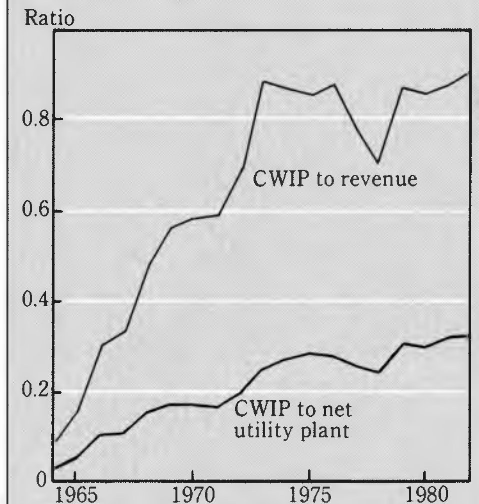
an expansion of output without new major capital expenses. Demand for electricity would increase, possibly making TFP climb upward. Also, energy source prices might stop their tremendous upswing of the 1970s. All this would be favorably reflected on Ohio's electricity prices, and possibly the gap between prices of California's electricity or that of other states would remain in Ohio's favor.

The alarming growth of CWIP undertaken by Ohio's electric utilities could lead to a situation considerably different from that in scenario I. Currently, there is a record high level of CWIP. In 1964, the ratio of CWIP to existing capital stock was 0.02, and the CWIP ratio to revenue was 0.07. In 1982, both of these ratios rose to 0.32 and 0.91, respectively (see chart 3).[7]

Scenario II. As time progresses, CWIP would reach its completion level, and then PUCO would be under pressure to include a great amount of capital in the rate base, which would automatically and dramatically increase the price of electricity. Most studies suggest that price elasticity for long-run demand of electricity exceeds unity (Sweeney 1984). By raising prices, a utility would not increase revenue in the long run, although in the short run electricity demand is fairly inelastic (Bohi 1981). By increasing prices, utilities would be able to recover the cost of CWIP, which then would be included in the capital (the rate base) in the short run. Nevertheless, if the consumption of electricity does not increase, in the long run utilities would have greater difficulty recovering their capital cost,

Chart 3 Increase in Construction Work in Progress



SOURCES: *Moody's Public Utility Manual*, Moody's Investors Services, Inc., New York, NY; and Standard & Poor's Compustat Services, Inc.

which would put *constant* upward pressure on their prices. Under this scenario, more companies would find it advantageous to settle in other states, thus increasing the excess capacity of Ohio's utilities and incurring greater payments to the remaining customers for idle capacity.

While factors not considered in the preceding scenarios can affect electricity prices, many factors can be incorporated in the framework of these scenarios. Acid rain proposals, for example, would require utilities to increase capital expenditures and, at the same time, lower productivity; then the declining TFP and the rising rate base undoubtedly would increase electricity prices, as explained in scenario II.

Conclusion

While the energy price shocks in the 1970s created a price advantage for Ohio's electric utilities, a relatively slow reduction in Ohio's nonfuel expenses jeopardizes this advantage. Especially in a period of flat energy prices, which is widely expected in the 1980s, Ohio's electricity prices may rise significantly compared with those of other states. This should be of great concern to the state officials, as energy prices, although not decisive, are an important factor in the location decisions of industries. It is thus important to preserve Ohio's historical advantage in electricity prices.

What are the sources of price improvements that can be expected in the coming years? The productivity of Ohio's utilities rose until the early 1970s, but afterwards it declined. Apparently, the ability to improve productivity through technological changes was exhausted by the early 1970s. Nevertheless, by increasing the level of capital utilization and returns to scale (assuming demand rises), utilities will have room for lowering their cost per unit of output. However, should the current high level of CWIP be allowed into the capital (the rate base) of the utility, the price of electricity relative to other states may be significantly increased, which would have an adverse effect on Ohio's economic growth in the long run. To prevent that, PUCO should consider basing its prices not only on the utility's performance but also on *changes in regional price differences* throughout the United States.

7. Most of the CWIP is devoted to the construction of four of Ohio's nuclear power plants. A smaller part of the CWIP is related to emission control, which was imposed by the Clean Air Act Amendments of 1970.

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ECONOMIC COMMENTARY

Ohio's Electricity Prices

by Philip R. Israilevich

The energy crisis of the 1970s had a dramatic effect on the comparative costs of electrical utilities across the nation. Triggered by the emergence of OPEC, oil prices in the United States rose 175 percent between 1973 and 1982 (after adjusting for inflation). Over the same period, natural gas prices increased 350 percent, while coal prices rose only 85 percent. The prices of primary energy sources (oil, coal, and natural gas) are a major cost component in the production of electricity. As a result, electrical utilities that use coal as the major fuel to generate electricity experienced much smaller increases in production costs than oil- or gas-dependent utilities. With 90 percent of their electricity generated from coal, Ohio's utilities have been major beneficiaries, along with Ohio's businesses and consumers, of a decline in coal prices relative to other natural fuels.

The relative decline of fuel costs to Ohio's utilities produced one of the slowest rates of electrical price increases in any state in the nation. In Ohio, utility prices are regulated, and changes in production costs are the major component of electrical price changes (see box 1). Fuel prices, of course, are not the only determinants of electricity prices. Nonfuel factors, such as declining utilization rates, increasing capital costs, and falling productivity, also increase the cost of producing electricity. One of the questions that we address in this article is whether falling relative coal prices have been overwhelmed by nonfuel factors that are rising more rapidly in Ohio than elsewhere. Or, how beneficial has it been to Ohio's consumers that their electrical utilities are coal-based?

Box 1 Utility Regulation in Ohio

The goal of utility regulation is to award the regulated utility a "fair rate of return" (technically called the cost of capital) on its assets. The process of price-setting can be expressed as the following equation:

$$\pi = PQ - wL - rk,$$

where

π = excess profit (loss),
Q = electricity output,
P = price per unit of output (Kwhr),
K = net value of capital of utility (rate base of utility),
r = rental per dollar of capital,
L = variable inputs (material, fuel, labor, services) used by utility, and
w = cost of variable inputs.

The main purpose of the Public Utilities Commission of Ohio (PUCO) is to adjust electricity prices to achieve the allowed rate of return on capital. In other words, revenue (PQ) should cover variable costs and capital costs ($PQ = wL + rK$). Therefore, electricity prices should be set at the level that guarantees no excess profit or loss ($\pi = 0$). If variable costs (wL) increase, prices would have to go up by the same amount, other factors being constant. Or, if the capital stock (the rate base) expanded, then the electricity price would have to be raised to cover the increase in the rate based and its cost (rK). PUCO is not allowed to include construction work in progress (CWIP) in the rate base until the construction work is at least 75 percent complete, after which PUCO uses its own discretion to account for CWIP.

In reality, PUCO cannot control prices continually. According to the well-accepted view of Joskow (1974), PUCO is a passive agent. It exercises its power when a utility files a petition regarding incurred losses or when it is pressured by consumer advocates to lower a utility's profit.

In a competitive environment, if demand rises, price increases; if demand falls, price declines. Nevertheless, under the current regulatory rule, a rise in consumption of electricity tends to lower electricity price, and a decline in consumption tends to increase electricity prices for the following reasons. The rise in electricity consumption increases capacity utilization, requiring less capital per unit of output (K/Q declines). At the same time, productivity of variable inputs also tends to increase (L/Q declines) because of an increasing return to scale and other factors. As a result, prices would have to decline to show no excess profit ($\pi = 0$).[a] The decline in consumption of electricity would drive up prices for similar reasons. Because of the passive nature of its regulation, PUCO would be more likely to impose a price increase (with certain lags) than a price decline (see Jaskow 1974).

a. Initially, $\pi = 0$ or $P = w(L/Q) + r(K/Q)$, then both L/Q and K/Q decline; therefore, P should be decreased to have $\pi = 0$.

Fuel Costs and Electricity Price Trends

The 1973 and 1979 oil embargoes dramatically increased fuel prices across the United States. Chart 1 shows the effect of these oil embargoes on the average electricity prices across the ten largest electricity-consuming states over the period 1971–81. (The combined electricity consumption of these 10 states represents 51 percent of the total U.S.

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electricity consumption in 1981.) In four of these states (Texas, Florida, California, and New York), the share of oil and natural gas in electricity production exceeds 50 percent of composite fuel (all fuels used exclusively for the production of electricity, measured in Btus). For the remaining six states, this share is below 20 percent.

The average price of electricity after the oil embargoes decreased in coal-consuming states compared with the average for the United States. Electricity prices in Ohio decreased relative to those of the oil-consuming states of California, Florida, New York, and Texas. The relative price differential between Florida and Ohio, for example, rose from 19 percent in 1971 to 40 percent in 1981; between California and Ohio, from 1 percent to 28 percent. Electricity prices in Texas were 9 percent lower than in Ohio in 1971, but rose to 6 percent above Ohio's by 1981. On the other hand, electricity in the state of Washington was 58 percent cheaper than Ohio's in 1971 and 66 percent cheaper than Ohio's in 1981. Because most of the electricity in Washington is generated by hydro-resources, the price of Washington's electricity was little affected by the energy crisis.

As fuel prices are but one component of electricity prices, we need to look at nonfuel factors to better understand the relationship between fuel costs and electricity prices. As shown in table 1, the lowest rate of change in the price of electricity took place in Ohio, as we would expect based on analysis of fuel prices only. Moreover, one might also expect that Ohio's price hike in electricity would be *much* smaller than that of California's. In fact, the price of a composite fuel in Ohio rose only 4 times in the 1971–81 period; in California the price of a composite fuel rose 12 times.[1] Yet, electricity prices increased in Ohio only slightly less than in California (a three-fold increase in Ohio, compared with a four-fold increase in California).

In other words, California's utilities compensated for the surge in fuel expenses by the decline in nonfuel expenses so that, despite a very steep surge in fuel prices, the actual price of electricity in California did not rise much above the price of electricity in Ohio. In fact, all of the states listed in table 1 seemed to do better than Ohio's utilities in terms of lowering their nonfuel expenses in the production of electricity.[2] The contribution of nonfuel factors to California's electricity prices would have resulted from (1) an increase the purchasing of cheaper electricity from other states; (2) technological changes that allowed substitution for cheaper fuels; and (3) improved productivity.

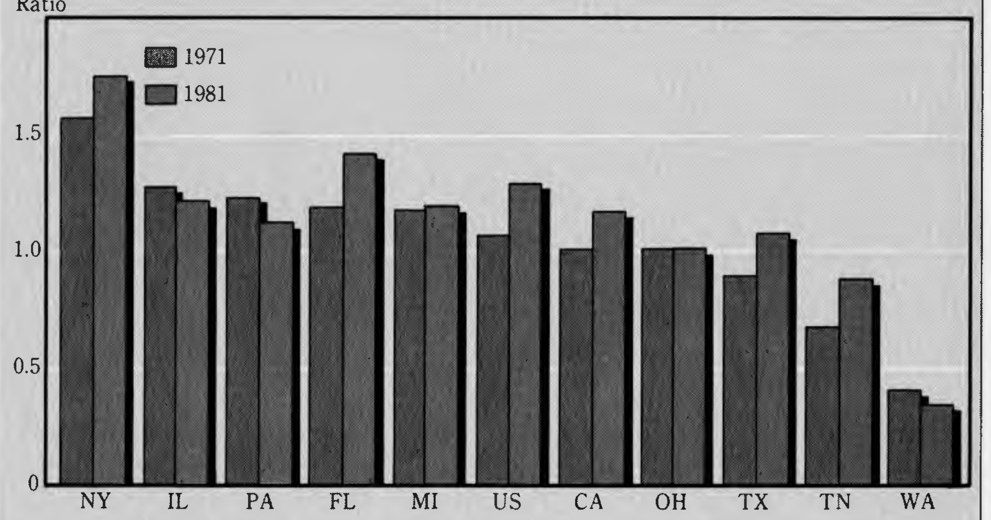
Realizing that each state's utilities have their own character, we might consider the nonfuel factors that could improve the performance particularly of Ohio's utilities. The purchase of electricity from other states historically was minimal in Ohio, and its future expansion is doubtful. Since Ohio's utilities are coal-operated, the substitution for cheaper fuel for existing generators would be improbable. Therefore, improvement in productivity would most probably assure stable electricity prices in Ohio relative to other states (again, assuming no change among fuel prices).

Regulatory Process and Productivity Trends

While the prices of electricity in Ohio might give our state officials some comfort, Ohio's price advantage could be reduced or eliminated if fuel prices were to stabilize. Considering that Ohio's utility prices are regulated, it is important to compare Ohio's utility prices with those of other states. Although utilities in various states do not compete directly with each other for electricity sales, there is an indirect competitive mechanism. Regulators who drive electricity prices above the price levels of other states can cause a decline in the industrial base in the state with higher electricity prices.

Yet, the regulatory price mechanism has no feedback from the falling demand for electricity, which would stop the price hike (see box 1). In Ohio, as well as in other states, regulators monitor the profits of regulated utilities. Profits of privately owned utilities are established by methods that are relatively uniform and comparable all over the country, yet regulators do not compare prices among states. Consequently, electricity prices vary considerably among states, even when the profits of utilities are regulated to the same level in every state.

Chart 1 Comparative Electricity Prices in 1971 and 1981



SOURCE: *State Energy Price and Expenditure Report 1970-1981*, Energy Information Administration, June, 1984.
NOTE: Prices are normalized for 1971 and 1981, based on Ohio's electricity prices.

1. Composite fuel prices represent the average of all fuels used exclusively for the production of electrical energy, measured in dollars per million Btu.

2. This is revealed by elasticities of electricity prices to fuel prices, which are reported below for 1971–81, derived from double log regressions for each state. Ohio has the highest elasticity, i.e., 1 percent of the fuel price increase would induce the highest increase of electricity prices in Ohio compared with the other listed states:

Ohio	0.65 (6.26)
California	0.42 (12.62)
Florida	0.60 (13.45)
Texas	0.52 (14.1)
United States	0.62 (12.40)

Table 1 Electricity Prices and Prices of Composite Fuel
Dollars per million Btu

	Electricity prices, \$/MBtu		Composite fuel prices, \$/MBtu		Electricity price ratios:	Fuel price ratios:
	1971	1981	1971	1981	1981/1971	1981/1971
Ohio	4.90	14.68	0.358	1.624	3.00	4.53
California	4.97	18.77	0.275	3.228	3.78	11.72
Florida	5.82	20.62	0.394	3.026	3.54	7.68
Texas	4.47	15.56	0.277	2.106	3.48	7.61
United States	5.27	16.09	0.320	1.748	3.05	5.46

SOURCE: Energy Information Administration, *State Energy Price and Expenditure Report 1970-81*, June 1984.

To analyze the price mechanism, it is important to measure a combined productivity of all input factors (such as fuel, labor, capital, and nonfuel materials). The regulated price is the sum of factor productivities, weighted by their own prices.[3] Economists compute *total factor productivity* (TFP) as the difference between the output growth rate and growth rates of the weighted factor inputs. TFP represents either output growth when all input factors are held constant or cost savings in producing a fixed output when input prices are fixed.[4] The ability to separate components of TFP from input prices can give regulators a useful tool for comparing the performance of utilities in different states.

The change in the price of electricity consists of changes in TFP and input prices.[5] Separating the analysis of trends in TFP and input prices thus provides a better perspective on changes in electricity prices in the future. For example, if coal-based utilities have technologically declined but oil-based utilities can continue to advance their technology, then TFP for oil-based utilities would grow, while TFP for coal-based utilities would not. Therefore, in a period of flat energy prices, the oil-based utilities would lower their prices of electricity compared with those of coal-based utilities.

Of the seven major Ohio utilities (which generate about 90 percent of the electricity produced in the state), TFP for each utility behaved consistently over time. TFP for each company rose from 1964 through 1972, meaning that production costs and, correspondingly, the price of electricity would decline if input prices remained stable. In fact, the TFP improvement was combined with moderate hikes in input prices. Even so, productivity improvements were so great that electricity prices in nominal terms declined. Post-1972 TFP started to decline, providing upward pressure on the price of electricity. In addition, during this period the price of fuel for electric utilities increased almost five times in nominal terms. As a result, revenue collected from electricity sales grew faster than the amount of electricity sold, and thus electricity prices rose. From 1980 to 1982, Ohio's electric utilities showed the highest price increase in the last two decades (see chart 2). The accompanying decline in TFP was attributed mostly to the decline in the consumption of electricity. Despite this decline, utilities increased their capital (rate base) to meet an anticipated demand that never materialized. The rate-base increase was passed on to the price of electricity. The combination of an increasing rate base and declining demand raised revenues, while the amount of electricity sold declined.

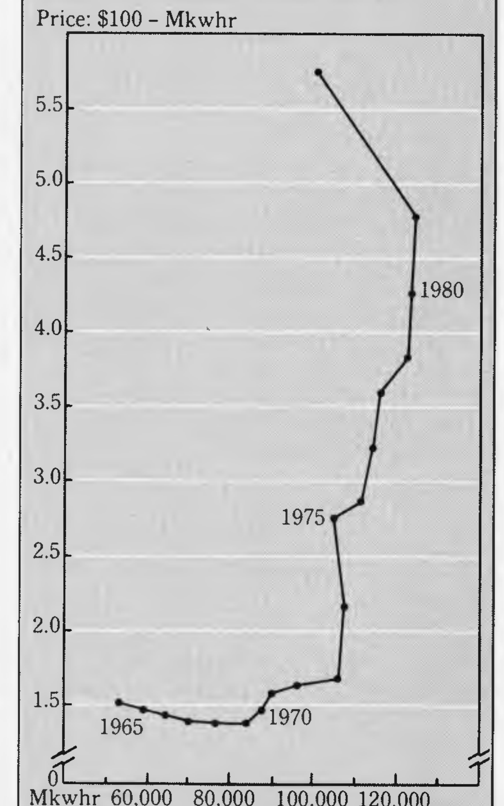
Implications for Future Prices of Electricity

Lower electricity prices allow lower production costs, translating into a competitive advantage for Ohio's businesses. Declines in electricity prices do not necessarily ensure expansion of businesses in a state, as a firm's location decision is affected by many factors.[6] Interestingly, three of the oil-consuming states discussed here (California, Florida, and Texas) are Sunbelt states—Ohio's major competitors in economic expansion over the last decade. The advantage of lower electricity prices in Ohio resulted mainly from fuel price differentials. Relative stability of fuel prices could eliminate this advantage in the future, making nonfuel factors a prime reason for interstate electricity price differences. The change from the relative decline of electricity prices to its relative increase could promote a deterioration of Ohio's industrial base.

Based on the historical observations of seven major Ohio utilities, two possible scenarios could shape electricity price changes in Ohio in the remainder of the 1980s:

Scenario I. The excess capacity accumulated in the last decade will allow

Chart 2 Electricity Prices and Quantity Sold by Ohio's Major Electric Utilities: 1964 to 1982



SOURCES: *Moody's Public Utility Manual*, Moody's Investors Services, Inc., New York, NY; and Standard & Poor's Compustat Services, Inc.

3. According to the equation shown in box 1, under zero profit conditions $P = w(L/Q) + r(K/Q)$, where terms in parentheses are the factor productivities.

4. There are two sources of TFP growth: (1) growth in output (electricity consumed) adjusted by return to scale (i.e., as output increases, input necessary to produce units of output declines), and (2) the effect of technological change. For more details on TFP, see Gollop and Roberts (1981).

5. This point is illustrated in "Ohio's Electric Utilities," a forthcoming working paper of the Federal Reserve Bank of Cleveland.

6. Theoretically, energy prices should play an important role in industrial location decisions. Presented data, however, cast some doubt on the significance of the role of energy in plant location decisions. For example, electricity in Ohio was cheaper than in Florida or California in 1971, and the gap in prices widened by 1981. Nevertheless, there were more companies settling in California and Florida than in Ohio during that period. Obviously, this should not lead to a conclusion that energy prices play no role in a firm's location; rather, other factors overwhelm the role of relative prices of electricity in the case of selected states.