FARM COUPLES' OFF-FARM CHOICE OF LABOUR SUPPLY: A PANEL DATA ANALYSIS OF JOB TRANSITIONS*)

ERIK BIØRN

Department of Economics, University of Oslo, P.O. Box 1095 Blindern, 0317 Oslo, Norway

E-mail: erik.biorn@econ.uio.no

HILD-MARTE BJØRNSEN

Norwegian Agricultural Economics Research Institute, P.O. Box 8024 Dep, 0030 Oslo, Norway

E-mail: marte.bjornsen@nilf.no

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ABSTRACT: The process describing how the population of farm units in Norway has evolved during the last 20 years has been far from stationary. In this paper, some labour market impacts of this process are examined, by combining a ten-year balanced panel data set from Norwegian farm couples (households) with discrete modeling of transition rates. The multi-dimensionality of the modelling problem, in addition to the panel format of the data, follows from the existence of two decision makers (partners) and the availability of four transitions in each period, as each of the partners (operator and spouse) can be in two states: 'in' or 'out', specifically: working fully on the farm or having supplementary outside occupation. A multinomial logit model is estimated for the first and second halves of the sample to address the problem of state dependence between years. The results indicate a movement towards the state where both partners in the households work off the farm. When either partner has higher education this has a positive effect on moving to a state where either or both work off-farm. The presence of small children has, on the other hand, a positive effect on moving from a state where the spouse works off-farm to a state where she only is on the farm.

KEYWORDS: Labour market transitions. Panel data. Nominal data. Markov chain. Logit model. State dependence. Multiple job-holding. Agriculture.

JEL CLASSIFICATION: C23, C25, C33, C35, J43, J62

*) The paper is incomplete and under revision. We shall be glad to send the revised version to anyone interested. Please contact the second author (marte.bjornsen@nilf.no).

1 Introduction

During the last 20 years, major transitions have occurred in the economic structure of the agricultural sector in Norway. These changes are not least visible in the labour market. The process describing how the population of farm units/farm couples evolves has been far from stationary. The purpose of this paper is to examine aspects of the *dynamics* of this process, by combining a ten-year panel data set from Norwegian farms with discrete response modeling relying on *transition rates*. This framework has been frequently used to describe labour market transitions, *e.g.*, transitions to and from unemployment states for *individuals*, but to the authors' knowledge it has been rarely used for labour supply transitions in *agriculture* and especially not for bivariate transitions relating to farm *couples*.

In response to the on-going and increasing entry of farmers in the off-farm labour market, partly accompanied by exits from agriculture, the literature concerning the labour decisions in farm households has flourished in the last 30 years. Numerous aspects of both the decision to *participate in off-farm labour* [Alasia, Weersink, Bollman and Cranfield (2009)] and of the *supply of on- and off-farm labour hours* are covered [Huffman and El-Osta (1997), Kimhi and Rapaport (2004)], sometimes modelled simultaneously with farm production and investment decisions [Ahituv and Kimhi (2002), Phimister and Roberts (2006)]. The literature includes longitudinal analysis addressing problems of heterogeneity and state dependence in off-farm labour participation [Ahituv and Kimhi (2006), Corsi and Findeis (2000)] but use of panel data exceeding two time periods are rare and state dependence is invariably modelled by use of a dummy variable representation of first-period labour participation in a bivariate choice situation.

In modelling discrete transitions, the 'multi-dimensionality' of the problem calls for attention: First and obviously, we have the two data dimensions: time period (year) and unit (farm couple, farm household). Second, the existence of two decision makers in each unit (farm couple) motivates a model with at least two equations. Third, in each period, *four states* are available for each couple, since each of its partners (operator and spouse) has two possible states, being either 'in' or 'out', *i.e.*, either having only one job, on the farm, or being involved in supplementary occupation outside the farm as well.

Several strategies for *modelling transitions between states* in this particular setting, can be imagined. One is to include lagged covariates, or lag distributions, in addition to the current covariates. Another is including lagged discrete responses as lagged endogenous explanatory variables. This strategy is often followed in single equation *binary* response contexts; for recent examples see Hyslop (1999), Carro (2006), Honoré and Kyriazidou (2000), and Browning and Carro (2010).[1] Our setting with a four-dimensional vector of binary responses would, however, in principle require that *four lagged responses* are accounted for. The solution might be a non-linear vector autoregressive (VAR) model of order 1, the non-linearity being due to the restricted range of the set of choice probabilities. Modeling transition probabilities by including *state dependent coefficients* for the covariates is a third, and somewhat simpler, solution. It is to some extent followed here.

[1] Honoré and Kyriazidou (2000, Section 4.3) also discuss multiple responses.

The transition probability framework we consider here may be related to the *Markov chain* model class, and syntheses of Logit models and Markov structured models have been proposed, see *e.g.*, Ordine (1992) for a fairly simple setup and Bartolucci and Farcomeni (2009) for a more elaborate one.

The rest of the paper is organized as follows. The basic framework is presented in Section 2, Section 3 describes the data. The various models of transition probabilities are presented in Section 4. In Section 5 we report and discuss the results.

2 Basics and notation

The *farm household* is the basic unit of analysis and is the represented by a *farm couple*: *i.e.* farm operator and his/her spouse, in the following often to be denoted as *partners*.[2] The farm operator is, by definition, occupied in farm labour while, in principle, the spouse may or may not contribute on the farm. We do not address the problem of spouses' on-farm labour in this paper – working on the farm is thus a conditioning event for the operator, but not for the spouse. Off-farm labour is assumed optional for both partners in any year t. Both farm operators and spouses are thus faced with the binary choice of participating in off-farm labour or not and the farm household, as a unit, can choose between four different off-farm labour states in every time period: *neither works off the farm* (00), *only the spouse works off the farm* (01), *only the operator works off the farm* (10), or *both work off the farm* (11).

We exploit only information on discrete responses to examine the transition probabilities between the different off-farm labour states and the dynamic structure is captured by conditioning the probability of being in any labour state in year t on the state in year $t-1$. A static representation of the probability of participating in off-farm labour and the mutual dependencies between the partners' decisions is explored in Bjørnsen (2006), while Bjørnsen and Biørn (2006) address the problem of modelling the farm couples' labour supply by static Tobit models with heterogeneity.

Let the partners' available states be indicated by

$$
\begin{aligned}
a &= \mathbf{1}\{\text{Operator works off-farm in year } t-1\},\\
b &= \mathbf{1}\{\text{Spouse works off-farm in year } t-1\},\\
c &= \mathbf{1}\{\text{Operator works off-farm in year } t\},\\
d &= \mathbf{1}\{\text{Spouse works off-farm in year } t\},
\end{aligned}
$$

where in general $\mathbf{1}\{\mathcal{A}\}=1$ if event $\mathcal{A}$ is true, $\mathbf{1}\{\mathcal{A}\}=0$ if event $\mathcal{A}$ is untrue. The probability that the *operator* in year t chooses state c given that a has been chosen in year $t-1$, and the probability that the *spouse* in year t chooses state d, given that state b has been chosen in year $t-1$, are, respectively,

$$
\begin{aligned}
&p_{Oac}^{t-1,t}, \qquad && a,c = 0,1,\\
&p_{Sbd}^{t-1,t}, \qquad && b,d = 0,1.
\end{aligned}
$$

These are *one-year transition probabilities for single individuals (partners).* The number of possible transitions during T years is $2^2(T-1)=4(T-1)$ for each individual.

[2] We label the partners the operator and the spouse in order to uniquely define them as *the farmer* and *the spouse of the farmer*, respectively. These definitions do not say anything about gender and we apply the term *spouse* solely in this sense.

The probability that the *couple* in year t jointly chooses state c for operator, d for spouse – state (cd) for short – given that it has in year t–1 chosen state a for operator, b for spouse – state (ab) for short – is

$$p^{t-1,t}_{(ab)(cd)}, \qquad (ab),(cd) = 00, 01, 10, 11.$$

These are *one-year transition probabilities for couples.* The number of possible transitions is $2^4(T-1)=16(T-1)$ for each couple. The definition could be extended to multi-year transitions in an obvious way, but such extensions will not occupy us in the following.

The probabilities $p^{t-1,t}_{(ab)(cd)}$ are formally conditional probabilities, interpreted as constructed from more basic *state probabilities* for pairs of years as follows: Let, in general, for any $s \neq t$,

$$\begin{aligned} q^{st}_{Oac} &= P\big(\text{Operator is in state } a \text{ in year } s \text{ and in state } c \text{ in year } t\big),\\ q^{st}_{Sbd} &= P\big(\text{Spouse is in state } b \text{ in year } s \text{ and in state } d \text{ in year } t\big),\\ q^{st}_{(ab)(cd)} &= P\big(\text{Couple is in state } (ab) \text{ in year } s \text{ and in state } (cd) \text{ in year } t\big), \quad a,b,c,d = 0,1, \end{aligned}$$

Hence, we can derive the following expressions for the transition probabilities defined above by setting $s=t-1$:

(1) $$p^{t-1,t}_{Oac} = \frac{q^{t-1,t}_{Oac}}{q^{t-1,t}_{Oa0} + q^{t-1,t}_{Oa1}}, \qquad a,c = 0,1,$$

(2) $$p^{t-1,t}_{Sbd} = \frac{q^{t-1,t}_{Sbd}}{q^{t-1,t}_{Sb0} + q^{t-1,t}_{Sb1}}, \qquad b,d = 0,1,$$

(3) $$p^{t-1,t}_{(ab)(cd)} = \frac{q^{t-1,t}_{(ab)(cd)}}{q^{t-1,t}_{(ab)(00)} + q^{t-1,t}_{(ab)(01)} + q^{t-1,t}_{(ab)(10)} + q^{t-1,t}_{(ab)(11)}}, \quad (ab),(cd) = (00),(01),(10),(11).$$

The full set of $2^4 = 16$ one-year transition probabilities for a couple is surveyed in the framed box below. During a panel period of length T, the number of possible *one-year transitions* is, as remarked, $n_T = 2^4(T-1) = 16(T-1)$. The number of distinct 'run-throughs' over a T-year sample period is $s_T=(2\times 2)^T=4^T$. For $T=10$, which is the time series length in the present panel, $n_T=144$, while $s_T = 4^{10}$, which exceeds one million(!)

Indexing couple by subscript i, we can arrange the joint state probabilities and the transition probabilities for years $t-1, t$, couple i in the (4×4) matrices

$$\boldsymbol{Q}_{i,t-1,t} = \begin{bmatrix} q^{t-1,t}_{00,00,i} & q^{t-1,t}_{00,01,i} & q^{t-1,t}_{00,10,i} & q^{t-1,t}_{00,11,i} \\ q^{t-1,t}_{01,00,i} & q^{t-1,t}_{01,01,i} & q^{t-1,t}_{01,10,i} & q^{t-1,t}_{01,11,i} \\ q^{t-1,t}_{10,00,i} & q^{t-1,t}_{10,01,i} & q^{t-1,t}_{10,10,i} & q^{t-1,t}_{10,11,i} \\ q^{t-1,t}_{11,00,i} & q^{t-1,t}_{11,01,i} & q^{t-1,t}_{11,10,i} & q^{t-1,t}_{11,11,i} \end{bmatrix}, \quad i = 1,\dots,N;\ t = 2,\dots,T,$$

$$\boldsymbol{P}_{i,t-1,t} = \begin{bmatrix} p^{t-1,t}_{00,00,i} & p^{t-1,t}_{00,01,i} & p^{t-1,t}_{00,10,i} & p^{t-1,t}_{00,11,i} \\ p^{t-1,t}_{01,00,i} & p^{t-1,t}_{01,01,i} & p^{t-1,t}_{01,10,i} & p^{t-1,t}_{01,11,i} \\ p^{t-1,t}_{10,00,i} & p^{t-1,t}_{10,01,i} & p^{t-1,t}_{10,10,i} & p^{t-1,t}_{10,11,i} \\ p^{t-1,t}_{11,00,i} & p^{t-1,t}_{11,01,i} & p^{t-1,t}_{11,10,i} & p^{t-1,t}_{11,11,i} \end{bmatrix}, \quad i = 1,\dots,N;\ t = 2,\dots,T.$$

FULL SET OF TRANSITION PROBABILITIES FOR THE COUPLES

One-year probabilities of transition from state (00): Neither works off-farm:

$$
\begin{array}{lllll}
p^{t-1,t}_{(00)(00)}: & \text{No. of persons whose state change} & = & 0, & \\
p^{t-1,t}_{(00)(01)}: & \text{No. of persons whose state change} & = & 1, & S_+ \\
p^{t-1,t}_{(00)(10)}: & \text{No. of persons whose state change} & = & 1, & O_+ \\
p^{t-1,t}_{(00)(11)}: & \text{No. of persons whose state change} & = & 2, & O_+S_+
\end{array}
$$

One-year probabilities of transition from state (01): Only Spouse works off-farm:

$$
\begin{array}{lllll}
p^{t-1,t}_{(01)(01)}: & \text{No. of persons whose state change} & = & 0, & \\
p^{t-1,t}_{(01)(00)}: & \text{No. of persons whose state change} & = & 1, & S_- \\
p^{t-1,t}_{(01)(11)}: & \text{No. of persons whose state change} & = & 1, & O_+ \\
p^{t-1,t}_{(01)(10)}: & \text{No. of persons whose state change} & = & 2, & O_+S_-
\end{array}
$$

One-year probabilities of transition from state (10): Only Operator works off-farm:

$$
\begin{array}{lllll}
p^{t-1,t}_{(10)(10)}: & \text{No. of persons whose state change} & = & 0, & \\
p^{t-1,t}_{(10)(00)}: & \text{No. of persons whose state change} & = & 1, & O_- \\
p^{t-1,t}_{(10)(11)}: & \text{No. of persons whose state change} & = & 1, & S_+ \\
p^{t-1,t}_{(10)(01)}: & \text{No. of persons whose state change} & = & 2, & O_-S_+
\end{array}
$$

One-year probabilities of transition from state (11): Both work off-farm:

$$
\begin{array}{lllll}
p^{t-1,t}_{(11)(11)}: & \text{No. of persons whose state change} & = & 0, & \\
p^{t-1,t}_{(11)(01)}: & \text{No. of persons whose state change} & = & 1, & O_- \\
p^{t-1,t}_{(11)(10)}: & \text{No. of persons whose state change} & = & 1, & S_- \\
p^{t-1,t}_{(11)(00)}: & \text{No. of persons whose state change} & = & 2, & O_-S_-
\end{array}
$$

Note: O_+, O_-, S_+, S_- in the rightmost margin are shorthands for the movements: 'operator out', 'operator in', 'spouse out', 'spouse in'. $t = 2, \dots, T$

In the following we will sometimes simplify notation by letting A and B replace (ab) and (cd) to indicate states chosen by the couple in years $t-1$ and t, respectively. Let $Z_{it} = B$ symbolize the (stochastic) event that couple i in year t chooses state $B \in (00, 01, 10, 11)$. Assume that the distribution of $Z_{it}|Z_{i,t-1}, Z_{i,t-2}, \dots, Z_{i1}$ does not depend on $Z_{i,t-2}, \dots, Z_{i1}$, *i.e.*, Z_{it} depends on the past via $Z_{i,t-1}$ only. We denote A as the *delivering* and B as the *receiving state*, for the couple, respectively. The state probabilities jointly for years $(t-1, t)$, marginal for delivering year $t-1$ and marginal for receiving year t can then be expressed as, respectively,

$$
\begin{aligned}
q^{t-1,t}_{ABi} &= P(Z_{i,t-1}=A, Z_{it}=B), \\
q^{t-1}_{A\bullet\, i} &= P(Z_{i,t-1}=A) = q^{t-1,t}_{A(00)i} + q^{t-1,t}_{A(01)i} + q^{t-1,t}_{A(10)i} + q^{t-1,t}_{A(11)i}, \\
q^{t}_{\bullet B\, i} &= P(Z_{it}=B) = q^{t-1,t}_{(00)Bi} + q^{t-1,t}_{(01)Bi} + q^{t-1,t}_{(10)Bi} + q^{t-1,t}_{(11)Bi}, \qquad A, B \in \{00, 01, 10, 11\},
\end{aligned}
$$

the last equality following from (3), $q^{t-1}_{A\bullet\, i}$ and $q^{t}_{\bullet B\, i}$ representing respectively the elements of the row-sum column and of the column-sum row of $\boldsymbol{Q}_{i,t-1,t}$. The transition probabilities satisfy

$$
p^{t-1,t}_{A(00)i} + p^{t-1,t}_{A(01)i} + p^{t-1,t}_{A(10)i} + p^{t-1,t}_{A(11)i} = 1, \qquad A \in \{00, 01, 10, 11\},
$$

The primary objectives of the paper are to structure the *transition probability* matrix $\boldsymbol{P}_{i,t-1,t}$ and its dependence on covariates by parameterizing them as Logit probabilities and to estimate the parameters of this structure. A panel data Logit analysis of *state probabilities* corresponding to $q^t_{\bullet B\, i}$ [or $q^{t-1}_{A\bullet\, i}$] for the same four states is considered in Bjørnsen (2006).

Several ways of *restricting the pattern of state probabilities* can be envisaged, *e.g.*,

$$(4)\quad q^{st}_{(ab)(cd)} = q^s_{(ab)} \cdot q^t_{(cd)} \qquad \forall (ab),(cd),\ t \neq s:$$

Couple's joint choice independent between years,

$$(5)\quad q^{st}_{(ab)(cd)} = q^{st}_{Oac} \cdot q^{st}_{Sbd} \qquad \forall (ab),(cd),\ t \neq s:$$

Individual partners' choices mutually independent,

$$(6)\quad q^{st}_{Zac} = q^s_{Za} \cdot q^t_{Zc} \qquad \forall a,c,\ t \neq s:$$

Partner Z's ($Z = O, S$) individual choice independent between years,

$$(7)\quad q^{st}_{(ab)(cd)} = q^s_{Oa} \cdot q^s_{Sb} \cdot q^t_{Oc} \cdot q^t_{Sd} \qquad \forall a,b,c,d,\ t \neq s:$$

Full independence between choices across partners and years.

The way the state probabilities (4)–(7) are parameterized restricts, of course, the transition probabilities. Utilizing (1)–(3) we find for example

$$(4) \implies p^{t-1,t}_{(ab)(cd)} = q^t_{(cd)} \qquad \forall\,(ab),(cd),$$

$$(5) \implies p^{t-1,t}_{(ab)(cd)} = \frac{q^{t-1,t}_{Oac}}{q^{t-1,t}_{Oa0} + q^{t-1,t}_{Oa1}} \cdot \frac{q^{t-1,t}_{Sbd}}{q^{t-1,t}_{Sb0} + q^{t-1,t}_{Sb1}}, \qquad a,b,c,d = 0,1,$$

$$(6) \implies \begin{cases} p^{t-1,t}_{Oac} = q^t_{Oc}, & a,c = 0,1, \\ p^{t-1,t}_{Sbd} = q^t_{Sd}, & b,d = 0,1. \end{cases}$$

These four examples may serve as benchmark cases, but are not equally relevant to our specific farm transition problem. Bjørnsen (2006) exemplifies a panel data Logit analysis of state probabilities corresponding to $q^t_{(cd)}$ above, coinciding with $p^{t-1,t}_{(ab)(cd)}$, irrespective of (ab) if the year independence assumption (4) were valid.

3 Data

Sources

The main body of data for this research is obtained from the Norwegian farm accountancy data survey administered by the Norwegian Agricultural Economics Research Institute (Norsk institutt for landbruksforskning, NILF). This is one of the more comprehensive sources of farm statistics in Norway and includes annual data for approximately 1000 farm households, representing different regions and produce. Most farm households in the survey report between 1800 and 6000 on-farm work hours yearly, while a standard man-labour year in the agricultural sector is set to 1875 hours. The survey includes management accounts drawn from tax accounts and additional information about the use of farmland, yields obtained and labour input.

The original panel data set underlying our final sample is unbalanced, and some five percent of the respondents is replaced each year. Since the above survey data base includes neither information on personal characteristics such as education, nor information about characteristics of the local labour market in different regions, we have supplemented it by other information extracted from relevant official statistics.

Sample selection

There is a possibility of endogenous sample selection because participation in the survey is voluntary and requires a minimum of 400 on-farm hours per year. We may thus suspect that the households included are more dedicated to farming than farm households outside the survey, *i.e.*, problems of self-selectivity, as discussed in *e.g.* Honoré, Vella and Verbeek (2008), may occur. Problems may also arise from the balancing of the data set. As remarked, the available sample consists of *farm couples*, not *farm units*, which implies – to ensure homogeneity of the panel – that farm units for which (i) there is no spouse in at least one of the ten years, or (ii) a (generational) change of management has taken place, are excluded. These selection criteria finally leave us with a ten-year *balanced panel* of 342 households which is representative with respect to regional spread, production composition and farm size. A potential attrition bias problem, might be created in this way.

Definitions

Of particular importance is the definition of working off-farm. Most of the farm operators report off-farm work in at least some years, but many supply only a marginal number of hours. As much as 35 per cent of the whole sample only work between 0 and 37.5 hours annually. The finding is not surprising because it is well known that many farmers take on small commissions, *e.g.*, from neighbours (road mending, snow clearing, holiday relief). We decided to *define working off the farm as having more than 37.5 annual working hours outside the farm.* This threshold equals one standard labour week. Operators working less than this outside the farm, are defined as not working off-farm. A way of rationalizing this 'truncation' may be that it contributes to reducing the impact of measurement error or misclassification: many respondents may take one standard labour week as the smallest 'accounting unit' when reporting. Moreover, the underlying supply structure for 'small jobs' may depart from the one we intend to analyze. Although the problem of few reported off-farm hours occurs less frequently for spouses, we choose the same definition of off-farm work for both. The covariates used in the Logit analysis are listed and defined in Table 1.

An overview of the transitions

Tables 3 through 6 display the transitions of the $N = 342$ farms/households between the four labour supply states during the $T = 10$ year period of observation. Tables 3 and 4 give a rather condensed overview. From Table 3 we see that 64 of the 342 farms, *i.e.*, less than 20 per cent, have stayed in the same state throughout the sample period. In only 8 farms both operator and spouse have worked fully on-farm during these 10 years, while in 30 farms both have worked off-farm in all the years, in 16 farms the spouse has worked off-farm, but the operator only on-farm throughout the period, while the opposite has been the case for 10 farms. Table 4 shows the number of year-to-year moves. In total, 770 such moves have taken place. This is slightly above 20 per cent of the maximal possible number of moves, *i.e.*, $342 \times 9 = 3762$, which would have occurred if all farms had changed state – irrespective of which – every year. Of these 770 year-to-year moves, 209 go *from* State 11 (Both work off-farm), 251 go *to* State 11, *i.e.*, the 'surplus' going into the State is 42 farms. There have been 176 moves from State 10 (Only operator works off-farm) and 151 in the opposite direction, *i.e.*, the 'surplus' going out of the state is 25 farms. From State 01 (Only spouse works off-farm) 215 farms have moves out, while 230 have gone in, giving a 'surplus' of in-going farms of 15. Finally, from State 00 (Neither work off-farm) 170 farms have moved out, while 138 have gone in, giving a 'surplus' of out-going farms of 32. Overall, 11 and 01 emerge as 'net-receiving' states and 10 and 00 as 'net-delivering' states.

Tables 5 and 6 give more nuances, and serves as a preamble to the following Logit analysis, in which the transition probabilities are related to covariates. The four (10×10) matrices in Table 5 specify the number of farms in each of the four states 11, 10, 01, and 00, in all pairs of years in the sample period. From the main diagonals we see that the number of farms in States 11 and 01 has been gradually increasing during the sample period, parallel with a decline for States 10 and 00. Adding these diagonal elements across states gives, of course, $N = 342$ in each year. A cursory inspection of the off-diagonal entries in Table 5, in particular the corners, is also interesting. For example, while in 126 farms both operator and spouse worked off-farm in the final sample year (2000), only 51 had this characteristic in both the first and final sample years (1991 and 2000). While in 108 farms only the spouse worked off-farm in the last year, only 53 farms had this characteristic in both the first and last years.

Table 6, in four parts (A–D), each having three (10×10) panels, describe the transitions between labour supply states more concisely, as one-year, two-year, ..., nine-year *transition rates*, empirical conditional frequencies. The entries *below* the main diagonals specify, *for all pairs of years* $(t, s\ :\ t = 2, \ldots, T;\ s = 1, \ldots, t)$, *the number of farms relative to the number of farms in year t* for the respective *'receiving state'* $B = 11, 10, 01, 00$ against all available *'delivering states'*. The entries *above* the main diagonal specify, *for all pairs of years* $(t = 1, \ldots, T{-}1;\ s = t{+}1, \ldots, T)$, *the number of farms relative to the number of farms in year t* for, respectively, the *'delivering state'* $A = 11, 10, 01, 00$ against all available *'receiving states'*. The diagonals, in boldface, give the one-year transition rates, *i.e.*, the empirical counterparts to (3). A cursory inspection of Table 6 suggests that our data support neither of the hypotheses (4)–(6), and do therefore definitely not support (7).

Of particular interest for this initial overview may be the north-eastern and the south-western corners of the matrices. From the second and third panels of Table 6.D we see, for example, that the number of farms in State 00 in 1991 and State 10 in 2000 is 27.8 per cent of the number *in State* 00 *in 1991*, and that the number of farms in State 00 in 1991 and State 01 in 2000 is 72.9 per cent of the number *in State* 00 *in 1991*.[3]

[3]Tables 6.B, third panel, and Table 6.C, third panel, 'mirror' these transitions, although with different normalizations. These rates, representing the same transitions, differ because of the different normalizations: the number of farms in State 00 in 1991 and State 10 in 2000 is 19.0 per cent of the number of farms *in State* 10 *in 2000*, and the number of farms in State 00 in 1991 and State 01 in 2000 is 25.8 per cent of the number of farms *in State* 01 *in 2000*, etc.

4 Models

From the setting described in Section 2, we now outline different model versions in the Logit class, serving to explain the transition probabilities as functions of covariates; see Table 1. This choice of covariates is not based on a specific theory of agents' optimization, but rather based on 'heuristical' arguments, not on a discrete choice dynamic programming setup, as exemplified by Keane and Wolpin (2009).

Structuring the transitions via one-year *transition* probabilities – the associated Markov chain, conditional on the covariates, being of the first order – imposes strong restrictions on the underlying *state* probabilities for years (s,t), denoted as $q^{st}_{(ab)(cd)}$ above. In the following, eight models will be presented and their relationships pointed out. Not all of them will be considered in the empirical part of the paper, however, *inter alia* due to the moderate sample size. The way they remember the past is different. Model 1 is the most general, least parsimonious one, while Model 8 is the most restrictive one. In view of the moderate size of the panel, $N=342$, the most flexible models with state dependent parameters, notably Model 1, is probably of minor interest. The situation at this point may change when we are able to – probably in the near future – to extend the sample, *inter alia* with respect to the time series length.

Model 1: Multinomial. Year and state dependent coefficients:

The *four submodels* describing couple i's transition from states $A=(00),(01),(10),(11)$, respectively, in year $t-1$ to state $B=(00),(01),(10),(11)$ in year t are

$$
\begin{aligned}
p^{t-1,t}_{(00)Bi} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(00)B}}}{\sum_B e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(00)B}}}, && B=(00),(01),(10),(11),\\
p^{t-1,t}_{(01)Bi} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(01)B}}}{\sum_B e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(01)B}}}, && B=(00),(01),(10),(11),\\
p^{t-1,t}_{(10)Bi} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(10)B}}}{\sum_B e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(10)B}}}, && B=(00),(01),(10),(11),\\
p^{t-1,t}_{(11)Bi} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(11)B}}}{\sum_B e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(11)B}}}, && B=(00),(01),(10),(11).
\end{aligned}
\tag{8}
$$

The state dependence is represented partly by the first subscript on the $\boldsymbol{\beta}$ coefficients, partly by the year superscript. Each model is subject to the normalization $\boldsymbol{\beta}^{t-1}_{AA}=0$, $A=(00),(01),(10),(11), \forall t$. The coefficients are assume to shift each year. This requires $4(T-1)$ Multiple Logit estimations. The number of coefficient vectors, $3\times4\times(T-1)$, is with $T=10$ equal to 108. This must, in view of the moderate panel size, be judged excessive.

Model 2: Multinomial. Year invariant, state dependent coefficients

This is obtained from Model 1 by omitting the $t-1$ superscript on the $\boldsymbol{\beta}$ coefficients and on the transition probabilities. Formally we impose on (8) the restrictions

$$\boldsymbol{\beta}^{t-1}_{AB} = \boldsymbol{\beta}_{AB} \quad \forall\, t, \qquad A,B=(00),(01),(10),(11).$$

The state dependence is represented by the first subscript on the $\boldsymbol{\beta}$ coefficients. Each model is subject to the normalization $\boldsymbol{\beta}_{AA} = 0$, $A = (00), (01), (10), (11)$. This requires only 4 Multiple Logit estimations, the number of coefficients vectors being $3\times4=12$, irrespective of T.

Model 3: Multinomial. State invariant, year dependent coefficients

This is obtained from Model 1 by omitting the first subscript on the $\boldsymbol{\beta}$ coefficients and on the transition probabilities. Formally we impose on (8) the restrictions

$$\boldsymbol{\beta}^{t-1}_{(00)B} = \boldsymbol{\beta}^{t-1}_{(01)B} = \boldsymbol{\beta}^{t-1}_{(10)B} = \boldsymbol{\beta}^{t-1}_{(11)B} = \boldsymbol{\beta}^{t-1}_{\bullet B} \quad \forall\, t, \qquad B=(00), (01), (10), (11).$$

The state dependence is represented by the year superscript on the $\boldsymbol{\beta}$ coefficients. Each model is subject to the normalization $\boldsymbol{\beta}^{t-1}_{\bullet(00)}=0$, $\forall\, t$. This gives $T-1$ Multiple Logit estimations, the number of coefficient vectors being $3\times(T-1)$, *i.e.*, 27 in the present case.

Model 4: Multinomial. State and year invariant coefficients

This is obtained from Model 1 by omitting both the $t-1$ superscript and the first subscript on the $\boldsymbol{\beta}$ coefficients and on the transition probabilities. Formally we impose on (8) the restrictions

$$\boldsymbol{\beta}^{t-1}_{(00)B} = \boldsymbol{\beta}^{t-1}_{(01)B} = \boldsymbol{\beta}^{t-1}_{(10)B} = \boldsymbol{\beta}^{t-1}_{(11)B} = \boldsymbol{\beta}_{\bullet B} \quad \forall\, t, \qquad B=(00), (01), (10), (11).$$

The model is subject to the normalization $\boldsymbol{\beta}_{\bullet(00)}=0$. This gives only one Multiple Logit estimation, the number of coefficients vectors being 3, irrespective of T. However, the pattern of the transition probabilities is admittedly somewhat 'degenerate', as no state dependence is modelled, the three coefficient vectors describing the 'receiving' state only.

In order to economise on the number of coefficients in Models 1 and 3, we can let the coefficients shift not each year, but be fixed for several successive years. In Section 5, we report results for a version with only one coefficient shift, taking place midway in the 10 year sample period; see Tables 7 and 8.

In the following models, Models 5 through 8, only two possible choices are specified each year: Stay ($B=A$) and Move ($B\neq A$)

Model 5: Binomial. Year and state dependent coefficients

Let in general B^* mean not B. We now only distinguish between states (00) and $(00)^*$, between states (01) and $(01)^*$, between states (10) and $(10)^*$, and between states (11) and $(11)^*$, respectively. Hence, we formally aggregate across three of the four choices specified in the Model 1, given by (8), to obtain

$$
\begin{aligned}
p^{t-1,t}_{(00)(00)i} &= \frac{1}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(00)(00)^*}}}, &\quad p^{t-1,t}_{(00)(00)^*i} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(00)(00)^*}}}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(00)(00)^*}}},\\
p^{t-1,t}_{(01)(01)i} &= \frac{1}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(01)(01)^*}}}, &\quad p^{t-1,t}_{(01)(01)^*i} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(01)(01)^*B}}}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(01)(01)^*}}},\\
p^{t-1,t}_{(10)(10)i} &= \frac{1}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(10)(10)^*}}}, &\quad p^{t-1,t}_{(10)(10)^*i} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(10)(10)^*}}}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(10)(10)^*}}},\\
p^{t-1,t}_{(11)(11)i} &= \frac{1}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(11)(11)^*}}}, &\quad p^{t-1,t}_{(11)(11)*i} &= \frac{e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(11)(11)^*}}}{1+e^{\boldsymbol{x}_{it}\boldsymbol{\beta}^{t-1}_{(11)(11)^*}}}.
\end{aligned}
\tag{9}
$$

This gives $4(T-1)$ Binomial Logit estimations in the same number of coefficient vectors.

Model 6: Binomial. Year invariant, state dependent coefficients

This is obtained from Model 5 by omitting the $t-1$ superscript on the $\boldsymbol{\beta}$ coefficients and on the transition probabilities. Formally we let in (9)

$$\boldsymbol{\beta}^{t-1}_{BB^*} = \boldsymbol{\beta}_{BB^*} \quad \forall\, t, \qquad\qquad B = (00), (01), (10), (11).$$

This gives 4 Binomial Logit estimations in the same number of coefficient vectors.

Model 7: Binomial. State invariant, year dependent coefficients

This is obtained from Model 5 by omitting the first subscript on the $\boldsymbol{\beta}$ coefficients and on the transition probabilities. Formally we let in (9)

$$\boldsymbol{\beta}^{t-1}_{BB^*} = \boldsymbol{\beta}^{t-1}_{\bullet B^*} \quad \forall\, t, \qquad\qquad B = (00), (01), (10), (11).$$

This gives $4(T-1)$ Binomial Logit estimations in the same number of coefficient vectors.

Model 8: Binomial. State and year invariant coefficients

This is obtained from Model 5 by omitting the $t-1$ superscript and the first subscript on the $\boldsymbol{\beta}$ coefficients and on the transition probabilities. Formally we let in (9)

$$\boldsymbol{\beta}^{t-1}_{BB^*} = \boldsymbol{\beta}_{\bullet B^*} \quad \forall\, t, \qquad\qquad B = (00), (01), (10), (11).$$

This gives 4 Binomial Logit estimations in the same number of coefficient vectors. This pattern of transition rates is admittedly ‘degenerate’.

5 Results

The number of observations underlying the covariates differs between the estimations, depending on period and the state we condition on. The highest number of observations (approx. 560) is obtained for the second period (1996–2000) when we condition on State 11 or State 01 in year $t-1$. This implies that these states are the most frequent in the sample applied. The coefficient estimates for Period 2 (1996–2001), conditioned on State 00 and State 10 in $t-1$ and Period 1 (1992–1995), conditioned on State 10 in $t-1$ are all based on less than 300 observations. The limited number of farm households in the panel is a challenge to the estimations despite the confined covariate matrix applied. It may be that we try to squeeze too much information out of the data and this is reflected in the statistical significance of estimation results.

The covariate vector contain four dummy variables which are chosen to capture characteristics of both partners, the household and the farm. Individual levels of education are often found to be important factors in explaining labour decisions and we have included a dummy for high education for both operator and spouse. Children, particularly small children, are assumed to influence the labour participation of primarily women, which in our sample corresponds well with spouses.[4] We have included a dummy for children younger than six years of age, *i.e.* pre-school age, which correlates negatively with the both partners' age. Hence we have omitted age as explanatory variables in order to save on the number of covariates in the model. Finally, the farm structure is represented by a single dummy for dairy production. Dairy farming is relatively labour intensive and is assumed to have a negative impact on the probability of working off the farm.

The marginal effects derived from the coefficients are presented in Table 7.A-D. We see that they differ quite substantially both in sign and in magnitude from the first to the second period as well between states, but overall they are not very statistically significant. When the farm couple has small children, the effect on the transition rate is significant when moving from State 01, *i.e.*, when the operator but not the spouse participated in off-farm work in year $t-1$. The largest effect is found for staying in the same state in year t, but the effect is opposite from the first to the second period. For the years 1992–1995, having small children increased the probability of staying in State 10 by 26 per cent, but for the years 1996–2000 the same probability decreased by 20 per cent. The probability of moving to State 00 and moving to State 11 was, however, positive in both periods. The last result is somewhat surprising, but may be explained as an income effect or possibly that the presence of small children indicates that the farm couple is young and thus more likely to work off the farm.

The fact that farm operators have higher education does not have any statistically significant effect on the transition probabilities. The marginal effects are, however, large when moving from State 01 and State 10. The probabilities for the operator to return from a state where he works off farm to a state where he only works on farm is, not surprisingly, negative. The effect of spouses' having higher education is more statistically significant, but not equally large in magnitude. Generally, we find that when either partner works off-farm in year $t-1$, this has a positive effect on the probability that also the partner will work off-farm in year t, and more so in the last five years (1996-2000) than in the first years (1992–1995). Education also has a positive effect on staying in the same state as last year, but there is an obvious movement towards being in State 11 in the sample.

Dairy farming is supposed to reduce the probability of, at least, both partners working off the farm because dairy cows need attendance several times per day. The effect on the transition rates is, however, not obvious. We find that the probability of moving to State 11 or staying in State 11 is negative for all states and both periods. The results are statistically significant when moving from State 01 in Period 1 and

[4]Approximately 97 per cent of all farm operators are male so, by assumption, an equal number of spouses are female

from State 00 and State 11 in Period 2. We also find positive effects of moving from State 11 to a state where at least one of the partners are home and of moving from State 01 or State 10 to State 00 where neither work off the farm.

References

Ahituv, A., and A. Kimhi (2002): Off-farm work and capital accumulation decisions of farmers over the life-cycle: the role of heterogeneity and state dependence. *Journal of Development Economics* **68**, 329–353.

Ahituv, A., and A. Kimhi (2006): Simultaneous Estimation of Work Choices and the Level of Farm Activity Using Panel Data. *European Review of Agricultural Economics* **33**, 49-71.

Alasia, A., A. Weersink, R.D. Bollman, and J. Cranfield (2009): Off-farm labour decisions of Canadian farm operators: Urbanization effects and rural labour market linkages. *Journal of Rural Studies* **25**, 12-24.

Anderson, T.W., and L.A. Goodman (1957): Statistical Inference About Markov Chains. *Annals of Mathematical Statistics* **28**, 89-110.

Bartolucci, F. and A. Farcomeni (2009): A Multivariate Extension of the Dynamic Logit Model for Longitudinal Data Based on a Latent Markov Heterogeneity Structure. *Journal of the American Statistical Association* **104**, 816-831.

Bjørnsen, H.-M. (2006): Off-Farm Labour Participation of Farm Households: A Bivariate Random Effects Approach. Unpublished Essay in: *Labour Supply and Living Conditions in Norwegian Farm Households*. PhD Dissertation. University of Oslo.

Bjørnsen, H.-M., and E. Biørn (2006): The Joint Labour Decisions of Farm Couples: A Censored Response Analysis of On-farm and Off-farm Work. Memorandum No. 05/2006. Department of Economics, University of Oslo.

Browning, M., and J.M. Carro (2010): Heterogeneity in dynamic discrete choice models. *Econometrics Journal* **13**, 1-39.

Carro, J.M. (2006): Estimating dynamic panel data discrete choice models with fixed effects. *Journal of Econometrics* **140** 503-528

Corsi, A., and J.L. Findeis (2000): True State dependence and Heterogeneity in Off-Farm Labour Participation. *European Review of Agricultural Economics* **2**, 127-151.

Honoré, B., and E. Kyriazidou (2000): Panel data discrete choice models with lagged dependent variables. *Econometrica* **68**, 839-874.

Honoré, B., F. Vella, and M. Verbeek (2008): Attrition, Selection Bias and Censored Regressions. Chapter 12 in L. Mátyás and P. Sevestre (eds.): *The Econometrics of Panel Data. Fundamentals and Recent Developments in Theory and Practice. Third Edition.* Berlin: Springer.

Huffman, W.E., and H. El-Osta (1997): Off-farm work participation, off-farm labor supply and on-farm labor demand of U.S. farm operators. Staff Paper No. 290, Department of Economics, Iowa State University, Ames, IA.

Hyslop, D.R. (1999): State Dependence, Serial Correlation and Heterogeneity in Intertemporal Labor Force Participation of Married Women. *Econometrica* **67**, 1255-1294.

Keane, M.P., and K.I. Wolpin (2009): Empirical applications of discrete choice dynamic programming models. *Review of Economic Dynamics* **12**, 1-22.

Kimhi, A., and E. Rapaport (2004): Time Allocation between Farm and Off-Farm Activities in Israeli Farm Households. *American Journal of Agricultural Economics* **86**, 716-721.

Ordine, P. (1992): Labour Market Transitions of Youth and Prime Age Italian Unemployed, *Labour* **6**, 123-143.

Phimister, E., and D. Roberts (2006): The effect of Off-farm Work on the Intensity of agricultural Production. *Environmental & Resource Economics* **34**, 493-515.

Prowse, V. (2007): Modeling Employment Dynamics with State Dependence and Unobserved Heterogeneity. Economics Series Working Papers from University of Oxford, Department of Economics, Discussion Paper No. 337.

Table 1: Definition of covariates

Symbol	*Definition*
CHILD6	Number for having children younger than 6 years of age
HIGEDU_O	Dummy for completed higher education (schooling > 13 years), operator
HIGEDU_S	Dummy for completed higher education (schooling > 13 years), spouse
MILK	Dummy for dairy farm

Table 2: Year specific distribution of farms by labour state

$N = 342,\ T = 10$

11: Both work off-farm.
10: Only Operator works off-farm.
01: Only Spouse works off-farm.
00: Neither work off-farm

Year	*Number of farms*					*Frequency, per cent*				
	11	10	01	00	Sum	11	10	01	00	Sum
1991	84	79	93	86	342	24.56	23.10	27.19	25.15	100
1992	96	63	96	87	342	28.07	18.42	28.07	25.44	100
1993	98	73	99	72	342	28.65	21.35	28.95	21.05	100
1994	106	67	103	66	342	30.99	19.59	30.12	19.30	100
1995	104	65	108	65	342	30.41	19.01	31.58	19.01	100
1996	114	62	103	63	342	33.33	18.13	30.12	18.42	100
1997	113	57	113	59	342	33.04	16.67	33.04	17.25	100
1998	118	55	121	48	342	34.50	16.08	35.38	14.04	100
1999	120	57	119	46	342	35.09	16.67	34.80	13.45	100
2000	126	54	108	54	342	36.84	15.79	31.58	15.79	100

Table 3: Farms in the same state throughout the sample period

State	*No. of farms*
11: Both work off-farm	30
10: Only Operator works off-farm	10
01: Only Spouse works off-farm	16
00: Neither work off-farm	8
Sum	64

Table 4: Number of year-to-year moves, 1991–2000

$t = 1992, \ldots, 2000$; $N = 342$

State in year $t-1$	*State in year* t				Sum
	11	10	01	00	
11	–	60	141	8	209
10	80	–	20	76	176
01	147	14	–	54	215
00	24	77	69	–	170
Sum	251	151	230	138	770

Table 5: Number of farms in the same state in years t and s

State 11: Both work off-farm

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	84									
1992	66	96								
1993	59	73	98							
1994	61	70	79	106						
1995	56	66	71	81	104					
1996	53	61	69	77	79	114				
1997	55	59	64	69	75	89	113			
1998	53	60	64	72	70	83	93	118		
1999	50	59	59	65	68	82	85	90	120	
2000	51	61	60	67	67	79	82	84	94	126

State 10: Only operator works off-farm

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	79									
1992	47	63								
1993	47	44	73							
1994	45	44	51	67						
1995	40	37	47	50	65					
1996	37	33	36	41	42	62				
1997	37	33	35	38	44	42	57			
1998	33	29	32	35	35	36	44	55		
1999	31	28	30	36	37	35	42	43	57	
2000	27	25	30	32	30	28	32	37	39	54

State 01: Only spouse works off-farm

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	93									
1992	69	96								
1993	66	76	99							
1994	66	75	83	103						
1995	63	70	74	81	108					
1996	51	56	64	66	72	103				
1997	54	58	68	68	74	84	113			
1998	58	63	71	72	73	80	95	121		
1999	54	62	66	64	71	76	79	92	119	
2000	53	58	62	62	60	62	72	81	88	108

State 00: Neither work off-farm

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	86									
1992	63	87								
1993	50	57	72							
1994	45	55	55	66						
1995	39	46	48	51	65					
1996	31	38	38	40	45	63				
1997	30	37	39	37	43	43	59			
1998	25	32	33	29	33	32	39	48		
1999	24	33	31	28	31	30	31	32	46	
2000	26	33	32	28	30	28	31	33	37	54

Table 6: Frequency of transitions between states, by year

Above diagonal ($s > t$): Conditional on delivering state.
Below diagonal ($s < t$): Conditional on receiving state

A. Transitions from/to State 11: Both off-farm

 # in State 10 *in year s and in State* 11 *in year t/# in State* 11 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.042**	0.092	0.057	0.067	0.053	0.044	0.059	0.075	0.079
1992	0.155	–	**0.071**	0.094	0.087	0.079	0.062	0.068	0.100	0.087
1993	0.179	0.104	–	**0.094**	0.067	0.088	0.106	0.110	0.133	0.103
1994	0.202	0.125	0.102	–	**0.038**	0.044	0.080	0.068	0.075	0.079
1995	0.214	0.125	0.143	0.085	–	**0.053**	0.062	0.076	0.083	0.095
1996	0.250	0.156	0.194	0.113	0.087	–	**0.097**	0.076	0.092	0.087
1997	0.214	0.167	0.184	0.123	0.096	0.079	–	**0.034**	0.050	0.071
1998	0.310	0.208	0.265	0.160	0.173	0.140	0.080	–	**0.058**	0.071
1999	0.262	0.198	0.245	0.142	0.144	0.114	0.053	0.042	–	**0.056**
2000	0.321	0.198	0.245	0.160	0.144	0.149	0.106	0.059	0.050	–

 # in State 01 *in year s and in State* 11 *in year t/# in State* 11 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.135**	0.143	0.123	0.173	0.184	0.204	0.186	0.192	0.175
1992	0.190	–	**0.153**	0.132	0.173	0.184	0.221	0.212	0.208	0.175
1993	0.226	0.135	–	**0.085**	0.154	0.140	0.159	0.161	0.183	0.159
1994	0.238	0.188	0.133	–	**0.192**	0.193	0.221	0.195	0.242	0.198
1995	0.202	0.167	0.153	0.123	–	**0.158**	0.186	0.212	0.208	0.190
1996	0.298	0.260	0.194	0.189	0.240	–	**0.124**	0.186	0.167	0.175
1997	0.310	0.281	0.224	0.236	0.231	0.096	–	**0.136**	0.175	0.175
1998	0.298	0.260	0.194	0.217	0.250	0.096	0.080	–	**0.167**	0.175
1999	0.333	0.271	0.255	0.283	0.260	0.132	0.186	0.186	–	**0.127**
2000	0.321	0.271	0.255	0.264	0.308	0.202	0.195	0.237	0.208	–

 # in State 00 *in year s and in State* 11 *in year t/# in State* 11 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.010**	0.020	0.038	0.029	0.035	0.009	0.017	0.017	0.008
1992	0.012	–	**0.010**	0.019	0.029	0.044	0.044	0.025	0.000	0.016
1993	0.060	0.021	–	**0.000**	0.038	0.026	0.035	0.017	0.008	0.040
1994	0.095	0.063	0.041	–	**0.010**	0.018	0.027	0.025	0.025	0.032
1995	0.155	0.104	0.041	0.009	–	**0.009**	0.009	0.000	0.008	0.008
1996	0.179	0.135	0.071	0.047	0.010	–	**0.000**	0.000	0.008	0.016
1997	0.167	0.115	0.092	0.057	0.038	0.035	–	**0.000**	0.008	0.000
1998	0.167	0.135	0.092	0.057	0.038	0.070	0.062	–	**0.008**	0.024
1999	0.238	0.167	0.122	0.094	0.096	0.088	0.071	0.025	–	**0.024**
2000	0.250	0.208	0.173	0.132	0.115	0.061	0.088	0.059	0.008	–

Table 6: Frequency of transitions between states, by year (cont.)

Above diagonal ($s > t$): Conditional on delivering state.
Below diagonal ($s < t$): Conditional on receiving state

B. Transitions from/to State 10: Only operator off-farm

 # in State 11 *in year s and in State* 10 *in year t/# in State* 10 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.206**	0.205	0.254	0.277	0.339	0.316	0.473	0.386	0.500
1992	0.051	–	**0.137**	0.179	0.185	0.242	0.281	0.364	0.333	0.352
1993	0.114	0.111	–	**0.149**	0.215	0.306	0.316	0.473	0.421	0.444
1994	0.076	0.159	0.137	–	**0.138**	0.194	0.228	0.309	0.263	0.315
1995	0.089	0.143	0.096	0.060	–	**0.145**	0.175	0.327	0.263	0.278
1996	0.076	0.143	0.137	0.075	0.092	–	**0.158**	0.291	0.228	0.315
1997	0.063	0.111	0.164	0.134	0.108	0.177	–	**0.164**	0.105	0.222
1998	0.089	0.127	0.178	0.119	0.138	0.145	0.070	–	**0.088**	0.130
1999	0.114	0.190	0.219	0.134	0.154	0.177	0.105	0.127	–	**0.111**
2000	0.127	0.175	0.178	0.149	0.185	0.177	0.158	0.164	0.123	–

 # in State 01 *in year s and in State* 10 *in year t/# in State* 10 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.032**	0.041	0.060	0.123	0.065	0.123	0.109	0.211	0.167
1992	0.025	–	**0.000**	0.000	0.077	0.065	0.088	0.109	0.123	0.130
1993	0.025	0.032	–	**0.060**	0.108	0.113	0.228	0.182	0.193	0.185
1994	0.038	0.016	0.000	–	**0.031**	0.065	0.123	0.109	0.123	0.093
1995	0.038	0.048	0.027	0.030	–	**0.065**	0.088	0.073	0.088	0.148
1996	0.076	0.095	0.068	0.090	0.062	–	**0.053**	0.073	0.140	0.111
1997	0.025	0.048	0.000	0.000	0.015	0.000	–	**0.036**	0.070	0.056
1998	0.038	0.048	0.014	0.015	0.031	0.032	0.035	–	**0.018**	0.037
1999	0.063	0.063	0.027	0.045	0.062	0.048	0.070	0.000	–	**0.037**
2000	0.025	0.079	0.055	0.060	0.077	0.081	0.105	0.055	0.035	–

 # in State 00 *in year s and in State* 10 *in year t/# in State* 10 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.270**	0.192	0.194	0.200	0.274	0.298	0.255	0.246	0.296
1992	0.127	–	**0.123**	0.104	0.138	0.177	0.158	0.145	0.158	0.222
1993	0.190	0.317	–	**0.119**	0.077	0.177	0.123	0.091	0.140	0.167
1994	0.165	0.190	0.082	–	**0.092**	0.161	0.158	0.164	0.158	0.241
1995	0.190	0.254	0.123	0.134	–	**0.161**	0.105	0.145	0.140	0.222
1996	0.165	0.222	0.151	0.149	0.154	–	**0.140**	0.109	0.105	0.204
1997	0.165	0.222	0.137	0.149	0.077	0.065	–	**0.036**	0.088	0.185
1998	0.152	0.238	0.123	0.164	0.138	0.129	0.088	–	**0.105**	0.167
1999	0.152	0.206	0.123	0.134	0.092	0.129	0.088	0.127	–	**0.185**
2000	0.190	0.206	0.096	0.119	0.108	0.161	0.123	0.091	0.105	–

Table 6: Frequency of transitions between states, by year (cont.)

Above diagonal ($s>t$): Conditional on delivering state.
Below diagonal ($s<t$): Conditional on receiving state

C. Transitions from/to State 01: Only spouse off-farm

 # in State 11 *in year s and in State* 01 *in year t/# in State* 01 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.167**	0.192	0.194	0.157	0.243	0.230	0.207	0.235	0.250
1992	0.140	–	**0.131**	0.175	0.148	0.243	0.239	0.207	0.218	0.241
1993	0.151	0.156	–	**0.126**	0.139	0.184	0.195	0.157	0.210	0.231
1994	0.140	0.146	0.091	–	**0.120**	0.194	0.221	0.190	0.252	0.259
1995	0.194	0.188	0.162	0.194	–	**0.243**	0.212	0.215	0.227	0.296
1996	0.226	0.219	0.162	0.214	0.167	–	**0.097**	0.091	0.126	0.213
1997	0.247	0.260	0.182	0.243	0.194	0.136	–	**0.074**	0.176	0.204
1998	0.237	0.260	0.192	0.223	0.231	0.214	0.142	–	**0.185**	0.259
1999	0.247	0.260	0.222	0.282	0.231	0.194	0.186	0.165	–	**0.231**
2000	0.237	0.229	0.202	0.243	0.222	0.214	0.195	0.182	0.134	–

 # in State 10 *in year s and in State* 01 *in year t/# in State* 01 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.021**	0.020	0.029	0.028	0.058	0.018	0.025	0.042	0.019
1992	0.022	–	**0.020**	0.010	0.028	0.058	0.027	0.025	0.034	0.046
1993	0.032	0.000	–	**0.000**	0.019	0.049	0.000	0.008	0.017	0.037
1994	0.043	0.000	0.040	–	**0.019**	0.058	0.000	0.008	0.025	0.037
1995	0.086	0.052	0.071	0.019	–	**0.039**	0.009	0.017	0.034	0.046
1996	0.043	0.042	0.071	0.039	0.037	–	**0.000**	0.017	0.025	0.046
1997	0.075	0.052	0.131	0.068	0.046	0.029	–	**0.017**	0.034	0.056
1998	0.065	0.063	0.101	0.058	0.037	0.039	0.018	–	**0.000**	0.028
1999	0.129	0.073	0.111	0.068	0.046	0.078	0.035	0.008	–	**0.019**
2000	0.097	0.073	0.101	0.049	0.074	0.058	0.027	0.017	0.017	–

 # in State 00 *in year s and in State* 01 *in year t/# in State* 01 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.063**	0.061	0.039	0.093	0.107	0.097	0.058	0.050	0.102
1992	0.129	–	**0.051**	0.019	0.065	0.087	0.071	0.041	0.034	0.065
1993	0.172	0.083	–	**0.029**	0.074	0.107	0.080	0.066	0.050	0.074
1994	0.215	0.146	0.071	–	**0.065**	0.107	0.088	0.058	0.050	0.083
1995	0.204	0.156	0.111	0.049	–	**0.068**	0.080	0.058	0.050	0.102
1996	0.290	0.229	0.162	0.107	0.083	–	**0.071**	0.083	0.076	0.120
1997	0.312	0.260	0.141	0.126	0.120	0.117	–	**0.058**	0.076	0.120
1998	0.376	0.281	0.212	0.194	0.176	0.146	0.071	–	**0.059**	0.083
1999	0.323	0.260	0.202	0.184	0.167	0.146	0.133	0.050	–	**0.037**
2000	0.258	0.219	0.162	0.155	0.148	0.175	0.097	0.025	0.017	–

Table 6: Frequency of transitions between states, by year (cont.)

Above diagonal ($s > t$): Conditional on delivering state.
Below diagonal ($s < t$): Conditional on receiving state

D. Transitions from/to State 00: Only spouse off-farm

 # in State 11 *in year s and in State* 00 *in year t/# in State* 00 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.011**	0.069	0.121	0.200	0.238	0.237	0.292	0.435	0.389
1992	0.012	–	**0.028**	0.091	0.154	0.206	0.186	0.271	0.348	0.370
1993	0.023	0.011	–	**0.061**	0.062	0.111	0.153	0.188	0.261	0.315
1994	0.047	0.023	0.000	–	**0.015**	0.079	0.102	0.125	0.217	0.259
1995	0.035	0.034	0.056	0.015	–	**0.016**	0.068	0.083	0.217	0.222
1996	0.047	0.057	0.042	0.030	0.015	–	**0.068**	0.167	0.217	0.130
1997	0.012	0.057	0.056	0.045	0.015	0.000	–	**0.146**	0.174	0.185
1998	0.023	0.034	0.028	0.045	0.000	0.000	0.000	–	**0.065**	0.130
1999	0.023	0.000	0.014	0.045	0.015	0.016	0.017	0.021	–	**0.019**
2000	0.012	0.023	0.069	0.061	0.015	0.032	0.000	0.063	0.065	–

 # in State 10 *in year s and in State* 00 *in year t/# in State* 00 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.115**	0.208	0.197	0.231	0.206	0.220	0.250	0.261	0.278
1992	0.198	–	**0.278**	0.182	0.246	0.222	0.237	0.313	0.283	0.241
1993	0.163	0.103	–	**0.091**	0.138	0.175	0.169	0.188	0.196	0.130
1994	0.151	0.080	0.111	–	**0.138**	0.159	0.169	0.229	0.196	0.148
1995	0.151	0.103	0.069	0.091	–	**0.159**	0.085	0.188	0.130	0.130
1996	0.198	0.126	0.153	0.152	0.154	–	**0.068**	0.167	0.174	0.185
1997	0.198	0.103	0.097	0.136	0.092	0.127	–	**0.104**	0.109	0.130
1998	0.163	0.092	0.069	0.136	0.123	0.095	0.034	–	**0.152**	0.093
1999	0.163	0.103	0.111	0.136	0.123	0.095	0.085	0.125	–	**0.111**
2000	0.186	0.138	0.125	0.197	0.185	0.175	0.169	0.188	0.217	–

 # in State 01 *in year s and in State* 00 *in year t/# in State* 00 *in year t*

$t\downarrow$ $s\rightarrow$	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1991	–	**0.138**	0.222	0.303	0.292	0.429	0.492	0.729	0.652	0.444
1992	0.070	–	**0.111**	0.212	0.231	0.349	0.424	0.563	0.543	0.389
1993	0.070	0.057	–	**0.106**	0.169	0.254	0.237	0.438	0.435	0.296
1994	0.047	0.023	0.042	–	**0.077**	0.175	0.220	0.417	0.413	0.296
1995	0.116	0.080	0.111	0.106	–	**0.143**	0.220	0.396	0.391	0.296
1996	0.128	0.103	0.153	0.167	0.108	–	**0.203**	0.313	0.326	0.333
1997	0.128	0.092	0.125	0.152	0.138	0.127	–	**0.167**	0.326	0.204
1998	0.081	0.057	0.111	0.106	0.108	0.159	0.119	–	**0.130**	0.056
1999	0.070	0.046	0.083	0.091	0.092	0.143	0.153	0.146	–	**0.037**
2000	0.128	0.080	0.111	0.136	0.169	0.206	0.220	0.188	0.087	–

Table 7. Multinomial Logit estimation, by 5-year period

A. Marginal effects, conditional on being in state 00 in previous year

a) Period: 1991-1995

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	.0579544	.0546548	1.06	0.289
highedu_o	.0207296	.1140794	0.18	0.856
highedu_s	-.0509114	.128536	-0.40	0.692
milk	-.0156738	.0579629	-0.27	0.787

Going to State 01

	dy/dx	Std. Err.	z	P>|z|
child06	-.0008906	.0350781	-0.03	0.980
highedu_o	-.0650165	.0948903	-0.69	0.493
highedu_s	.1164861	.0513546	2.27	0.023
milk	-.0445607	.0355694	-1.25	0.210

Going to State 10

	dy/dx	Std. Err.	z	P>|z|
child06	-.0801755	.0451012	-1.78	0.075
highedu_o	.0136389	.0801917	0.17	0.865
highedu_s	-.1109281	.1272568	-0.87	0.383
milk	.0338843	.0457901	0.74	0.459

Going to State 11

	dy/dx	Std. Err.	z	P>|z|
child06	.0231117	.0191938	1.20	0.229
highedu_o	.0306481	.0288951	1.06	0.289
highedu_s	.0453534	.0243276	1.86	0.062
milk	.0263502	.0273835	0.96	0.336

b) Period: 1996-2000

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.1271322	.0602562	-2.11	0.035
highedu_o	1.208841	57.5029	0.02	0.983
highedu_s	-.0560192	.1219268	-0.46	0.646
milk	.066504	.0602429	1.10	0.270

Going to State 01

	dy/dx	Std. Err.	z	P>|z|
child06	.0096598	.0454968	0.21	0.832
highedu_o	-1.505	70.32738	-0.02	0.983
highedu_s	-.1146023	.1177766	-0.97	0.331
milk	.0104485	.0460722	0.23	0.821

Going to State 10

	dy/dx	Std. Err.	z	P>|z|
child06	.0352338	.0408515	0.86	0.388
highedu_o	.1453865	8.810727	0.02	0.987
highedu_s	.1159813	.0555564	2.09	0.037
milk	-.0317126	.0404292	-0.78	0.433

Going to State 11

	dy/dx	Std. Err.	z	P>|z|
child06	.0822386	.0296679	2.77	0.006
highedu_o	.150772	4.014748	0.04	0.970
highedu_s	.0546402	.0421107	1.30	0.194
milk	-.0452398	.0278923	-1.62	0.105

Table 7. Multinomial Logit estimation, by 5-year period (cont.)

B. Marginal effects, conditional on being in state 01 in previous year

a) Period: 1991-1995

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.0661253	.0442715	-1.49	0.135
highedu_o	.6481834	29.34504	0.02	0.982
highedu_s	.0938461	.0529642	1.77	0.076
milk	.0399223	.0453723	0.88	0.379

Going to State 11

	dy/dx	Std. Err.	z	P>|z|
child06	.026312	.0382408	0.69	0.491
highedu_o	.155645	4.842596	0.03	0.974
highedu_s	-.0425201	.0413316	-1.03	0.304
milk	-.0867536	.0359881	-2.41	0.016

Going to State 00

	dy/dx	Std. Err.	z	P>|z|
child06	.0362712	.0235469	1.54	0.123
highedu_o	-.6185801	30.12932	-0.02	0.984
highedu_s	-.0594631	.038864	-1.53	0.126
milk	.027932	.0264304	1.06	0.291

Going to State 10

	dy/dx	Std. Err.	z	P>|z|
child06	.0035414	.0131306	0.27	0.787
highedu_o	-.1852163	18.41216	-0.01	0.992
highedu_s	.0081361	.0134455	0.61	0.545
milk	.0188964	.0181005	1.04	0.296

b) Period: 1996-2000

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.1032883	.0417623	-2.47	0.013
highedu_o	.5039505	21.00829	0.02	0.981
highedu_s	.0200902	.0460037	0.44	0.662
milk	-.0667654	.037026	-1.80	0.071

Going to State 11

	dy/dx	Std. Err.	z	P>|z|
child06	.050885	.0368544	1.38	0.167
highedu_o	.1356688	4.682846	0.03	0.977
highedu_s	.0468457	.0352291	1.33	0.184
milk	.0451225	.0323956	1.39	0.164

Going to State 00

	dy/dx	Std. Err.	z	P>|z|
child06	.0512536	.0218031	2.35	0.019
highedu_o	-.6838743	25.97557	-0.03	0.979
highedu_s	-.0640201	.0343923	-1.86	0.063
milk	.0079329	.020275	0.39	0.696

Going to State 10

	dy/dx	Std. Err.	z	P>|z|
child06	.0011492	.0114254	0.10	0.920
highedu_o	.0442486	.2855232	0.15	0.877
highedu_s	-.0029153	.0122608	-0.24	0.812
milk	.0137075	.012662	1.08	0.279

Table 7. Multinomial Logit estimation, by 5-year period (cont.)

C. Marginal effects, conditional on being in state 10 in previous year

a) Period: 1991-1995

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.2635554	.056115	-4.70	0.000
highedu_o	1.314932	130.1691	0.01	0.992
highedu_s	.0910061	.1112978	0.82	0.414
milk	-.0548548	.0568193	-0.97	0.334

Going to State 11

	dy/dx	Std. Err.	z	P>|z|
child06	.1396031	.0412915	3.38	0.001
highedu_o	.3775087	33.74234	0.01	0.991
highedu_s	.1103745	.0546763	2.02	0.044
milk	-.000082	.0430798	-0.00	0.998

Going to State 00

	dy/dx	Std. Err.	z	P>|z|
child06	.1346861	.0404158	3.33	0.001
highedu_o	-1.761613	169.0626	-0.01	0.992
highedu_s	-.2034016	.1179962	-1.72	0.085
milk	.0565883	.0451685	1.25	0.210

Going to State 01

	dy/dx	Std. Err.	z	P>|z|
child06	-.0107338	.0285095	-0.38	0.707
highedu_o	.0691715	5.151472	0.01	0.989
highedu_s	.0020211	.0299753	0.07	0.946
milk	-.0016515	.0203316	-0.08	0.935

b) Period: 1996-2000

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.1950586	.0565869	-3.45	0.001
highedu_o	.1887158	15.10801	0.01	0.990
highedu_s	.0498736	.0927621	0.54	0.591
milk	-.0105444	.0553415	-0.19	0.849

Going to State 11

	dy/dx	Std. Err.	z	P>|z|
child06	.0922357	.0413278	2.23	0.026
highedu_o	.1259182	3.244018	0.04	0.969
highedu_s	.0626617	.0529405	1.18	0.237
milk	-.0174905	.040366	-0.43	0.665

Going to State 00

	dy/dx	Std. Err.	z	P>|z|
child06	.0584619	.0420744	1.39	0.165
highedu_o	.1595279	2.897732	0.06	0.956
highedu_s	-.0977631	.08104	-1.21	0.228
milk	.0291127	.0413418	0.70	0.481

Going to State 01

	dy/dx	Std. Err.	z	P>|z|
child06	.0443609	.0249221	1.78	0.075
highedu_o	-.4741619	21.2481	-0.02	0.982
highedu_s	-.0147722	.0415583	-0.36	0.722
milk	-.0010778	.0241022	-0.04	0.964

Table 7. Multinomial Logit estimation, by 5-year period (cont.)

D. Marginal effects, conditional on being in state 11 in previous year

a) Period: 1991-1995

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.0300909	.0463782	-0.65	0.516
highedu_o	.187586	5.388409	0.03	0.972
highedu_s	.1791646	4.115356	0.04	0.965
milk	-.0256393	.0439497	-0.58	0.560

Going to State 01

	dy/dx	Std. Err.	z	P>|z|
child06	.011601	.0403214	0.29	0.774
highedu_o	-.0801875	1.349971	-0.06	0.953
highedu_s	-.0292483	1.030486	-0.03	0.977
milk	.0123015	.0378524	0.32	0.745

Going to State 10

	dy/dx	Std. Err.	z	P>|z|
child06	.0160372	.0271329	0.59	0.554
highedu_o	-.012528	.6630428	-0.02	0.985
highedu_s	-.047285	.5062601	-0.09	0.926
milk	.0110473	.0267252	0.41	0.679

Going to State 00

	dy/dx	Std. Err.	z	P>|z|
child06	.0024509	.0096775	0.25	0.800
highedu_o	-.0948067	7.392455	-0.01	0.990
highedu_s	-.1025625	5.646127	-0.02	0.986
milk	.0022888	.0096582	0.24	0.813

b) Period: 1996-2000

Staying

	dy/dx	Std. Err.	z	P>|z|
child06	-.0536089	.0426514	-1.26	0.209
highedu_o	.2551486	5.556357	0.05	0.963
highedu_s	.0087828	.041515	0.21	0.832
milk	-.0730772	.0363315	-2.01	0.044

Going to State 01

	dy/dx	Std. Err.	z	P>|z|
child06	-.0008276	.0382678	-0.02	0.983
highedu_o	-.0950695	1.081857	-0.09	0.930
highedu_s	.0455485	.0330691	1.38	0.168
milk	.0746659	.0319009	2.34	0.019

Going to State 10

	dy/dx	Std. Err.	z	P>|z|
child06	.0456789	.0218734	2.09	0.037
highedu_o	-.0431239	.6317674	-0.07	0.946
highedu_s	-.0496674	.0292911	-1.70	0.090
milk	.0052158	.0209088	0.25	0.803

Going to State 00

	dy/dx	Std. Err.	z	P>|z|
child06	.0087527	.0087375	1.00	0.316
highedu_o	-.1168939	7.263052	-0.02	0.987
highedu_s	-.0046613	.0101178	-0.46	0.645
milk	-.0068015	.0085457	-0.80	0.426

Table 8. Multinomial Logit. Coefficients by 5-year period

A. Conditional on being in state 00 in previous year

a) Period: 1991-1995

Number of obs	= 311
LR chi2(12)	= 17.81
Prob > chi2	= 0.1215
Log likelihood	= -252.28965
Pseudo R2	= 0.0341

	Coef.	Std. Err.	z	P>|z|
State 00_	(base outcome)			
State 01_				
child06	-.0781364	.3988748	-0.20	0.845
highedu_o	-.6712787	1.06017	-0.63	0.527
highedu_s	1.251405	.5840703	2.14	0.032
milk	-.4191366	.400037	-1.05	0.295
_cons	-1.73	.3565255	-4.85	0.000
State 10_				
child06	-.6463835	.3749579	-1.72	0.085
highedu_o	.0655949	.66557	0.10	0.921
highedu_s	-.7234508	1.062642	-0.68	0.496
milk	.2572697	.3822108	0.67	0.501
_cons	-1.583111	.3456254	-4.58	0.000
State 11_				
child06	.8666258	.7538885	1.15	0.250
highedu_o	1.189265	1.145236	1.04	0.299
highedu_s	1.947767	.9062361	2.15	0.032
milk	1.067376	1.094733	0.98	0.330
_cons	-4.996603	1.152802	-4.33	0.000

b) Period: 1996-2000

Number of obs	= 282
LR chi2(12)	= 23.95
Prob > chi2	= 0.0206
Log likelihood	= -249.38083
Pseudo R2	= 0.0458

	Coef.	Std. Err.	z	P>|z|
State 00_	(base outcome)			
State 01_				
child06	.252734	.4247631	0.59	0.552
highedu_o	-13.32019	623.8154	-0.02	0.983
highedu_s	-.8056819	1.05973	-0.76	0.447
milk	-.0126094	.4197647	-0.03	0.976
_cons	-1.64333	.3801295	-4.32	0.000
State 10_				
child06	.5304741	.4379867	1.21	0.226
highedu_o	-.3353829	1.084808	-0.31	0.757
highedu_s	1.150826	.5791007	1.99	0.047
milk	-.3986633	.4215428	-0.95	0.344
_cons	-1.761491	.378325	-4.66	0.000
State 11_				
child06	1.762277	.5525111	3.19	0.001
highedu_o	1.251832	.8660693	1.45	0.148
highedu_s	1.168395	.85976	1.36	0.174
milk	-.9696046	.5519421	-1.76	0.079
_cons	-2.728295	.5193747	-5.25	0.000

Table 8. Multinomial Logit. Coefficients by 5-year period (cont.)

B. Conditional on being in state 01 in previous year

a) Period: 1991-1995

Number of obs	=	391
LR chi2(12)	=	20.48
Prob > chi2	=	0.0586
Log likelihood	=	-256.83385
Pseudo R2	=	0.0383

	Coef.	Std. Err.	z	P>|z|
State 01_	(base outcome)			
State 11_				
child06	.2734609	.3267915	0.84	0.403
highedu_o	.3546118	.5635929	0.63	0.529
highedu_s	-.4279534	.3517737	-1.22	0.224
milk	-.6844214	.3071055	-2.23	0.026
_cons	-1.354609	.2502004	-5.41	0.000
State 00_				
child06	.7784069	.4671838	1.67	0.096
highedu_o	-12.70322	608.2907	-0.02	0.983
highedu_s	-1.255007	.7622911	-1.65	0.100
milk	.4895046	.5364726	0.91	0.362
_cons	-3.002264	.4993545	-6.01	0.000
State 10_				
child06	.3180006	.8796028	0.36	0.718
highedu_o	-13.10658	1225.227	-0.01	0.991
highedu_s	.4106524	.8878509	0.46	0.644
milk	1.209059	1.116274	1.08	0.279
_cons	-4.981619	1.11828	-4.45	0.000

b) Period: 1996-2000

Number of obs	=	563
LR chi2(12)	=	29.55
Prob > chi2	=	0.0033
Log likelihood	=	-395.41087
Pseudo R2	=	0.0360

	Coef.	Std. Err.	z	P>|z|
State 01_	(base outcome)			
State 11_				
child06	.4540353	.2790298	1.63	0.104
highedu_o	.14727	.5284515	0.28	0.780
highedu_s	.2597955	.2633408	0.99	0.324
milk	.36994	.2419798	1.53	0.126
_cons	-1.928711	.2199359	-8.77	0.000
State 00_				
child06	1.035294	.3962927	2.61	0.009
highedu_o	-12.63284	481.9988	-0.03	0.979
highedu_s	-1.143546	.6222792	-1.84	0.066
milk	.2260451	.3801671	0.59	0.552
_cons	-2.730014	.3325745	-8.21	0.000
State 10_				
child06	.2175604	.868947	0.25	0.802
highedu_o	2.785029	.8183403	3.40	0.001
highedu_s	-.2203528	.9264002	-0.24	0.812
milk	1.107371	.9051714	1.22	0.221
_cons	-5.163134	.9228096	-5.60	0.000

Table 8. Multinomial Logit. Coefficients by 5-year period (cont.)

C. Conditional on being in state 10 in previous year

a) Period: 1991-1995

Number of obs	=	282
LR chi2(12)	=	36.78
Prob > chi2	=	0.0002
Log likelihood	=	-242.01393
Pseudo R2	=	0.0706

	Coef.	Std. Err.	z	P>|z|
State 10_	(base outcome)			
State 11_				
child06	1.443783	.3882097	3.72	0.000
highedu_o	.2493247	.6199898	0.40	0.688
highedu_s	.6030571	.4589192	1.31	0.189
milk	.098005	.3685335	0.27	0.790
_cons	-2.043711	.3354054	-6.09	0.000
State 00_				
child06	1.478574	.402137	3.68	0.000
highedu_o	-15.50022	1494.114	-0.01	0.992
highedu_s	-1.678749	1.055623	-1.59	0.112
milk	.5202562	.407494	1.28	0.202
_cons	-2.106098	.3690846	-5.71	0.000
State 01_				
child06	.0036125	1.092182	0.00	0.997
highedu_o	.6081642	1.128334	0.54	0.590
highedu_s	-.0498727	1.114788	-0.04	0.964
milk	.0193332	.7475375	0.03	0.979
_cons	-3.243459	.6399511	-5.07	0.000

b) Period: 1996-2000

Number of obs	=	296
LR chi2(12)	=	19.40
Prob > chi2	=	0.0792
Log likelihood	=	-254.69793
Pseudo R2	=	0.0367

	Coef.	Std. Err.	z	P>|z|
State 10_	(base outcome)			
State 11_				
child06	1.043383	.4018434	2.60	0.009
highedu_o	.6581293	.6393526	1.03	0.303
highedu_s	.4188439	.5007838	0.84	0.403
milk	-.1227218	.3779584	-0.32	0.745
_cons	-1.99176	.3250497	-6.13	0.000
State 00_				
child06	.7916907	.427007	1.85	0.064
highedu_o	1.020288	.6469568	1.58	0.115
highedu_s	-.8903043	.7839414	-1.14	0.256
milk	.2582732	.4009125	0.64	0.519
_cons	-2.112433	.356077	-5.93	0.000
State 01_				
child06	1.427098	.6282354	2.27	0.023
highedu_o	-12.1582	555.5581	-0.02	0.983
highedu_s	-.4436986	1.100727	-0.40	0.687
milk	-.0116998	.6368535	-0.02	0.985
_cons	-3.150291	.5658645	-5.57	0.000

Table 8. Multinomial Logit. Coefficients by 5-year period (cont.)

D. Conditional on being in state 11 in previous year

a) Period: 1991-1995

Number of obs	=	384
LR chi2(12)	=	15.91
Prob > chi2	=	0.1953
Log likelihood	=	-258.43659
Pseudo R2	=	0.0299

	Coef.	Std. Err.	z	P>|z|
State 11_	(base outcome)			
State 01_				
child06	.12225	.3270437	0.37	0.709
highedu_o	-.8266115	.5654818	-1.46	0.144
highedu_s	-.4744529	.3412952	-1.39	0.164
milk	.1203695	.3064601	0.39	0.694
_cons	-1.506818	.261628	-5.76	0.000
State 10_				
child06	.2928114	.4546894	0.64	0.520
highedu_o	-.4988421	.8013956	-0.62	0.534
highedu_s	-1.025942	.5727066	-1.79	0.073
milk	.2091117	.4479615	0.47	0.641
_cons	-2.344313	.3820997	-6.14	0.000
State 00_				
child06	.3664296	1.248123	0.29	0.769
highedu_o	-12.49495	959.0284	-0.01	0.990
highedu_s	-13.48408	732.4568	-0.02	0.985
milk	.3375788	1.245524	0.27	0.786
_cons	-4.336326	1.051128	-4.13	0.000

b) Period: 1996-2000

Number of obs	=	569
LR chi2(12)	=	31.43
Prob > chi2	=	0.0017
Log likelihood	=	-375.63523
Pseudo R2	=	0.0402

	Coef.	Std. Err.	z	P>|z|
State 11_	(base outcome)			
State 01_				
child06	.0694509	.3168364	0.22	0.826
highedu_o	-1.002754	.4545672	-2.21	0.027
highedu_s	.2993075	.2712782	1.10	0.270
milk	.6140401	.2616107	2.35	0.019
_cons	-2.002257	.2514631	-7.96	0.000
State 10_				
child06	.8362973	.3830347	2.18	0.029
highedu_o	-1.117242	.7606353	-1.47	0.142
highedu_s	-.8377075	.5104361	-1.64	0.101
milk	.1871793	.377092	0.50	0.620
_cons	-2.53901	.345494	-7.35	0.000
State 00_				
child06	1.095012	.9297408	1.18	0.239
highedu_o	-13.76309	839.8447	-0.02	0.987
highedu_s	-.5671887	1.157848	-0.49	0.624
milk	-.6789522	.9420102	-0.72	0.471
_cons	-4.122551	.7760797	-5.31	0.000