International Journal of Energy Economics and Policy
Vol. 3, No. 2, 2013, pp.118-126
ISSN: 2146-4553
www.econjournals.com

Market Changes, Business Cycles and Fluctuations in Electricity Prices - EU Evidence from Germany and Slovenia

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ABSTRACT: This article deals with interesting oscillation pattern in electricity prices during the period of EU electric power supply liberalization process, its transition from infrastructure to market activity and during last economic crisis, when at first prices declined significantly, to be raised afterward and start to decline again during the last recession. Using empirical evidence from Germany and Slovenia and based on short theoretical background we try to explain how can such strong oscillations occur and what we can expect in the future? It was discovered that such oscillations can be connected with business cycles dynamic, only that electricity prices oscillations proved to be even stronger unless a major technological breakthrough occurs in the way energy is produced or spent. Economic growth affects electricity prices even in relative terms, causes growth in prices with respect to inflation and vice versa. To conclude, we can expect relative growth of electric power prices together with economic recovery in the near future, but growth should be moderately slower than growth of real GDP.

Keywords: Prices oscillation; Business Cycles; EU; Economic development; Supply-Demand; Forecasting and simulations; Electricity
JEL Classifications: E3; O1; Q4; F4; G1

1. Introduction

In the contemporary techno-economic paradigm (Perez, 1983) with a flexible economy based on information and communication technologies, economic growth is based on knowledge. More precisely, economic growth is based on the continuous improvement of technological knowledge and enterprising spirit. These two have replaced price (costs of productive factors – raw materials and other natural resources, labour and/or capital) as the crucial factors of competitiveness. In contemporary conditions the economy needs specific regulation and a specific institutional framework to assure for itself proper support of knowledge implementation. This support is provided by modern economic policy. Part of it is intensive development policy, and part of development policy includes dealing with different "bottle necks", i.e. process limitations that can completely halt economic development and even the normal function of the modern economy. One area where such limitations can occur is power supply (Križanič, et al., 2006 or Festić et al., 2009). The energy supply sector needs special institutional infrastructure, both because this sector has great external economies and diseconomies and because it is capital intensive. If we limit ourselves to managing solely on electric power, the important role of state becomes clear.

This applies to both investment and management in the energy sector, particularly during the period of industrialization once mass production of standard goods prevailed. This was the case in developed western countries, in developing countries, and in former socialist economies. In the seventies (after two "oil shocks") the economy changed in the developed countries. The technological base turned from standardized to flexible technologies, and there was also a change in the key factor of economic growth: from capital formation and mass use of cheap raw materials to wide use of

knowledge on the platform of information and communication technologies. With this new technological connection the management of certain sectors radically changed from infrastructure to market oriented activity (Križanič, 2001). The entry barriers for new suppliers were eased, and the supply became more flexible in adapting to changing market conditions. This period saw the electricity supply sector face this transition from infrastructure to market based management, as well as the telecommunications industry, air and railway transport, supply of natural gas and supply of oil derivatives. The transition from infrastructure to market oriented activity more or less failed in railway transport and succeeded in the telecommunications industry as well as in air transport. Numerous problems with this kind of transformation arose in the electricity supply sector. Collateral damage included blackouts – electric power supply shortages due to the time lag between demand dynamics and ability of the supply to adapt in the middle or long term. When the price elasticity of supply exceeds the price elasticity of demand, we face a permanently unstable market. By the Cobweb Theorem[1] balance between demand and supply is not possible. Thus a special need for state regulation in the electric power supply sector remains. Nevertheless, in the developed countries the transition of electric power supply has finished. The market price of electricity, a price that covers costs of production (also the cost of capital needed for new investments), transport, distribution, and regulation (together with securing a stable supply), is the basis for estimation of costs in the production of goods and services that require energy. When energy costs are included in the final price of a good, there is no market distortion or dumping connected with state aid. Electric power supply transition in the EU from infrastructure to market activity took place in the last decade of the former century. The process caused a typical oscillation in electricity prices. First, after liberalization in this sector, prices declined, and then they started to grow. By the end of that period they had grown faster and more than they declined. During the recession, demand for electricity and prices again declined. This process was running within the market framework with several independent and sovereign economic subjects on both the supply and demand sides. In this article we analyze the mentioned electricity price dynamics for industrial use in Germany and in Slovenia. According to the results, we first define electric power (it can also be seen as a kind of intermediate good) in terms of the Prebisch-Singer Thesis and in terms of Engel's Law. At the end we econometrically estimate the relationship between economic growth and industrial electricity prices in Germany and Slovenia. Some evidence about electricity market and prices can also be find in Zachmann (2008).

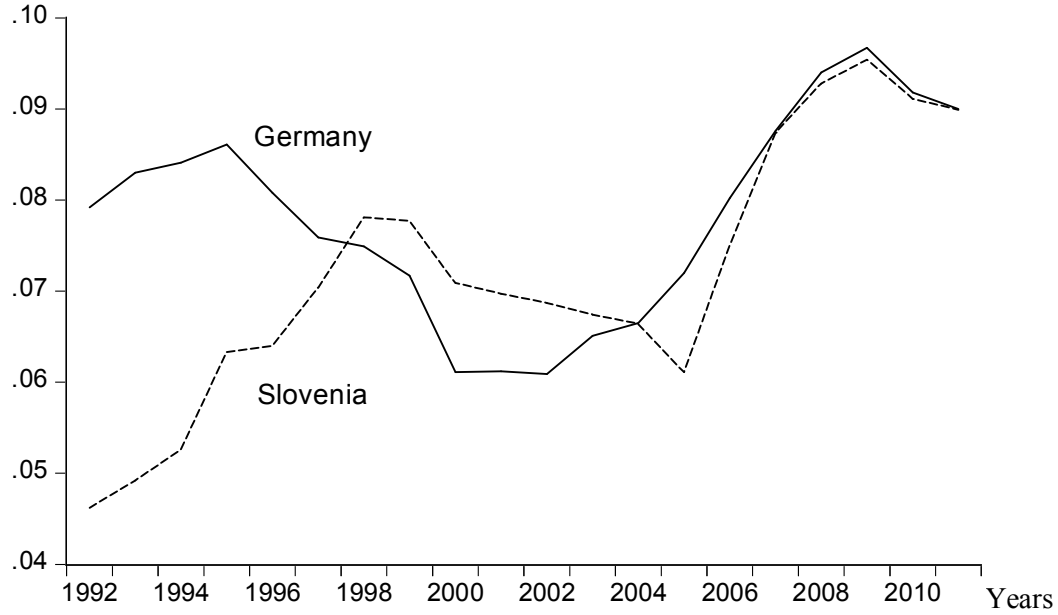
2. Electricity Price Oscillation and Short Evidence

Raul Prebisch and Hans Singer (1950) defined an interesting thesis (called the Prebisch-Singer Hypothesis) that prices of raw materials gradually decline relative to the prices of finished goods and that economies with comparative advantages based on abundant natural resources gradually lose their position to exporters of finished goods. This notion, based on exploring economic behaviour over a particular time period, was never recognized as an economic law. The oil crisis in the seventies was an event unexplainable by and seemingly contrary to the Prebisch-Singer Thesis. A similar event occurred in first decade of this century on the general raw material markets, so it is not limited to the energy sector. The rise of some BRIC economies (Brasil, Russia, India, China) identifies that the Prebisch-Singer Thesis is not universally valid. Technological advance is not fast enough to reduce the need for natural resources per unit of final product to the extent that total demand for natural resources will be reduced. This proves especially impossible in the times of living standard modernization in China, India and Brasil. Some evidence about electricity price dynamics can also be observed by Park et. al. (2006) or Hellström et al. (2012).

We can conclude that economic theory cannot expect long term, low level raw material prices or energy prices, electric power prices in particular. Expectations about this issue are important. They influence the investment decisions in the energy sector. In the case of Slovenia, for instance, electricity price expectations are the key factor in investment decisions on the chain of hydroelectric power plants on the middle stream of the Sava River.

[1] The Cobweb Theorem describes the oscillation of prices, demand and supply in circumstances when suppliers decide on the quantity of supply before knowing the prices at which this supply will be sold. A typical case of this kind is agriculture due to its annual cycle. The Cobweb Theorem was analyzed and introduced by Nicholas Kaldor (1934).

Figure 1. The electricity prices for industrial use 1992 to 2012



Graphic 1. The electricity prices for use in industry (500–2000 MWh annually) in €/kWh
Source: Eurostat, EEX – European Energy Exchange

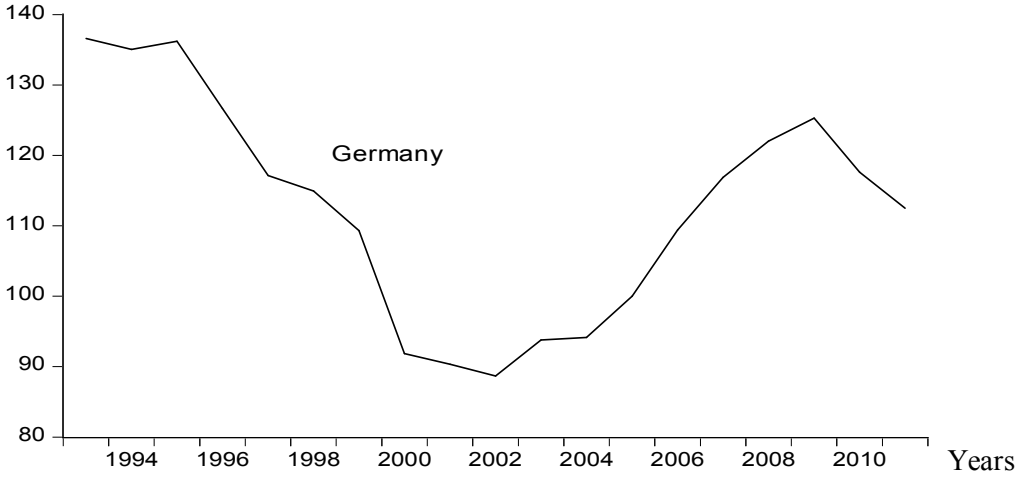
Figure 1 and the first two columns of Table 1 show four significantly different periods in electricity price[2] dynamics during the last two decades:

a) The period of rising electricity prices connected with economic growth when the energy sector still operated as part of infrastructure: Prices and quantities of produced electric power were regulated, and the state was the main investor in new capacities. In Germany this institutional framework's influence on electricity price dynamics ended in 1995 and in Slovenia in 1998.
b) The period of electricity prices' sharp decline after the liberalization of this particular market: This period ended in 2002 in Germany and in 2005 in Slovenia. According our specific sample of electricity prices, they fell by 29% in Germany and 22% in Slovenia during this period.
c) The period of rising electricity prices in the liberalized market framework driven by the large demand for energy on world's market: This period ended with the financial crisis in 2008 and from 2009 on. In the period of fast growth the electricity prices of our specific sample increased by 59% in Germany and 56% in Slovenia.
d) During the financial crises and in the liberalized market framework, electric power prices (our sample) declined: in Germany by 7% and in Slovenia by 6%. By the end of our study period of this good the process had completely equalized Slovenian prices were with German prices.

How can such strong oscillations in electric power prices during last two decades be explained? The initial liberalization effect of electricity price decline directly benefited the economy, but it was only temporary. The next period saw a strong need for new investment in the electric power supply sector to assure stable and safe coverage of demand. This established the need for new suppliers and forced electricity prices to grow. In the liberalized framework the decline in demand during the recession after 2008 had the effect of reducing electric power prices again.

[2] In this analysis we are focusing on electricity prices for industrial use of 500 MWh up to 2000 MWh annually (Group IC by Eurostat standards). The Eurostat data are published through the first half of 2012, and they show approximately 20% higher price levels than average in the European Energy Exchange (EEX - Leipzig) spot market in 2012.

Figure 2. The combined index of relative (to inflation) electricity prices in Germany



Graphic 2. Relative electricity prices in €/MWh as Index 2005=100
Source: Eurostat, EEX – European Energy Exchange and own calculation

Table 1. The electricity prices for industrial use from 500 to 2000 MWh annually

	I.	II.	III.	IV.	V.	VI.
	Electric power prices in Germany	Electric power prices in Slovenia	Index of electric power prices in Slovenia relative to Germany	Index of electric power prices relative to inflation in Germany	Index of electric power prices relative to GDP growth in Slovenia	Index of electric power prices relative to GDP growth in Germany
	€/MWh	€/MWh	%	2005=100	2005=100	2005=100
1992	79	46	58.3	135.1	129.9	128.2
1993	83	49	59.3	136.6	134.7	135.6
1994	84	53	62.5	135.0	136.6	134.1
1995	86	63	73.5	136.2	153.0	135.1
1996	81	64	79.2	126.7	149.2	125.8
1997	76	70	92.8	117.1	156.6	116.1
1998	75	78	104.3	114.9	167.7	112.5
1999	72	78	108.4	109.3	158.4	105.7
2000	61	71	116.0	91.8	138.6	87.4
2001	61	70	113.9	90.3	132.3	86.3
2002	61	69	112.8	88.7	125.6	85.8
2003	65	67	103.5	93.8	119.8	92.1
2004	67	66	99.8	94.1	113.1	93.0
2005	72	61	84.9	100.0	100.0	100.0
2006	80	75	93.5	109.4	116.0	107.4
2007	88	87	99.8	116.9	126.4	113.6
2008	94	93	98.7	122.0	129.8	120.5
2009	97	95	98.7	125.3	144.7	130.8
2010	92	91	99.2	117.6	136.5	119.2
2011	90	90	99.9	112.5	133.9	113.4

Source: Eurostat, EEX – European Energy Exchange

Taking the period of the last two decades (1992 till 2011), we can see that electricity prices (our sample) were growing on average 0.7% annually in Germany and 3.6% annually in Slovenia. At the end of this period electricity prices in Slovenia had levelled with German prices. If we consider just the period after electricity market liberalization, looking at electric power price (our sample) dynamics during business expansion and contraction, we can see that in this new framework electricity prices were growing by 4.4% on average annually in Germany and by 6.6% annually in Slovenia. Unless a major technological breakthrough occurs in the way energy is produced or spent, we can with great certainty expect the growth of electric power prices over time. According to German experience after 2002, this price growth could be around 4% annually. In 2012, the prices of electricity were extremely low on the European Energy Exchange (EEX) as a consequence of the deepening recession in Europe. This decline in prices was partly caused by lower demand and mainly by the expectations of electricity traders that electric power would be available at "acceptable" prices in the future. Such expectations commonly precede sharp rises in commodity prices, for instance, the growth of oil prices in the 1970s. Disappointment with such expectations then causes price oscillation in the opposite direction (upward).

The relation between Slovenian and German electricity prices and between the electricity prices in Germany and German inflation is shown in the third and fourth column of Table 1. Relative electric power prices are represented just for Germany in Figure 2. When electric power supply still operated as part of infrastructure, Slovenian prices of this good were significantly lower than in Germany, but they had already started to grow. After that, during the sector's transition, the decline of Slovenian electricity prices was similar than in Germany, and finally the prices of electric power (our sample – electricity for industrial use of specific annual size) in Slovenia levelled with those in Germany. Slovenia started to be part of a broader electricity market with shared destiny.

Comparing the electric power prices for certain levels of industrial use and German inflation (HICP – the harmonized index of consumer prices) shows that electric power prices relatively declined in the period of electricity market liberalization, and from 2002 on they started to grow faster than inflation. From 2002 to 2009 the electricity prices for industrial use (our sample) grew 41% more than the German HICP. In the times of recession electric power prices (our sample) relatively declined by 10%. At the end of the period (2011) these relative prices were still 27% higher than in 2002. We can conclude that in the market framework electricity prices grow faster than inflation and have greater oscillations through the business cycle. The Prebisch-Singer Thesis of relative decline in the prices of intermediate goods, e.g. electric power so does not explain such price dynamics. There is no doubt that we can expect long term relative growth of electric power prices.

3. Methodology and Data Sources

The connection between German and Slovenian economic growth (rGDP) and electricity price dynamics (rPE) in the period from 1993 to 2011 (annual data) was estimated in the following equations:

$$rPE = f(rGDP, \ldots, u) \quad (1)$$

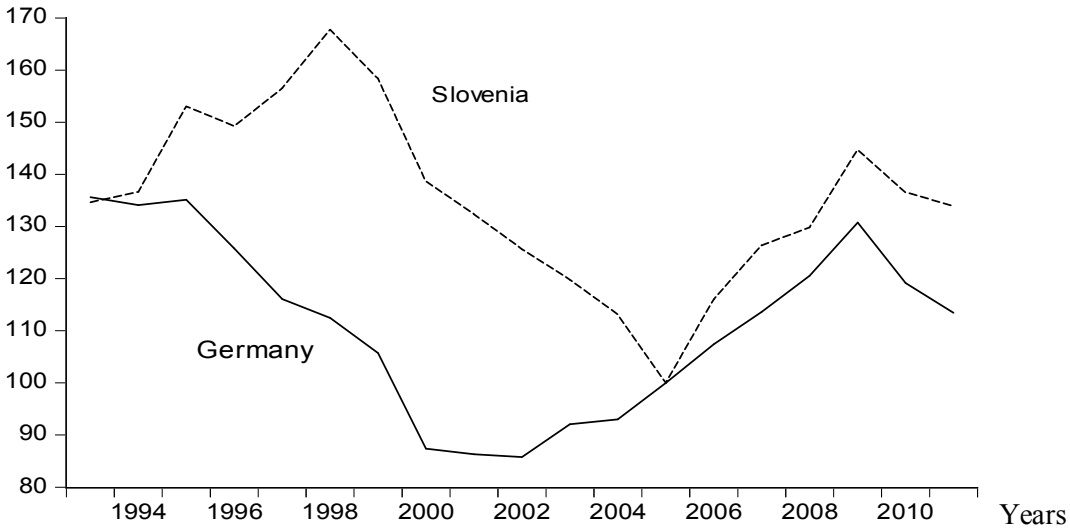
The equations contain the residual term (u) that represents the unexplained part of dependent variable variance. In explaining the electricity prices in Germany the AR(1) term is used as an instrumental variable to reduce the influence of variables that were not included in the equation. A constant term is also used in explaining the relative electricity prices (to inflation) in Germany. The equation for Slovenian electricity prices also includes German prices, serving as a proxy for the circumstances on the wider electric market. Additionally, the equation for Slovenian prices includes a one period (year) lagged variable. The data have been collected from Eurostat and EEX. The data on electric power prices from 1992 to 2011 in Germany and Slovenia are based on two different methodologies. For 2007 these data are available based on both methodological approaches. So we adopted a time series scale for electricity prices by multiplying the data from 1992 to 2006 as a quotient of these prices in 2007. For all the series (the growth rates of German and Slovenian electric power prices for industrial use 500–2000 MWh annually; the growth rates of relative electric power prices for this specific group of users with respect to inflation in Germany; the growth rates of real GDP in Germany and Slovenia) included in econometric equations the unit root test was estimated, and we confirmed that the series are stationary at a 5% level.

4. Electricity Prices, Economic Growth and Engel's Law

The comparison of electric power price (our sample) dynamics with economic growth is represented in last two columns (the fifth and the sixth column) of Table 1 and in Figure 3. The results reveal how to classify electricity according the Engel's Law (Engel, 1857)[3]. This law distinguishes goods as superior, normal, and inferior according the growth or decline of demand for these goods connected to income growth. If we can expect that the growth of real income will have a downward influence on the demand of given commodity, then this commodity belongs to the inferior type of goods. Our results show that in the times of economic growth electricity prices (for industrial use of certain size) grow even faster, and in times of recession they decline more than real GDP. Electric power price oscillation is in this case the consequence of changes in demand for electricity. Our study shows that the growth and the decline in demand for this commodity are larger than the growth and the decline in income. According to Engel's Law, electricity is at least normal if not a superior good, and we can expect a rise in demand for this commodity together with economic growth. In the contemporary economy overall growth of electric power prices is expected. How electricity demand and supply and prices of this commodity affects economic growth can also be seen from many research evidence, done by scholars, like Ayres and Warr (2010), Saatci and Dumrul (2013) or Lau et. al. (2011), etc.

Figure 3. The combined index of electricity prices per unit of GDP in Germany and Slovenia

Index 2005=100



Graphic 3. Relative electricity prices in €/MWh as Index 2005=100
Source: Eurostat, EEX – European Energy Exchange and own calculation

The results presented in Table 2 show the connection between the economic growth and the growth of electricity prices (our specific sample). We estimated this relationship for Germany and Slovenia, and for Slovenia we also took into account the influences of the broader electric power market. In Table 2 we can see that a 1% increase or decline in German real GDP influences a change of electricity prices (our sample) in the same direction by 0.7%, and note that this effect is delayed one year. So we can conclude that electricity is a normal and not a superior good according to Engel's Law. In Slovenia this effect is slightly stronger. For each percentage of economic growth (or contraction) the electricity prices (our sample) change in the same direction by 0.8%.

[3] Ernst Engel was a German statistician. He discovered the different regime in demand dynamics for different goods, originally in the demand for food, connected to real income changes (originally changes in households' real income).

The influence is spread over a longer period. This delay is shown by the lagged (for one year) dependent variable (electric power prices for industrial use of specific size in Slovenia). Taken together[4], the direct and lagged influence of economic growth on electricity prices (our sample) in Slovenia is 1:1. A 1% rise in electric power (our sample) prices follows a 1% growth in Slovenian GDP, compensating for the adoption period.

Table 2. The influence of Economic growth / decline on electricity prices in Germany and Slovenia between 1993 and 2011 – econometric equations with explanation

		Constant	GDP	Electricity[1] prices in Germany	Electricity[1] prices in Slovenia	AR(1) term[4]	R^2	LM[3]
			growth rate	growth rate				
Electric power[1] prices in Germany	growth rate		0.65 (-1)[2]			0.60	0.37	0.88
	(t-statistic)		(1.3)			(2.9)		
Electric.[1] prices according to inflation in Germany	growth rate	-2.14	0.59 (-1)[2]			0.56	0.31	0.96
	(t-statistic)	(-0.6)	(1.0)			(2.4)		
Electric power[1] prices in Slovenia	growth rate		0.78	0.61	0.22 (-1)[2]		0.37	0.57
	(t-statistic)		(1.8)	(2.1)	(1.1)			

[1] The electricity prices (€/kWh) for use in industry (500–2000 MWh annually). The equation that describes the Slovenian prices of this commodity also contains a dependent variable with a lag time of one period (year); this means the Koyck lag distribution of all independent variables (in this case Slovenian GDP and German electric power prices) influences all time-related calculations (all periods of analysis).
[2] The number in parenthesis shows the time lag (in years) of economic growth influence on the dynamics of electricity prices.
[3] Breusch-Godfreyev serial correlation LM test (three years time lag) shows that there is no autocorrelation.
[4] AR(1) term is the result of the autoregressive process (forming an instrumental variable) to reduce autocorrelation. In both cases when the AR(1) term was used, the estimated "inverted AR root" was lower than one, so we can conclude that model is stationary and the econometric results are correct.
[5] R^2 is the fraction of variance of the dependent variable (in our case electric power price dynamics) explained by independent variables (in our case real GDP growth, electricity prices on a wider market than just Slovenia, and instrumental variables). The robustness of the explanation of electricity price dynamics is not high but acceptable for analysis based on this strongly oscillating series.

Economic growth affects electricity prices even in relative terms (compared to inflation). Growth of German real GDP by 1% causes 0.6% growth in electricity prices (our sample) with respect to inflation. And of course, a decline in real GDP of 1% causes a decline of relative (to general inflation) electric power prices (industrial use of specific size) of 0.6% in Germany. Slovenia is now part of wider electric power market. The circumstances (and balanced prices) on this market can be more or less accurately seen via the German prices of this commodity.

The rise or fall of electric power prices (for industrial use per year) in Germany by 1% causes the adaptation in Slovenian prices of same commodity in the same direction by 0.6% in the short run and 0.8% after the adoption period (the long run effect).

[4] If the short run (same period) effect of a unit change in the independent variable is the value *b*, and if *d* represents a coefficient of a one period lagged dependent variable, then the long run (cumulative) effect of a sustained unit change in the independent variable is: *b/(1-d)*.

Results show that electric power prices will rise together with the recovery of economic growth. Electricity price growth should be stable and moderately slower than long term growth of real GDP. The electricity prices should also rise in relative terms according to level of other prices represented by the inflation index (HICP – the harmonized index of consumer prices).

5. Conclusions and Further Expectations

Electric power supply liberalization process and its transition from infrastructure to market activity in the last two decade caused a typical oscillation pattern in electricity prices, when at first prices decline, to be raised afterward and start to decline again during the last recession. Process was running within a liberalized market framework with several sovereign economic subjects on both the supply and demand sides. Using empirical evidence from Germany and Slovenia and based on short theoretical background defining electricity as a kind of intermediate good in terms of the Prebisch-Singer Thesis and as a king of final good in terms of Engel's Law, we try to explain how can such strong oscillations occur and what we can expect in the future?

It was discovered that such oscillations can be connected with business cycles dynamic, only that electricity prices oscillations proved to be even stronger. According to Engel's Law, electricity is at least normal if not a superior good and we can expect a rise in demand for it together with economic growth unless a major technological breakthrough occurs in the way energy is produced or spent. Economic growth affects electricity prices even in relative terms, causes growth in prices with respect to inflation and vice versa. The Prebisch-Singer Thesis of relative decline in the prices of intermediate goods, e.g. electric power, on the contrary does not explain such price dynamics. To conclude, we can expect relative growth of electric power prices together with economic recovery in the near future, but growth should be moderately slower than growth of real GDP.

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