Electric Power Deregulation: Potential Impacts on Irrigated Crop Production in the Texas High Plains

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ABSTRACT

Deregulation of the electric power industry has the potential to broaden the electric power markets in Texas by providing consumers with the ability to purchase their electric power needs from more than one supplier. Yet, not all segments of the consuming public may benefit from deregulation, in particular the agricultural industry in the Texas High Plains (THP), which is a major consumer of electricity for irrigation during the peak summer consumption period. The objectives of this study were to estimate the impacts on irrigated crop production in the THP from increasing electric power rates, and determine the associated impacts on the THP regional economy from changes in agricultural production. Nineteen county-level linear programming models (LP) were used to estimate the effects of increased electric rates on crop production. Key findings indicated that regional economic impacts from increasing electricity rates appear to be minor, yet farm level impacts could have a greater relative effect.

KEY WORDS electricity, deregulation, economic evaluation

Deregulation of the electric power industry in Texas has potential benefits for electricity consumers. The deregulation and restructuring of the electric utility industry is viewed as a positive progression that will broaden the electric power market for consumers and allow for comparative shopping. Consumers in the aggregate may benefit from deregulation,[2] however the distribution of benefits may be quite diverse across the various consuming segments of the market, such as residential, commercial, industrial and agricultural.

Who will be the winners and losers under deregulation? Several studies have indicated that industrial and commercial customers stand to be the big winners under retail deregulation (Chernoff and Sanchez, 1998; Chilton et al., 1997). Large industrial and commercial

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[2]As will be discussed, "re-regulation" may be the more appropriate term. States that have "deregulated" thus far, have placed limits/conditions on what utility companies can do with some electric rates.

customers who have high, consistent load factors and the ability to shift loads will be able to exert significant market power. Residential and small commercial customers may initially benefit from deregulation if rate reductions are mandated. Rural customers in low-cost states may face rate increases (Chernoff and Sanchez, 1998).

Irrigated agriculture is an important consumer of electric power in the Texas High Plains (THP). Electricity for irrigation represented approximately 38% of the total annual electricity usage over the period 1993-1998 for eleven rural electric cooperatives which serve much of the THP region (Golden Spread Electric Cooperative, 1999). However, this irrigation demand for electricity entails significant seasonal variations because irrigation customers consume the majority of their power over the crop growing season, the peak summer consumption period.

The use of electricity as an irrigation fuel has been increasing across the THP in recent years. This shift to electricity as a power source has resulted from reduced irrigation well yields which have encouraged the instillation of submersible pumps and the increased use of center pivot sprinkler irrigation systems. It is estimated that 55% of the irrigated acres in the THP use electricity as the source of power. The use of electricity for irrigation varies across the region, with electricity use estimated at 61% of irrigated acres in the southern sub-region and 53% of irrigated acres in the northern sub-region (Wolgamott, 1998).

Agricultural production, principally irrigated production, is an important component of the THP regional economy. The potential impact of electric power deregulation on agricultural production in the region and the resulting effects on the regional economy are important issues. Therefore, the objective of this study was to estimate the potential impacts of increasing electric rates on the THP regional economy. Specifically, the objectives were to (1) estimate the impacts on irrigated crop production in the THP from increasing electric power rates, and (2) determine the associated impacts on the THP regional economy from changes in agricultural production value.

This study was conducted for a defined region of 19 counties in the THP (Figure 1). The region was divided into northern and southern sub-regions in order to account for differences in cropping patterns across the region. The northern sub-region consisted of Armstrong, Bailey, Briscoe, Castro, Cochran, Deaf Smith, Floyd, Hale, Lamb, Parmer, Randall and Swisher Counties. The southern sub-region consisted of Crosby, Garza, Hockley, Lubbock, Lynn, Terry and Yoakum Counties. The selection of the study region was determined by the number of irrigated acres within these counties as well as the diversity in crop production. Wheat, corn, grain sorghum and cotton are the major crops produced within the study region.

Regional Agricultural Economy

Irrigated agricultural production is an integral component of the economy of the THP. Irrigated production of the four major field crops (corn, grain sorghum, wheat and cotton) within the study region contributed $1.06 billion directly to the regional economy in 1996 (Texas Agricultural Statistics Service). Crop production in the study region represented 60% of the state's cotton production, 37% of the state's corn production, 26% of the state's grain sorghum production, and 19% of the state's wheat production (Texas Agricultural Statistics Service). The three-year average planted acreages of the four major field crops in the study region are shown in Table 1. Of the 4.857 million acres, 53% were irrigated while 47% were dryland. As depicted in Table 2, 59% of the 2.910 million acres composing the northern sub-region were irrigated. Table 3 shows the allocation of acres within the southern sub-region, with 43% of the planted crop acreage

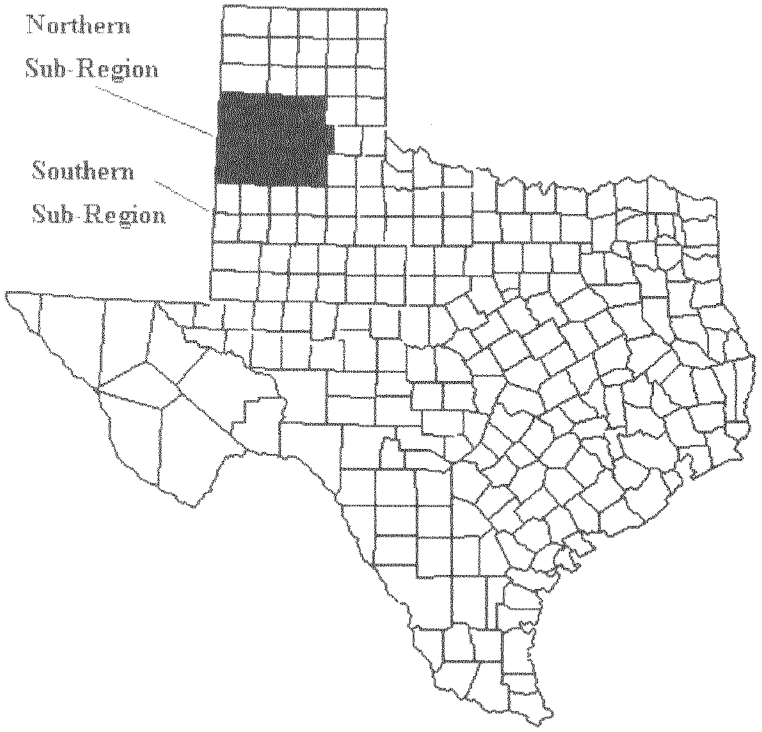

Figure 1. The Study Region.

Table 1. Regional Crop Acres (3-Year Average 1994-1996).

Crop	Irrigated	Dryland	Total
		(1,000 Acres)	
Cotton	1,537.7	980.8	2,518.5
Corn	467.5	-0-	467.5
Grain Sorghum	234.7	475.4	710.1
Wheat	327.0	833.9	1,160.9
Total	2,566.9	2,290.1	4,857.0

Table 2. Northern Sub-Region Crop Acres (3-Year Average 1994-1996).

Crop	Irrigated	Dryland	Total
		(1,000 Acres)	
Cotton	751.5	198.5	950.0
Corn	464.0	-0-	464.0
Grain Sorghum	197.8	264.9	462.7
Wheat	311.0	722.7	1,033.7
Total	1,724.3	1,186.1	2,910.4

Table 3. Southern Sub-Region Crop Acres (3-Year Average 1994-1996).

Crop	Irrigated	Dryland	Total
		(1,000 Acres)	
Cotton	786.2	782.3	1,568.5
Corn	3.5	-0-	3.5
Grain Sorghum	36.9	210.6	247.5
Wheat	15.5	111.2	126.7
Total	842.1	1,104.1	1,946.2

in irrigated production. Cotton dominates regional production with 52% of the total crop acres planted to cotton. In 1996, the region contributed 60% and of the state's total upland cotton production and 14% of total U.S. upland cotton production. In the study region, 62% of the cotton acreage is found in the southern sub-region, equally dispersed between both irrigated and dryland production practices.

While cotton is the primary crop planted in the southern sub-region, feed grain production (corn and grain sorghum) is located principally in the northern sub-region. In this region, 71% of the 926,700 acres of feed grains are irrigated. Feed grain production from the irrigated corn and grain sorghum produced in the region has contributed to the establishment of the region as the leading cattle feeding area in the nation. In 1996, fed cattle marketings in the study region totaled 3.108 million head, representing 57% of the state's total fed cattle marketings with a total value of $2.0 billion (Texas Agricultural Statistics Service). Several major packing plants are located in the study region with annual slaughter capacity in excess of 2.33 million head (Southwestern Public Service, 1998).

Agribusiness in the THP is composed of many interdependent components that sustain and enhance economic growth for the region. In addition to the commodity production sectors within the economy, a major element of this system is the agribusiness infrastructure. This infrastructure includes grain elevators, cotton gins, cattle feedlots, farm machinery and equipment dealers, trucking firms, production input suppliers (seed, fertilizer, chemicals), meat packing plants, cotton oilseed processing plants and textile mills. The agribusiness sector contributes to the production, marketing, processing and transporting of the agricultural products produced in the region and plays a primary role in the contribution of economic value to the regional economy.

Several other industries in the U.S. have been "deregulated" in recent years, such as natural gas, telecommunications, banking and airlines. Industries that have been deregulated in the past bring many issues of this policy change to the surface. For instance, rather than pure deregulation, changes within the regulation system occur. Most often, the impacts of the changes are not distributed uniformly across the nation. In particular, rural areas experience different impacts as compared to urban areas where the volume of transactions is large enough to enhance a workable competitive market. Finally, results from an ideal competitive situation often do not occur across a single national market as firms find ways to exploit market power and establish barriers to entry (Freshwater et al., 1997). Freshwater et al. notes that, by and large, deregulation of these industries has netted positive results, although the distribution of benefits has not been uniform.

MATERIALS AND METHODS

The estimation of the impacts of possible increases in electric rates for irrigation customers on agricultural production and the regional economy involved two types of analytical tools. Linear programming (LP) models were used to estimate acreage changes and levels of production of the four major crops at various electric rates. IMPLAN (an input-output model) was used to estimate the regional economic impacts given the estimated shifts in production patterns (MIG, Inc., 1995).

Estimating crop acreage changes was accomplished by using county level LP models that were constructed to take into account the variation in the hydrological characteristics of the aquifer and crop production patterns across the region. The LP models used county-specific information on pumping depth, saturated thickness of the aquifer, acres of each crop (corn, grain sorghum, wheat and cotton), crop yields, acres for each condition of irrigation (furrow, sprinkler, dryland), acres for each type of irrigation fuel and other quantitative variables, including electric rates. The estimated proportion of irrigated acres where electricity was the irrigation fuel used was held constant in the models, as it was beyond the scope of this study to predict how fuel source choices would change in the future in response to electric rate increases. Consequently, electric rate increases did not impact all irrigated acres within a county; only the proportion that used electricity as a source of power was impacted.

The estimated farm level production value for each crop was obtained by multiplying the estimated acres of each crop within a county by the average county yield and projected crop prices. Estimates of the production value were found for six levels of electric rates. The county estimates of farm level production value for each crop were aggregated for the study region and compared to a baseline scenario that represented the current electric rate structure. Changes in the total farm level production value for each crop were entered into IMPLAN to obtain the estimated regional economic impacts.

Model and Assumptions

Models were run for various electricity rates which represent the current rate as well as six scenarios at increased rates. The electric rates used in the LP models were 7.3¢, 8.0¢, 8.75¢, 9.5¢, 11.0¢, 12.8¢ and 14.6¢/ kWh which represent the current electric rate and increases of 10%, 20%, 30%, 50%, 75% and 100%, respectively. The current rate was calculated to be 7.3¢/kWh, which represented an average of irrigation service rates across the region and included an allowance for demand charges in the rate structure (Wolgamott, 1998). The model solutions were estimated using increased electric rates because rates in the THP are low relative to the rest of the state and may not be expected to decrease significantly under deregulation.

The initial crop acreages used in the models were an average of the 1994-1996 crop years (Texas Agricultural Statistics Service). Yield estimates for each crop were the nine-year average (1988-1996) county yield (Texas Agricultural Statistics Service). Crop prices were the average of projected crop prices for 1998-2007 from the Food and Agricultural Policy Research Institute with the cotton price adjusted to the THP (FAPRI, 1998). The irrigation acreages under both furrow and sprinkler technologies were calculated using a survey of center pivots and acres under sprinkler irrigation conducted in 1996 (New, 1996).

Several assumptions were made that affect the model formulation. Acres of each crop were maintained across all electric rates with the exception of corn, which was allowed to shift to grain sorghum because dryland corn is not produced in the region. This constraint was included in the models because production relationships relating crop production to applied irrigation water were not readily available for the region given the time frame for the project. The inclusion of these relationships possibly would have allowed the transition of crop acres to lower irrigation application rates within a specific crop activity. Model solutions estimated without this constraint went to almost total cotton production, even under the current electric rate structure, due to the relative profitability of cotton to the other crops and the lower water requirement of cotton. Therefore, the restriction on shifts between crops was included in the models. Irrigation technology shifts were allowed between furrow, sprinkler and dryland. The cost of natural gas rates was held constant at $2.99/mcf with no acreage increases allowed for natural gas as the irrigation pumping fuel.

Estimation of Production

The LP models used to derive crop acreages under the various electric rate scenarios maximized returns to management and risk. The crop production costs used in the models included the variable cost of production inputs (Texas Agricultural Extension Service, 1998), estimated irrigation cost under each irrigation system, a depreciation cost for machinery and equipment (including the irrigation system) and a land charge. Electric costs for irrigation as a percent of total production costs ranged from 8% to 36% depending on the crop, irrigation technology and county. An initial model was estimated using average acreages for each crop and irrigation condition at the current electric rate. This model represented the current state of crop production for each county and was used as the baseline for comparison purposes.

A set of models was estimated allowing for the optimization of irrigation conditions at the various rate scenarios. Each model could shift crop acres between irrigation system technologies or dryland production in order to maximize the return to management and risk. By comparing the results at the increased electric rate scenarios to the baseline model, the impacts on crop acres due to changes in electricity rates were estimated.

IMPLAN Application

The changes in the value of production for each electric rate scenario were evaluated using IMPLAN (MIG Inc., 1995). A regional input-output model was constructed for the study region using the 1995 database (MIG Inc., 1995). Input-output analysis makes the assumption that interindustry transactions plus final demand equals the total economic activity in an economy. IMPLAN gives estimates of economic impacts given changes in final demand. These final demand changes were derived from the changes in the production value of respective economic sectors. It should be noted that total economic activity in an economy, as estimated by IMPLAN, is based on the gross sales or production values of the sectors within the economy.

The changes in production value for each crop derived from the various electric rate scenarios represent changes in final demand for the relevant economic sector. The economic sectors within the model affected by the changes in crop production value were the cotton sector, feed grain sector (corn and grain sorghum) and food grain sector (wheat). The IMPLAN database does not break each crop production sector into irrigated or dryland, therefore, the irrigated a dryland production values were aggregated. The estimated changes in each crop's production value under each electric rate scenario were evaluated to give estimated total regional economic impacts. The impacts are specified as direct, indirect and induced. The direct effect represents the change in production value

Table 4. Regional Acreages in Crops Under Alternative Electric Rate Increase Scenarios.

	Baseline	10%	20%	30%	50%	75%	100%
	(1,000 acres)						
Dryland	2,276.46	2,276.46	2,403.30	2,408.36	2,479.39	2,479.39	2,590.08
Irrigated	2,567.47	2,567.47	2,440.63	2,435.56	2,364.53	2,364.53	2,253.85
Furrow	1,001.37	1,001.37	934.42	929.35	858.32	858.32	822.03
Sprinkler	1,566.10	1,566.10	1,506.21	1,506.21	1,506.21	1,506.21	1,431.82

Table 5. Northern Sub-Regional Acreages in Crops Under Alternative Electric Rate Increase Scenarios.

	Baseline	10%	20%	30%	50%	75%	100%
	(1,000 acres)						
Dryland	1,183.67	1,183.67	1,222.62	1,227.68	1,298.72	1,298.72	1,350.50
Irrigated	1,724.78	1,724.78	1,685.83	1,680.77	1,609.74	1,609.74	1,557.95
Furrow	724.99	724.99	686.04	680.98	609.95	609.95	592.42
Sprinkler	999.79	999.79	999.79	999.79	999.79	999.79	965.53

Table 6. Southern Sub-Regional Acreages in Crops Under Alternative Electric Rate Increase Scenarios.

	Baseline	10%	20%	30%	50%	75%	100%
	(1,000 acres)						
Dryland	1,092.79	1,092.79	1,180.68	1,180.68	1,180.68	1,180.68	1,239.58
Irrigated	842.69	842.69	754.80	754.80	754.80	754.80	695.90
Furrow	276.38	276.38	248.38	248.37	248.37	248.37	229.61
Sprinkler	566.31	566.31	506.42	506.42	506.42	506.42	466.29

for a given sector. The indirect effect represents the response of all other sectors to the change in final demand in a given sector due to the iteration of industries purchasing from other industries. The induced effect represents the response of all sectors caused by the expenditures of new household income generated by the direct and indirect effects for changes in final demand for a given sector. The total economic impact is the sum of the direct, indirect and induced effects.

RESULTS AND DISCUSSION

Production Changes

The effects of increasing electric rates on crop acres under dryland and irrigated conditions and the type of irrigation technology used in crop production are summarized in Tables 4 through 6. Shown in these tables are the acres of irrigated and dryland crop production and the acres under furrow and sprinkler technologies. The 10% electric rate increase had no effect on the level of irrigated acres. Electric rate increases of 20% to

Table 7. Regional Production Value of Crops Under Alternative Electric Rate Increase Scenarios.

	Baseline	10%	20%	30%	50%	75%	100%
				(million $)			
Cotton	814	814	802	801	793	793	787
Corn	184	184	184	184	182	182	166
Sorghum	77	77	77	77	78	78	81
Wheat	103	103	103	103	103	103	103
Total	1,178	1,178	1,166	1,165	1,156	1,156	1,137
Change from Baseline	—	0	−12	−13	−22	−22	−41

Table 8. Northern Sub-Regional Production Value of Crops Under Alternative Electric Rate Increase Scenarios.

	Baseline	10%	20%	30%	50%	75%	100%
				(million $)			
Cotton	362	362	357	356	348	348	348
Corn	183	183	183	183	181	181	165
Sorghum	59	59	59	59	60	60	63
Wheat	94	94	94	94	94	94	94
Total	698	698	693	692	683	683	670
Change from Baseline	—	0	−5	−6	−15	−15	−28

100% resulted in a decrease in irrigated acres and an increase in dryland acres at the regional and sub-regional levels. A 30% electric rate increase resulted in a 5% (131,910 acre) decrease in irrigated acres regionally, 67% of which occurred in the southern sub-region. At the 50% electric rate increase, irrigated acres decreased by 8% regionally (202,940 acres) with no additional decrease in the southern sub-region and a 115,040 acre decrease in the northern sub-region. In the southern sub-region, the impacts were constant from the 20% through the 75% electric rate increase levels. In the northern sub-region, additional adjustments in irrigated acres occurred at the 50% and 75% electric rate increase scenarios. Irrigated acres declined further in the northern and southern sub-regions under the 100% electric rate increase scenario.

As electric rates increased, the irrigation technologies used in the production process changed. Regionally, the level of furrow irrigated acres decreased by 7% and 14% at the 30% and 50% electric rate increases, respectively. Of the 72,180 acre regional decrease in furrow irrigated acres at the 30% electric rate increase, 61% (43,940 acres) were in the northern sub-region. Acres under sprinkler technologies declined marginally across the electric rate scenarios. At the 30% and 50% electric rate increases, sprinkler acres declined by 4% across the region.

The production value of crops for the region and sub-regions are shown in Tables 7 through 9. Under the baseline scenario, the total value of crop production in the region was estimated at $1.178 billion. Cotton production contributed 69% of the region's total crop production value with feed grains (corn and grain sorghum) and wheat contributing 22% and 9% of the crop production value, respectively.

As electric rates increased, it was estimated that at the 30% electric rate increase scenario the regional production value of crops would be expected to decline by $13

Table 9. Southern Sub-Regional Production Value of Crops Under Alternative Electric Rate Increase Scenarios.

	Baseline	10%	20%	30%	50%	75%	100%
			(million $)				
Cotton	452	452	445	445	445	445	439
Corn	1	1	1	1	1	1	1
Sorghum	18	18	18	18	18	18	18
Wheat	9	9	9	9	9	9	9
Total	480	480	473	473	473	473	467
Change from Baseline	—	0	−7	−7	−7	−7	−13

Table 10. Regional Economic Impacts Under Various Electric Rate Scenarios.

	10%	20%	30%	50%	75%	100%
			(million $)			
Direct	0	−12.000	−13.000	−22.000	−22.000	−41.000
Indirect	0	−6.144	−6.657	−11.199	−11.199	−20.066
Induced	0	−2.318	−2.512	−4.219	−4.219	−7.448
Total	0	−20.463	−22.169	−37.418	−37.418	−68.544

million, all coming from cotton production. The northern and southern sub-regions showed a $6 million and $7 million decrease in cotton value, respectively. At the 50% electric rate increase scenario, the total regional decrease in crop production value was estimated at $22 million. Cotton production represented $21 million of this decrease while feed grain production represented $1 million. Corn production decreased by $2 million while grain sorghum production increased by $1 million. The impact on crop production value did not change through the 75% electric rate increase scenario. At a 100% electric rate increase, crop production value decreased by $41 million regionally. Cotton represented 66% of the decrease ($27 million) while corn production value declined by $18 million, and grain sorghum value increased by $4 million.

In the southern sub-region, the impact of increased electric rates was felt at the 20% electric rate increase scenario and was constant up to the 75% electric rate increase. The impacts were reflected only in cotton production. In the northern sub-region, the impact of increased electric rates was reflected across a greater range of rate changes. Cotton was the major crop affected as electric rates increased up to the 50% electric rate increase scenario. As rates increased beyond the 30% electric rate increase, corn production was affected. There was an increase in grain sorghum production at the higher electric rate levels as grain sorghum was substituted for irrigated corn production. Under all electric rate scenarios analyzed wheat production was not affected given that it was primarily a dryland crop.

Aggregate Economic Impacts

Direct regional impacts on the economy from increased electric rates are the changes in production value shown in Table 7. The total annual regional economic impacts of increased electric rates are shown in Table 10. Estimates are shown for the direct, indirect, and induced economic impacts of changes in the production value of the crops. At the 30% electric rate increase scenario, the total regional economic impact was estimated to be a decrease in economic activity of $22.2 million. Of this, $13.0 million came from a reduction in crop production value, and $9.17 million came from the impacts on other sectors of the regional economy. At the 50% electric rate increase scenario, the negative regional economic impacts increased to $37.4 million with economic impacts beyond the reduction in crop values of $15.4 million. The regional economic impacts of the 100% electric rate increase scenario was estimated to be a decrease in economic activity of $68.5 million.

Farm Level Impacts of Increased Electric Rates

The farm level impacts of increased electric rates differ from the aggregate impacts as measured by the regional crop production values and economic impacts using the IMPLAN model. The farm level impacts of increased electricity rates varied across counties and crops due to differing crop yield levels, pumping lifts and saturated thickness of the aquifer. Hale County was selected to illustrate farm level impacts on cotton profitability as electric rates increased. Hale County is located in the northern sub-region of the study area and has 408,033 acres in production of the four crops considered in this study. The cropping mix is 55% cotton, 18% corn, 10% grain sorghum and 17% wheat. Irrigated acres total 338,066, of which 56% are furrow irrigated and 44% are under sprinkler irrigation. Acres with electricity as the power source make up 40% of total irrigated acres.

Using results from the initial baseline model for Hale County, a weighted average per acre net return to management and risk for irrigated cotton was derived (weighted by acres under furrow and sprinkler irrigation methods using electricity and natural gas). At the baseline electric rate scenario, the weighted average net return was $28.01 per acre. The weighted average net return declined to $21.95 per acre under the 30% electric rate increase scenario. This represents a 22% decrease in net return per acre for irrigated cotton. If only the acres using electricity as the power source were considered, net return per acre was found to be 40% lower under the 30% electric rate increase scenario as compared to the baseline scenario. Results using the 50% electric rate increase scenario indicated that per acre net return decreased 36% and 67%, respectively, for total irrigated cotton acres and acres irrigated using electricity as the power source.

SUMMARY AND CONCLUSIONS

The primary objectives of this study included the estimation of potential impacts of increased electric rates on irrigated agricultural production in the THP and the resulting economic impacts on the region's economy. The results of this study showed the expected shifts in irrigated crop production as electric rates increased. The range of electric rate scenarios used in the models was from the baseline level of 7.3¢/kWh up to 14.6 ¢/kWh which represents a 100% increase. Due to current electric rates in the THP being low relative to rates throughout Texas, changes in the THP rates may be anticipated. While the changes in rates cannot be accurately estimated because of many undetermined conditions, some groups in the industry believe that a 30% increase (from an average of 7.3¢/kWh to 9.5¢/kWh) is realistic (Wolgamott, 1998).

The results indicated that an increase of 10% in electric rates would have no impact on the levels of crop production within the study region. As electric rates increased by 20% and 30%, cotton production levels were impacted primarily in the southern sub-region. The reduction in the value of cotton production under the 20% and 30% electric rate increases ranged from $12 to $13 million. This reduction in cotton production value represented only a 1.5% decline in total cotton value for the region.

The results regarding crop production value can be segmented as follows: the 10% electric rate increase had no impact on crop production value; the 20% and 30% electric rate increase reduced crop production value by $12 to $13 million, respectively; the 50% and 75% electric rate increases reduced the crop production value by $22 million; and the 100% electric rate increase had a $41 million negative impact on crop production value. The impact of electric rate increases was found to primarily affect cotton production. Wheat production was not affected under any of the electric rate scenarios, while grain sorghum production would be expected to increase under the higher rate scenarios as corn production acreage shifts to grain sorghum.

The regional economic impacts estimated with IMPLAN followed the trends in crop production value. The loss in regional economic activity at the 20% and 30% electric rate increase scenarios was $20 to $22 million, respectively, while at the 50% and 75% electric rate increase scenarios regional economic activity would be expected to be reduced by $37 million. The regional negative impact at the 100% electric rate increase was $68 million. The magnitude of the loss in economic activity across the electric rate scenarios is minor when compared to a total regional economy of $21 billion (MIG, Inc., 1995). The regional economic impacts may be further separated into the impacts on individual sectors of the economy. Using the results from the 30% increase in electric rates, the total negative economic impact was estimated at $22.2 million of which $13 million was directly from reduced crop production value, $6.7 million was from indirect impacts on other sectors of the economy and $2.5 million was from induced impacts on households within the economy. Of the $6.7 million in indirect negative impacts, the economic sectors most affected included: agricultural, forestry and fishery services—$1.5 million; wholesale trade—$1.1 million; and real estate—$1.7 million. Induced impacts totaled $2.5 million, with economic sectors most affected being: owner occupied dwellings—$0.25 million; hospitals—$0.15 million; doctors and dentist—$0.15 million; eating and drinking—$0.15 million; and banking - $0.11 million. Given that the southern sub-region had the greatest proportion of the reduced crop production value, the sector affects may be weighted more toward the southern sub-region.

The economic impacts estimated using the IMPLAN input-output model are driven off of aggregate production values from each sector of the economy. Therefore, estimates of the impacts on the regional economy were related to regional changes in the gross values of crop production. While the negative regional economic impacts are relatively small compared to the regional economy, the impacts on individual farms are more significant. For example, in Hale County the 22% reduction in per acre net return for irrigated cotton could significantly affect individual farming operations. In particular, those farms using electricity as the only irrigation fuel would be expected to experience a 40% reduction in net returns for irrigated cotton. For farmers who are dependent on electricity for irrigation, structural changes in their operations would be necessary. The option of converting to natural gas as an energy source may be limited for many farmers due to availability and the cost of building pipelines and replacing pumps. While the negative impact of increased electric rates on the regional economy is not expected to be severe, the impact on current farm families' incomes is likely to be greater, especially if electricity is the primary energy source for the farm.

The results of this study show that electric rate increases associated with deregulation could have a negative impact on the economy of the THP and individual farms where electricity is the primary source of irrigation fuel. The regional economic impacts appear to be minor, while the farm level impacts could have a greater relative effect. However, a broad spectrum of possible responses exists. There are economic, technological, and managerial approaches to dealing with possible electric rate increases that could ease the transition to a fully deregulated electric power market.

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