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The Sensitivity of UK Agricultural Employment to Macroeconomic Variables 1960–1996

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1 Agriculture's contribution to rural employment

In the UK agriculture continues to have a major impact on the landscape, occupying 77% of the total land area, but its direct contribution to national employment is marginal. In 1996 the agricultural sector accounted for 1.7% of the British workforce, down from 2.1% in 1981 and 2.5% in 1971. Some of the reasons for this are the UK's early industrialisation as well as the distinctive inheritance traditions, which have prevented the progressive fragmentation of landed property. More fundamentally the continued decline can be attributed to the fact that (1) food comprises a decreasing proportion of household spending as incomes rise, and (2) the increase in technology which has led to the substitution of farm labour by various forms of capital.

Agriculture has important impacts on other sectors of the economy. There are jobs upstream of farming in firms that provide inputs to the industry, just as there are jobs downstream of farming in the product processing sectors. In short, taking into account direct and indirect employment from agriculture, it is clear that agriculture still plays a significant role in the economy and labour markets of some rural localities. When governments and the EU Commission are formatting agricultural policies, they have to take these knock-on effects into account.

One of the main characteristics of agricultural labour is its flexibility. There are regular periodic emergencies which must be covered by flexible labour inputs, which is one of the main reasons why farming has traditionally been a family business. Two of the most significant trends over recent years have been the increased "flexibility" of the hired workforce and the growing importance of farm family labour (Errington and Gasson, 1993). Flexible labour has been used to cut down on production costs. Another factor related to the increased use of seasonal and casual labour in UK farming is the effect on family farms of increased female participation in off-farm paid employment (Gasson, 1988).

Despite the fact that the total agricultural workforce fell by 22% from 351,000 in 1980 to 274,000 in 1994, the farm family workforce has remained relatively stable in the face of a continuing downward trend in the hired workforce. The hired workforce decreased by 37% from 1980 while in the same period family labour fell by 11%. One of the main reasons for the stability of family labour is that in agriculture the growing number of part-time farmers have had a major effect on the family component of the workforce. There is evidence to suggest that part-time farmers also include a growing proportion of "new entrants" attracted by the residential qualities of the

farmhouse rather than the productive potential of the farm (Gasson, 1988). In periods of high unemployment in the economy the farm may be used as an "employment refuge" by farm family members, and more children seek employment at home than would otherwise be the case (Gasson and Errington, 1993). It is important therefore, to recognise that hired labour and family labour can react differently to changes in the economy or policy.

Alternative employment opportunities outside agriculture are viewed as "pull factors", which attract agricultural labour to leave the sector. The goal of this paper is to identify the factors which have an impact on farm labour and can be seen as reasons for the decline in the agricultural labour force. Both family and hired labour will be examined since these elements of the agricultural workforce are deemed to react in different ways. While hired labour may be made redundant if farm incomes fall, the family workforce will tend to be more "sticky" and may continue to work on the farm especially if no other employment opportunities are available. Rather than joining the registered unemployed, the farm family worker will simply become underemployed remaining on the farm in what may amount to "disguised unemployment" (Errington,1993).

2 Literature Review

A recent OECD report (1994) set out to determine the influence that future economic and general employment conditions might have on farm labour. In particular, the study was interested in finding out whether farm employment is sensitive to changes in the business cycle. In their analysis, the OECD researchers used equations linking family and hired farm labour to various agricultural and macroeconomic variables. These equations were estimated for eight countries for the period 1970–1987. Among the explanatory variables used were total unemployment, manufacturing employment, non-agricultural earnings, real interest rate, agricultural prices and an exchange rate. Their econometric results provided empirical evidence that aggregate hired and family labour in the farm sectors of the eight countries were insensitive to change in macroeconomic variables. In other words, neither category of farm labour seemed to be heavily influenced by the business cycle. The authors indicated that the farmers may have adjusted the number of days they worked in farming in response to macroeconomic and general employment conditions. The data used in the study combined younger and older farm workers. One might expect that younger people would show higher mobility between sectors than older people. The data were also aggregated across the full range of educational attainment even though mobility almost certainly varies with the amount and quality of educational

qualifications (OECD,1994).

A comparative study of European Community farm labour by France's Institut des Statistiques et des Etudes Economiques also evaluated the determinants of farm employment. This analysis confirmed the findings of the OECD study. The conclusion was based on an evaluation of the relationship between various macroeconomic variables and farm employment in EC member countries. The French report (Vert, 1987) draws the following conclusions regarding the determinants of farm employment in the EC: "The rather marked rigidity of agricultural employment (due to the predominance of family employment and to the fact that agriculture is not only an activity but also a profession, and a lifestyle) means that the most important factor determining the population of farmers is the difference in the number of farmers leaving for retirement compared with the number of young farmers entering the sector. This implies that the number of farmers at any given time is largely determined by the age pyramid and that the economic context only plays a role by altering the dominant demographic trend".

A study of Finnish farm family employment from 1960-1979 (Makinen, 1982) related farm employment to a variety of macroeconomics and farm sector variables. The study found no statistically significant relationship in Finland between farm family employment and GNP, the non-farm unemployment rate, and the availability of part-time employment outside agriculture.

The Australian Bureau of Labour Market performed seven regression analyses of agricultural labour markets in a variety of sectors and for several categories of farm labour. The report concluded with the following statement: "That the results (of the studies) show relatively little consistency is not surprising, given the variation in models and data used, and the time periods studied. The implication is that our understanding of the determinants of the level of labour used in agriculture is not well developed (Powell, 1985).

Tyrchniewicz and Schuh (1969) used a six equation simultaneous equations model that took account of the interrelationship among the three components—hired labour, operator labour and non-family labour. Their model consisted of demand and supply equations for each component, with price and quantity assumed to be endogenously determined, subject to a set of exogenous variables. The supply equations expressed farm employment as a function of real wages of farm labour, a measure of income earned in non-agricultural employment, the amount of unemployment and the size of the civilian labour force. The demand equations were a function of real wage rates of farm labour, an index of prices for agricultural products, an index of other inputs prices, and a measure of technology. Their results illustrated

that a given increase in non-farm income relative to farm wage rates would result in a proportionally larger decline in the quantity of labour supplied. For operator labour the difference was much greater implying that members of the agricultural labour force are more responsive to changes in non-farm income than to changes in returns to agricultural labour. They concluded by stating that increases in non-farm income, in the long run, would result in a sizeable shift of labour out of agriculture. Therefore, some variables outside agriculture had a sizeable impact on agricultural employment.

There have been a number of econometric studies of employment in UK agriculture since the 1960's. Cowling and Metcalf (1968) attempted to explain the variability in the outflow of labour from UK agriculture, between the years 1960-1964 and across regions. They claimed to have found that the following variables had a significant effect on the loss of agricultural labour in a region: the level of unemployment, the ratio of agricultural earnings to industrial earnings and the ratio of earnings to agricultural product prices. A subsequent study by Cowling, Metcalf and Rayner (1970) covered the determination of employment of both hired and family workers measured in full-time man equivalents in England and Wales (1946-1964). The supply of labour was related to lagged real earnings in agriculture and lagged ratios of indices of the cost of employment and product prices to an index of input prices. This study also found that the employment of farm labour was sensitive to these macroeconomic variables.

Finally, Lund et al (1982) estimated demand and supply equations for the agricultural labour force of England and Wales (1960–1980). Their results showed that demand for labour was affected by output potential, the stock of machinery, expected product prices and average holding size. The supply of labour was found to be sensitive to the level of earnings elsewhere, to supplementary benefits, the local job opportunities and some apparent decline in the "attractiveness" of agricultural employment.

3 Data

The main source of statistical information on the total numbers of persons within the agricultural workforce is the Ministry of Agriculture, Forestry and Food (MAFF) June Census. The labour force is divided into the hired workforce and the family workforce, where the family workforce is defined as all the other workers other than the hired workers. Unfortunately, the full breakdown of the agricultural workforce is not available before 1970. The numbers of workers were first split between family and hired in 1970, with the former defined as "relatives of the farmer, partners or directors or

their spouses, not having a contract of employment". However, MAFF have estimated the hired workforce back to 1960 and have added all the other farm workers as family labour.

The source for the macroeconomic variables is the Office of National Statistics. These variables include the rates of unemployment, employees in manufacturing industry, average industrial weekly wage, the inflation rate, the percentage change in GNP and an interest rate. The employment and unemployment statistics are taken from the British Labour Statistics Historical Abstract. This study uses annual data from 1960 to 1996, which is the most consistent time series available. A longer time series, or quarterly data, would have given the author more scope in the econometric analysis but such data is unavailable. Furthermore, data by age group would enable an analysis of the different reactions of younger and older farmers. One would expect that younger farmers would show higher mobility between sectors than older ones. Despite these inadequacies the model using this data was found to be adequate in examining the sensitivity of the two components of agricultural labour to macroeconomic variables.

4 The econometric study

This section reports the statistical and econometric analysis which has been conducted to investigate the sensitivity of the agricultural labour force to macroeconomic variables. The analysis was done for the family labour force and the hired labour force to determine the different reactions of both. The variables presumed to affect the agricultural labour force include the unemployment rate, the industrial weekly wage, the agricultural weekly wage, the percentage change in GNP, the inflation rate and an interest rate. The first essential part of an econometric analysis is to check the variables to see if they are stationary or not. This is done by the use of a unit root test (Augmented Dickey Fuller test) on each of the variables. A stationary series has basic statistical properties which are invariant with respect to time. Thus, it has a constant mean, a constant variance, and covariances between observations which depend only upon their distance apart in time. Table 1 shows the results of this test on each of the variables in the model:

From Table 1 the author concluded that all the variables, except X6, were non-stationary which invalidates the use of an Ordinary Least Squares regression. The OECD study (1994) "Farm Employment and Economic Adjustment in OECD Countries" failed to present any results of unit roots tests on the variables in their model. They proceeded to estimate their models using Ordinary Least Squares without having checked for stationarity. They

mentioned the fact that testing for cointegration would be impossible given their data constraints. Unit root tests on the variables is an essential step before cointegration can be carried out.

Cointegration allows us to test for the presence of long term relationships between model variables. The cointegration procedure contains two steps, the first of which is to test the variables for unit roots. The second step involves an OLS regression on the variables in question and testing the residuals from this regression for stationarity. Cointegration can be regarded as the empirical counterpart of the theoretical notion of a long-run or equilibrium relationship. If two or more integrated variables are not cointegrated there can be no long-run relationship between them and regressions linking them will be spurious. Tests for cointegration constitute tests of whether such relationships exist, and, hence, have been suggested as a means to test the equilibrium propositions of economic theory (Hallam, 1991). Given the relative short time series, it was decided that it would be impossible to fully test for such long term relationships. One of the main reasons for this was that the power of the tests would be very weak. However, when family labour and hired labour were tested for cointegration it was found that there seemed to be no long-run relationship between them. Figure 1 (see appendix) would seem to support this hypothesis.

Before 1969, family and hired labour moved together, see Figure 1, but since then they have been moving apart. There seems to be a structural break around the year 1969. It would have been useful to test for this structural break but the present data series deems this impossible. As mentioned earlier there seems to be the presence of disguised unemployment in the family labour sector. This analysis supports this hypothesis and it indicates that the two series have been moving apart in recent years. Figure 1 shows that the decline in the hired labour has been rapid and the decline in the family labour force has been gradual (the family labour force increased slightly in times of high unemployment).

Having found that the variables were non-stationary a difference model was used. A unit root test on the differenced variables proved that the variables were stationary (see Table 2). Firstly, all the variables and their lags were used in the first model. The variables were used in log form so that the coefficients would give us elasticities. In the first model the dependent variable was family labour (X1). Following the first OLS the insignificant variables (DLX4, DLX9, DLX2(-1), DLX4(-1), DLX5(-1), DLX7(-1), DLX9(-1)) were dropped and the model was rerun. The diagnostic tests revealed the presence of serial correlation so the Cochrane Orchutt procedure was used to correct for this. Two lags were used in the procedure but only one lag was found to be significant. After dropping the insignificant variables (DLX5,

DLX7, DLX3(-1)) and rerunning the model, a negative relationship between family labour, the unemployment rate (X3) and the interest rate (X8) were found, but the elasticities were very small, see Table 3. Hired labour was found to be positively related to family labour but the T statistic was only significant at the 1% level. These results in Table 3 illustrate that the elasticity of changes in agricultural family labour is only slightly affected by the macroeconomic variables (specifically the unemployment, interest rate). More lags of family labour were introduced and the model was rerun but the results remained unchanged (see Table 5).

The same procedure was run for hired labour as the dependent variable. Again all the variables and their lags were put in the model, the insignificant variables were dropped (DLX1, DLX4, DLX5, DLX9, DLX1(-1), DLX3(-1), DLX4(-1), DLX5(-1), DLX8(-1)) . The diagnostic tests revealed that the model was free of heteroscedasticity, serial correlation and functional form bias (see Table 4). The model was rerun with more lags of hired labour but it failed to change the results (see Table 6).

The model found that hired labour was sensitive to changes in the inflation rate (X7) , but, like the family labour model, the elasticities were very small. Therefore, one can conclude that the elasticity of changes in the two parts of the agricultural workforce are only slightly effected by changes in the macroeconomic variables. This supports the hypothesis that agricultural labour is relatively insensitive to changes in the economy. The analysis also indicates that family and hired labour react differently to these changes. This has major implications for policymakers who are trying to curtail the decline in rural employment. The policy implications of this analysis are that, although agricultural labour is relatively insensitive to changes in macroeconomic variables, the different components of this labour force will react differently. The family labour force is declining at a much slower rate than hired labour. Among the reasons for the relative stability of the family workforce is that the growing number of part-time farmers has had a major effect on the family component of the workforce(Errington, 1992). There is evidence that this category contains a growing proportion of new entrants' attracted by the residential qualities of the farmhouse rather than the productive potential of the farm (Gasson, 1998). Another reason is that, in times when incomes are falling , family members are more likely to accept an effective reduction in their wage, so improving their position vis-a-vis hired workers (Errington et al, 1997). Finally, in times of high unemployment in the economy, it is believed that the farm is used as an employment refuge' by farm family members, and more children seek employment at home rather than would otherwise be the case (Errington and Gasson, 1993).

5 Conclusion

The model presented above suggests that the agricultural workforce is not particularly sensitive to business cycle conditions (as measured by the rates of change in various macroeconomic variables). The results indicate that there is a negative relationship between farm labour and some macroeconomic variables, but the coefficients are very small. The main reason that can be given for this is the characteristics of the agricultural labour force. The flexibility, especially in the family labour force, means that changes in the economy are absorbed more easily. The decision to leave farming is likely to involve transaction costs, and the acquisition of new skills, which would act to lower responsiveness to short-term cyclical factors (OECD, 1994).

The results presented in the analysis suggests that the short-term conditions prevailing in labour markets and in the economy in general will not have a major impact on farm family and hired labour. Family labour, as shown in Figure 1, actually increased at times of high unemployment which supports the hypothesis that the family farm provides an "employment refuge". The analysis also illustrates that hired labour reacts differently than family labour to changes in the economy. One reason for this is that when farm incomes are falling, family members are more likely to accept a reduction in their wage. The hired labour is shown to be more sensitive but these differences are very slight. For policymakers at the national or EU level it is the ever-increasing importance of family labour among the workforce and the tendency of farm family businesses to absorb otherwise unemployed family members that is of particular significance (Errington, 1993). This, coupled with the fact that the agricultural workforce is relatively insensitive to changes in macroeconomic variables, points out that the employment situation in rural areas is much worse than we are led to believe. When developing new policy changes, it is important for policymakers to be able to distinguish job losses leading to registered unemployment among the hired workers from the increase in underemployment among the family workers. From a rural development perspective, the continuation of agricultural activities in rural areas is essential to prevent the economic and social disintegration of these areas.

Table 1: Tests for Stationarity on the Variables

Variable	Description	ADF Statistic
X1	Family labour	-2.5391(-3.5426)
X2	Hired labour	-1.8849(-3.5426)
X3	Unemployment rate	-2.7760(-3.5426)
X4	Industrial weekly wage	-2.3144(-3.5426)
X5	Agricultural weekly wage	-2.3145(-3.5426)
X6	% change in GNP	*-4.5959(-3.5426)*
X7	Inflation rate	-1.9871(-3.5426)
X8	3 monthly interest rate.	-2.6160(-3.5426)
X9	Total employment	-3.0653(-3.5426)

Note: The ADF tests include a time trend.

Table 2: Unit Roots tests on differenced variables

Variable	ADF Statistic
DX1	-3.4577(-2.9665)
DX2	-3.1244(-2.9798)
DX3	-3.4390(-2.9472)
DX4	-3.8288(-2.9472)
DX5	-3.6005(-2.9499)
DX7	-5.4520(-2.9472)
DX8	-4.6767(-2.9472)
DX9	-5.7843(-2.9472)

Table 3: Cochrane-Orcutt Method using DX1 as the Dependent Variable

Cochrane-Orcutt Method AR(1) Converged after 4 iterations

Dependent variable is DLX1

36 observations used for estimation from 1961 to 1996

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.0042850	.0096407	-.44447[.660]
DLX2	.21289	.12297	1.7313[.093]
DLX3	-.030515	.015809	-1.9302[.062]
DLX8	-.029978	.014011	-2.1395[.040]

R-Squared	.64684	F-statistic F(4, 30)	13.7371[.000]
R-Bar-Squared	.59976	S.E. of Regression	.016010
Residual Sum of Squares	.0076893	Mean of Dependent Variable	-.018790
S.D. of Dependent Variable	.025943	Maximum of Log-likelihood	97.7443
DW-statistic	2.0593		

Table 4: OLS using DX2 as Dependent Variable

Ordinary Least Squares Estimation

Dependent variable is DLX2

35 observations used for estimation from 1962 to 1996

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.038391	.0032238	-11.9087[.000]
DLX7	-.017744	.0087911	-2.0183[.052]
DLX7(-1)	-.022736	.0087717	-2.5920[.014]

R-Squared	.23648	F-statistic F(2, 32)	4.9556[.013]
R-Bar-Squared	.18876	S.E. of Regression	.019071
Residual Sum of Squares	.011638	Mean of Dependent Variable	-.038341
S.D. of Dependent Variable	.021174	Maximum of Log-likelihood	90.4910
DW-statistic	1.9525		

Diagnostic Tests

* Test Statistics	* LM Version	* F Version	*
* A:Serial Correlation	*CHI-SQ(1)= .1313E-4[.997]	*F(1, 31)= .1163E-4[.997]	*
* B:Functional Form	*CHI-SQ(1)= .0032776[.954]	*F(1, 31)= .0029033[.957]	*
* C:Normality	*CHI-SQ(2)= 69.7278[.000]	* Not applicable	*
* D:Heteroscedasticity	*CHI-SQ(1)= .0061491[.937]	*F(1, 33)= .0057987[.940]	*

Table 5: Ordinary Least Squares Estimation of DX1 with lags

Dependent variable is DLX1
34 observations used for estimation from 1963 to 1996

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.0028157	.0035395	-.79552[.433]
DLX1(-1)	.73827	.16692	4.4229[.000]
DLX1(-2)	.016883	.16080	.10500[.917]
DLX8	-.030470	.012261	-2.4851[.019]

R-Squared	.62597	F-statistic F(3, 30)	16.7355[.000]
R-Bar-Squared	.58856	S.E. of Regression	.016176
Residual Sum of Squares	.0078500	Mean of Dependent Variable	-.016788
S.D. of Dependent Variable	.025219	Maximum of Log-likelihood	94.1073
DW-statistic	2.2114		

Diagnostic Tests

* Test Statistics	* LM Version	* F Version	*
* A:Serial Correlation	*CHI-SQ(1)= 2.4309[.119]	*F(1, 29)= 2.2330[.146]	*
* B:Functional Form	*CHI-SQ(1)= 3.5560[.059]	*F(1, 29)= 3.3873[.076]	*
* C:Normality	*CHI-SQ(2)= 2.5367[.281]	* Not applicable	*
* D:Heteroscedasticity	*CHI-SQ(1)= .092311[.761]	*F(1, 32)= .087117[.770]	*

Table 6: Ordinary Least Squares Estimation of DX2 with lags

Dependent variable is DLX2
35 observations used for estimation from 1962 to 1996

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.038391	.0032238	-11.9087[.000]
DLX7	-.017744	.0087911	-2.0183[.052]
DLX7(-1)	-.022736	.0087717	-2.5920[.014]

R-Squared	.23648	F-statistic F(2, 32)	4.9556[.013]
R-Bar-Squared	.18876	S.E. of Regression	.019071
Residual Sum of Squares	.011638	Mean of Dependent Variable	-.038341
S.D. of Dependent Variable	.021174	Maximum of Log-likelihood	90.4910
DW-statistic	1.9525		

Diagnostic Tests

* Test Statistics	* LM Version	* F Version
* A:Serial Correlation	*CHI-SQ(1)= .1313E-4[.997]	*F(1, 31)= .1163E-4[.997]
* B:Functional Form	*CHI-SQ(1)= .0032776[.954]	*F(1, 31)= .0029033[.957]
* C:Normality	*CHI-SQ(2)= 69.7278[.000]	* Not applicable
* D:Heteroscedasticity	*CHI-SQ(1)= .0061491[.937]	*F(1, 33)= .0057987[.940]

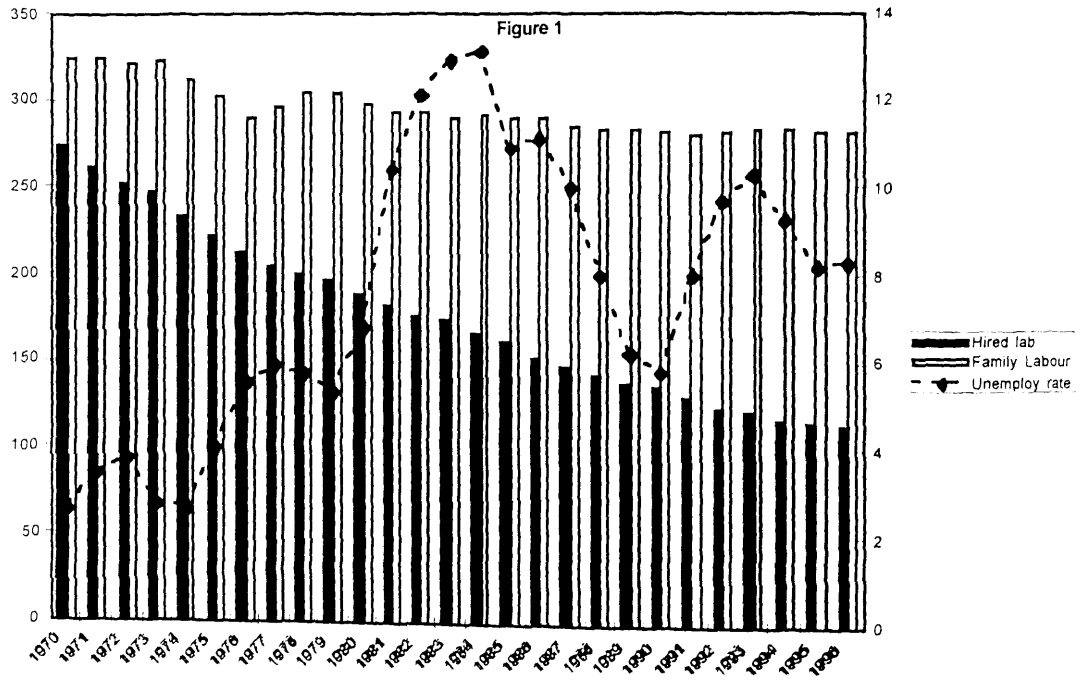
Figure 1
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