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Effect of IRC Code 1031 on Texas Agricultural Land Price

By Beom Su Park, James W. Richardson, Ph.D., and Charles J. Gilliland, Ph.D.

Abstract

In this paper, we examine the effect of Section 1031 tax deferred payment on Texas agricultural land price. To analyze the effects, we estimate the market equilibrium price function using the dynamic panel model and Texas agricultural land sales for 1965-2007. We argue that Section 1031 increases both demand and supply of agricultural land by its tax reducing effect. Our empirical estimation shows that Section 1031 decreases the market price which means the supply curve shifted to the right more than the demand curve.

IRC code 1031 (Section 1031) allows land owners to sell real property without capital gains tax when they buy so-called "like-kind" properties within 45 days. To defer capital gains taxes, sellers must find the replacement properties in a short period, thus increasing the demand for like-kind properties. In general, the Section 1031 tax provision has an affect on the demand and supply of land and will result in a land market price change.

Colwell and Dehring (2001) suggested the analytical framework to compare the benefits of Section 1031 tax deferred simultaneous exchanges with the benefits of taxable delayed exchanges. However, there were few studies quantifying the affect of Section 1031 on land market price.

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Some observers and economists suggested that Section 1031 contributed to increased land price. They argued that especially for business property, the expected capital gains would be increased by Section 1031 by deferring tax payments, and those capital gains affects would increase the land price (Holmes and Slade 2001, and Ling and Petrova 2008). Holmes and Slade (2001) showed tax deferred simultaneous exchanges of properties increased the market value of the properties. They found that sellers of properties are willing to pay a risk premium for buying replacement properties in 45 days to defer capital gains taxes, when they analyzed the Phoenix apartment market cases using a hedonic regression method. Ling and Petrova (2008) got similar results from apartment and office building transactions for 15 cities. They argued that the exchangers need to pay a premium since the U.S. commercial real estate market is not perfect and it is not easy to find replacement properties in 45 days. However, the above two studies focused on the demand. Hedonic regression is usually used to evaluate market demand. So their models and results did not reflect the effects of Section 1031 on the supply side. In addition, they used the urban real estate (apartment, office) market sales data. The results for farmland may be different.Helmers, Shaik, and Atwood (2008) described two possibilities of the Section 1031 effects on land prices. First, many land owners who sell land try to find replacement land, so the demand for land increases as well as the price of land. Second, in a competitive market, the tax reduction by Section 1031 will cause a decrease in the observed supply price since the supply price will change from $P_s + tax$ to P_s. They argued that if the increase in demand price is not substantial enough to offset the decrease in supply price, the equilibrium price will go down. Moreover, they showed the empirical result of negative price effects for Section 1031 for Iowa, Kansas, Missouri, Nebraska, North Dakota, and South Dakota.

The present study examines the effect of Section 1031 on the price of agricultural land in Texas. Whether the effect would be positive or negative is investigated by estimating the market equilibrium land price function. Moreover, we will develop the empirical model using the dynamic panel data analysis method with county level panel data in Texas. This method will be used because it will give consistent and more efficient estimators of the market equilibrium price function.[1]

Theoretical Model

Market price of land is determined by demand and supply. So, the effect of Section 1031 on Texas farmland price can be measured by the net effects of changes on the demand and supply for Texas farmland. We can expect the effect of Section 1031 on land supply will be positive since the seller can defer the capital gains tax. Also, the effect on land demand is expected to be positive as the buyer (the future seller) can expect to get more future capital gains.

In Figure 1, the demand and supply curve without Section 1031 are given by $D_{D=0}$ and $S_{D=0}$. The equilibrium price without Section 1031 is E0. When Section 1031 is applied, the supply curve shifts from $S_{D=0}$ to $S_{D=1}$. If the demand curve shifts exactly the same amount as the supply curve, equilibrium changes from E_0 to E_2, and price will not change ($P_0=P_2$). If the demand curve shifts less, D_1, price falls to P_1. If the demand curve shifts more, D_3, price rises to P_3. Thus, the sign of the price change caused by Section 1031 depends on the relative changes of the demand and supply curves caused by Section 1031.

To analyze the effects of Section 1031 on Texas farmland price, we must specify the supply and demand for Texas farmland.

Supply for agricultural land

We can assume that land owners who want to sell land try to maximize their total net benefit (TNB) from selling land. Their supply decision will be (see the appendix for details):

$$(1)\quad Acre_t^{S} = f(\overset{(+)}{P_t}, \overset{(-)}{P_T^{e}}, \overset{(+)}{D}, \overset{(?)}{FI_t}, \overset{(-)}{FI^{e}}, \overset{(-)}{PI_t}, \overset{(-)}{PI^{e}}, \overset{(-)}{r}, \overset{(-)}{t})$$

where $Acre_t^s$ is the supplied quantity (total acres sold at the year t), P_t is sale price, P_0 is the initial price the land owner paid, $(P_t - P_0)\times Acre$ is capital gains, t is tax rate of capital gains, $t(1-D)$ is the Section 1031 effect[2] (D=1 if Section 1031 is applied, otherwise 0), and $t(1-D)(P_t - P_0)Acre$ is the tax payment for the capital gains with Section 1031 effect. *FI* is farm income per acre from the land, *PI* is non-farm personal income per acre from owning the land, $L(r)$ is the expected loan for the replacement land per acre, and r is interest rate for land loans, so $r*L(r)*$acre is the expected interest costs of a loan for buying replacement land. We can expect *Acre* supplied to be positively correlated with price as in a usual supply curve, and Section 1031 dummy also will be positively correlated with *Acre* since if D=1, the marginal benefit increases so both Acre and price increase. If the non farm personal income (PI)[3], the expected future incomes (FI^e, PI^e), and the expected future price (P_T^e) are high, the opportunity cost of selling the land now is high, so we can assume they are negatively correlated with the land supply. Expected prices are unobservable so one year lagged prices are used as a proxy for expected prices in the

Norlovian expectations model. However, farm income is not always significant for the supply decision (Richardson, et al, 2009), so we cannot assume whether the effect of farm income on the agricultural land supply will be positive or not. Capital gains tax rate t can be assumed to be negative because marginal cost of selling the land increases as the tax rate goes up.

Demand for agricultural land

If we assume the single market specification (partial equilibrium model) without any constraints, the buyers demand decision will be:

$$(2) \quad Acre_t^{d} = g(\overset{(-)}{P_t}, \overset{(+)}{FI^e}, \overset{(+)}{PI^e}, \overset{(+)}{P_T^e}, \overset{(+)}{D}, \overset{(-)}{r}, \overset{(-)}{t})$$

where P_T^e is the expected price when the buyer sells the land in the future. $(P_T^e - P_t) \times Acre$ is the expected capital gain, $L(r)$ is the loan per acre to buy land, and $r \times L(r) \times Acre$ is the interest costs. For the demand equation, P_t is expected to be negatively related with Acre as general demand relationship. The FI^e, PI^e, and PT^e can be positively related with *Acre* since if FI^e, PI^e and PT^e increase, marginal benefit is expected to increase, and r is negatively related with *Acre* because as *r* rises the marginal cost of buying land increases. If Section 1031 is applied, D=1, expected capital gains increase, so D and *Acre* are positively related. Capital gains tax rate t is expected to be negatively related because expected future gains from selling the land in the future will decrease if tax rate increases.

Market equilibrium price

Consequently, we can derive the market equilibrium price from the equilibrium condition for supply and demand,

$$(3) \quad \begin{aligned} &Acre_t^{d} = Acre_t^{s} \text{ (equilibrium condition)} \\ &P_t = h(D, \overset{(+)}{FI}, \overset{(+)}{PI}, \overset{(+)}{FI^e}, \overset{(+)}{PI^e}, \overset{(+)}{P_T^e}, r, t) \text{ (market equilibrium price function).} \end{aligned}$$

So, we can conclude the effect of Section 1031 (D) on P_t will be decided by the relative effect of demand and supply. D is a dummy variable that when changed from 0 to 1, both the demand curve and supply curve will shift to the right. If the supply curve shifts more, the price will fall, and if the demand curve shifts more, the price will rise.

The effect of r and t on the equilibrium price is also determined by the relative effects on demand and supply. Variables *FI, PI,* FI^e, PI^e, and PT^e are expected to be positively related with P_t from solving the equilibrium condition.

Empirical Model

Data

To estimate equation (3), the agricultural land transaction data for parcels of 10 or more acres for each county in Texas from 1965 to 2007 will be used. Farm income and non-farm personal income level of each county are not available, so the annual real farm income per farm household and real non-farm personal earnings per capita for Texas are used as proxy variables. The income data were obtained from USDA/ERS and USC/Bureau of Economic Analysis. Mortgage interest rates were obtained from the Dallas Federal Reserve Board. Capital gains tax rates are different by seller's owning years and marginal income tax rates. The top rate for capital gains will be used as a representative tax rate for each year. The tax rate data were obtained from CTJ (Citizens for Tax Justice).[4]

Model and Method

To do empirical estimation of equation (3), first we should specify the functional forms of demand and supply. Here, we used the log-log specification since the correlations between dependent and independent variables for log-log specification are clearer than those for no-log specification. Also, log-log specification is easier to handle and yields elasticities directly. We use lagged variables on the right hand side as the proxy for expected prices hypothesized in the model (see Appendix). The lag lengths are decided based on the significance of their coefficients. If the coefficient of a lagged variable is not significant, we don't include it as an explanatory variable. So the empirical model will be (see Appendix for details):

$$(4) \quad \begin{aligned} ln(P_{it}) = {} & \beta_0 + \beta_1 ln(P_{it-1}) + \beta_2 ln(P_{it-2}) + \beta_3 ln(P_{it-3}) + \beta_4 ln(P_{it-4}) + \\ & \beta_5 ln(acre_{it}) + \beta_6 ln(acre_{it-1}) + \beta_7 \ln(FI_t) + \beta_8 \ln(FI_{t-1}) + \beta_9 \ln(FI_{t-2}) + \\ & \beta_{10} \ln(PI_t) + \beta_{11} D_{80} + \beta_{12} r_t + \beta_{13} D_{80} \times r_t + \beta_{14} t + chrt_i + u_{it}. \end{aligned}$$

The characteristics of each county, $chrt_i$, depends on the characteristics of the land such as the distance from metropolitan area, the quality of soil, and so on. We assume these variables are not time varying. Some county values can change over time, but time varying characteristics can be explained by *FI, PI, acre*, or *P*. So, *chrt* means only time constant effects in this model associated with price.

We did not consider the interaction effects of Section 1031 dummy variable D_{80} with other explanatory variables except interest rate r, because tax deferment is only an income increasing effect and expected not to change demand/supply elasticities. However, we took the interaction with interest rate into account since individuals can change their demand/supply response to interest rate if income changes.

There are some problems with estimating equation (4) directly. $chrt_i$ are unobservable, and the equation (4) has dynamic properties (it includes lagged dependent variables on the right hand side). To overcome the problems, some mathematical and econometrical manipulations are needed on equation (4). We will apply "dynamic panel model analysis" which was suggested by Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998).

Results and Discussion

Table 1 reports parameter estimates for equation (4), the empirical model. All of the parameters are statistically significant. The $price_{t-5}$, $acre\ traded_{t-2}$, $farm\ income_{t-3}$, $personal\ income_{t-1}$, and older historical information are found to be not significant, so they were excluded in the model. The R^2 is 0.8607, thus this model is revealed to fit historical data well as we see in Figure 2. The results of the price equilibrium model estimated for equation (4) are explained below.

The elasticity of personal income is positive as expected, but that of farm income in the current period is negative. The coefficient estimates of $lnFI_{it}$ and $lnPI_{it}$ are -0.0197 and 0.7801, respectively. From these results, we can confirm that the market price is more sensitive to non-farm personal income in the current period than to farm income in the current period. Traditional agricultural economics theory puts more emphasis on farm income. However, recent studies by Hardie, Narayan, and Gardner (2001), Richardson, et al (2009), and Gilliland (2003, 2005) showed that the non-farm income such as agricultural recreational use and capital investment uses are more important than farm income in explaining prices of farmland. The empirical results in this study are consistent with the results of these studies.

The farmland prices in *t-1* to *t-4*, acres traded in *t* and *t-1*, farm income in *t-1* and *t-2*, $ln(acre_{it})$, $ln(acre_{it-1})$, $ln(FI_{it-1})$, $ln(FI_{it-2})$ are all related to the hypothesized expectation variables (FI^e, PI^e, and PT^e). The elasticity estimates of *price* in *t-1* to *t-4* are 0.3643, 0.1631, 0.1208, 0.0496, respectively. These results show that demanders build up their price expectation based on historical farmland price series. Also, the results show that buyers and sellers put more emphasis on recent price information than past information, as indicated by the greater elasticity for $price_{t-1}$ than $price_{t-2}$ and older lagged prices.

The estimated coefficients of transaction volume (acres sold in the county) ($Acre_t$ and $Acre_{t-1}$) are -0.1384, 0.0189, respectively. The negative coefficient of $Acre_t$ indicates that the model is consistent with supply and demand theory, i.e., that as the number of acres offered for sale increases price falls. Inversely, when acres sold was large last year, the prices tend to fall in the current year.

The coefficient estimates of past farm income in *t-1* and *t-2* are, respectively, 0.0974, 0.1171. As we expected, the effects of past farm income on farmland price is positive since higher farm income increases the farmland price.[5] The results show that the effect of farm income two years ago is significant, but past personal (non-farm) income was not significant. This means that lagged personal income data are not necessary to explain farmland prices because the time series of *PI* is so stable. In addition, the farm income data last year are not fully informative enough, so farm income data two years ago are needed for buyers of agricultural to develop their farmland price expectations. Figure 3 shows that the time series of farm income are more volatile than personal income, which supports the econometric results that lagged farm income is needed to explain farmland prices. The coefficient estimate for the Section 1031 dummy variable D_{80} is -1.5775. By this result, we can confirm the effect of Section 1031 on agricultural land prices in Texas is negative. The theoretical model says a land price decrease would occur if the supply shifts to the right more than the demand, which appears to be the case for Texas agricultural land. The seller's benefits from Section 1031 can be realized only after selling the land, thus the 1031 exchange provision provides an incentive to increase supply. However, the buyer's benefits from Section 1031 would be realized in the future, and therefore the gains are uncertain. As a result, the supply of Texas agricultural land shifts to the right more than the demand shifts, as indicated by the -1.5775 coefficient for D80 in Table 1. These results agree with results Helmers, Shaik, and Atwood (2008) reported for Midwest states.

The coefficients for the mortgage interest rate r_t and $D_{80}\times rt$ are estimated to be -7.6316 and 11.9439. In general it is considered that high interest rates decrease demand for land by pushing up buying costs, and so it lowers market price. This is confirmed by the negative coefficient of r_t -7.6316. However, the results in this study show the effect of the interest rate after Section 1031 is positively (-7.6316+11.9439=4.3123) related to farmland price. The explanation is that before Section 1031 sellers were not as concerned about interest rate; interest rate was the buyer's concern. With Section 1031 exchanges, the sellers are also buyers, so now both buyers and sellers are sensitive to interest rates. If the sum of the coefficients for rt and $D_{80}\times r_t$ is greater than zero, the supply curve for Texas agricultural land shifted to the right (increased) more than the demand curve, From $S_{D=0}$ to S_{D1} and E_0 to E_1 in Figure 1.

The model results indicate that capital gains tax rates, t, and their changes since 1965 have reduced farmland values. The results suggest that a one percent increase in the capital gains income tax rate reduces Texas farmland values by 0.4 percent. Lower farmland prices are a result of lower capital gain tax rates (and exclusions in some years) which encouraged sellers to increase the supply of farmland as land owners expected a smaller loss of the sales price due to taxes.

The equilibrium model for farmland prices estimated here combines the forces that affect both supply and demand, making the results more robust than traditional studies that have attempted to explain farmland price using a conventional single equation models. The model is able to sort out the net effects of variables that shift both supply and demand. A case in point is current year's farm income is less important than non-farm personal income in explaining farmland prices. In a market where farm income is rather risky multiple year lags of farm income are necessary to capture the effects of this variable on farmland prices. Another factor in Texas that contributed to the results of the model is that the majority of farmland sales are to non-farmers who are purchasing land for recreational pursuits.[6] The equilibrium model captures the market's price movements associated with the number of acres being traded. The model indicates that an increase in acres sold (supplied) causes prices to decrease, as economic theory would indicate. Another interesting result is that interest rates affected farmland prices differently before and after 1031 exchanges. Interest rates had a smaller and negative impact on farmland price prior to 1031 exchanges and a larger and positive impact after the exchanges were permitted. With the opportunity to do a 1031 exchange sellers became buyers of land so high interest rates reduced the supply of farmland on the market and strengthened prices. The dummy variable used to test if the supply of land increased more than the demand was highly significant and indicated that supply did increase more than demand after the 1031 exchanges were permitted. In any market when supply outpaces demand the equilibrium price will fall. One explanation of this supply and demand shift is that many 1031 exchanges involve selling farmland in the way of urban development at very high prices and acquiring farmland in more remote locations where the price per acre is much lower. The effect is likely to be a price reduction in the selling area (near population centers) while the positive effect on demand for land will be smaller and would be felt in more remote regions with fewer sales. By capturing the supply and demand forces at work we have been able to isolate the effects of a structural shift in the Texas farmland market caused by the 1031 exchange provision in the income tax code.

Summary and Conclusion

Theoretically, the effect of Section 1031 on farmland values is determined by both demand and supply shifts caused by land transactions taking advantage of Section 1031 exchanges. To detect the effect of Section 1031 on farmland prices in Texas this study estimates the market equilibrium price function related to tax reforms in Section 1031. The empirical results verify that the effect is to reduce agricultural land price in Texas. These results are consistent with Helmers, Shaik and Atwood's (2008) analysis of farmland in Nebraska and other Plains states.

The reason for the negative effect on price is inferred by the difference between supply shifts and demand shifts. The supply curve shifts to the right more by Section 1031 than the demand curve, and equilibrium price point moves from E0→E1 in Figure 1. Many forces in the Texas farmland market can help explain these shifts. The majority of farmland buyers are purchasing farmland for recreational/non-consumptive purposes. Non-farm income is driving these purchases more than farm incomes. Large developers have, until recently, been purchasing large ranches to subdivide them into more affordable parcels for consumers wanting a rural residence/recreation experience. So demand shifts have been more responsive to non-farm income in the near term. Supply shifts have been in part driven by the sale of high priced farmland near urban development and the breakup of large parcels in rural areas of the state; these types of sales are facilitated by 1031 exchange provisions.

Footnotes

1 See Wooldridge ("Econometric Analysis of Cross Section and Panel Data" chapter 12, 2002), Blundell and Bond (1998)

2 We assume the case that capital gains tax is fully reduced when Section 1031 is applied.

3 Richardson, et al (2009) reported that, "The elasticity of price per acre with respect to personal income has ranged between 0.353 in 1990-1994 and 1.160 in 2000-2004. The elasticity of price per acre with respect to net farm income peaked at 0.267 in 2000-2004. Personal income is several magnitudes more important than net farm income in determining rural land values in Texas." For this reason non-farm income for Texas is included in both the supply and demand equations.

4 Available at http://www.ctj.org/pdf/regcg.pdf

5 The model is suggesting that a longer term trend on farm income is necessary to explain prices of farmland. The current year's coefficient on farm income is -0.019 but the lagged farm income variables in t-1 and t-2 have coefficients of 0.097 and 0.117, respectively. The effects of the lagged farm income variables far outweigh the effect of current farm income. An explanation is that farm incomes are quite risky in Texas and a trend in farm income is more important to land prices than the current year's farm income level. See Figure 3 for a comparison of risk for farm income and non-farm personal income.

6 A survey as to Texas farmland buyer motives reported that 67 percent of the respondents named recreation (hunting and fishing) as a very important motive among buyers in the 2001 land market (Tierra Grande). Agricultural production was named by only 15 percent of respondents falling well short of the percent that saw non-consumptive recreation as a very important motive. 1031 exchange had not emerged as the force it would exert later with only 9 percent seeing it as a very important buyer motive.

7 The most important tax reform related with Section 1031 is traced to 1979, so we use 1980 as the changing point. Helmers, Shaik, and Atwood also use 1980 as their break point.

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Figure 1. The effect of Section 1031 on farmland price

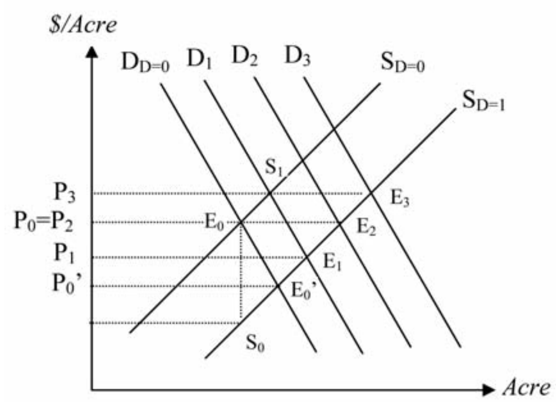
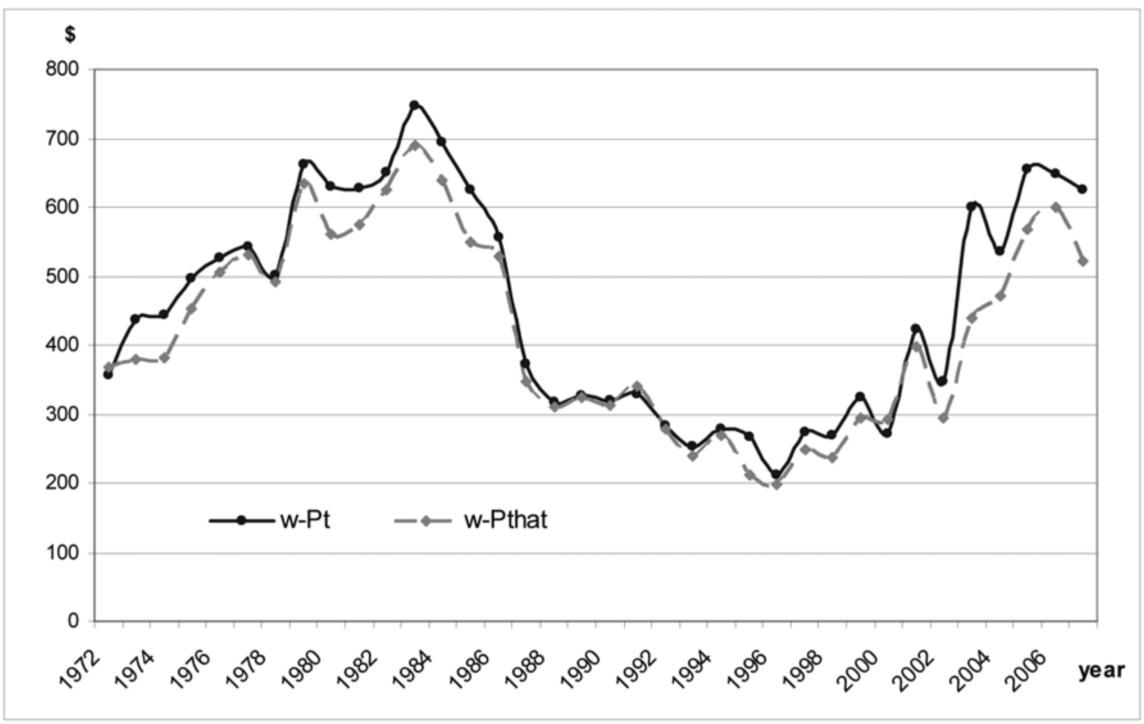


Figure 1. Texas average farmland price 1972-2007



Note) w-Pt: actual weighted average real price per acre of Texas farmland each year (weighted by traded acreage of each county)

w-P that: estimates of weighted average real price per acre of Texas farmland each year (weighted by traded acreage of each county)

Figure 1. Texas farm income and personal income 1965-2007

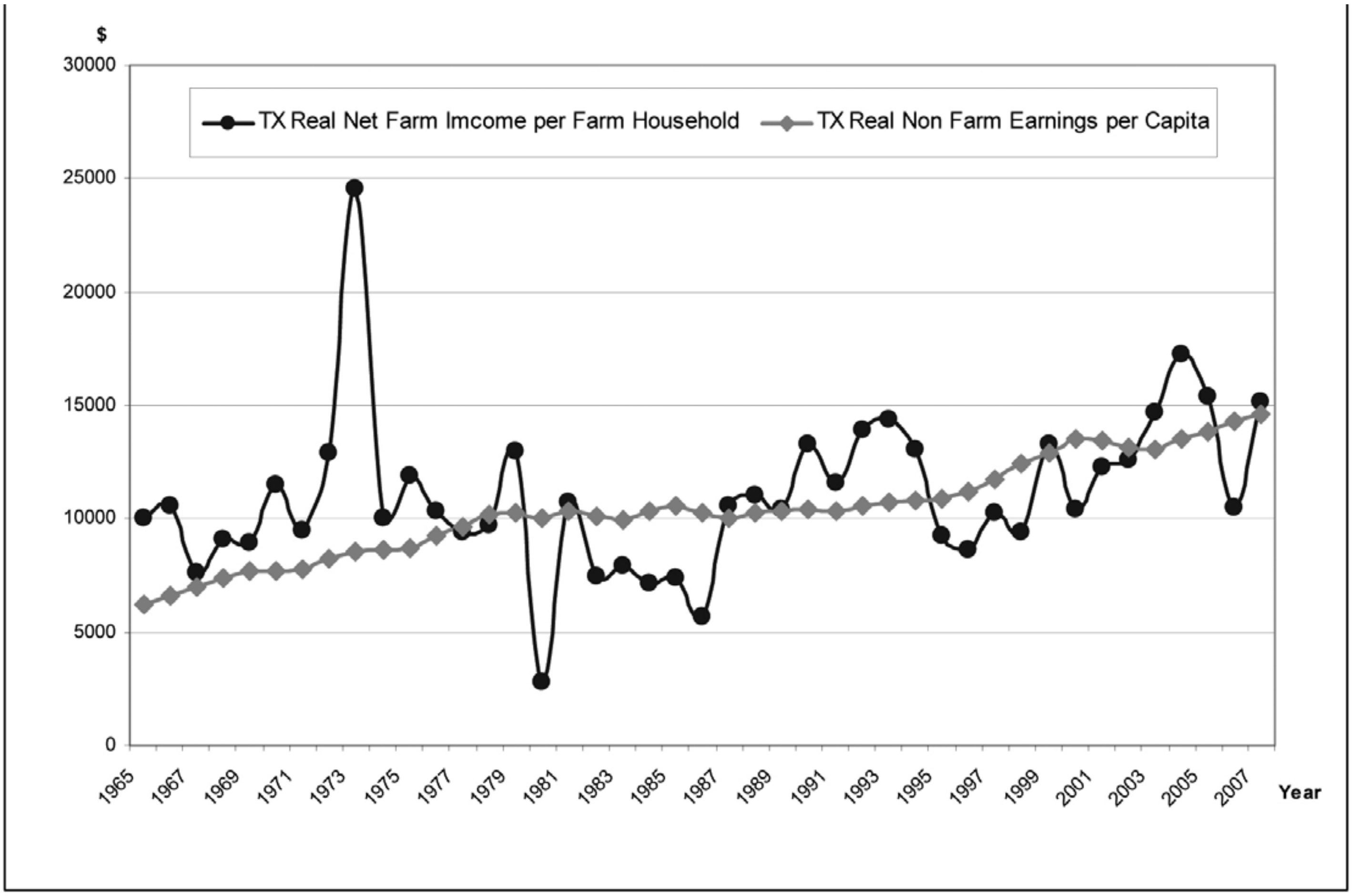


Table 1. The empirical results for estimating impacts of Section 1031 on Texas agricultural land prices

Coefficients	Parameter Estimate	t-value
Intercept	-4.9329180	-11.92**
$ln(P_{it-1})$ *Real Price*$_{t-1}$	0.3643201	35.75**
$ln(P_{it-2})$ *Real Price*$_{t-2}$	0.1631442	16.51**
$ln(P_{it-3})$ *Real Price*$_{t-3}$	0.1208197	10.52**
$ln(P_{it-4})$ *Real Price*$_{t-4}$	0.0496078	4.55**
$ln(acre_{it})$ *Traded Acre*$_t$	-0.1384175	-19.31**
$ln(acre_{it-1})$ *Traded Acre*$_{t-1}$	0.0189250	2.50*
$ln(FI_t)$ *Farm Income*$_t$	-0.0196663	-2.42*
$ln(FI_{t-1})$ *Farm Income*$_{t-1}$	0.0973623	12.34**
$ln(FI_{t-2})$ *Farm Income*$_{t-2}$	0.1171358	15.24**
$ln(PI_t)$ *Personal Income*$_t$	0.7800672	19.75**
D_{80} *Section 1031 DV*	-1.5775390	-29.37**
r_t *Interest Rate*$_t$	-7.6316010	-15.90**
$D_{80} \times r_t$ *DV * Interest Rate*	11.943910	22.39**
t Capital gains tax rate	-1.5575910	-20.74**
R-square	0.8607041	

** denotes p-value<0.01 and * denotes p-value<0.05

Appendix

Log-log specification of equilibrium price function

$$(4)\quad ln(P_{it}) = \beta_0 + \beta_1 ln(P_{it-1}) + \beta_2 ln(P_{it-2}) + \beta_3 ln(P_{it-3}) + \beta_4 ln(P_{it-4}) + \beta_5 ln(acre_{it}) + \beta_6 ln(acre_{it-1}) + \beta_7 \ln(FI_t) + \beta_8 \ln(FI_{t-1}) + \beta_9 \ln(FI_{t-2}) + \beta_{10} \ln(PI_t) + \beta_{11} D_{80} + \beta_{12} r_t + \beta_{13} D_{80} \times r_t + \beta_{14} t + chrt_i + u_{it}.$$

where i means each county, t means each year, P is real price per acre, $acre_{it}$ is the average acres sold per transaction of each county at each year, FI is real farm income per farm household in Texas, PI is real non-farm earnings per capita of Texas, D_{80}[7] equals 1 if $t \geq 1980$ and 0 if $t < 1980$ for the Section 1031 dummy variable, r is nominal mortgage rate, t is capital gains tax rate, and $chrt$ is unobserved characteristics related with P for each county. The error term u_{it} is assumed to be distributed independent with an expected value of zero.

To specify the functional forms of demand and supply, checking partial correlations are needed.

Partial Correlation Coefficients

No log model: p-corr of P_{it} with			Log-Log model: p-corr of $ln(P_{it})$		
Variable	Corr.	Significance	Variable	Corr.	Significance
$acre_{it}$	-0.1787	0.000	$ln(acre_{it})$	-0.6753	0.000
FI_t	-0.0009	0.932	$ln(FI_t)$	-0.0321	0.003
PI_t	0.2003	0.000	$ln(PI_t)$	0.2150	0.000
r_t	0.1560	0.000	r_t	0.2172	0.000
D_{80}	-0.1818	0.000	D_{80}	-0.2810	0.000

As we see above, log-log specification is better as a whole, since correlation coefficients of log-log model are nearer to ±1, and significances are better.

To specify supply function, we can assume that land owners who want to sell land try to maximize their total net benefit (*TNB*) from selling land. Their supply decision will be drawn from:

(5) $\max_{acre} TNB = total\ benefit - total\ opportunity\ cost$

The total benefit will be the difference between total income (land price per acre × acre) and capital gains tax if we assume the expected total benefit from replacement property is exactly the same as the total income from selling the land. The total opportunity costs will be the future land value, the farm income and personal income obtained from owning the land. Then equation (1) will be modified as:

$$\text{(5a)} \quad \begin{aligned} \max_{acre}\ TNB = {} & P_t(Acre)\times Acre - t(1-D)(P_t(Acre)-P_0)Acre - P_{iT}^{e}\times Acre \\ & - FI(Acre)\times Acre - PI(Acre)\times Acre - r\times L(r)\times Acre \end{aligned}$$

If we assume log linear model, the supply specification of the equation (1) is

$$\text{(6)} \quad \begin{aligned} ln(Acres_{it}^{s}) = {} & \alpha_0 + \alpha_1 ln(P_{it}) + \alpha_2 ln(FI_t) + \alpha_3 ln(PI_t) + \alpha_4 r_t + \alpha_5 D_{80} + \alpha_5 D_{80} r_t + \\ & \alpha_6 \ln(P_{iT}^{e}) + \alpha_7 t + chrt_i^{s} \end{aligned}$$

If we assume the single market specification (partial equilibrium model) without any constraints, the buyers demand decision comes from:

(7) $\max_{acre} TNB = total\ expected\ benefit - total\ opportunity\ cost$

Total expected benefit will be the sum of the expected farm income (FI^e) and the expected non-farm personal income (PI^e). One more expected benefit will be the expected capital gains from selling in the future. The expected capital gains will not be realized before the buyer sells the land, but those gains should be included as capital gains which are important for the investors as they are closely related to Section 1031. Total opportunity cost can be the money the buyer pays for the land if we assume buying the land will be his or her best alternative. In addition, if we allow the possibility of a mortgage loan, the interest should be included in the total cost. Thus the demand equation decision can be expressed as:

$$(7a)\quad \max_{acre} TNB = (FI^{e} + PI^{e})Acre + (1 - t(1-D))(P_T^e - P_t(Acre))Acre - P_t(Acre) \times Acre - r \times L \times Acre$$

The demand specification of the equation (2) is

$$(8)\quad ln(Acres_{it}^{d}) = \gamma_0 + \gamma_1 ln(P_{it}) + \gamma_2 ln(FI^{e}) + \gamma_3 ln(PI^{e}) + \gamma_4 ln(P_{iT}^{e}) + \gamma_5 r_t + \gamma_6 D_{80} + \gamma_7 D_{80} r_t + \gamma_7 t + chrt_i^d$$

From the equilibrium condition (equation (3)), the equilibrium price function is

$$(9)\quad ln(Acres_{it}^{s}) = ln(Acres_{it}^{d})$$

$$ln(P_{it}) = \delta_0 + \delta_1 ln(FI_t) + \delta_2 ln(PI_t) + \delta_3 r_t + \delta_4 D_{80} + \delta_5 D_{80} r_t + \delta_6 t + chrt_i + \delta_7 ln(FI^{e}) + \delta_8 ln(PI^{e}) + \delta_9 ln(P_{iT}^{e})$$

We assume the expectations for *FI, PI,* P_T are built up based on market information such as current and past traded Acres, Prices, and past *FI, PI*, because the current information of *FI, PI* are unknown until the end of year. Then the expectation function specification is:

$$(10)\quad \delta_6 ln(FI^{e}) + \delta_7 ln(PI^{e}) + \delta_8 ln(P_{iT}^{e}) = E(\delta_6 ln(FI^{e}) + \delta_7 ln(PI^{e}) + \delta_8 ln(P_T^{e}) | \Omega_t)$$

$$= k(\Omega_t)\ (\ \Omega_t = \{Acres_{it}, Acres_{it-1}, ..., P_{it,} P_{it-1}, ..., FI_{t-1}, ..., PI_{t-1} ...\}\ )$$
$$= \varphi_0 + \varphi_1 ln(P_{it}) + \varphi_2 ln(P_{it-1}) + \varphi_3 ln(P_{it-2}) + \varphi_4 ln(P_{it-3}) + \varphi_5 ln(P_{it-4})$$
$$\varphi_6 ln(Acre_{it}) + \varphi_7 ln(Acre_{it-1}) + \varphi_8 ln(FI_{t-1}) + \varphi_9 ln(FI_{t-2})$$

(assume log – linear form, only a few lagged information considered)

To replace the equation (10) with (11) provides the final empirical model

$$(4)\quad ln(P_{it}) = \beta_0 + \beta_1 ln(P_{it-1}) + \beta_2 ln(P_{it-2}) + \beta_3 ln(P_{it-3}) + \beta_4 ln(P_{it-4}) + \beta_5 ln(acre_{it}) + \beta_6 ln(acre_{it-1}) + \beta_7 \ln(FI_t) + \beta_8 \ln(FI_{t-1}) + \beta_9 \ln(FI_{t-2}) + \beta_{10} \ln(PI_t) + \beta_{11} D_{80} + \beta_{12} r_t + \beta_{13} D_{80} \times r_t + \beta_{14} t + chrt_i + u_{it}$$

Equation (4) presents some problems for a simple OLS model. First, *chrt*s are not observable. Some of *chrt*s such as miles from metropolitan area are known, but others like soil composition, water and air conditions, etc are unknown. Moreover, we cannot exclude the possibility of correlation between *chrt*s and other explanatory variables (not random effect, but fixed effect). So, we should take the first difference of equation (6) to get rid of *chrt*s.

$$\text{(4a)}\quad \Delta ln(P_{it}) = \beta_1 \Delta ln(P_{it-1}) + \beta_2 \Delta ln(P_{it-2}) + \beta_3 \Delta ln(acre_{it}) + \beta_4 \Delta ln(acre_{it-1}) + \beta_5 \Delta ln(FI_t) + \beta_6 \Delta ln(FI_{t-1}) + \beta_7 \Delta ln(PI_t) + \beta_8 \Delta ln(PI_{t-1}) + \beta_9 \Delta D_{80} + \beta_{10} \Delta r_t + \Delta u_{it}$$

Second, still this model has endogenous problem. Since $Cov(P_{it-1}, u_{it-1}) \neq 0$, the correlation between $\Delta ln(P_{it-1}) = ln(P_{it-1}) - ln(P_{it-2})$ and $\Delta u_{it} = u_{it} - u_{it-1}$ is not 0. Because of these reasons, the simple fixed effects model estimators cannot be consistent and efficient.

To overcome the issues described above, we use the dynamic panel model analysis approach suggested by Arellano and Bond, Arellano & Bover, and Blundell & Bond. They suggested using system-GMM approach with instrumental variables (IV). Because dynamic panel model uses IV, it is important to choose optimal IV matrix *Z*. For *Z* to guarantee the consistent and unbiased estimator, *Z* should satisfy $E(Z'\Delta u_{it})=0$ for the equation $\Delta Y_{it} = \Delta X_{it}\beta + \Delta u_{it}$ ($E(\Delta X_{it}'\Delta u_{it}) \neq 0$). Even if $E(Z'\Delta u_{it})=0$, Z should be well correlated with ΔX_{it}, because there can be a weak IV problem. Arellano and Bond (1991), Arellano and Bover (1995) showed the extended IV matrix (system GMM approach) such as lagged explanatory variable are asymptotically efficient by Monte Carlo study. Blundell and Bond (1998) showed system GMM approach with additional moment conditions such as $E(u_{it}\Delta Y_{it-1})=0$ is optimal by Monte Carlo result. In this study, Blundell and Bond model will be applied, so the IVs for equation $\Delta Y_{it} = \Delta X_{it}\beta + \Delta u_{it}$ (X_{it} is sequentially endogenous) are:

(7) $IVs\ for\ \Delta u_{it} = Z_{it} = (X_{it-1}, X_{it-2}, \ldots, X_{i1})$

$IVs\ for\ \Delta u_{it-1} = Z_{it-1} = (X_{it-2}, X_{it-2}, \ldots, X_{i1})$

...

$IVs\ for\ \Delta u_{i2} = Z_{i2} = (X_{i1})$, *since the assumption* $u_{it} \sim iid$ *means* $Cov(\Delta u_{it}, X_{it-1})=0$

Then, we can safely run the feasible GMM using 'xtdpsys' command in STATA version 10.1.