FACTOR MARKETS

Comparative Analysis of Factor Markets for Agriculture across the Member States

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Barbara Tocco, Alastair Bailey and Sophia Davidova

The Reallocation of Agricultural Labour across Sectors:

An Empirical Strategy for Micro Data

ABSTRACT

This paper presents an empirical methodology for studying the reallocation of agricultural labour across sectors from micro data. Whereas different approaches have been employed in the literature to better understand the mobility of labour, looking at the determinants to exit farm employment and enter off-farm activities, the initial decision of individuals to work in agriculture, as opposed to other sectors, has often been neglected. The proposed methodology controls for the selectivity bias, which may arise in the presence of a non-random sample of the population, in this context those in agricultural employment, which would lead to biased and inconsistent estimates. A 3-step multivariate probit with two selection and one outcome equations constitutes the selected empirical approach to explore the determinants of farm labour to exit agriculture and switch occupational sector. The model can be used to take into account the different market and production structures across European member states on the allocation of agricultural labour and its adjustments.

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FACTOR MARKETS Coordination: Centre for European Policy Studies (CEPS), 1 Place du Congrès, 1000 Brussels, Belgium Tel: +32 (0)2 229 3911 • Fax: +32 (0)2 229 4151 • E-mail: info@factormarkets.eu • **web:** www.factormarkets.eu

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Barbara Tocco, Alastair Bailey and Sophia Davidova*

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1. Introduction

The labour allocation decisions of farmers have extensively been examined in the literature. In particular, the determinants of the on-going structural change in the European Union and the mobility of agricultural labour has been subject to empirical investigation. The push- and pull- factors which have allowed a reallocation of farm labour to non-farm activities have been studied through different econometric specification and type of data. Focusing on micro-level data, the characteristics of individuals and of the farm holdings can be used to explain the patterns of labour adjustments. The overall findings from previous evidence emphasise the role of human capital for the mobility of labour and recognise the importance of economic and labour market conditions for off-farm employment. The literature generally starts from agricultural census data and farm surveys to estimate the decisions of farm operators (and their spouses) to leave the sector and enter non-farm activities. The proposed methodology in this paper seeks to extend the analysis by also taking into account the decision of individuals to work in agriculture in the first place. From an empirical point of view, we argue that agricultural workers constitute a self-selected sample, and may be a non-random sample from the whole population, so that, due to unobservable characteristics, it would seem appropriate to control for selection bias.

Generally, in order to understand the factors which favour (or hinder) the mobility of labour, it becomes important to get firstly a deeper understanding on the determinants of agricultural employment. In particular, the residential choice of individuals and the existence of market imperfections, such as imperfect information, may have a significant impact on the occupational choice of individuals. For instance, as emphasised by Johnson (1991), individuals are faced by an occupation-residential choice paradigm, whereby their choice of being engaged in farming poses a restriction on their residential choice and likewise their choice of a farm residence reduces their employment opportunities across sectors. Furthermore, the geographical dispersion of the agricultural industry and its rural location imply that there are high costs of obtaining information about off-farm employment, which would lead to a low probability of moving and switching occupational sector (Huffman, 1977). The high costs of moving, also due to the distance between rural and urban markets, would also suggest that people in rural areas are often 'trapped' in their occupational choices. Moreover, as pointed out by Corsi and Findeis (2000) persistence in a particular state, or state dependence, may explain a certain rigidity in off-farm labour adjustment and the tendency for individuals to remain in the same employment situation. As suggested by the authors, previous experience should be taken into account as a determinant to participate in off-farm employment. By the same token, we can interpret the inertia of farm family labour in moving across sectors as a consequence of their occupational choice on the farm in the first place. To take into account these considerations and reflect that the decision of working in agriculture may not be a 'choice' but a consequence of individual and locational variables, we

* Barbara Tocco, Alastair Bailey and Sophia Davidova are researchers at the University of Kent, School of Economics (UNIKENT).

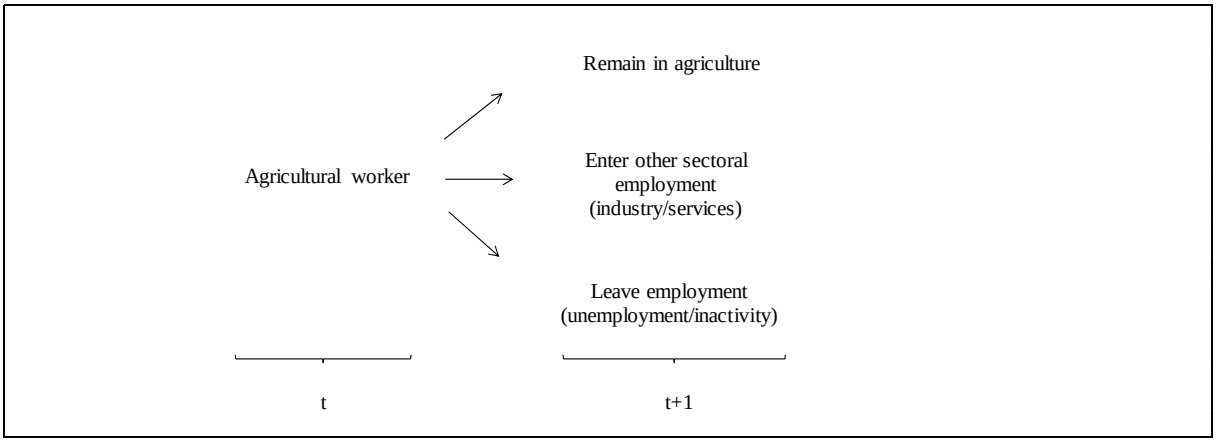
adopt a selection approach and examine the determinants of agricultural labour to move across sectors. The paper starts by presenting an occupational choice model commonly employed in the empirical literature, the multinomial logit, and extends the analysis by taking into account the problem of selectivity bias. The envisaged methodology is set out and the careful choice of exclusion restrictions is also outlined. Hence, the methodology can be applied to empirical data to examine the determinants to leave agricultural employment and change occupational sector.

2. The mobility of Agricultural Labour: A Multinomial Logit Model

The mobility of agricultural labour has been investigated through different econometric specification which strictly depend upon the specific research questions under analysis. Focusing on micro-data, the dependent variable can be constructed so that to answer different but related questions. The most relevant to our purpose include the participation decision of farm operators in the off-farm market (for instance Huffman, 1980; Sumner, 1982; Kimhi, 1994; Juvančič, and Erjavec, 2005), the change in agricultural employment (Pfeffer, 1989) and the reallocation of labour across sectors (Bojnec and Dries, 2005; Gullstrand and Tezic, 2008). In general, the decisions of farmers to exit agriculture and enter non-farm activities are based on the comparison of the different occupational choices' utilities. Occupational choice models are commonly employed and consist in estimating the likelihood of a certain outcome to occur. For this purpose simple binary models (probit or logit) or multivariate specification, in the presence of more than two categories, can be used.

When examining the discrete probability of leaving agriculture it becomes important to bear in mind that labour outflows from agriculture can be due to transfers into the non-farm economy or to exits out of employment, i.e. unemployment or inactivity. Hence, using a simple probit/logit specification would not allow the researcher to differentiate among those farmers who exit due to retirement or due to their tranferabble skills which would allow them to relocate in alternative sectoral occupations. Since the focus of our research consists in the intersectoral mobility of agricultural labour, as the reallocation of farm labour across sectors represents a fundamental source of structural change, a multivariate specification would be preferred. In our context, we can think of a two-period model (t and t+1), where the farmer in period t is faced with the decision to either stay in agriculture or to exit in the next period (t+1), and thus either find employment in other sectors (industry or services) or leave employment altogether (unemployment or inactivity). A graphic representation of the farmer's decisions can be represented by the following (Figure 1):

Figure 1. Labour flows out of agriculture: A multinomial logit



From a theoretical point of view, we can assume a single utility maximisation over the life-time, where the optimal migration decisions of farmers can be determined by comparing the indirect utilities of the different occupational choices, so that:

$U_{agri} > U_{non\text{-}agri}$, $U_{agri} > U_{out}$	Remain in agriculture	
$U_{non\text{-}agri} > U_{agri}$, $U_{non\text{-}agri} > U_{out}$	Other sectoral employment	(1)
$U_{out} > U_{agri}$, $U_{out} > U_{non\text{-}agri}$	Leave employment	

The random utility model is given by:

$$U_{ij} = \beta_j x_i + \varepsilon_{ij} \tag{2}$$

where U_{ij} is the indirect utility of choice j for individual i, x_i is a vector of characteristics which affect the choice of occupational choice, β_j is the vector of choice-specific parameters, and ε_{ij} is the disturbance.

A commonly employed methodology in occupational choice theory is the multinomial logit, which has also been used for studying the outflows of labour from agriculture (see Ingham and Ingham, 2004; Bojnec and Dries, 2005; Van Herck, 2009; Tocco et al. 2012). In this specification, the dependent variable is categorical and can take more than two mutually exclusive unordered outcomes ($j = 0, \ldots, m$). The model is expressed as (Greene, 2003):

$$Prob\ (Y_i = j) = \frac{e^{\beta_j' x_i}}{\sum_{k=0}^{m} e^{\beta_k' x_i}} \ , \qquad \text{for } j = 0, \ldots, m \tag{3}$$

where the outcome Y_i for the farmer i, conditional on the regressor x_i, is one of m alternatives. Further levels of disaggregation would allow to distinguish among industry and services, as well as among unemployment, and different forms of inactivity, such as retirement. A convenient normalization for the identification of the model consists in setting $\beta_o = 0$. Since the probabilities sum to one, only m - 1 parameter vectors need to be estimated to determine the m probabilities. Hence, the remaining coefficients β_j measure the change relative to the reference group Y = 0. The probabilities can be summarized as:

$$Prob\ (Y_i = j) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=1}^{m} e^{\beta_k' x_i}} \ , \qquad \text{for } j = 0, \ldots, m \tag{4}$$

$$Prob\ (Y_i = 0) = \frac{1}{1 + \sum_{k=1}^{m} e^{\beta_k' x_i}}$$

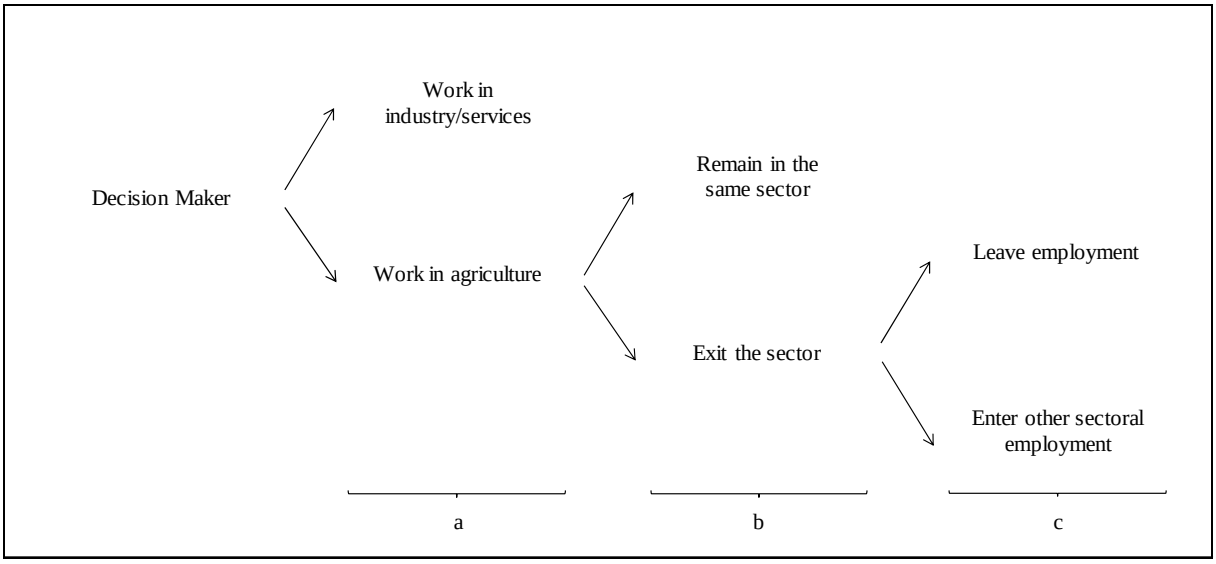
In this approach, each outcome or occupational choice (j) is compared with the base category (Y = 0) of individuals who remain in agriculture in the second period. The coefficients of the multinomial model are interpreted in comparison to the base category so that a positive coefficient means that, as the regressor increases, individuals are more likely to choose alternative j than alternative 0.

One of the problems with such specification is that we start our analysis from a restricted sample, i.e. those engaged in agriculture in period t, without controlling for the decision to work in the farm sector in the first place. As a consequence, the self-selected sample may not be randomly drawn from the population. In particular, due to some unobserved characteristics, the occupational decisions of agricultural workers may be different from those of the excluded sample (Heckman, 1979), so that there may be a dependence between the decision to work in agriculture and the subsequent decision to exit the sector. The initial condition problem, i.e. the correlation of the errors in the decision functions, may lead to sample selection and thus to biased and inconsistent estimates. In order to control for the possible correlation of the errors a selection methodology would be preferred.

3. Controlling for Selection: A 3-Step Multivariate Probit Approach

A discrete choice methodology which would allow us to control for selectivity bias is the bivariate probit with selection (van De Ven and van Praag, 1981), which consists in specifying a selection equation and an outcome equation, both constructed as binary probits. The stata command *heckprob* provides an easy way to estimate the system of equations and control for the correlation between the errors, by fitting maximum-likelihood probit models with sample selection. This approach would allow us to determine the probability of working in agriculture (period t) and conditional on this, examine the probability of exiting the sector (in period t+1). Nonetheless, the category of individuals leaving agriculture is quite heterogeneous so that it becomes essential to distinguish among those who, after leaving the sector, enter alternative employment activities from those who become unemployed or leave the labour force. For this reason, an extension of this model can be adopted and tested empirically, consisting in a 3-step multivariate probit approach with two selection and one outcome equations. The econometric specification, similarly set out by Vadean and Piracha (2009) consists of: a) a first probit to control for selection into agricultural employment; b) conditional on this, a second probit equation controls for selection into leaving the farm sector and finally c) an outcome probit equation to examine the probability of changing sectoral employment. To best visualize this approach we can think of a decision tree where a decision marker is faced by three sequential dichotomous decisions, so that only when the first choice of working in agriculture has been made, the individual can decide to either remain in the farm sector or exit; and if he decides to leave he can either leave employment altogether or enter non-farm activities (Figure 2):

Figure 2. Decision tree of labour outcomes: a 3-step multivariate probit with selection



Therefore we observe whether farmers leave current employment or enter other sectoral employment only if they decide to exit the sector, which, in turn, is conditional upon working in agriculture in the first place.

Hence, the system of observed binary outcomes can be specified as:

$$y_j^{agriempl} = (x_j\beta + u_{1j} > 0) \quad \text{a. selection into agricultural employment} \quad (5)$$

$$y_j^{leave} = (w_j\Upsilon + u_{2j} > 0) \quad \text{b. selection into leaving agriculture} \quad (6)$$

$$y_j^{otherempl} = (z_j\delta + u_{3j} > 0) \quad \text{c. outcome for switching occupational sector} \quad (7)$$

where $y_j^{leave} > 0$ if $y_j^{agriempl} = 1$ and missing otherwise; and $y_j^{otherempl} > 0$ if $y_j^{leave} = 1$ (and thus $y_j^{agriempl} = 1$) and missing otherwise. Assuming that the errors have zero means and unit variances, we can denote the correlation among error terms of the sequential probits (u_{1j}, u_{2j} and u_{3j}) respectively by p_{12} and p_{23}:

$$corr\ (u_{1j}, u_{2j}) = p_{12} \tag{8}$$
$$corr\ (u_{2j}, u_{3j}) = p_{23}$$

and can test the hypothesis that $p = 0$. The maximum likelihood estimation of the multivariate probit consists in deriving, after each selection equation, inverse Mill's ratios, which are then plugged as regressors in the next equation at each stage. The inverse Mills' ratio (λ) is given by the ratio of the probability density (φ) and the cumulative distribution (Φ) of the standard normal distribution:

$$\lambda_j(\cdot) = \frac{\varphi(\cdot)}{\Phi(\cdot)} \tag{9}$$

The hypothesis of independence of the errors can be tested directly by using the coefficient of lambda (Cameron and Trivedi, 2010). Whereas the statistical significance of lambda confirms the presence of selection bias, we cannot necessarily infer that its non-significance provides support for the independence of the errors, as for it to be ensured, the model ought to be correctly specified. In particular, the use of appropriate exclusion restrictions becomes fundamental in this approach.

4. Main Determinants and Choice of Exclusion Restrictions

The empirical estimation is based on micro data from the EU-LFS. Consistent with previous empirical literature, the covariates employed in the analysis include socio-economic factors at the individual level and macro indicators at the regional level which control for labour market and farm specific conditions. We assume that the decision of agricultural workers to switch occupational sector is affected by individual and family characteristics, such as gender, age, educational level, marital status, presence of children, professional status in previous job, as well as regional macro conditions, namely population density, unemployment rate, reservation wage, relative importance of agriculture and job opportunities in the non-farm economy.

We use the same set of variables in the three sequential probits and seek for valid exclusion restrictions to identify the model. In particular, the selection methodology requires us to impose some identification variables which exert a non-trivial impact on the selection equation but are assumed not to have a significant effect on the outcome equation (Cameron and Trivedi, 2010). The choice of these exclusion restrictions and their validity are often problematic and must be borne out of economic theory. The first equation, i.e. the probability of agricultural employment, is identified by the specific field of educational education. We assume that the type of education received, which may be endogenous to the occupational choice, matters to a great extent for the initial decision to work in a specific sector, whereas it would appear less significant in the subsequent decision to exit farming activities. Instead, the general level of educational attainment and the accumulation of human capital would seem more important determinants for entry in the non-farm economy, in terms of transferrable skills. As exclusion restrictions for the second probit equation, i.e. the probability of leaving farm activities, regional farm indicators can be used. The assumption is that specific market and production structures entail different labour requirements, so that these variables would have a significant impact on establishing a first occupational match in the agricultural sector and thus may affect the decision to stay rather than leave the sector,

regardless of whether individuals subsequently change occupational sector or leave the labour force altogether. Therefore we control for the farm size, the production system of the holdings and the extent to which labour is employed on a full-time basis. Hence, we include the inverse Mill's ratios in the second and third probit to control for selection and test the hypothesis of correlation among the errors by looking at the significance of lambda.

5. Conclusion

The paper has discussed the problem of selection bias which may arise in the presence of a non-random sample of the population. Since the low mobility of agricultural workers might be a consequence of their occupational choice on the farm in the first place, which is very much dependent on individual and locational variables, we present an empirical approach to take into account the dependence of the different occupational choice decisions. Therefore, the reallocation of agricultural labour across sectors can be investigated by employing a 3-step multivariate probit where it becomes possible to control for selection in the decision to work in agriculture and in the subsequent decision to exit the sector. As presented in the paper, this methodology is an extension of the bivariate probit with selection and, in contrast with the multinomial logit, is also able to identify the best bundle of characteristics (individual and regional) to establish a first occupational match and determine agricultural employment. This empirical strategy will be tested on micro-data in the next deliverable (D12.1) with the purpose of exploring the determinants of farm labour to leave agriculture and change sectoral employment. The study will be based on selected European Member States to estimate the impact of different market and production structures on the allocation and migration of farm labour.

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Comparative Analysis of Factor Markets for Agriculture across the Member States

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The Factor Markets project in a nutshell

Title	Comparative Analysis of Factor Markets for Agriculture across the Member States
Funding scheme	Collaborative Project (CP) / Small or medium scale focused research project
Coordinator	CEPS, Prof. Johan F.M. Swinnen
Duration	01/09/2010 – 31/08/2013 (36 months)
Short description	Well functioning factor markets are a crucial condition for the competitiveness and growth of agriculture and for rural development. At the same time, the functioning of the factor markets themselves are influenced by changes in agriculture and the rural economy, and in EU policies. Member state regulations and institutions affecting land, labour, and capital markets may cause important heterogeneity in the factor markets, which may have important effects on the functioning of the factor markets and on the interactions between factor markets and EU policies. The general objective of the FACTOR MARKETS project is to analyse the functioning of factor markets for agriculture in the EU-27, including the Candidate Countries. The FACTOR MARKETS project will compare the different markets, their institutional framework and their impact on agricultural development and structural change, as well as their impact on rural economies, for the Member States, Candidate Countries and the EU as a whole. The FACTOR MARKETS project will focus on capital, labour and land markets. The results of this study will contribute to a better understanding of the fundamental economic factors affecting EU agriculture, thus allowing better targeting of policies to improve the competitiveness of the sector.
Contact e-mail	info@factormarkets.eu
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