University of Idaho
College of Agricultural and Life Sciences

Department of Agricultural
Economics and Rural Sociology

An Econometric Approach to Evaluating Development Pressure on Cropland in South-Central Idaho

by

Orestes Vasquez, James R. Nelson and Joel R. Hamilton*
Department of Agricultural Economics and Rural Sociology
University of Idaho

Paper presented
in
Rural Development Policies Session
At
Forty-First Annual Meeting of the
Western Regional Science Association
Monterey, CA
February 2002

A.E. Research Series No. 02-01

Departmental Working Paper Series

*Vasquez is a former Research Assistant, Nelson and Hamilton are both Professors,

College of Agricultural and Life Sciences
University of Idaho
Moscow, ID 83843-2334

An Econometric Approach to Evaluating Development Pressure on Cropland in South-Central Idaho

By

Orestes Vasquez, James R. Nelson and Joel R. Hamilton

Introduction

The objective of this paper is to quantify the effect of development pressure on farmland values in a South-central Idaho study area. If farmland value can be segmented into agricultural value and development value increment, then as development pressure on farmland increases, the ratio of farmland value to returns to land from agriculture should increase, *ceteris paribus*. For purposes of this paper, the ratio specified above is defined as an income multiplier (IM).

Income Multipliers

The concept of income multipliers can be traced back as far as 1740 in an article written by Thomas Miles. In his book, *The Concise Practical Measurer; or a Plain Guide to Gentlemen Builders*, he states that to estimate the present value of the land, the rent should be multiplied by a specified number of years (Boykin, 1976).

Although the concept has evolved over time, its use has remained as a unit of comparison across sales with similar characteristics. Appraisers commonly use income multipliers to compare properties with regular and constant returns (especially rental housing and commercial buildings). They generally define income multipliers as the ratio between the sale price of a property and its effective gross income (Appraisal

Institute, 1996). However, although income multipliers have been used extensively in the appraisal field as a tool for valuing real property, due to their conceptual simplicity they have received little academic attention (Boykin, 1994).

Income multipliers have been criticized for failure to account for the remaining economic life of comparable properties. This is a legitimate criticism if buildings of different ages are being appraised, but it is not a relevant criticism relative to valuing land (with life into perpetuity).

Boykin (1994) established a relationship between Price earnings ratio (P/E ratio), used to value a particular stock, and the income multiplier as a unit to value real estate. Many investors use P/E ratios as good benchmarks to value securities. The advantage of the P/E ratio is the simplicity of its application and the availability of information. He concluded that the same could apply to income multipliers as a simple and direct method of valuing real estate.

Ratcliff (1971) cites a University of California study in which 84 income property appraisal reports were prepared, with a comment that, if the appraisers would have only used the income multipliers for their final values they would have been within 1% of the appraised values. Another study cited by Ratcliff (1971) is of 385 sales in the Vancouver, British Columbia metropolitan area. He used income multipliers to predict sale prices for different types of properties and compared the predicted sale prices with the actual sale prices. He found that the differences ranged from 4 to 8 percent.

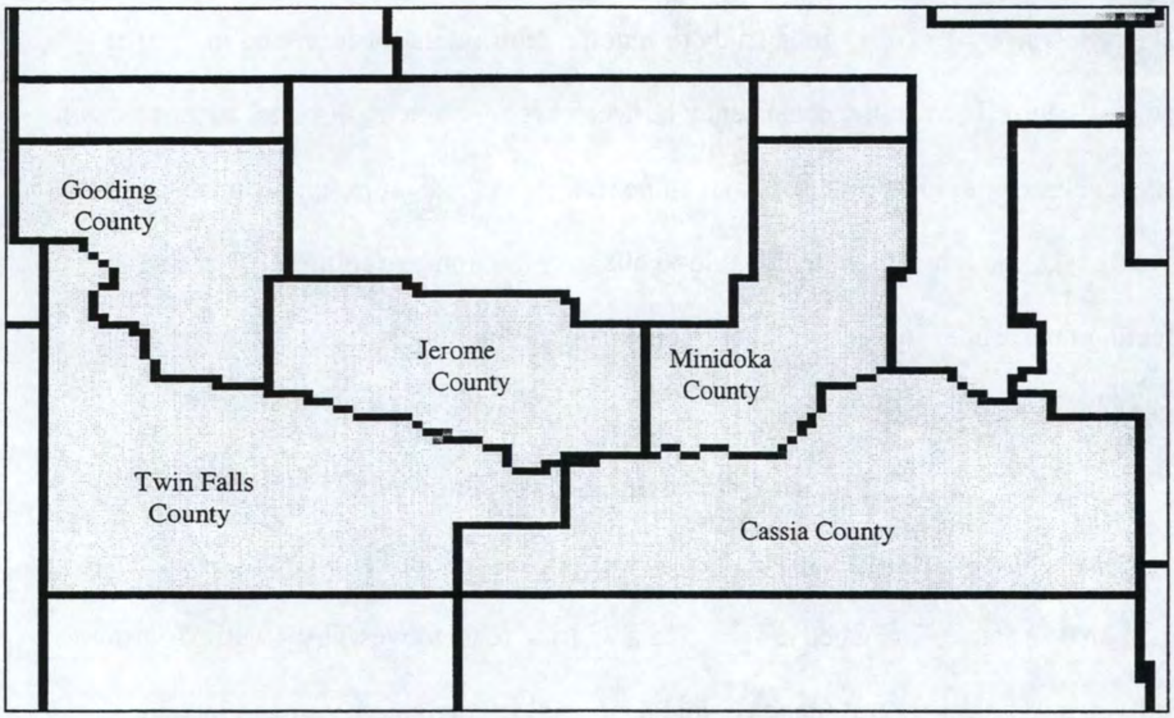
He concluded that income multipliers are good predictors because they are market derived and do not rely on personal judgment. If decisions of market participants are based on the same variables, then income multipliers of similar properties will have the same ratios. Also, he pointed out that, usually, future sales reflect past market activity, and income multipliers modify themselves over time.

Nelson et al. (2001) did a study of income multipliers for farmland in Canyon County, Idaho. They found consistency between high-income multipliers and areas with high development pressures and low-income multipliers and areas with low development pressures. Although they were not able to quantify the non-agricultural variables affecting land values, they found that tracts that exhibited higher aesthetic qualities had higher income multipliers.

Study Area and Survey Data

In the study reported herein, the author used data from Farm Credit Services (FCS) on 453 sales of irrigated cropland in a 75 mile (east to west) by 40 mile (north to south) area in South-central Idaho (Figure 1) to evaluate irrigated cropland income multipliers. This region of southern Idaho is commonly known as the Magic Valley. The Snake River flows through the region from east to west. Within the region there are approximately 988 thousand acres of highly productive irrigated cropland, some irrigated pastureland, and quite a lot of dry, high desert range. Major crops in the Magic Valley are potatoes, sugar beets, wheat, dry beans, alfalfa and corn (mostly for silage).
The FCS data set included information on the area of the tract, location of the tract year, month of sale, net rent and sale price of the tract. With the help of Geographical Information System (GIS) specialists at the University of Idaho, more data were gathered. These were locational and specific aesthetic attributes of each individual parcel. They

Figure 1. Idaho's Magic Valley



consisted of distance from largest town in the area, distance to major roads, presence of water bodies, slope of the tract, altitude of the tract and type of soil present in the tract.

Using data from the 2000 US Census, some socioeconomic variables were gathered. These variables were: population, median family income and population density.

The General Model

If the present value of expected future benefits associated with converting a tract of land to a non-agricultural use, such as development, exceeds the present value of future benefits from keeping the tract in agriculture, the market value of the tract will be greater than if the expected future use of the land is limited to agriculture. Thus, the income multiplier for the land's agricultural rent will be greater than if the expected future use of the land is limited to agriculture. So, a tract of land will have an income multiplier greater than would be expected for farmland, if it's long term highest and best use is for some sort of development rather than for agriculture. Income multipliers are better indicators of such development potential or pressure than are land prices, because they can be used to evaluate levels of development pressure on parcels that have greatly differing land values attributable to agriculture

Ordinary least squares regression techniques were used in this study to estimate a model with income multipliers (IM) as the dependent variable. This model can be specified as follows;

$$IM\ (z)=IM\ (z1, z2, \ldots\ zn) \qquad \text{(Eq. 1)}$$

The income multiplier IM (z), is a function of its z characteristics determined by the interaction of agricultural and non-agricultural attributes that influence IM's. This model is used to calculate marginal income multipliers for each of the parcel characteristics, *ceteris paribus*.

The marginal income multipliers of land attributes are the first derivatives of the function specified above with respect to the relevant characteristics. The marginal income multiplier of each characteristic is given

$$\partial IM/\partial Z=b1 \qquad \text{(Eq. 2)}$$

A list of independent variables that were used in estimating the model and their expected signs is shown in Table1. The dependent variable IM is derived by dividing the total sale value of the tract by the gross agricultural rent of that tract.

The variable Size reflects the area in acres of the transacted tract of land after netting out waste and road. It is hypothesized that smaller land transactions are more likely to be used for residential or industrial development, while larger parcels are usually used for agricultural purposes. Therefore, parcel size should have a negative relationship with IM.

With the help of GIS technology, the shortest distance in meters from tracts of land to population centers and distance from parcel to roads was determined. For simplicity, straight lines were used from each tract to the desired location. Two criteria were used in the models. These were distance from tract to population centers greater than 1000 people recognized by the census in meters (Dis1000) and distance to roads from parcels (Proximityrds). It has been hypothesized that distance to population centers and to roads have an inverse relationship with development pressure. People like to live near population centers due to accessibility to goods and services these centers provide.

Table 1. Regression model variables for IM.

Symbol	Variable	Expected Sign
Continuous variables		
Size	Size of tract (acres)	(-)
Dist1000	Distance to towns (mt)>500 people	(-)
Proximityrds	Distance to all types of roads.	(-)
Elev	Elevation in meters	(?)
Slope	Slope of tract	(?)
Soils	Average land capability class (1-7)*	(-)
Popu	County population	(+)
Nifarmc	Net farm income by county ($)	(+)
Dcows	Number of dairy cows in county	(+)
Discrete variables (1,0)		
Irri (1-2)	Type of Irrigation (furrow=0, other=1)	(+)
Yrsale (1993-1994)	Year sale occurred	(+)
Water	Presence of water bodies	(-)
Cassia	Located in Cassia County	(?)
Gooding	Located in Gooding County	(?)
Jerome	Located in Jerome County	(?)
Mind	Located in Minidoka County	(?)
Tfall	Located in Twin Falls County	(?)

*Highest capability class for agricultural land is 1, and lowest capability class is 7.

A negative relationship should exist between IM and distance to population centers and roads.

With the use of GIS technology, elevation (Elev) and slope (Slope) of the tracts were estimated. The sections were divided into plots of 90 meters by 90 meters, by averaging all the plots of a determined section, the altitude in feet and slope in percentage were determined for the sections and applied to specific tracts within sections. Observations made by the author in the study area indicated that rural home sites are built near rivers and streams. Since water courses have relatively low elevations in an area, it was expected that elevation has a negative relationship with respect to IM. Studies have shown that, for agricultural land, an inverse relationship exists between sale price and slope. The greater the slope, the more vulnerable the tract is to erosion (Palmquist and Danielson, 1989). This may be true for residential land also, or home sites on uneven ground may be thought to be more interesting than flat sites. Consequently, there was no expectation for the sign of a slope coefficient.

The socioeconomic indicators used in the study were total population of the county in which each tract of land was sold (Popu), the farm income of that county (Nifarmc) and the population of dairy cows in the county (Dcows). These variables were expected to be positively related IM. The greater the population and net farm income the more market participants and greater disposable income in the area for residential or commercial purposes. South-central Idaho has been developing a big dairy industry that is competing for resources (land, water, and farm labor) with cropland farmers. This added pressure, as indicated by number of cows in each county, was expected to directly affect IM.

Categorical variables were used to specify year of sale (1, 0). It is hypothesized that development pressure increases over time. Therefore, intercept shifters were used for the years 1993 through 1998, with 1993 as the base case (implicitly included in the intercept), these should be positively related to IM.

Categorical variables were also used to determine the presence of water bodies (1=yes, 0=no). Because lakes, streams, and rivers enhance the aesthetic characteristics of a parcel, there should be a positive relationship between presence of these water bodies and IM, since market participants will give land an added consumptive value.

To try to homogenize the data, dummy variables were introduced for the different counties in the area. These were Cassia, Gooding, Jerome, Minidoka and Twin Falls. Cassia was used as the base case; therefore, it was implicitly included in the intercept and the others serve as intercept shifters.

Results

Income Multipliers (IM) were determined for all of the parcels in the data set by dividing total sale value of each tract by gross rent of the tract. Regression models were run for all sales parcels, then run iteratively as parcels with low IM's were removed. Goodness of fit of models improved during this iterative process until all tracts with IM's less than 20 were eliminated. IM's less than 20 indicate that agricultural returns to land values are greater than 5% of land value, suggesting that little, if any, of the land value is attributable to development (all is attributable to agriculture). On the other hand, tracts with IM's that are greater than 20 have an additional value that does not seem to be attributable to agriculture. In this case, the influencing factor is likely to be residential or commercial development. A Chow test was run which documented that parcels with

IM's greater than 20 are from a different population than those with IM's less than 20 (Table 2). Regression analysis for parcels with IM's greater than 20 yielded the results shown in Table 3.

Table 2. Chow test to determine optimum IM population.

Model	Error Sum of Squares	N	F Value
Constrained	1.24E+04	454	3108.06***
IM greater than 20	5.68E+12	79	
IM less than 20	4.84E+10	375	

***Significant@<0.001 with 446 degrees of freedom for the numerator and 8 for the denominator.

The model yielded a highly significant F-test, implying an important interaction of the variables in the model. Not all of the signs of the coefficients were consistent with expectations. Although Twin Falls is the most developed and populated county, it had significantly lower IM's than Cassia County. This result was initially thought of as counter intuitive. However, it was learned during visits with local officials in the study area that Twin Falls County has notably more stringent rural zoning than do the other study area counties. This information makes the negative coefficient for the Twin Falls dummy variable more understandable. Proximity to roads had a positive coefficient. This indicates that as a tract of land lies farther away from roads, its IM (development pressure) increases, which is not consistent with expectations. The study area has many good rural roads (around almost every section). Possibly being away from roads (by necessarily short distances) gives desirability to a parcel.

Table 3. Regression statistics for IM.

Variable	Coefficient	t-statistic
Intercept	37.39	5.9***
Tfalls	-24.44	-1.88*
YR1996	2.5	2.08**
Proximityrds	0.001	5***
Dis1000	-0.00013	-2.27**
Elev	-0.02	-2.46**
Popu	0.0006	1.9*
F test+	7.59***	
R^2=	0.43	

*Significant@.10
**Significant@.05
***Significant@.01

Tests of Heteroskedasticity and Multicollinearity

A test of first and second moment specification was conducted to determine the presence of heteroskedasticity in the database. It tests a joint null hypothesis that indicates that errors are homoskedastic, the errors are independent of the regressors and the model is correctly specified. This test was presented by White in the May, 1980 issue of Econometrica. The result was a Chi-square of 26.1 with a probability of 0.7594. In this case the null hypothesis could not be rejected.

Table 4 presents a correlation table between the different variables. In this model Twin Falls was highly correlated with Elevation and Population, but since these variables were judged to be likely factors affecting income multipliers, they were left in the model to avoid possible biased estimators if eliminated.

Table 4. Correlation matrix of variables.

Variable	Twin Falls	Yr1996	Dis1000	Proximityrds	Elev	Popu
Twin Falls	1.00	0.20	0.09	0.04	0.81	-0.99
Y1996	0.20	1.00	-0.05	-0.21	0.13	-0.18
Dis 1000	0.09	-0.05	1.00	-0.05	-0.15	-0.12
Proximityrds	0.04	-0.21	-0.05	1.00	0.00	-0.04
Elev	0.81	0.13	-0.15	0.00	1.00	-0.80
Popu	-0.99	-0.18	-0.12	-0.04	-0.80	1.00

From the estimated econometric model, marginal income multipliers were derived from each variable with respect to IM. Results of the marginal income multipliers are shown in Table 5. An increase in the distance of one meter from the nearest road will increase the IM by 0.001 or for every kilometer further away from a road the IM will increase by one unit. On the other hand, an increase of one meter from a population

Table 5. Marginal IM.

Variable	Mean	Change in IM
$\partial IM/\partial Proximityrds$	457.20	0.00104
$\partial IM/\partial Dis1000$	13316.60	-0.00013
$\partial IM/\partial Elev$	1191.20	-0.02040

center of 1000 persons or more will decrease the IM by 0.00013 or for every kilometer further away the IM decreases 0.13.

As elevation increases one meter the IM decreases –0.02, therefore, an increase in 100 meters will decrease the IM by 2. For a population increase of one person, the IM increases 0.00058, or for every 1000 persons the IM increases by 0.58.

Conclusions and Implications

An econometric model was used in this study to determine the effects of development characteristics on income multipliers (IM's). A major conclusion of the study is that high (IM's) on farmland are significantly affected by development related variables, indicating that IM's can be used to evaluate, at least in an ordinal sense, development pressures on farmland values.

The practical applicability of comparative analysis of income multipliers to evaluate farmland conversion pressures can be further tested by replication in other study areas of the effort documented in this paper. A similar study is planned of an area under much heavier development pressure than Idaho's Magic Valley.

The statistical estimation of land and its associated value is a complex process that involves a variety of influences. By analyzing the implications that time, agricultural returns and development pressures have on the value of land; investors can make better-informed decisions regarding the inclusion of agricultural land in their portfolios. However, besides the implications that this study has for investors, such analysis can also be useful to local government planners, tax assessors, road builders, appraisers, etc, who have interests in such issues as determining base values for farmland and determining what areas surrounding an urban area are experiencing the most developmental pressures.

If income multipliers are reliable measures of development pressures on farmland, they can be utilized to estimate the portions of a parcel's value attributable to agricultural use value. Agricultural use value of a parcel is simply the net agricultural income (net rent) from the parcel multiplied by an income multiplier for a comparable property that is under no development pressure. Since agricultural use of a parcel and development of a parcel are mutually exclusive, the development value of a parcel that is valued at a level greater than its agricultural value is the market value of the parcel. The difference in the market value of a parcel and the agricultural value of a parcel is the development increment related to the development potential of the parcel. Of course, each of these values is, conceptually, a measure of present value of anticipated net returns (adjusted for risk).

Comparative analyses of agricultural income multipliers for land for which farming is truly the highest and best use and of agricultural multipliers for farmland that is under high pressure for conversion to development should yield good estimates of the agricultural value and the development increment components of the land with development potential. This information could be quite useful to local government officials and decision makers with nonprofit entities who are working to preserve farmland and agricultural areas by use of such mechanisms as purchasable development rights, transferable development rights and farmland trusts.

If additional research can further support the validity of analysis of income multipliers to evaluate farmland conversion pressures, application of such multipliers can have much significant use. The concept of income multipliers is simple. However, economists and public and private decision makers concerned with land values should not assume that conceptual simplicity implies lack of usefulness and applicability.

References

Appraisal Institute. 1996. "The Appraisal of real estate." Eleventh Edition. Chicago. Appraisal Institute, 819.

Bodie, Z., Kane, A. and Marcus, A. J. 1998. "Essentials of Investments." Third Edition. Irwin McGraw Hill, Boston, MA, 611p.

Boykin, J. H. and Gray, M. T. 1994. "The Relevance and Application of the Gross Income Multiplier." The Appraisal Journal. April 1994:203- 208.

Boykin, J. H. 1976. "Real Property Appraisal in the American Colonial Era." The Appraisal Journal. July, 1976:370.

Cooney, K. S. 1993. "Adjusting Overall Rates and Gross Income Multipliers: A Fresh Perspective." The Appraisal Journal. October 1993:570-575.

Chicoine, D. 1981. "Farmland Values at the Urban Fringe: An Analysis of Sale Prices." Land Economics 57,3(1981):353-362..

FAO. "Agricultural Land Prices." June 1997. http://www.fao.org/sd/LTdirect/LTan0016. htm.

Idaho Agricultural Statistics. 1996. Idaho Agricultural Statistics Service, Boise, ID.

Idaho Agricultural Statistics. 2000. Idaho Agricultural Statistics Service, Boise, ID..

Kmenta, J. 1997. Elements of Econometrics, Second Edition, University of Michigan Press, Ann Arbor, MI.

Nelson, J. R., Vasquez, O. H. and Hamilton, J. R. 2001. "Use of Agricultural Land Values and Capitalization Rates (or Income Multipliers) to Evaluate Demand for Farmland Conversion to Nonagricultural Uses," Southwestern Economics Journal, Vol. 4, No. 2, Fall 2001, in press.

Palmquist, R. B. and Danielson, L. E. 1989. "A Hedonic Study of the Effects of Erosion Control and Drainage on Farmland Values." American Journal of Agricultural Economics. 71(1989): 55-62.

Ratcliff, R. 1971. "Don't Underrate the Gross Income Multiplier." The Appraisal Journal April 1971:264.

SAS Institute, Inc. 1999. SAS Introductory Guide, Third ed. Cary, NC: SAS Institute Inc., 1985 Survey. 6106 Vance Jackson #2, San Antonio, TX.

White, H. 1980. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity". Econometrica 48,4(1980):817-838.

U.S. Census Bureau. 2000. "United States Census Data 2000." United States Department of Commerce. http://factfinder.census.gov/servlet/BasicFactsServlet.