

THE ECONOMIC EFFECTS OF AN INCREASE
IN THE KANSAS GASOLINE TAX

prepared by

Robert Glass
Research Economist

and

David Rearden
Research Assistant

with

David Burress
Assistant Professor of Economics, and Research Associate

Institute for Public Policy and Business Research
The University of Kansas
Lawrence, Kansas 66045

Executive Director: Dr. Anthony Redwood
Institute for Public Policy and Business Research

Report # 165

July, 1989

EXECUTIVE SUMMARY.

This paper investigates the economic impact of a two cent a gallon increase in the Kansas gasoline tax, with the proceeds expended on highway construction. It considers both the direct effect on gasoline sales, and also the total effects on the Kansas economy resulting from multiplier effects on state taxes and highway expenditures. This paper pays special attention to effects in the Kansas border counties near Kansas City.

Two methods of analysis are employed to measure the direct effect of the tax increase on gasoline demand. First, an estimate of the Kansas price elasticity of gasoline from a previous study is used to assess the effect of taxes on Kansas gasoline sales. This evaluation reflects the reduction in all gasoline purchases in Kansas due to the gasoline tax, including the substitution of gasoline purchased outside Kansas for gasoline purchased in Kansas. Second, regression analysis is utilized to try to estimate the effect on Kansas gasoline sales of a tax rate disparity between Kansas and Missouri; this should measure only the portion of sales lost as a result of substitute purchases of Missouri gasoline. The tax rate differential turns out to have the expected sign, but is statistically insignificant in explaining Kansas gasoline sales.

Third, the impact of the tax and expenditure increase on the whole Kansas economy is analyzed using income and industry multipliers from the Kansas Long Term Model. However, the actual benefits from using improved highways are not considered. Also, the "excess burden" or deadweight loss of taxation is not considered (but we assume this is small in the following discussion). Therefore what the paper measures is not a total impact, but rather a lower bound. If the unmeasured benefits of using the improved highways (net of excess burdens) happen

to exceed this lower bound, then the net impact of the project on Kansas income would be positive.

In particular, after a two cent tax increase, gasoline consumers would spend more income on gasoline and receive less gasoline in return, and wholesalers and retailers of gasoline would have less income; however, state gasoline tax revenues and expenditures would increase. Taking into account the indirect and induced demands, the Kansas economy would suffer a net loss of real value equal to around 65% of the revenues raised, as a consequence of the program.

However, as noted above, this negative result ignores the benefits of utilizing the new or improved highways; it is also subject to some uncertainty. A better way to view this result is that the project has a positive net real effect on Kansas real income, provided that the value of the user benefits of new highways exceeds 65% of the corresponding highway expenditures.

By way of comparison, a household or firm ordinarily demands that the value of user benefits resulting from an expenditure it makes should exceed 100% of the cost. The main difference in the case of the state-wide project is that some portion of the gasoline tax burden can be exported to non-Kansans, mainly in the form of reduced nation-wide returns to owners of oil wells and refineries.

INTRODUCTION.

The direct effect of an increase in the Kansas gasoline tax will consist of a reduction in the amount of gasoline purchased in Kansas for two reasons. First, by all reliable empirical measures, the total demand for gasoline in Kansas and elsewhere falls as the price of gasoline rises. Second, an increase in the Kansas gasoline tax will result in some substitution of out of state gasoline for Kansas gasoline (if the gasoline taxes of bordering states do not change). This substitution effect will occur primarily in the border counties of Kansas, and predominately in the metropolitan areas of Johnson County and Wyandotte County. The purpose of this report is to place some bounds on the extent of both of these direct effects and to indicate the approximate size of the impact of these effects on the Kansas economy as a whole. In addition to these direct effects, we will also consider indirect and multiplier effects of both taxes, and highway expenditures.

Unfortunately, we have been unable to find any previous studies which have investigated the substitution of gasoline purchases across border states; but several studies have examined the total effect of prices on gasoline demand. The first part of this report briefly reviews these relevant studies. The second part uses the work of one of these studies to estimate the total effect of a two cent gasoline tax increase on demand. This estimate places an upper bound on the amount of substitution of out of state gasoline for Kansas gasoline that will take place. Multipliers from an input-output model of Kansas are then used to estimate the total impact on the Kansas economy which result. The third part presents the results of our own statistical analysis of the substitution effect. The fourth part contains concluding remarks.

A REVIEW OF PREVIOUS STUDIES.

Although we have been unable to find any previous research analyzing interregional gasoline sales, we have found studies in three related subject areas: 1) Regional gasoline demand; 2) The border tax problem; and 3) State and sub-state excise taxes.

1. Regional gasoline demand.

An enormous amount of scholarly energy has been expended on trying to estimate gasoline demand. Dahl [1986] provides a survey of the more recent literature on gasoline demands in general. The literature survey in Greene [1980] reviews earlier attempts at estimating regional gasoline demand.

The only article which investigates the effect of gasoline price differentials within a large urban area is Haining [1983]. Haining replaces the "classical system of discrete market regions" with "a network of interdependent, overlapping and possibly volatile market regions because customers are able to search, at virtually no cost, for the particular good as part of a multipurpose trip." Haining develops three models of intraurban price competition and estimates one of these models using gasoline prices for Sheffield, England. The results of this research suggest that as the price of gasoline fell, different sub-regions (separate roadway systems) displayed different competitive spatial attributes. For several reasons, Haining suggested "The results given here must be interpreted with some caution."

2. The border tax problem.

Haining's article suggests a broader question: if a particular region is divided into more than one governmental jurisdiction, what role will different commodity tax rates play in the price competition? This question has provided the impetus for a great deal of theoretical and empirical work. Mintz and Tulkens [1986] in the introduction of their article provide a guide to the theoretical literature. The empirical research that is most relevant to this report falls into the category of "the border tax problem." This research is concerned with the impact of tax rate differentials (primarily sales tax differentials) between regions.

One of the earliest of these studies [McAllister, 1961] examined the effect of the sales tax differential between Washington State and Oregon and Idaho using survey data for three pairs of cities located closely together but separated by a state border. He found that the tax differential between cities affected the purchasing plans of consumers, but due to the nature of the data, quantification of the extent to which consumer choices actually altered due to the tax differential was impossible.

In the early 1970's, Mikesell approached the border problem with two different methodologies. In one study [Mikesell 1970] he used cross-sectional data for the center cities of 173 SMSA's to test the hypothesis that the sales tax rate differential was significant in explaining per capita sales. He found the differentials were significant and that a one percent tax rate increase in the central city would reduce per capita sales between 1.69 and 10.97%. In a second study, Mikesell [1971] focused on the difference in per capita sales between southern Illinois border counties and non-border counties. Again he found that sales tax rate differentials affected per capita sales.

Fisher [1980] argued the previous studies underestimated the effect of the sales tax differential and were, in fact, finding lower bounds on the effect of sales tax differentials because they implicitly assumed that factor supplies were perfectly elastic. Fisher went on to investigate the influence of sales tax differentials in the Washington D.C. metropolitan area. His conclusion was that except for food, there was "no strong evidence that tax rate differences on other commodities cause consumers to change the location of their purchases"[p. 185]. This conclusion contrasted sharply with Fisher's theoretical criticism of previous studies. The irony was not lost on Fisher, who argued that his result might not contradict previous studies.

Fox [1986] compared the consequence of a sales tax differential between states to an income tax differential between states. His results indicate that an increase in a sales tax differential reduces retail sales activity and employment in retail sales. However, changes in income tax differentials seem to have no measurable impact on either retail sales activity or retail sales employment. Fox used three Tennessee metropolitan areas which each bordered on a different state for his study.

Mikesell and Zorn [1986] investigated the effect of a sales tax differential using a singular data set. Due to a lost lawsuit and an ensuing bankruptcy, a small town in Mississippi was allowed for three years to have a sales tax rate one half of one percent higher than the rest of the state. This unique situation allowed Mikesell and Zorn to estimate the impact of the sales tax rate differential on a small community. They found that a one percent increase in the sales tax would result in a 3.07% decline in the city's retail sales.

Another rare situation provided Walsh and Jones [1986] with the opportunity to investigate the border tax problem as a sales tax declined over time in a predetermined pattern. In their 1988 article, the authors investigated the effect of West Virginia's gradual elimination of their three percent sales tax on grocery store sales. The sales tax was reduced one percent per year until it was eliminated. The authors found that "increases in grocery store sales are more rapid in those West Virginia counties which border neighboring states ... than among interior counties" [p. 261]. The authors attribute this increase in grocery sales to West Virginian shoppers shopping in West Virginia rather than crossing the border as they apparently had in the past.

Finally, Eisler, in a Wall Street Journal article [1989], provides some particularly interesting and illuminating anecdotal evidence concerning the relationship between Washington State, a high sales tax and no income tax state and Oregon, a high income tax and no sales tax state. The sales tax in Seattle is 8.1% while Portland, Oregon is the largest U.S. city with no sales tax. Eisler reports that Seattle has 18% more money to spend per capita than Portland, yet Portland spends 69% more per capita on general merchandise than Seattle.

The preponderance of evidence indicates that sales tax rate differentials affect relative retail sales activity, and that the larger the differential and the closer the alternative shopping possibilities are, the greater the effect. Table I summarizes the elasticities estimated in the studies described above. It appears that a one percent retail tax differential in a border region leads to a reduction in sales for the higher tax area of between 0.44% and 10.97%.

Table I.

Summary of estimated border tax effects on retail sales

Author	Year	Percent reduction in sales per 1 percent tax differential
Mikesell	1970	1.69% to 10.97%
Fisher	1980	7.17% for food, statistically insignificant for all commodities and apparel
Fox	1986	0.44% to 3.73%
Mikesell & Zorn	1986	3.07%
Walsh & Jones	1988	5.88% for grocery stores

However, this conclusion does not necessarily transfer to a gasoline tax rate differential because gasoline represents a small portion of the ordinary household budget. For example, it is relatively easy to imagine someone traveling from Seattle to Portland to purchase an expensive durable good. It is difficult to imagine many consumers traveling 200 miles to save eight cents per gallon on gasoline. Thus, the sales tax differential literature may provide an upper bound on the magnitude of the effect we would expect from a gasoline tax rate differential.

The fact that no study can be found investigating the border tax problem for gasoline taxes does not mean it cannot be a problem. For example, tax rate differentials for another selective excise tax, the cigarette tax, have generated problems with bootlegging of cigarettes when the disparities between state cigarette taxes have grown large. Warner [1982] points out that "Due to its clandestine nature, the magnitude of cigarette bootlegging can only be estimated

roughly, but all reasoned estimates place it in the hundreds of millions of dollars per year in the mid-1970's" [p. 483].

3. State and sub-state excise taxes.

The excise tax literature, although extensive, is of little help in determining if a border tax problem can develop for gasoline taxes. Gold [1983] in a survey of state finances points out that excise taxes "were the slowest growing sources of state revenue because they are generally specified in terms of units of output rather than as a percentage of price" [p. 13]. The declining importance of gasoline taxes as a source of revenue partially accounts for the lack of empirical evidence. A second problem is pointed out by Bowman and Pratt [1983] in a survey of local revenue diversification choices. "Where motor fuel taxation is the major source of local selective excise tax revenue--Hawaii--the fact that the taxing counties are islands effectively diminishes the border city effect" [p. 189].

However, this literature does provide estimates of the total loss of sales which results from state-wide taxes on various goods, including gasoline; we apply one such result in the following section.

THE TOTAL ECONOMIC EFFECTS OF A KANSAS GASOLINE TAX:
AN APPLICATION OF PREVIOUS WORK.

1. The direct effect of gasoline taxes on sales and revenue.

Our analysis begins with an estimate of the short run Kansas price elasticity for gasoline (-0.345) developed by Bowman and Mikesell [1983]. This price elasticity includes both demand effects: the reduction in total gasoline demand by Kansans due to higher prices, and the substitution of gasoline purchased in other states. As Table II illustrates, the effect of taxes is sensitive to the initial price level of gasoline. Table II indicates how much the demand for Kansas gasoline would have declined in FY1988 with a two cent increase in the gasoline tax, assuming several different levels of the pre-tax base gasoline price.¹ (In other words the first line assumes the price of gasoline, including taxes, was initially 70 cents and then an additional two cent tax is added to the 70 cents.) The largest decline in gasoline demand shown in this table occurs at the lowest base price of 70 cents; it is 13.7 million gallons or slightly less than a one percent decline in the total demand for Kansas gasoline. The third column of Table II contains the increase in consumer expenditures for gasoline due to the tax increase. The increase is a result of the inelastic nature of the demand for gasoline in Kansas.² The last column of

¹Since no 1988 price for gasoline in Kansas exists, the 1987 national price for gasoline was updated using the national 1988 CPI for gasoline. The result was an estimate of 95.6 cents per gallon for gasoline. Then the price elasticity mentioned above (-0.345) was used to calculate the quantity of gasoline demanded given the price. The base used was the 1988 Kansas sales of 1269.55 gallons at 95.6 cents per gallons.

²Demand is considered inelastic if the absolute value of the price elasticity is less than one. In this case, the absolute value of the price elasticity is 0.345.

Table II.

The Direct Effects of a Two Cent Increase
 In the Kansas Gasoline Tax
 On Consumers and State Government
 (In 1988 Dollars)

Average Base Price of Gasoline	Decline in Gas Demand (millions of gallons)	Increase in Consumer Dollars Spent on Gas	Net Increase of Kansas Revenues from the Tax Increase
\$.70	13.7	\$ 17.9 mil.	\$ 26.0 mil.
.80	11.6	17.3 mil.	25.3 mil.
.90	9.9	16.8 mil.	24.6 mil.
1.00	8.6	16.2 mil.	23.9 mil.
1.10	7.5	15.6 mil.	23.1 mil.
1.20	6.7	15.0 mil.	22.3 mil.
1.40	5.3	13.9 mil.	20.6 mil.
1.60	4.2	12.7 mil.	18.9 mil.

(NOTE: Based on total FY1988 sales of gasoline in Kansas of approximately 1269.55 million gallons at an estimated price of 95.6 cents per gallon.)

Table II contains an estimate of the net effect of the tax increase on gasoline tax revenues in FY1988. The net effect was found by first taking the projected FY1988 Kansas sales of gasoline at each price and multiplying it by the exact tax rate of 11 cents to give an estimate of revenues before the tax increase.³ Then the estimated decline in gasoline demand, column two, was subtracted from FY1988 actual gasoline sales and the result was multiplied by 13 cents which represents the estimate of tax revenue with the tax increase. Finally, the base estimate was subtracted from the new revenue estimate to give the net revenue effect of the tax.

In all cases considered, consumers spent more on gasoline and the total tax revenue increased with the two cent increase in the tax rate. This is due to the inelastic nature of the price elasticity of demand used to calculate the price and tax effects. It is also important to note that the increase in state government revenues due to the increased tax rate declines as the price of gasoline rises. The decline in tax revenue is a result of the per unit structure of the gasoline tax and the fact that as the price of gasoline rises, fewer gallons of gasoline are consumed. At 70 cents a gallon, we estimate that approximately 1390 gallons would be consumed while at \$1.60 a gallon the estimated consumption gasoline drops to 980 gallons. As was pointed out in the survey of previous studies, this loss of sales is exactly the phenomenon that

³This method overestimates actual FY1988 gasoline tax receipts by about \$230,000: the correct figure is \$139.42 million and the estimate is \$139.65 million which represents an error of 0.165 percent. The discrepancy resulted when the gasohol tax rate rose to the same level as other gasoline taxes. Remittances of gasohol taxes for FY1988 represent, in part, sales and inventories from the previous fiscal year. Quantities reported were consequently taxed at two different rates. There is now no separate category of gasohol in the state accounts, and accounts were forced to add up to aggregate levels.

federal, state and local governments experienced in the 1970's and early 1980's with the dramatic price increase of gasoline during that period.

2. The direct effect of gasoline taxes on wholesalers and retailers.

In addition to the effect of the gasoline tax rate increase on consumer income and on state governmental revenues, the wholesale and retail sellers of gasoline will be affected. We showed above that consumers will be spending more income on gasoline and that state government will be taking more of the dollars spent on gasoline as taxes. The resulting effect on retailers is the difference between increased consumer expenditures on gasoline and increased state governmental gasoline tax revenues. In all cases, the increase in tax revenue more than offsets the increase in consumer expenditures for gasoline which means a decline in gasoline sales revenue to retailers. The dollar decline in final sales at the retail level for Kansas gasoline is shown in column two of Table IV and represents the total decline in sales at the retail level throughout all of Kansas, not just the border counties affected by interstate competition. The decline in revenue in the border counties cannot be more than the figures in column two and would probably be significantly less; thus, column two represents the upper bound of the direct effect of the increased gasoline tax on retailers in border counties.

3. Indirect effects on the Kansas economy.

As these direct effects of the gasoline tax and the corresponding government expenditures flow through the Kansas economy, they produce further effects in the economy. We will estimate these further effects using multipliers

from the Kansas Long Term Model.⁴ Our result is conceptually similar to a cost benefit analysis, but differs in the following three respects:

i. We will neglect the effects on citizens of other states, addressing only the effects within Kansas.

ii. We will neglect the excess burden of the gasoline tax. However, most studies have found the excess burdens resulting from small increases in an excise tax to be a relatively small fraction of revenues.⁵

iii. Since we have not studied the direct economic benefits to users of new Kansas highways and highway maintenance, we will neglect these benefits. Therefore, our net result should be viewed as a lower bound estimate of the total benefits and costs of a two cent gasoline tax, with the proceeds expended on highways.

In particular, first we treat the extra consumer expenditure for gasoline as a loss in real income to consumers. By multiplying the increase in consumer expenditures for gasoline due to the tax increase by the multiplier for changes in exogenous income,⁶ we are able to estimate the total effect of the loss in consumer purchasing power as a result of the tax increase. Second, by multiplying

⁴The multipliers from the Kansas Input-Output Model can be found in Burress [1989]. The use of the construction income/export multiplier to estimate the total effect of the increase in state governmental revenues is based on the assumption that the additional tax revenue will be used to construct or rebuild highways. The values of the multipliers are 1.5 for exogenous income and 0.44 for construction.

⁵For example, see Rosen [1978].

⁶Among other things, we are assuming that consumer income is constant so that the increase in consumer expenditures on gasoline results in a decrease in consumer income available for other purchases or savings and investment. With the multiplier, we are trying to measure the effect on the Kansas economy of this reduction in consumer income.

the increase in state government revenues by the income/export multiplier for construction, we are able to estimate the impact on Kansas personal income of the increased state government revenue. The results of these calculations estimating the total impact of these direct effects can be found in column three of Table III for consumer income and column five for state government revenue.

We must also consider the total effect of the decline of sales to retailers and wholesalers previously discussed. Because of the nature of wholesale and retail trade, not all of the decline in revenue will result in less income to the wholesaler and retailer; some of the decline in income will be passed back to the refiner and transporter of gasoline. At the national level, the average trade margin⁷ for gasoline (wholesale and retail combined) is 30.7% with nearly all of the rest of the cost assumed by the refiner and producer of crude oil products. If the refiner of the gasoline sold in Kansas is outside the state, then that portion of the decline in gasoline demand which affects the refiner does not affect a Kansas business. Even if a refiner is in Kansas, the market for refined petroleum products is a competitive national market and the decline in Kansas gasoline demand (of between 4.2 and 13.7 million gallons) will have little or no influence on profits at the national level. In either case it seems more appropriate to ignore the refiner and analyze only the effect on Kansas wholesalers and retailers of gasoline. Therefore, we are assuming that portion of the effect of the tax increase which is passed back to refiners and producers of petroleum products, does not affect the Kansas business

⁷The trade margin used here is actually a tax plus trade margin for the wholesale and retail trade of gasoline at the national level. The trade margin represents the part of total cost of gasoline production and sales which is allocated to wholesalers and retailers. Since we have used a tax plus trade margin we are over estimating the effect on wholesalers and retailers in Kansas.

Table III.

The Income Multiplier Effects
of a 2 cent increase in the Kansas Gasoline Tax:
Consumers and Government
(In 1988 Dollars)

Average Base Price of Gasoline	Increase in Consumer Dollars Spent on Gas (= decline in other purchases)	Income Effect of the Decline in other Consumer Purchases*	Increase in Kansas Revenue (= increase in Highway Expenditure)	Income Effect of the Increase in Highway Expenditure
\$.70	\$ 17.9 mil.	\$-26.8 mil.	\$ 26.0 mil.	\$ 11.4 mil.
.80	17.3 mil.	-26.0 mil.	25.3 mil.	11.1 mil.
.90	16.8 mil.	-25.2 mil.	24.6 mil.	10.8 mil.
1.00	16.2 mil.	-24.3 mil.	23.8 mil.	10.5 mil.
1.10	15.6 mil.	-23.4 mil.	23.1 mil.	10.2 mil.
1.20	15.0 mil.	-22.6 mil.	22.3 mil.	9.8 mil.
1.40	13.9 mil.	-20.8 mil.	20.6 mil.	9.0 mil.
1.60	12.7 mil.	-19.0 mil.	18.9 mil.	8.3 mil.

NOTE: * includes the extra dollars spent on gasoline as a measure of the lost welfare.

community, and as a consequence, is exported--paid by someone other than a Kansan.

The tax increase will also increase the trade margin from 30.7% to 32.1%. Column three of Table IV pro-rates the loss of revenue to the Kansas wholesalers and retailers based on their share of the cost of gasoline using the new trade margin. As before, we use an income/export multiplier, but this time for wholesale and retail sales from the Kansas Long Term Model⁸ to allow us to estimate the effect on the whole economy of the decline in gasoline revenue to wholesale and retail establishments. The estimated approximate loss of Kansas personal income which the decline in wholesale and retail trade revenue will cause can be found in column four of Table IV. A disproportionate amount of this personal income loss will occur in the border counties of Kansas.

Finally, to capture the complete effect in Kansas of the two cent increase in the gasoline tax, we subtract the impact on consumers and wholesalers and retailers from the effect of the increase in state governmental revenues. The result of these calculations can be found in column four of Table V. Again notice that as the price of gasoline rises, the general size of the program and net effect on Kansas income diminishes.

However, by comparing the last columns of Tables II and V, we can calculate that the net loss of equivalent income in Kansas is between 63% and 66% of the total revenues raised, no matter what the scale of the program.

It is apparent that Kansas real personal income decreases from this tax increase, according to our calculation. However, recall that we have omitted the

⁸Burress[1989]. Since no multiplier exists for wholesale and retail sales of gasoline in Kansas, we have chosen to use the wholesale and retail trade income/export multiplier which has a value of 0.66.

Table IV.

The Direct Effects and Income Multiplier Effects
of a Two Cent Increase in the Kansas Gasoline Tax
On Wholesalers and Retailers
(In 1988 Dollars)

Average Base Price of Gasoline	Revenue Loss to Wholesale and Retail Trade Due to the Tax	Wholesale and Retail Trade Portion of Total Cost	Income Effect of the Decline in Revenue
\$.70	\$ 8.1 mil.	\$ 2.6 mil.	\$-1.7 mil.
.80	8.0 mil.	2.6 mil.	-1.7 mil.
.90	7.8 mil.	2.5 mil.	-1.7 mil.
1.00	7.7 mil.	2.5 mil.	-1.6 mil.
1.10	7.5 mil.	2.4 mil.	-1.6 mil.
1.20	7.3 mil.	2.3 mil.	-1.5 mil.
1.40	6.8 mil.	2.2 mil.	-1.4 mil.
1.60	6.3 mil.	2.0 mil.	-1.3 mil.

Table V.

The Total Effect of a Two Cent Increase
In the State Gasoline Tax
(In 1988 Dollars)

Average Base Price of Gasoline	Income Effect of the Decline in Consumer Purchases	Income Effect of the Decline in Wholesale and Retail Revenue	Income Effect of the Increase in Highway Expenditure	Total Income Effect in Kansas of the Program
\$.70	\$-26.8 mil.	\$-1.7 mil.	\$ 11.4 mil.	\$-17.1 mil.
.80	-26.0 mil.	-1.7 mil.	11.1 mil.	-16.6 mil.
.90	-25.2 mil.	-1.7 mil.	10.8 mil.	-16.0 mil.
1.00	-24.3 mil.	-1.6 mil.	10.5 mil.	-15.4 mil.
1.10	-23.4 mil.	-1.6 mil.	10.2 mil.	-14.8 mil.
1.20	-22.6 mil.	-1.5 mil.	9.8 mil.	-14.3 mil.
1.40	-20.8 mil.	-1.4 mil.	9.1 mil.	-13.1 mil.
1.60	-19.0 mil.	-1.3 mil.	8.3 mil.	-12.0 mil.

direct benefits of using improved highways from this calculation. When these are included, it is arguable that such a tax and revenue program could have strongly positive effects on Kansas income and output.

GASOLINE SUBSTITUTION ACROSS KANSAS BORDERS:

NEW STATISTICAL RESEARCH.

We used regression analysis to investigate the effect of a gasoline tax differential on the annual sales of Kansas gasoline.⁹ In variant regressions, additional explanatory variables such as per capita income and per capita numbers of cars in Kansas were tried and found to have economically small and statistically insignificant effect either on estimated gasoline sales or on the main parameter of interest. Therefore the discussion of our results omits reference to these variables.

The estimated equation has as the right hand side variable the percentage increase in the price of gasoline caused by the difference in gasoline tax between Missouri and Kansas. This can be written as $\Delta P/P = (P + \Delta\tau)/P = 1 + \Delta\tau/P$ where P is the price of gasoline in 1967 dollars and $\Delta\tau$ is the difference between the Kansas tax rate and the Missouri tax rate in 1967 dollars. The left hand side variable, gas_t , is total taxable gasoline sales in millions of gallons.

The estimated equation is then

$$gas_t = \beta_0 + \beta_1(1 + \Delta\tau)_t + \epsilon_t.$$

⁹Monthly and annual gasoline sales data were provided by the Kansas Department of Revenue. For the data prior to 1982, the twelve monthly figures were averaged to provide an annual figure. After 1982, the annual figures provided by the department were used. The Kansas City gasoline price data was provided by the Bureau of Labor Statistics. The Kansas City Consumer Price Index was used to deflate the retail price of gasoline and the nominal tax difference. The period we used for estimation was 1970 to 1986.

Several different forms of the basic equation stated above were estimated, and in all cases the coefficient for the tax differential proved to be insignificant¹⁰. Thus, although we believe that the tax differential has some effect on gasoline consumption patterns in border counties, because of the size of this phenomenon and because of the limitations of the data, we have been unable to measure it precisely. The technical problems involved in the estimation process are explained more fully in the Appendix to this paper.

¹⁰ That is, in each variant regression, the hypothesis that this coefficient was not different than zero could not be rejected by a t-test with $p=.05$.

CONCLUSION.

We have approached the question of the impact of a gasoline tax rate increase using two distinct procedures. First, we used the estimate of the short run gasoline price elasticity in Kansas developed by Bowman and Mikesell to assess the direct consequence of the tax increase on the Kansas economy. This was done by estimating the direct effect on the income of gasoline consumers, sales to retailers of gasoline, and tax revenues to the state government. This analysis allowed us to place an upper bound on the impact of the tax increase on border county gasoline retailers.

Second, we have attempted, and failed, to measure the impact of a gasoline tax differential on the sales of gasoline in Kansas. Our failure to measure the effect of the gasoline tax differential with Missouri suggests that the effect of the gasoline tax in the border regions will be substantially less than the upper bound we placed on it in the third section of our paper. However, without more and better data we are not able to confidently quantify the amount of substitution of Missouri gasoline sales for Kansas gasoline sales that will occur as a result of the tax differential.

Additionally, we have examined the full impact of the tax increase--the effect on gasoline consumers, state tax revenues, and gasoline wholesalers and retailers; and the ensuing total effect on the Kansas economy. The tax increase would cause Kansas personal income to decline. However, our analysis of the tax increase has not taken into account any benefit that Kansans would receive from new highways and the improved older highways.

APPENDIX.

A fact complicating our analysis is the unusual pattern of the gasoline sales data: two distinct periods emerge. Before 1978, gasoline sales are generally rising while after 1978, sales fall almost monotonically. The hypothesis of different models or parameter values for the two periods was tested using the Chow test. This test uses three separate Ordinary Least Squares (OLS) estimations. One covers the whole period of the sample, and the other two consist of one for each subperiod (1970 to 1977 and 1978 to 1986). This procedure is followed for both linear and log-linear forms of the equation above. In both cases, the null hypothesis of no difference in the parameters between time periods cannot be rejected at any reasonable degree of confidence (the relevant F-statistic with 2 and 13 degrees of freedom is .44 for the linear model and .47 for the log-linear model). It is also noted the adjusted R-squareds are uniformly small, ranging from .05 to .50.

The OLS estimation technique provides unbiased ($E(b_0) = \beta_0$ and $E(b_1) = \beta_1$) and efficient (lowest variance of estimates b_0 and b_1) estimates provided we are justified in making some common assumptions about the disturbance term ϵ_t . One such assumption is that the disturbance terms are independent of each other across time: a random deviation at time t does not affect the disturbance term at time $t+1$. The OLS estimations used in the Chow test also provide evidence of autocorrelation (the Durbin-Watson statistic ranges between .45 and .76 for all six regressions which solidly supports positive autocorrelation), and this means the data violate the independence assumption. Thus, even though all but two of the estimates of β_1 (both nonsignificant coefficients occurred in the second

Table VI

Regression Estimates and Their T-ratios
Using the Cochrane-Orcutt Procedure

	Linear model		
	1970-1986	1970-1977	1978-1986
b_0	1870.6	1444.1	158.1
(t-ratio)	(1.96)*	(1.63)	(.091)
b_1	-561.2	15.15	982.2
(t-ratio)	(-.596)	(.018)	(.612)

	Log-linear Model		
	1970-1986	1970-1977	1978-1986
b_0	7.177	7.273	7.042
(t-ratio)	(166.3)*	(66.0)*	(59.6)*
b_1	-.4622	.0392	.7890
(t-ratio)	(-.622)	(.0601)	(.584)

* indicates significance at the five percent level of confidence on a one-tailed t-test.

subperiod) and all estimates of β_0 are significant at the five percent level of confidence (according to their t-ratios), the level of confidence cannot be trusted since autocorrelation causes the variances of the estimates to be underestimated (and hence the t-ratios are upward biased).

New estimations were run using the Cochrane-Orcutt procedure to correct for the autocorrelation. The coefficients and their t-ratios are presented in Table VI. The estimates of β_1 are not statistically different from zero in any period and have the correct sign only in two cases (both for the entire sample). Further, the Chow test indicates the existence of two different regimes or models (1970 to 1977 and 1978 to 1986).¹¹ The F-values are 11.11 for the linear model and 10.69 for the log-linear model with 2 and 9 degrees of freedom.¹² The first result helps explain the second. When the slope coefficient is statistically insignificant, the mean of the dependent variable is the best guess or forecast (with the least squares criteria) of itself. Since gas sales have a higher mean over the first period, the intercept term (a parameter) is noticeably higher for that period.

¹¹Kwast [10] investigated the possibility that gasoline demand in the U.S. experienced a structural change in 1973-1974 due to the first oil crisis. The author rejects the hypothesis of instability and concludes that the elasticity of demand has remained stable over the 1967-1977 period.

¹²The Cochrane-Orcutt procedure loses two degrees of freedom for each subperiod since one observation is lost at the beginning of the subsample and the other stems from estimation of the autocorrelation coefficient. The critical value for an F-test with 2 and 9 degrees of freedom and one percent level of confidence is 8.02.

REFERENCES.

- American Petroleum Institute. 1989. Basic Petroleum Data Book. Vol. 9, No.1. January.
- Bowman, John H. and John L. Mikesell. 1983. "Recent Changes in State Gasoline Taxation: An Analysis of Structure and Rates." National Tax Journal. Vol. 36, No. 2. June.
- Bowman, John H. and Michael D. Pratt. 1983. "Selective Excise Taxation as a Means of Local Revenue Diversification: Patterns, Trends, and Policy Issues." Proceedings of the Seventy-Sixth Annual Conference: National Tax Association-Tax Institute of America.
- Burress, David. 1989. "Economic Impact Multipliers for Kansas", Kansas Business Review, 12(3), Spring, pp. 1-9.
- Dahl, Carol A. 1986. "Gasoline Demand Survey." The Energy Journal. Vol. 7, No. 1.
- Eisler, Gary. 1989. "Portland, Ore.: Washington's Bargain Basement." Wall Street Journal. January 25: p. A16.
- Fisher, Ronald C. 1980. "Local Sales Taxes: Tax Rate Differentials, Sales Loss, and Revenue Estimation." Public Finance Quarterly. Vol. 8, No. 2. April.
- Fox, William F. 1986. "Tax Structure and the Location of Economic Activity Along State Borders." National Tax Journal. Vol. 39, No. 4. December.
- Gold, Steven D. 1983. "Recent Developments in State Finances." National Tax Journal. Vol. 36, No. 1. March.
- Greene, David L. 1980. "The Spatial Dimension of Gasoline Demand." Geographical Survey. Vol. 9, No. 2. April.
- Haining, Robert. 1983. "Modeling Intraurban Price Competition: An Example of Gasoline Pricing." Journal of Regional Science. Vol. 23, No. 4.
- Kwast, Myron L. 1980. "A Note on the Structural Stability of Gasoline Demand and the Welfare Economics of Gasoline Taxation." Southern Economic Journal. Vol. 46, No. 4. April.
- McAllister, Harry E. 1961. "The Border Tax Problem in Washington." National Journal Tax. Vol. 14, No.4. December.
- Mikesell, John L. 1970 "Central Cities and Sales Tax Rate Differentials: The Border City Problem. National Tax Journal. Vol. 23, No 2. June.
- Mikesell, John L. 1971. "Sales Taxation and the Border County Problem." Quarterly Review of Economics and Business. Vol. 11, No. 1. Spring.

- Mikesell, John L. and C. Kurt Zorn. 1986. "Impact of the Sales Tax Rate on Its Base: Evidence from a Small Town." Public Finance Quarterly. Vol. 14, No. 3. July.
- Mintz, Jack and Henry Tulkens. 1986. "Commodity Tax Competition Between Member States of a Federation: Equilibrium and Efficiency." Journal of Public Economics. Vol. 29.
- Rosen, Harvey S. 1978. "The Measurement of Excess Burden with Explicit Utility Functions", Journal of Political Economy 78(2 part 2), April, pp. S121-136.
- U.S. Bureau of the Census. various years. Statistical Abstract of the United States. various editions. Washington, D.C.
- Walsh, Michael J. and Jonathan D. Jones. 1988. "More Evidence on the 'Border Tax' Effect: The Case of West Virginia, 1979-84." National Tax Journal. Vol. 41, No. 2. June.