LsI	LrI	MI	UMI	UI
Firewood		7.54	22.16	20.15	15.27	9.71	2.49
Kerosene Oil		0.84	1.11	2.05	1.28	1.59	0.33
Dung cakes		0.77	3.05	1.65	1.51	0.96	0.27
Gas (piped)		20.26	14.59	15.46	17.91	20.95	21.56
Gas (cylinder)		3.63	1.61	1.68	2.67	3.57	4.26
Electricity		63.05	49.93	54.35	56.85	59.47	67.66
Other Agri. wastes such as: bagasses, cottonsticks, etc.		0.72	4.28	1.51	1.41	0.67	0.21
Others		3.18	3.28	3.14	3.09	3.09	3.23

* Other energy sources include charcoal, coal (soft, hard, peat), electrical items (bulbs, tubelights, etc) and match & candles
Income Groups: LsI=Lowest Income, LrI=Lower Income, MI=Middle Income, UMI=Upper Middle Income, UI=Upper Income Note: All figures represent breakup of household energy expenditure in percentages of total energy expenditure

Table 4 Break-up of Energy Expenditure in Rural Pakistan (2004-05)

Household Energy Spending in Pakistan (Rural) 2004							
Income Groups							
	Total	Rural(Mean)	LsI	LrI	MI	UMI	UI
Firewood		32.14	34.79	34.49	34.88	30.70	28.36
KeroseneOil		4.22	5.81	4.98	4.66	4.19	2.55
Dungcakes		5.47	5.75	6.15	6.70	5.27	4.11
Gas(piped)		1.42	0.90	1.03	0.82	1.72	2.14
Gas(cylinder)		3.89	0.77	1.65	2.59	4.36	7.61
Electricity		41.66	36.23	38.31	39.70	43.24	46.88
OtherAgri.wastesuchas: bagasses,cottonsticks,etc.		7.06	11.65	9.27	6.49	6.14	4.38
Others*		4.13	4.10	4.12	4.16	4.36	3.95

* Other energy sources include charcoal, coal (soft, hard, peat), electrical items (bulbs, tubelights, etc) and match & candles. Income Groups: LsI=Lowest Income, LrI=Lower Income, MI=Middle Income, UMI=Upper Middle Income, UI=Upper Income Note: All figures represent breakup of household energy expenditure in percentages of total energy expenditure

2.2.1.4 Animal and Agricultural Wastes

Table 5 also shows that significant portion of income expenditure is also spent on animal and plant waste. This tendency of spending for these particular sources is higher in lower income groups of rural areas. About 17% of total energy expenditure at lowest income group is allocated for animal and plant waste. This also shows that by average, rural households may not be having free access to these sources as normally believed. Due to their abundant availability in rural areas, rural people might sell these sources to other households and earn part of their livelihoods.

3 Rural Energy Market Structure: from Definition to its Role

In energy expenditure analysis of households, most importantly, at rural levels, we can see that by average, all the sources require a certain amount of expense which household has to bear in order to utilize the source. Certainly, there might be occasions where rural household might be able to avail certain source without any cost, as by collecting firewood from a nearby forest than to buy it from the market. However even at the rural level, the choice of energy sources for household also depend on the prevailing 'market structure' in the community.

In general definition, "Market Structure" refers to the manner in which firms are organized or inter-related (White, 1982). The market structure may refer to different market forms, i.e., competitive (perfect or oligopolistic) or monopolistic (Sen, 1999), based on the number of firms in the market and their relative size (White, 1982). Market structure refers to the type and organization of the energy firms within a specific market.

In case of energy market structure in developing countries, the scope of market structure broadens as there are many other players involved, which provides energy products and services for the consumers, especially at rural level (Francois and Wooton, 2001; White, 1982; Hannan and McDowell, 1990, Sen, 1999; Smith and Dahl, 1965; Hirschey, 1985).

Based on energy source supply, access and consumption patterns, the energy market structure can be categorized into urban and rural energy markets, specifically for developing countries. As we have discussed earlier in the case of Pakistan, urban households usually rely on electricity and gas, which is mostly

provided by the national firms. On the other hand, rural household use variety of sources to meet their domestic energy needs, as mentioned earlier.

Apart from electricity and gas (piped) supplied by the national supplier which is usually the national energy firm(s), rural households directly collect or buy other energy sources from the local community. In many instances, as the energy is considered as one of the main impediments for the growth and development of rural communities, other actors have also involved, most notably non-governmental organizations and donor or funding agencies, both of which could be national or international.

3.1 Linking Market Structure and Energy Access

Unlike energy ladder (Leach, 1987), the market structure approach is not based on the household income level and its subsequent energy choices, rather the differentiation is based on physical and market factors. The approach develops a relatively holistic perspective, keeping in consideration the household energy access in terms of market actors, including suppliers, distributors, firm and donors. Due to this characteristic, the rural market structure could be further categorized into following levels:

3.1.1 1st Level: Producers

Producers at this level are the ones who produce biomass including animal waste, plant and crop residues etc as a source of energy for rural households. Producers utilize themselves, sell or 'give away' products that could be used as potential energy source by rural households. This level is most convenient and immediate access for rural households. Usually the sources available are abundant (at least in rural areas) and most preferred due to their least economic value. However on the other side, sources in level 1 market structure are most unsustainable, environmentally un-benign and injurious for health. In certain cases, where demand for such sources is high, a competitive structure may also be present and consumers might have to pay a nominal price for energy source. Producers include landlords, farmers, livestock owners etc. In case of firewood, there are instances where households could also buy it, in addition to freely collecting it (Davis, 1998).

3.1.2 2nd Level: Distributors

Not a single household in any rural community can survive by only limited to level 1. Therefore the households need to leap at next level for sources required for other purposes like lighting and cooking. Energy sources are available through local distributors, who are normally selling those products. In an under-developed rural community, as is the usual case in most of the developing countries, the household has to commute for the access and buy it from nearby market. Kerosene oil, Liquid Petroleum Gas, Diesel, candle sticks are examples at this level, whereas distributors include nearby shop and stores, gas stations etc.

3.1.3 3rd Level: Suppliers

Consumer at this level has privilege to the access to energy sources at their door step. This implies that the energy consumer or user is able to utilize the installed infrastructure by the government which is pre-requisite for the particular energy sources at this level. Suppliers are national energy firms which supply energy sources to the households. Examples include firms supplying electricity and natural (fossil) gas through pipes. In most of the developing countries, these energy services are only limited to public utility firms which are normally having monopoly for such services.

In case of Pakistan, Water and Power Development Authority (WAPDA) acts as the main governing body. WAPDA is also involved in limited electricity generation, along with Independent Power Producers (IPPs) – private players involved in electricity generation and transmission to public distribution companies which are working under WAPDA. Since distribution companies under the authority (WAPDA) are directly associated with households, both urban and rural, therefore they are more important and relevant actors for our market structure analysis.

Household Access Levels	Energy Sources	Market Structure Characteristics	Relative Energy Poverty
Level 1: 'Producers'	firewood, animal dung, plant waste etc	Producers utilize (themselves), sell or 'give away' products that could be used as potential energy source users/buyers choose their preferred energy source	high
Level 2: 'Distributors'	kerosene oil, diesel, Liquid Petroleum Gas (LPG), candle sticks	concentration of energy source distributors in rural level competition take place among certain distributors	high to moderate
Level 3: 'Suppliers'	electricity, natural (fossil) gas (piped)	Energy is supplied through suppliers, usually at national level	low or absent
Level 4: 'Distributors, suppliers and/or Donors'	renewable energy technologies, cooking stoves, diesel generators etc.	competitive markets may exist but not common in developing countries direct buyer-seller relationship doesn't exist in many cases • involvement of other actors like donor agency, government body is common	low

Figure 1 Levels in Rural Market Structure, Corresponding Energy Sources and Relative Energy Poverty

Source: Author

3.1.4 4th Level: Distributors, Suppliers &/or Donors

4th and last level represents a mix of actors active in delivering energy services to rural households. As in previous section, we have differentiated households based on their income and energy expenditure, the role of relevant actors comes into play accordingly. For instance in case of rural poor with lowest and lower income level, donors play very important role for delivering energy services. Donors could be local or national government, non-governmental organizations, also local or international working within that particular community or region to deliver energy services with the involvement of energy source suppliers and distributors.

However at this level, the suppliers and distributors offer different products as compared to preceding levels of rural market structure. Most commonly, the energy products offered at this level are energy technologies, which include renewable energy technologies like micro hydro plants, solar photovoltaic, wind technologies etc. Though these levels of household access do not represent in consecutive order, yet using technology on their own for energy remains the final choice for rural households mainly due to cost factor.

3.2 Do We Need Such Market Structure Classification?

This approach of classifying market structure into different levels based on products and market actors, addressing the same set of needs – cooking, lighting, cooling, etc, might be debatable as it differs from

the traditional definition of market structure, which focuses more on number of firms, rather than type of firms or actors. Nonetheless, the approach allows disassociating the traditional approach of using income as the main factor for decision making in energy products (see Energy Ladder: Leach, 1987, Barnett, 2000).

In the former section of energy expenditure as part of household income, it is clearly shown that households in urban and rural parts of Pakistan use a mix of energy sources to meet their energy requirements, which is true for all income groups, including the upper income group of urban areas. However, in the case of the upper income class of rural areas, the difference of energy mix compared to the upper income class of urban areas could be attributed to many factors including economic (income levels, living standards etc), social (number of household members, gender, etc), physical (infrastructure availability, available natural resources etc), cultural (taste preferences, traditions, norms etc) as well as market (structure, user-buyer relationship, number of actors etc).

Another important aspect which is taken into consideration is that of technology, in this case, renewable energy technologies, diesel generators, special cooking stoves etc. Rural households are not able to access such technologies without the financial intermediation of donors. Despite of the continuous energy shortage at urban and rural levels in developing countries, technology based solutions are still not an alternative due to high costs, maintenance requirements and human resource capabilities. Moreover, corresponding to the market structure approach, renewable energy technology firms are also very limited in their operations and generally function with the financial assistance of donors like governmental organizations and local or foreign non-governmental organizations.

4 Concluding Remarks

In this paper, we have attempted to highlight one of the most consistent intimidations by the sustainable development in rural communities i.e., energy poverty. Parallel to that, an attempt is also made to derive a relationship between energy sources used by rural and urban communities at different income levels and their prevailing market structures.

Apart from income constraints faced by the rural households in particular, market constraints in terms of market structure also multiply the energy poverty situation and its effects. Specifically, we have classified the rural energy market structure into four levels, which helps us to understand the pattern of household energy access, specifically in rural communities.

Market structure analysis provides research and policy implications, as it is widely assumed that normally household income is the most decisive factor for energy choices in households, however as we can see from household survey data mentioned in the paper, rural rich are also having higher proportions of unreliable and non-convenient energy sources in their energy mix, which is contrary to 'energy ladder' assumption. Though, there is high need of research to be conducted to further testify the approach in the discussed direction.

References

- Barnett, A. (2000). 'Energy and the Fight against Poverty', Sussex Research Associates Ltd., United Kingdom.
- Davis, M. (1998). 'Rural Household Energy Consumption: The Effects of Access to Electricity – Evidence from South Africa', *Energy Policy*, Vol. 26, No. 3, pp. 207-217.
- DTI (2002). 'Energy – Its impact on the Environment and Society', Department of Trade & Industries, Government of United Kingdom.
- Fankhauser, S., & Tepic, S. (2007). 'Can poor consumers pay for energy and water?, An affordability analysis for transition countries', *Energy Policy* Vol. 35, No. 2, pp. 1038-1049.
- Federal Bureau of Statistics of Pakistan (<http://www.statpak.gov.pk/depts/index.html>).
- Francois, J., & Wooton, I. (2001). 'Market structure, trade liberalization and the GATS', *European Journal of Political Economy* Vol. 17, No. 2, pp. 389-402.

- Ghaffar, M.A. (1995). 'The energy supply situation in the rural sector of Pakistan and the potential of renewable energy technologies', *Renewable Energy* Vol. 6, No. 8, pp. 941-976.
- Gururaja, J. (2003). 'Energy for Sustainable Development: Reiview of National and International Energy Policies', *National Resources Forum*, Vol. 27, pp. 53-67.
- Hannan, T.H., & McDowell, J.M. (1990). 'The Impact of Technology Adoption on Market Structure', *The Review of Economics and Statistics*, Vol. 72, No. 1, pp. 164-168.
- Hirschey, M. (1985). 'Multinational involvement and risk', *Economics Letters* Vol. 19, No. 3, pp. 261-265.
- Hosier, R.H., & Kipondya, W. (1993). 'Urban household energy use in Tanzania: Prices, substitutes and poverty', *Energy Policy* Vol. 21, No. 5, pp. 454-473.
- Howells, M.I., Alfstad, T., Victor, D.G., Goldstein, G., & Remme, U. (2005). 'A model of household energy services in a low-income rural African village', *Energy Policy* Vol. 33, No. 14, pp. 1833-1851.
- Karekezi, S. (2002a). 'Poverty and Energy in Africa', *Energy Policy*, Vol. 30, pp. 915-919.
- Leach, G. (1987). 'Energy Transition in South Asia' in *Transitions between Traditional and Commercial Energy in the Third World*, Surrey Energy Economics Centre, Discussion paper series no 35, University of Surrey.
- Martins, J. (2005). 'The Impact of the Use of Energy Sources on the Quality of Life of Poor Communities Social Indicators Research', Vol. 72, pp. 373-402.
- Noim Uddin, Sk., Taplin, R. & Yu, X. (2007). 'Energy, Environment and Development in Bhutan', *Renewable and Sustainable Energy Reviews*, Vol. 11, Issue 9.
- Pachauri, S., Mueller, A., Kemmler, A. & Spreng, D. (2004) 'On Measuring Energy Poverty in Indian Households', *World Development*, Vol. 32, No. 12, pp. 2083-2104.
- Pokharel, G.R. (2006). 'Promoting Sustainable Development by Creating Enterprises on Renewable Energy Technologies in Nepal: Case Studies on Micro Hydropower Projects', PhD Dissertation, Universitat Flensburg.
- Reddy, A.K.N. (2000). 'Energy and Social Issues, in "World Energy Assessment"', UNPD, New York. ISBN 92-1-126-126-0.
- Sen, A.K. (1999). 'Development as Freedom', 1st Edition, *First Anchor Books Edition*, New York.
- Smith, F.J., & Dahl, D.C. (1965). 'Market Structure Research. How and for What?', *Journal of Farm Economics* Vol. 47, No. 2, pp. 465-467.
- WEO, World Energy Outlook. (2002). Paris: International Energy Agency.
- White, A.P. (1982). 'A Note on Market Structure Measures and Characteristics of Markets That They "Measure"', *Southern Economic Journal* Vol. 49, No. 2, pp. 542-549.