D.E.Ü. İ.İ.B.F. Dergisi
Cilt: 11, Sayı: II, 1996, ss.251-261

MORE EFFICIENT ESTIMATORS OF THE FACTORS AFFECTING ENTERPRISE PROFITABILITY OF FARMS USING SEEMINGLY UNRELATED REGRESSION

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ABSTRACT

In this study, econometric models were developed for profitibalities of farm enterprises. Three enterprises such as tobacco, cotton and wheat were taken into consideration. The independent variables involved in the models are specific costs which are expected to be effective on the profitabilities, gross margins. Estimators were first obtained through least squares and then more efficient estimators were found through seemingly unrelated regression using cross sectional farm data. All the estimators were interpreted and compared to each others.

Introduction

One of the indicators of profitability of an enterprise in a farm business is the gross margin. It has become widespread in the UK since about 1960, when it was first popularised amongst farm management advisers (Barnard, Nix, 1976).

The gross margin is an appropriate measure of profitability to use for comparing enterprises for short run decisions in agriculture. It is the return over variable costs. In other words, it is calculated by subtracting variable costs[2] from revenue[3]. Gross margins can be used to make comparisons among enterprises that place similar demands upon the limiting resources of the business (Castle et al., 1987).

Since the highest gross margin refers to the most profitable enterprise, if a farmer allocates his restricting resources to the enterprises with the highest gross margins, then he may get the most profitable cropping pattern. Although the farmer can maximize his profit in this fashion, he may wish an enterprise with a less gross margin to be in the cropping pattern. In this case he is advised to find a way to increase the gross margin using the resources efficiently more than ever. If he can know how much the gross margin of the enterprise is affected by each resource and how much change in profitability occurs depending on a change in the resources then his success in decision making would increase.

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2 Variable cost: Specific costs made for the relevant enterprise, which are depending on the production size, increasing with an increase or decreasing with a decrease in production size.

3 Revenue: The product of price and yield of the enterprise plus value of by product.

The purpose of this paper is to specify econometric models for various enterprises in which a farmer can discern the effects of restricted resources on gross margins of the enterprises. The seemingly unrelated regression were used to get more efficient regression parameters so that the farmer can take fastidious decisions on the necessary measures in increasing present gross margin levels to have more profitable cropping patterns.

The enterprises involved in this paper are tobacco, cotton and wheat, which are intensively grown in Akhisar and nearby and whose cross-sectional data, 80 face to face farmer interviews, were collected through a farm management research[4] (Kabacık, 1992).

Seemingly unrelated regression (SUR)

The seemingly unrelated regression is recursive model which occurs occasionally in business and economic modelling. It consists of a series of endogenous variables that are considered as a group because they bear a close conceptual relationship to each other (Pindyck, Rubinfeld, 1991). As is known, in the classical linear regression model the estimators are found to be unbiased and efficient. This is true if the specification of the regression model involves all the variables. However if there exists some other piece of information that has not been taken into account, then the result concerning the properties of the least square estimators can no longer be considered established. One such additional piece of information would be the knowledge that the disturbance (error term) in the regression equation under consideration could be correlated with the disturbance in some other regression equation (Kmenta, 1986). For example interest might center on demand equations, investment functions for a number of firms or consumption functions for subsests of the population. Suppose that time series data suitable for estimation for a number of demand equations are available. The disturbances in these different equations at a given time are likely to reflect some common unmeasurable or omitted factors and hence could be correlated. The same is also likely to be true when time series observations are used to estimate investment functions for different firms, different consumption functions of different subsests of the population or many other examples. With investment functions of a number of firms the general state of the economy is probably to have similar effects on the disturbances of the different functions. Although SUR is usually described in the context of estimating a number of equations using time series data, it can also be equally relevant for cross-sectional data[5] (Judge et al, 1988).

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[4] I am indepted to Sevgi Kabacık to allow me use the data that she collected for her MSc thesis.

[5] G.G. Judge, R.C. Hill, W.E. Griffiths, H. Lütkepohl, T-C Lee (1988), Introduction to the Theory and Practice of Econometrics, 2nd Ed, Canada.

Correlation between disturbances from different equations at a given time is known as contemporaneous correlation. When contemporaneous correlation exists, it may be more efficient to estimate all equations jointly, rather than to estimate each one seperately using least squares (LS). It is sometimes possible to obtain a better estimator by viewing the equation as part of a system (Harvey, 1990). The appropriate joint estimation technique is SUR. It should be noted that SUR may give less standard errors for estimators than LS.

In this framework, SUR is a method which can be used for agricultural econometric modelling as well. In fact each farm in an agricultural area earns gross margins from a range of crop enterprises and if cross sectional farm data are used to estimate gross margin functions for different crop enterprises then it is quite likely that some unmeasurable characteristics of a certain farm could have similar effects on the disturbances of all the gross margin functions.

Theoretical background for SUR

SUR estimation is simply the application of generalized least squares estimation to a group of seemingly unrelated equations. The equations are related thorough the nonzero covariances associated with error terms across different equations. Seemingly unrelated model may be generalized by writing the system of G equations as follows:

$$Y_i = X_i \beta_i + u_i \qquad i = 1, 2, ..., G \tag{1}$$

Y_i = N x 1 vector, X_i = N x K_i matrix, β_i = K_i x 1 vector, u_i = N x 1 vector

According to the assumptions of the seemingly unrelated model, there is no autocorrelation within equations, but cross equation correlation does exist;

$$E(u_i u'_j) = \begin{bmatrix} \sigma_{ij} & 0 & \dots & 0 \\ 0 & \sigma_{ij} & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \sigma_{ij} \end{bmatrix} = \sigma_{ij} I \tag{2}$$

where I is a G x G identity matrix. This relationship applies to the covariances between two arbitrary equations in the system of G equations. To generalize this result in matrix form:

$$\Omega = E(u\,u') = \begin{bmatrix} E(u_1 u'_1) & E(u_1 u'_2) & \dots & E(u_1 u'_G) \\ E(u_2 u'_1) & E(u_2 u'_2) & \dots & E(u_2 u'_G) \\ \dots & \dots & \dots & \dots \\ E(u_G u'_1) & E(u_G u'_2) & \dots & E(u_G u'_G) \end{bmatrix} \tag{3}$$

Substituting from equation (2):

$$\Omega = \begin{bmatrix} \sigma_{11} I & \sigma_{12} I & \dots & \sigma_{1G} I \\ \sigma_{21} I & \sigma_{22} I & \dots & \sigma_{2G} I \\ \dots & \dots & \dots & \dots \\ \sigma_{G1} I & \sigma_{G2} I & \dots & \sigma_{GG} I \end{bmatrix} \tag{4}$$

All information about error covariances is contained in the matrix Ω. The most efficient estimation of equation (1) is obtained by applying generalized least squares estimation to get

$$\hat{\beta} = (X' \Omega^{-1} X)^{-1} (X' \Omega^{-1} Y) \tag{5}$$

$$\text{with } E[(\hat{\beta} - \beta)(\hat{\beta} - \beta)'] = (X' \Omega^{-1} X)^{-1} \tag{6}$$

In practice the elements of Ω must be estimated. This is accomplished by using the residuals obtained when LS estimation is applied to each of the G equations:

$$\sigma_{ii} = \frac{\hat{u}_i \, \hat{u}_i'}{N - K_i}$$

$$\sigma_{ij} = \frac{\hat{u}_i \, \hat{u}_i'}{\sqrt{(N - K_i)(N - K_j)}}$$

$$\hat{u}_i = Y_i - X_i \hat{\beta}_i$$

There are two important cases in which SUR estimation is equivalent to the equation-by-equation application of LS. The first case occurs when $s_{ij} = 0$ for every i an j, $i \neq j$. Then W simplifies to

$$\Omega = \begin{bmatrix} \sigma_{11}I & 0 & \dots & 0 \\ 0 & \sigma_{22}I & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 \,.. & 0 & \dots & \sigma_{GG}I \end{bmatrix} \quad (7)$$

The use of simple matrix algebra [substituting equation (7) into equation (6)] is sufficient to prove the stated result. A second less obvious case occurs when $X_i = X$ for every i = 1, 2, .., G ($K_i = K$ is implicit). This occurs when the identical set of independent variables appears in each equation. Once again the proof involves a straightforward application of the techniques of matrix algebra.

Econometric Models for Gross Margins

Econometric models of gross margins for each of the three enterprises are separately specified in double log linear equations for ease of interpretation. In all the models, gross margins are dependent variables while variable costs of each enterprise are independent variables. Since enterprises require different resources for production, models specified naturally included different explanatory variables. These are presented in table 1.

Table 1: Dependent and independent variables for each enterprise

	Tobacco	Cotton	Wheat
Dependent	Gross Margin	Gross Margin	Gross Margin
Independent	Labor costs Sprays costs	Labor costs Seeds costs Fertilizer costs Sprays costs Fuel costs	Seeds costs Fertilizer costs

Tobacco and wheat enterprises possess only two explanatory variables while there exist five explanatory variables for cotton. Only labor costs are considered as variable costs since family labor is not included in the variable costs as a cost component. Other costs which consist of an insignificant part of the variable costs are omitted.

The observation numbers of the SUR models for tobacco-cotton

Tobacco-wheat, Cotton-wheat and Tobacco-cotton-wheat are 21, 37, 17 and 17 respectively. The data sets may consists of different observations obtained from different farms because of jointly selecting nonzero observations related to the variable costs of the enterprises.

Two tail t-test applied for the null hypothesis in which the related estimator is zero. However for some unexpected estimators, one tail t-test was used to test the null hypothesis which is meaning the estimator to be greater than zero or less than zero.

Comparison of Alternative LS and SUR Estimators

All the models specified for the enterprises were first solved using LS. SUR solutions were taken for all couples of the three enterprises and at the end keeping the three enterprises together as equations systems.

The results obtained for the couple of tobacco-cotton are given in table 2.

Table 2: LS and SUR estimators of Tobacco and cotton

		LS		SUR	
Equation	Coefficient	Coefficient Estimate	Std. Error of Coefficient Estimator	Coefficient Estimate	Std. Error of Coefficient Estimator
Tobacco	Labor costs	-0.175	0.134	-0.188	0.117
	Sprays costs	-0.006	0.178	-0.087	0.155
Cotton	Labor costs	-0.005	0.216	0.165	0.169
	Seed costs	-0.273	0.401	-0.512	0.312
	Fertilizer costs	-0.520	0.430	-0.467	0.334
	Sprays costs	-0.168	0.206	-0.259	0.161
	Fuel costs	0.153	0.197	0.206	0.155

No estimator is found statistically significant[6] for the couple of tobacco and cotton in both LS and SUR. However it is clearly seen that all the estimators in SUR are more efficient than in LS since they all have less standard errors as expected.

[6] The minimum significance level to accept esmators to be different from zero is 0.21 in LS and 0.11 in SUR

Comparative results of the couple of tobacco and wheat are in table 3.

Table 3: LS and SUR estimators of tobacco and wheat

		LS		SUR	
Equation	Coefficient of	Coefficient Estimate	Std. Error of Coefficient Estimator	Coefficient Estimate	Std. Error of Coefficient Estimator
Tobacco	Labor costs	-0.264**	0.108	-0.242*	0.092
	Sprays costs	-0.095	0.136	0.001	0.116
Wheat	Seed costs	-0.042	0.616	-0.042	0.525
	Fertilizer costs	-0.187	0.296	-0.187	0.253

* Significant at level 0.01. ** Significant at level 0.05.

In table 3, only labor cost estimators of tobacco are statistically significant both in LS and SUR. Therefore, it may be said that when a farmer increases labor expenditures for tobacco by 10% then gross margin of tobacco decreases by about 2.5%. The sign of the estimator is plausible since tobacco agriculture requires intensive work force mainly consisting of family labour which is not considered as a variable cost element for any enterprise theoretically. In other words, the more the labor the less the gross margin. On the other hand profitability of tobacco is not affected by the sprays costs. It is also seen from table 3 that there exist no variable costs that influence wheat gross margin. As expected again, SUR provides more efficient estimators.

Table 4: LS and SUR estimators of wheat and cotton

		LS		SUR	
Equation	Coefficient	Coefficient Estimate	Std. Error of Coefficient Estimator	Coefficient Estimate	Std. Error of Coefficient Estimator
Tobacco	Seed costs	0.301	0.587	0.185	0.534
	Fertilizer costs	0.142	0.332	0.160	0.302
Cotton	Labor costs	0.528 **	0.185	0.532 *	0.151
	Seed costs	-0.384	0.311	-0.425***	0.254
	Fertilizer costs	0.193	0.422	0.268	0.345
	Sprays costs	-0.415 **	0.189	-0.434 *	0.155
	Fuel costs	0.326 ***	0.161	0.356 **	0.131

* Significant at level 0.01. ** Significant at level 0.05. *** Significant at level 0.10.

No estimator for wheat that is different from zero has been found in both methods. This is not different from the previous solutions for wheat.

LS gives three statistically significant estimators for cotton while SUR provides four which are all with less standard errors.

According to the SUR results for cotton: (1) when labor costs of cotton is increased by 10% then the gross margin increases about by 5.3%. In fact, unlike tobacco agriculture, labor is hired for cotton production particularly during the harvesting period. It is likely that the higher the payment for unit labor is the more quality harvesting or the more amount the cotton harvested per unit time. (2) If a cotton producer relatively increases seeds costs then his profitability decreases. This is an unexpected finding. Probably the seeds purchased are not desired quality or the farmer uses much more seeds than necessary. However since such a case has not been studied in the research, the real reasons should be examined in the future farm management researches. (3) There exists an adverse relation between sprays costs and the gross margin of cotton unlike expected. It may be concluded that the cotton sprays have not effective enough on the diseases or insects, or the farmer uses pesticides excessively. Again these are also expected to be involved in the future studies. (4) If a cotton farmer increases fuel costs by 10% then he may increase cotton gross margin by about 3.6%. As the fuel costs are mainly made for tractor use for tillage, the more tillage, the higher the yield of cotton.

To avoid the unexpected estimators obtained for sprays costs and seed costs, it is accepted that Ho hypothesis is the estimator > 0 and tested in one tail t-test. The new test gives us that both the estimators are not different from zero.

Table 5: LS and SUR estimators of tobacco, cotton and wheat

		LS		SUR	
Equation	Coefficient	Coefficient Estimate	Std. Error of Coefficient Estimator	Coefficient Estimate	Std. Error of Coefficient Estimator
Tobacco	Labor costs	-0.225 ***	0.116	-0.200 **	0.093
	Sprays costs	-0.230	0.161	0.201	0.129
Cotton	Labor costs	0.053	0.238	0.232	0.171
	Seed costs	-0.390	0.425	-0.581 * * *	0.292
	Fertilizer costs	-0.350	0.408	-0.359	0.283
	Sprays costs	-0.067	0.226	-0.147	0.158
	Fuel costs	0.108	0.213	0.172	0.151
Wheat	Seed costs	0.057	0.800	0.200	0.711
	Fertilizer costs	0.024	0.443	-0.034	0.396

** Significant at level 0.05.
*** Significant at level 0.10.

The SUR model including all the three enterprises confirms that tobacco gross margin is adversely affected by increasing hired labor about in the same percentage, 0.200, and that cotton gross margin decreases by an increase in seeds costs in SUR, 0.581. Because of such an unexpected result, the estimator for seed costs was tested in one tail t-test for the hypothesis of the estimator>0 and it was found to be insignificant.

LS and SUR models presents again no statistically significant estimator for wheat.

As in the previous alternative models, more efficient estimators have been again obtained for all enterprises in SUR.

Conclusion

In all the models for gross margins SUR presented more efficient estimators than LS, as is expected. When examined the SUR solutions obtained for the three crops wholly, it can be concluded that: The costs from labor adversely influence the profitability of tobacco while it increases the profitability of cotton which are in fact expected results. The profitability of cotton can be increased by increasing fuel costs coming from tillage, which is also a plausible finding. It was found that the profitability of wheat is not affected by any of the variable costs considered in this paper. Since wheat is really grown for family needs rather than marketing in the research area, the wheat farmers are not very aware of the necessary input levels which are inevitable for a succesful result. An interesting finding is that fertilizer costs affect none of the profitabilities of the crops. This seems questionable. Therefore the reasons for this are the aspects to be studied in a future research. In two sided t-tests, it was found that the more the cost for sprays, the less the profitability of cotton. Although this problem was overcome by one tail t-test, it keeps the need to be studied in a complementary research. Another interesting result is that the SUR models insistently presented a negative relationship between the cost for seeds and the profitability of cotton. This also seems questionable and needs to be studied. However, through one tail t-test, such estimators were accepted insignificant.

According to the results, the farm management researchers should keep in mind there may be some problems in input use and expenditures made for them though meaningful effects of the use of some of them on enterprise profitability were found.

Görünüşte ilgisiz regresyon yöntemini kullanarak tarım işletmelerinde üretim dalı kârlılığını etkileyen faktörlerin daha etkin tahmincilerinin elde edilmesi üzerine bir çalışma

ÖZET

Bu çalışmada tarım işletmelerindeki üretim dallarının kârlılıklarına ilişkin ekonometrik modeller geliştirilmiştir. Üretim dalı olarak tütün, pamuk ve buğday alınmıştır. Modellerdeki bağımsız değişkenler, üretim dallarının kârlılığını (brüt marj) etkilediği kabul edilen değişken (spesifik) masraflardır. Tahmincilerin belirlenmesinde önce en küçük kareler yöntemi kullanilmış ardından daha etkin tahmincileri verecek olan görünüşte ilgisiz regresyon (SUR) uygulanmıştır. Bu amaçla yatay kesit işletme verilerinden yararlanılmıştır. Bulunan tahminciler değerlendirilmiş ve birbirleriyle karşılaştırılmıştır.

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