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Measurement errors in panel surveys, evaluation of Markov Quasi-Simplex and Markov Latent Class models

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Content

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  - Markov quasi-simplex
  - Markov latent class
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- Second look at the data
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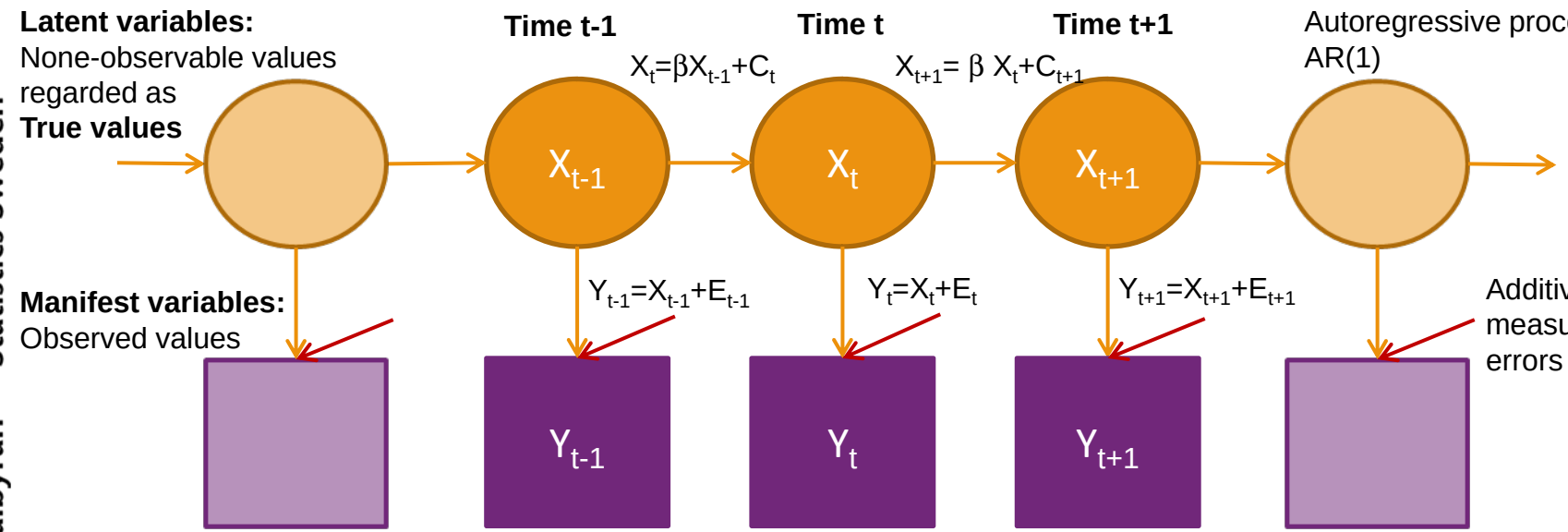
Measurement errors in panel surveys

- If the same object is measured at least three times and the change of the object follows a Markov-process, then aspects of the measurement process can be estimated
- Markov Quasi-Simplex for continuous data
- Markov Latent Class models for categorical data

- Common:
  - The true unobserved value is modelled as a latent variable
  - Changes follows a Markov process
  - Measurement errors are independent

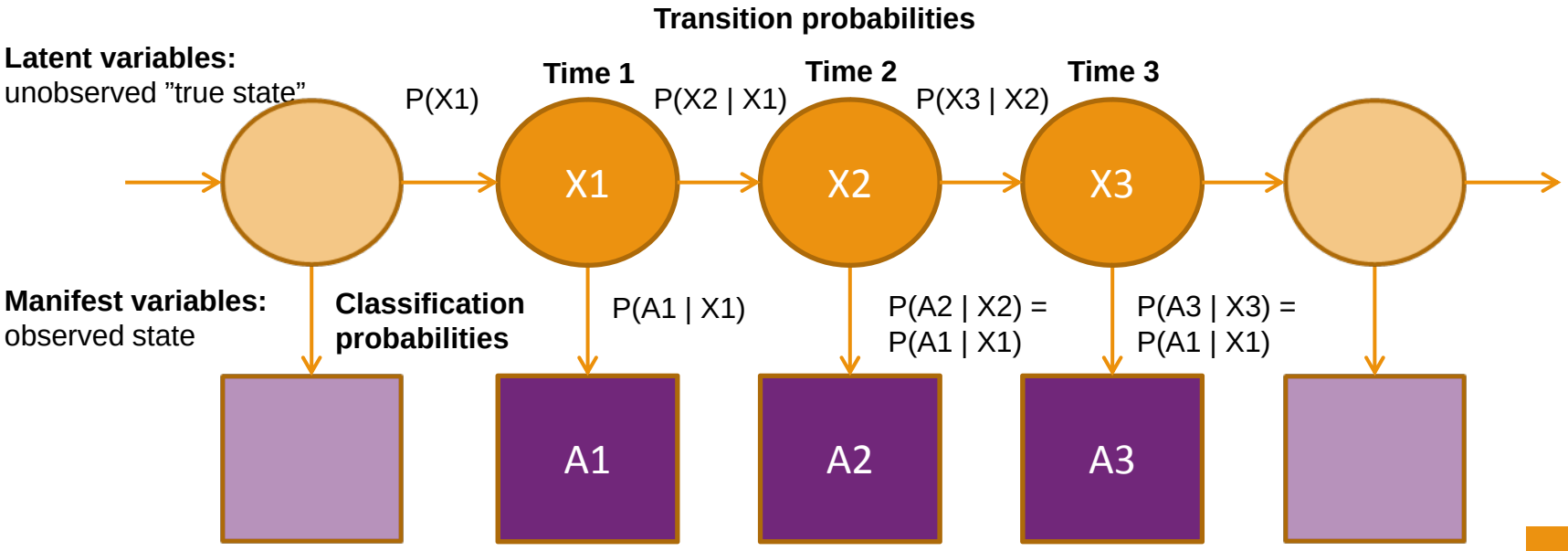
Markov Quasi-Simplex Model, continuous data



$$\text{Reliability (definition): } \rho_t = \frac{Var(\text{true value})}{Var(\text{observed value})} = \frac{Var(X_t)}{Var(X_t+E_t)}$$

$$\text{Derived from the model: } \rho_t = \frac{Corr(Y_{t-k},Y_t)Corr(Y_t,Y_{t+k})}{Corr(Y_{t-k},Y_{t+k})} = \frac{Cov(Y_{t-k},Y_t)Cov(Y_t,Y_{t+k})}{Cov(Y_{t-k},Y_{t+k})Var(Y_t)}$$

Markov Latent Class Model, categorical data



Each variables has three levels (states):
Employed (E),
Unemployed (U), and
Not in Labor Force (N)

Parameters in this model:
P(X1) consists of 2 parameters
P(X2 | X1) consists of 6 parameters
P(X3 | X2) consists of 6 parameters
P(A1 | X1) consists of 6 parameters
In total 20 parameters

Observations:
For each person we will have the values of A1, A2, and A3. The number of persons will be summarized in a 3x3x3 contingents table, with 27 cells.

The data could be fitted to the model with 6 degrees of Freedom

Assumptions:
First order Markov property, i.e. the state a person is in at time t, can only depend on the state it is in at time t-1.
Same classification probabilities at each time.
The classifications of a person at two time points are independent.

Example 1: invoice value of arrivals and of dispatches within the European Union (Intrastat)

- Cut-off survey, including all enterprises with a total value of commodities dispatched from Sweden of more than 4.5 million SEK or with a total value of commodities arrived to Sweden of more than 4.5 million SEK
- The survey collects monthly the value and volume at commodity level

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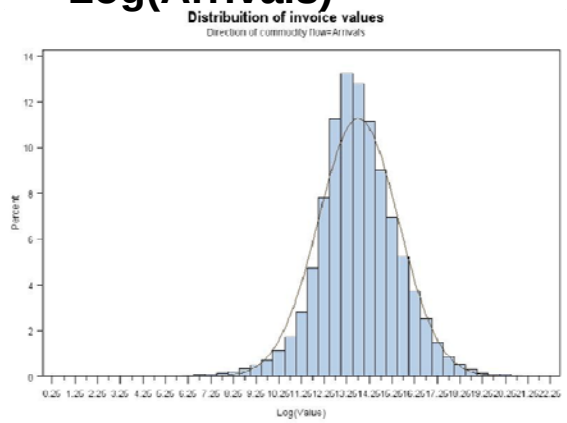
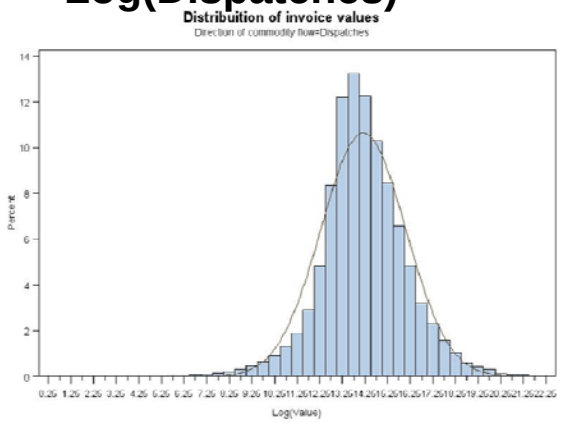
Example 1: Method

- The primary variables for this presentation is the total monthly values of each enterprise for dispatches and arrivals, respectively, summed over all commodities
- A Markov quasi-simplex model over three time points was used to estimate the reliability
- A log-transform of the total values was used

Log(Arrivals)



Log(Dispatches)



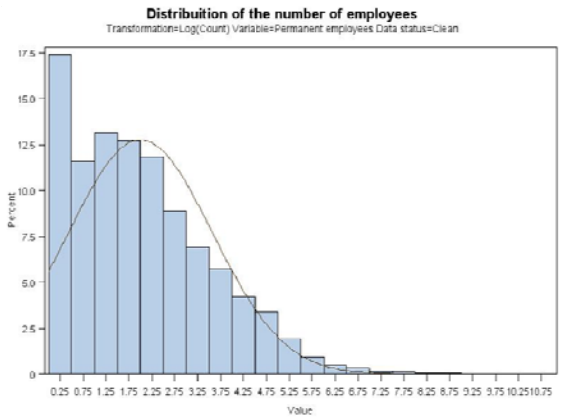
Example 2: Short-Term Employment Survey (STES)

- Stratified simple random sample. Stratification based on industry and size
- The sample size is roughly 19 000 enterprises within both the private and the public sector
- All larger enterprises and the public sector are included in the sample. This group contributes data every month
- other enterprises in the sample contribute data for every third month
- A selected enterprise might stay in the survey for several years

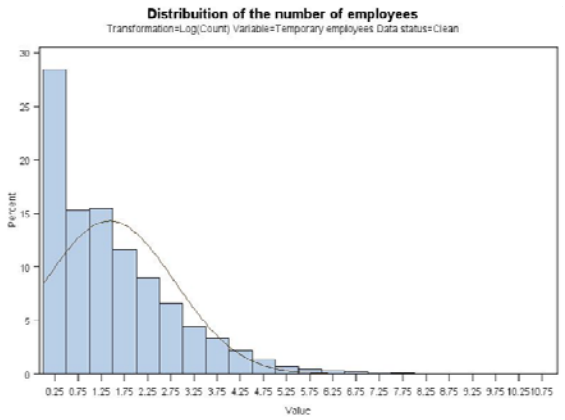
Example 2: Method

- The primary variables for this presentation is the total number of Permanent and Temporary employees
- A quasi-simplex model over three time points was used to estimate the reliability
- A log-transform of the total number of employees was used

Log(Permanent employees)



Log(Temporary employees)



Example 3: Swedish labor force survey (LFS)

- Stratified systematic sample with rotating panel samples. Stratified by region and gender, within strata individuals are sorted by country of birth and date of birth
- Age range 15-74
- Sample size 29 500
- Each individual is interviewed, by telephone, every third month during two years (8 interviews per individual)

Example 3: Method

- The primary variable for this presentation is the labor force status, which is a categorical variable taking 3 values: Employed (E), Unemployed (U), and Not in labor force (N)

- Markov Latent Class Analyses were used to estimate the classification probabilities
  - Probability that a person with true status X is classified as status Y

Measurements in LFS

Months:

J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Individual j is measured every 3 months for a total of 8 times

Individual k is measured every 3 months for a total of 8 times, non coincides with measurements of j

Individual l is measured every 3 months for a total of 8 times, some coincides with measurements of j

Time points in models

Three time points one month apart

Not possible in LFS,
only for subset of enterprises in STES

Months:

J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Three time points three months apart

Months:

J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Three time points six months apart

Months:

J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Three time points twelve months apart

Not possible in LFS

Months:

J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

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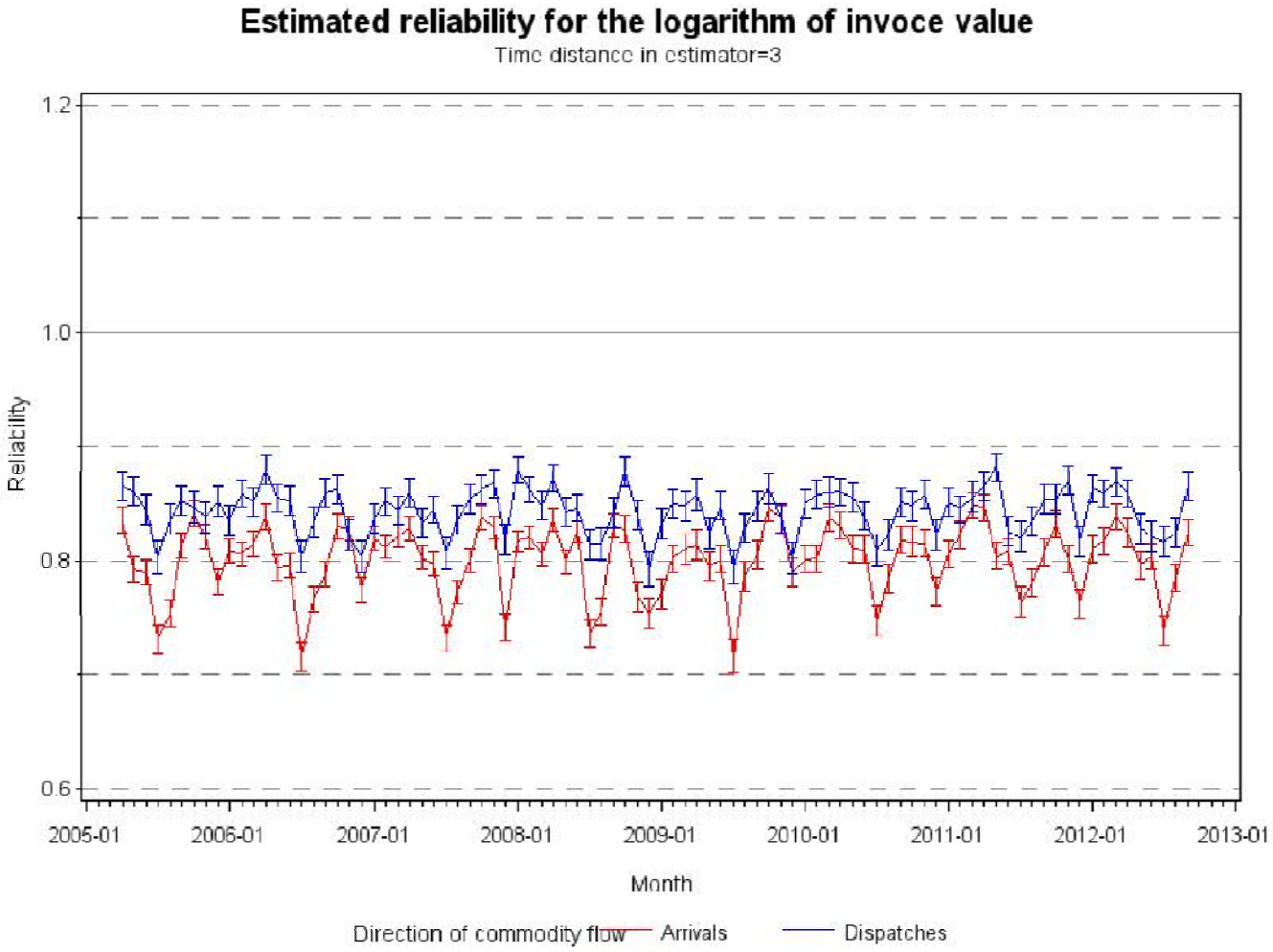
FIRST RESULTS

Intrastat: Arrivals and Dispatches



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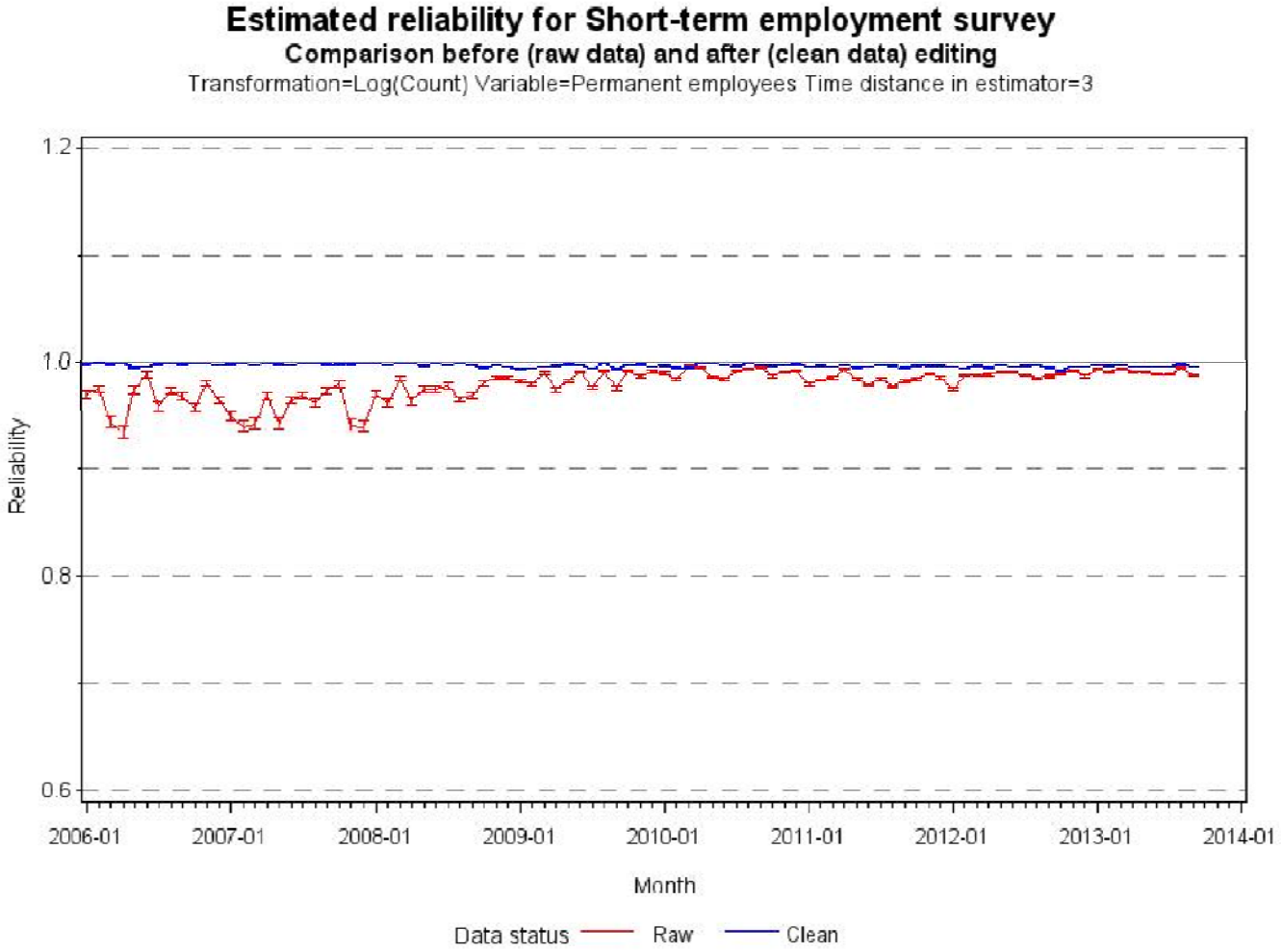
Remarks

- There are drops in the estimated reliability in July and December

STES: Permanent employees
Before and after editing process



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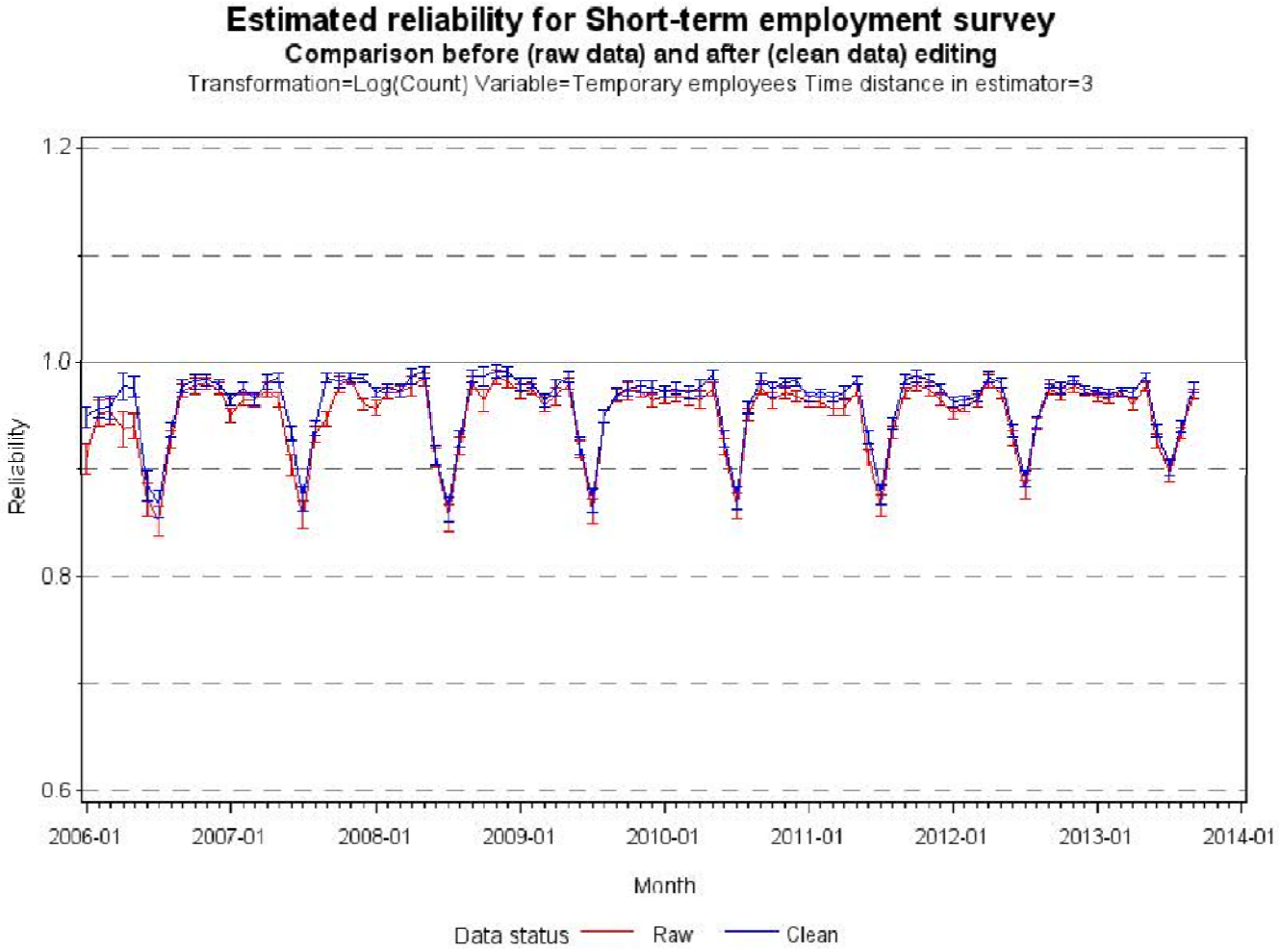
STES: Temporary employees
Before and after editing process



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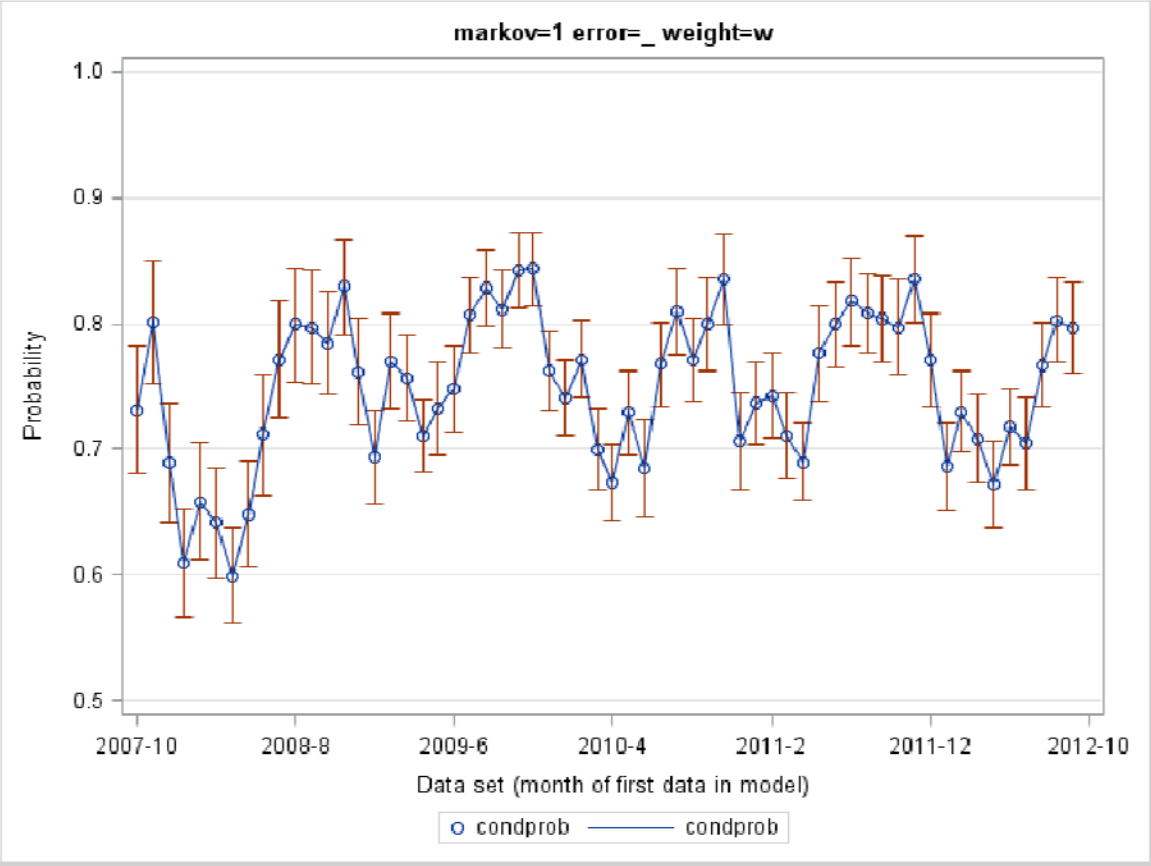
Remarks

- The estimated reliability was higher for data that had undergone the normal editing process compared to the raw uncorrected data
- There are drops in the estimated reliability in July

LFS: Probability to classify an unemployed person as unemployed



Weighted data, 1st order markov; time homogeneous classification probabilities

lEM program was used for estimating the markov latent class models. Vermunt, J.K. (1997). LEM: A General Program for the Analysis of Categorical Data. Department of Methodology and Statistics, Tilburg University"

Remarks

- There is a 12 months cycles are present

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A SECOND LOOK

Intrastat – VAT values

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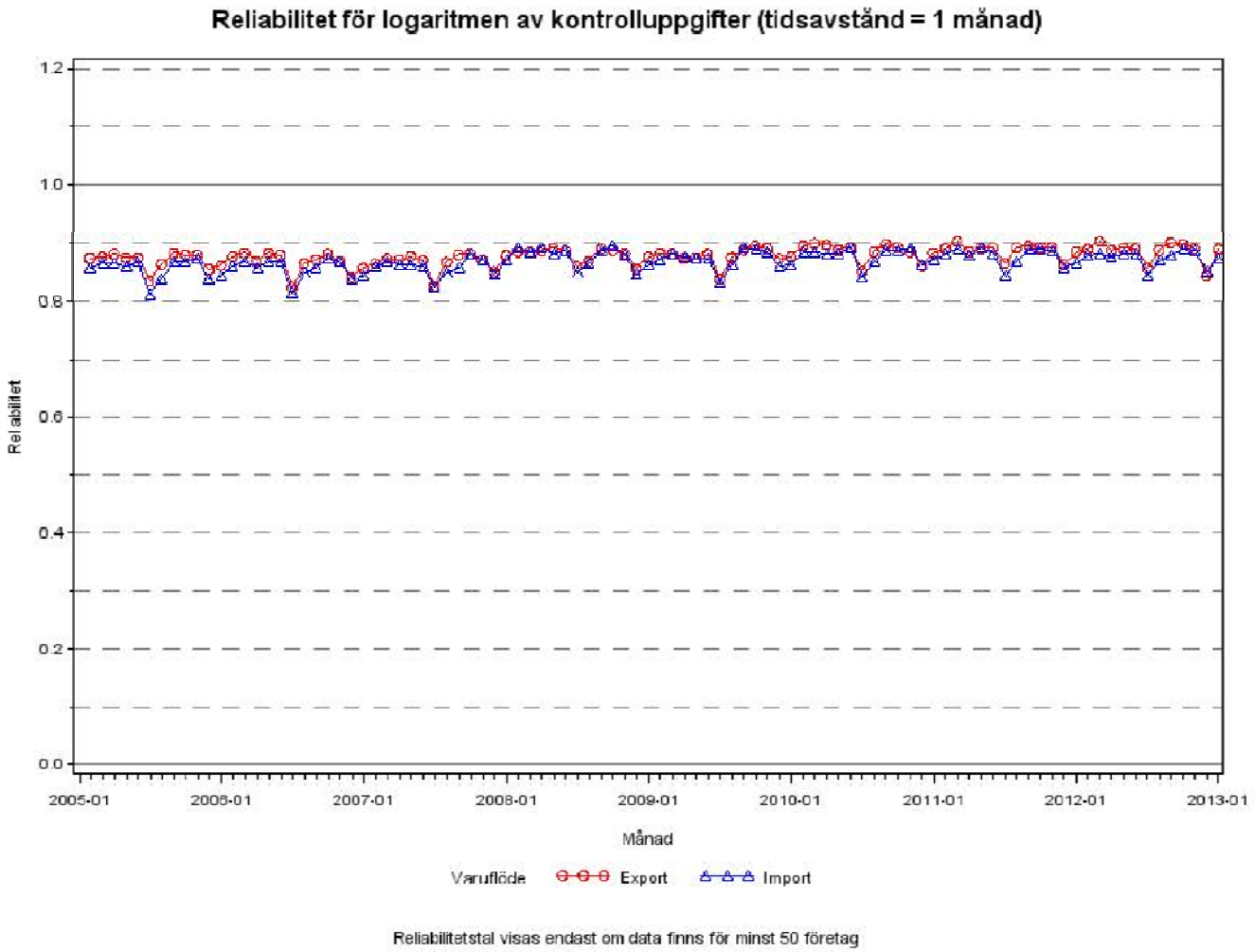

Remarks

- The VAT values reported has similar estimated reliability as the values derived from the invoices
- The VAT could be regarded as close to the true value

Intrastat – time distance 3 months

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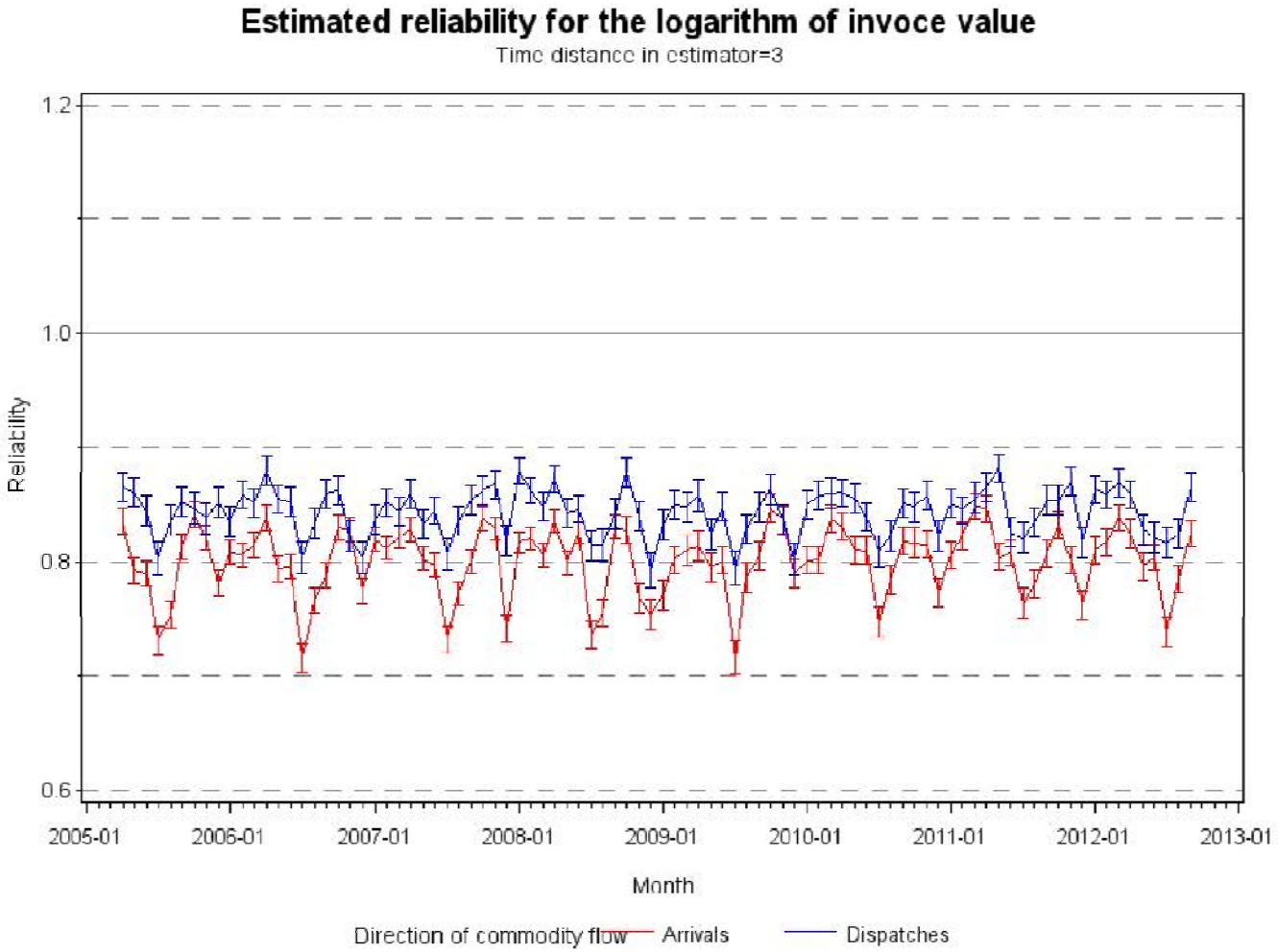

Intrastat – time distance 6 months

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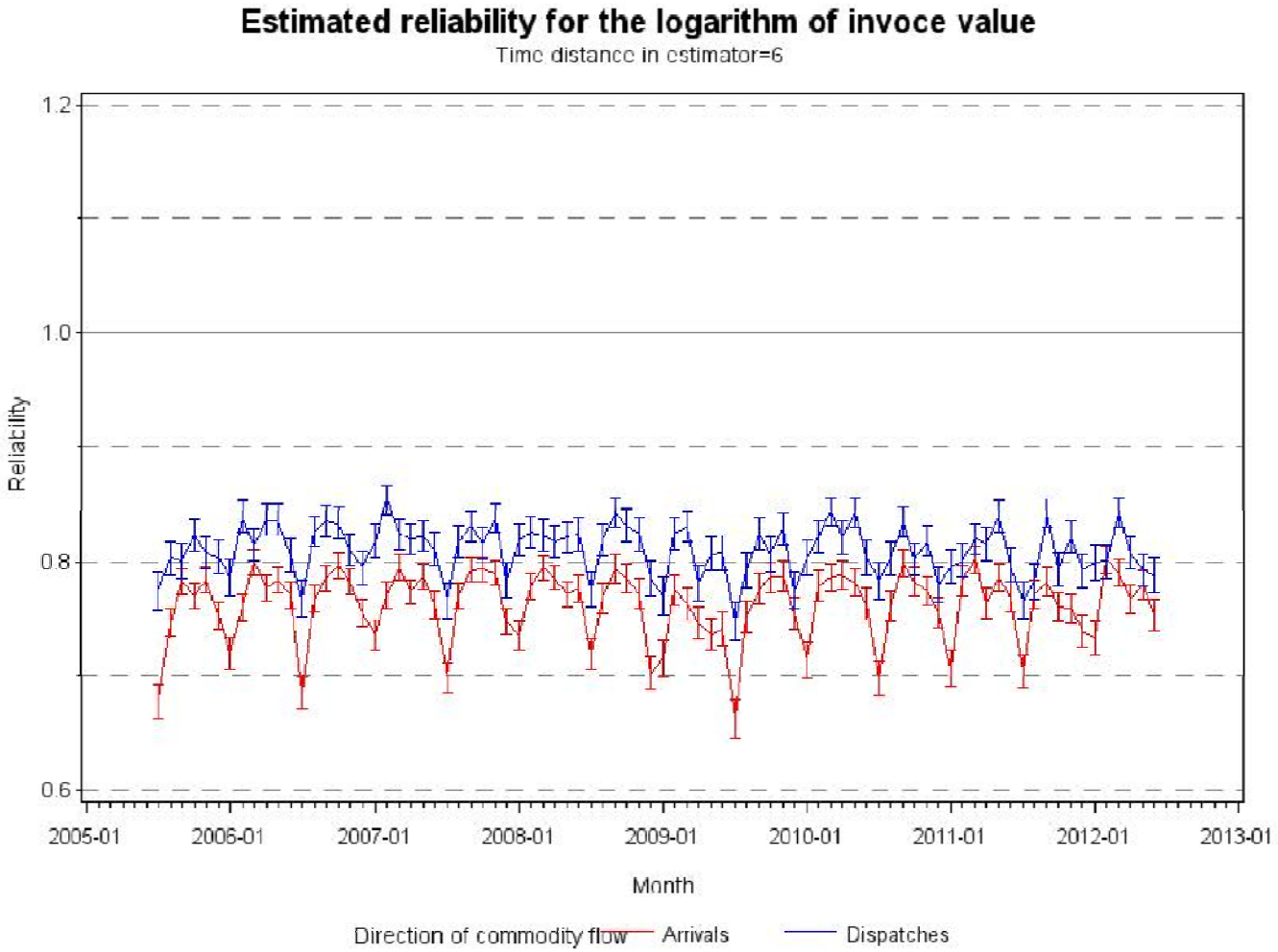

Intrastat – time distance 12 months

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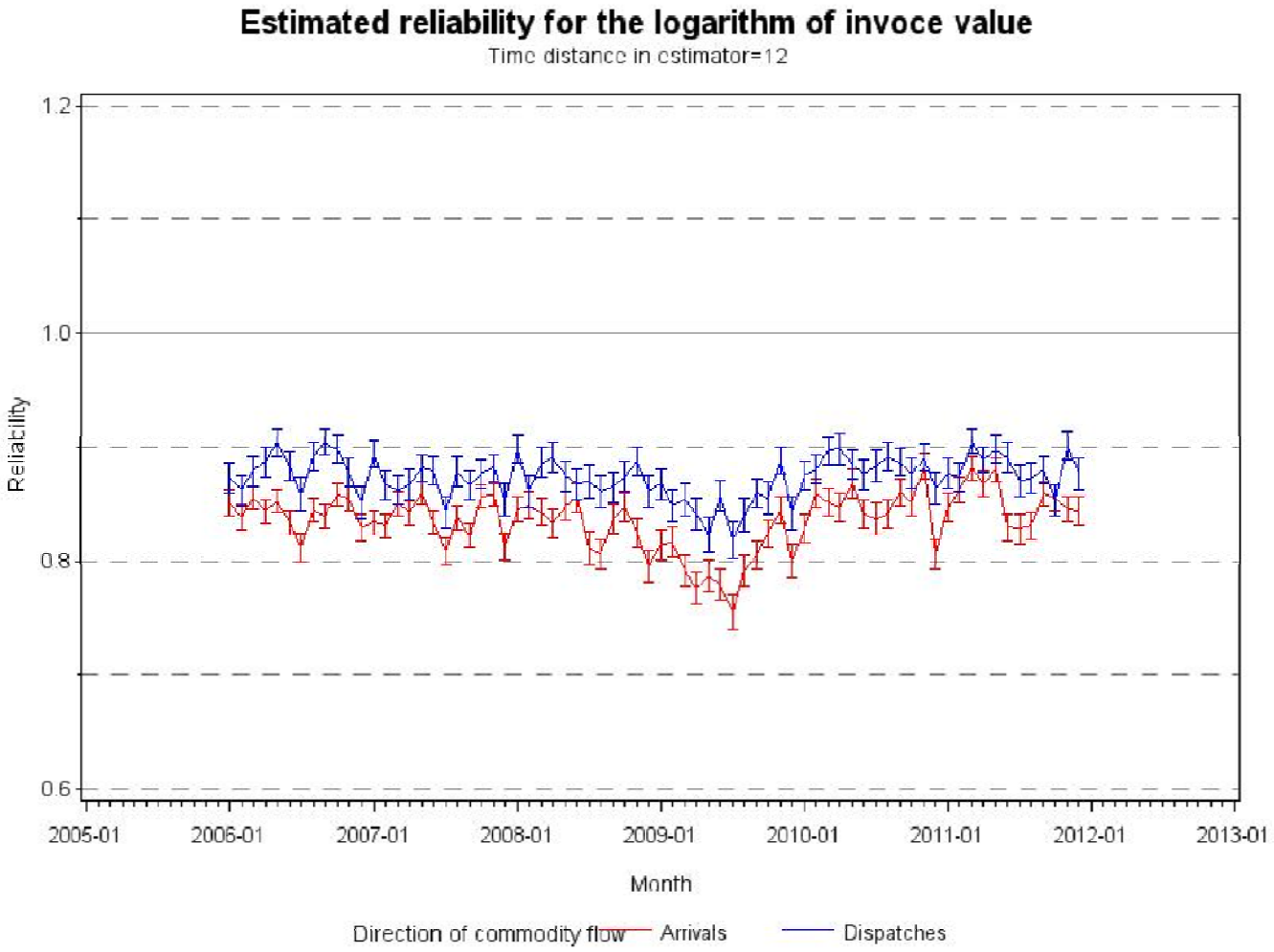
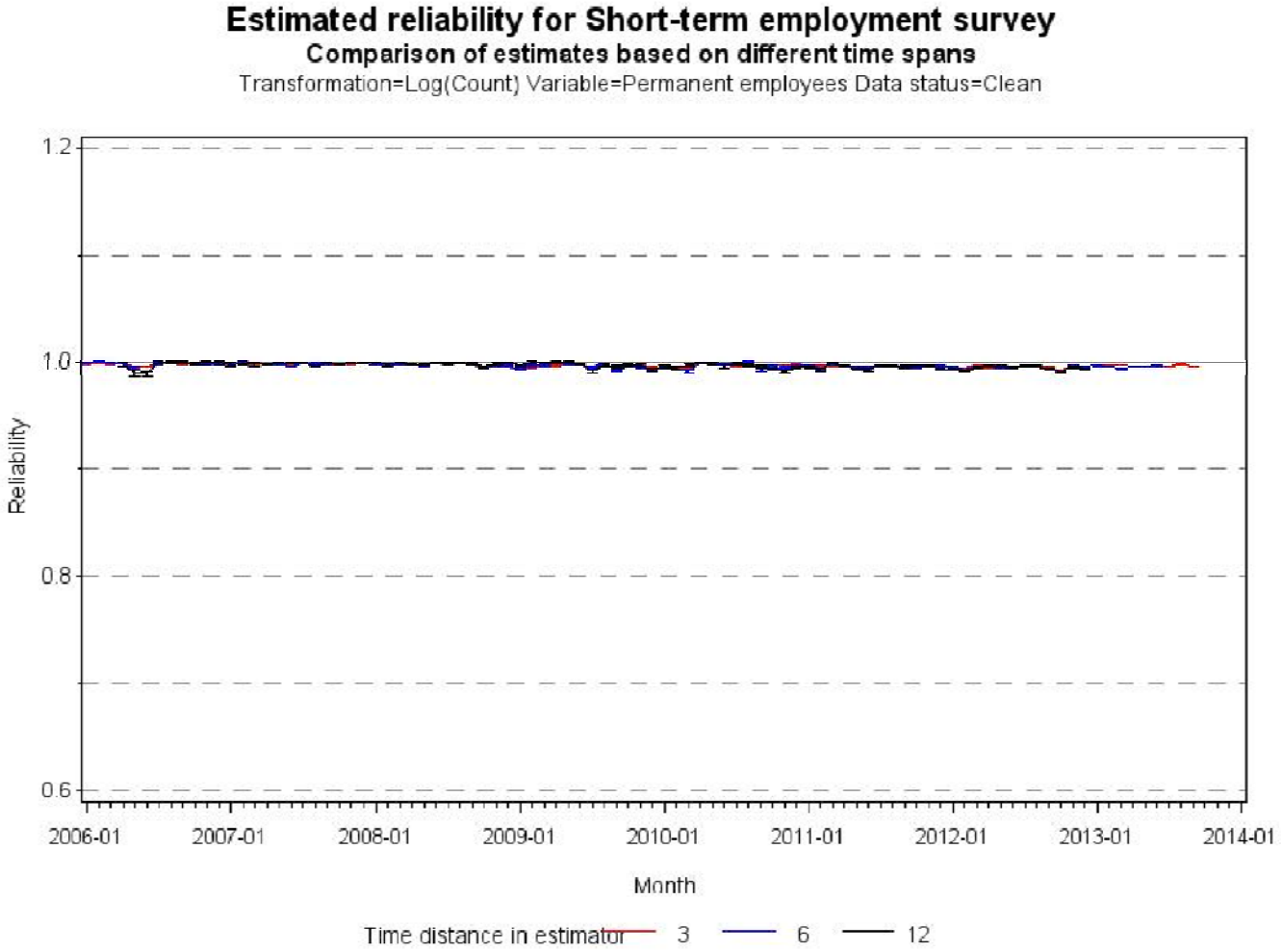


Remarks

- The estimated reliability with 6 months time differences is lower than an estimate with 3 months difference
- The estimated reliability with 12 months time differences does not exhibit the ”drops” and are about the same magnitude as the 3 months difference

- Suggests that there are within object variability that is not captured by the autoregressive process
- The model would then underestimate the true reliability

STES – Permanent employees 3, 6, and 12 months apart



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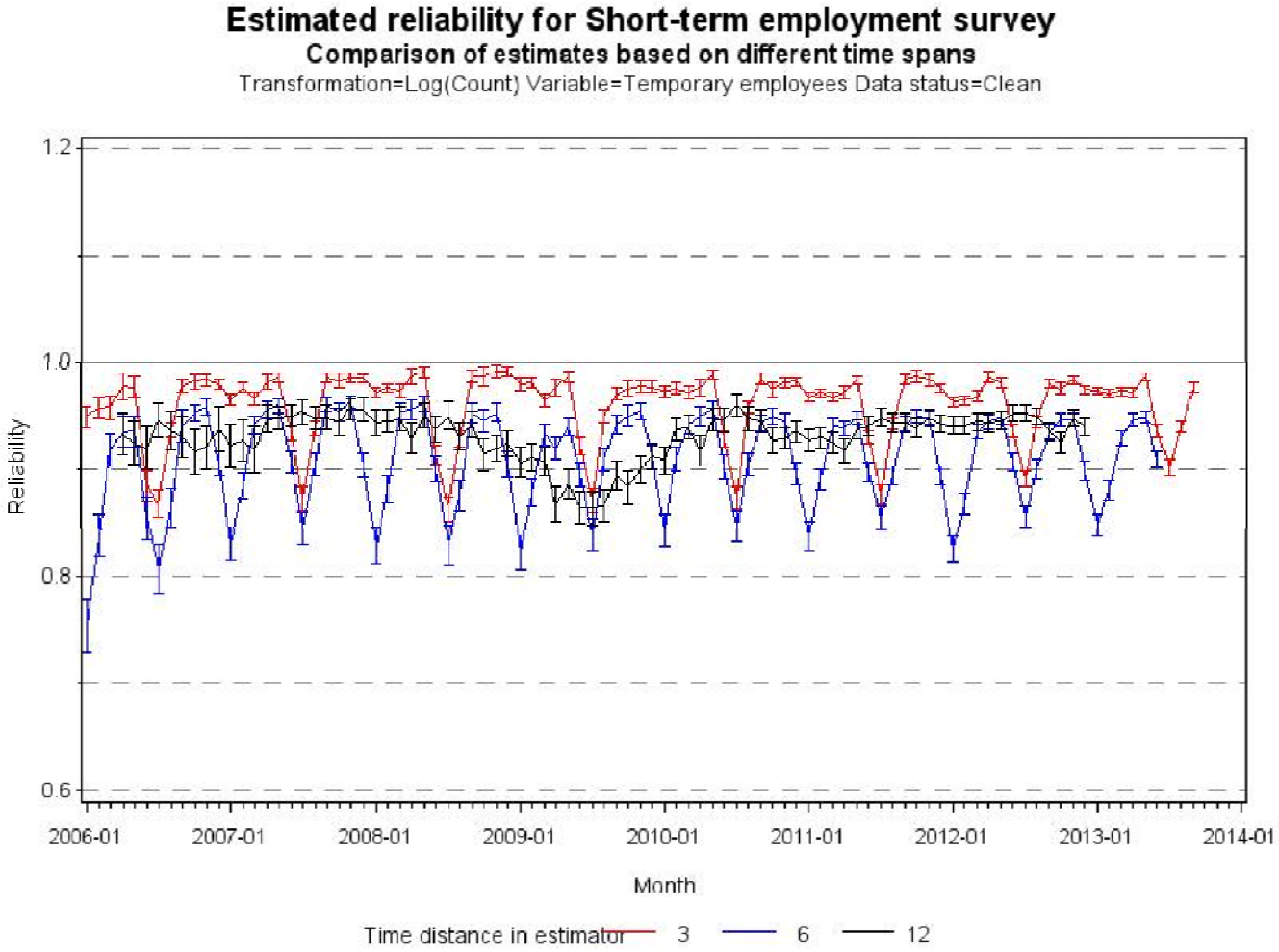
STES – Temporary employees 3, 6, and 12 months apart



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Remarks

- Nothing happens with the permanent employees, so the reliability could be regarded as almost 1

- Temporary employees, there is a seasonal pattern, which disappears in the 12 months curve
- Thus, the model could adjust for seasonal effects,
- but look at the drop 2009, which might be due to a recession. In order for the model to adjust for an economic cycle we would need data for at least two complete cycles

LFS: Comparison with a reinterview study

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Results from LFS reinterview study

	Obs. EMP	Obs. UNE	Obs. NLF
True EMP	0.986	0.004	0.010
True UNE	0.044	0.866	0.088
True NLF	0.003	0.003	0.994

Data from LFS (Dec12, Mar13, Jun13)

	Obs. EMP	Obs. UNE	Obs. NLF
True EMP	0.991	0.006	0.004
True UNE	0.036	0.858	0.107
True NLF	0.003	0.009	0.988

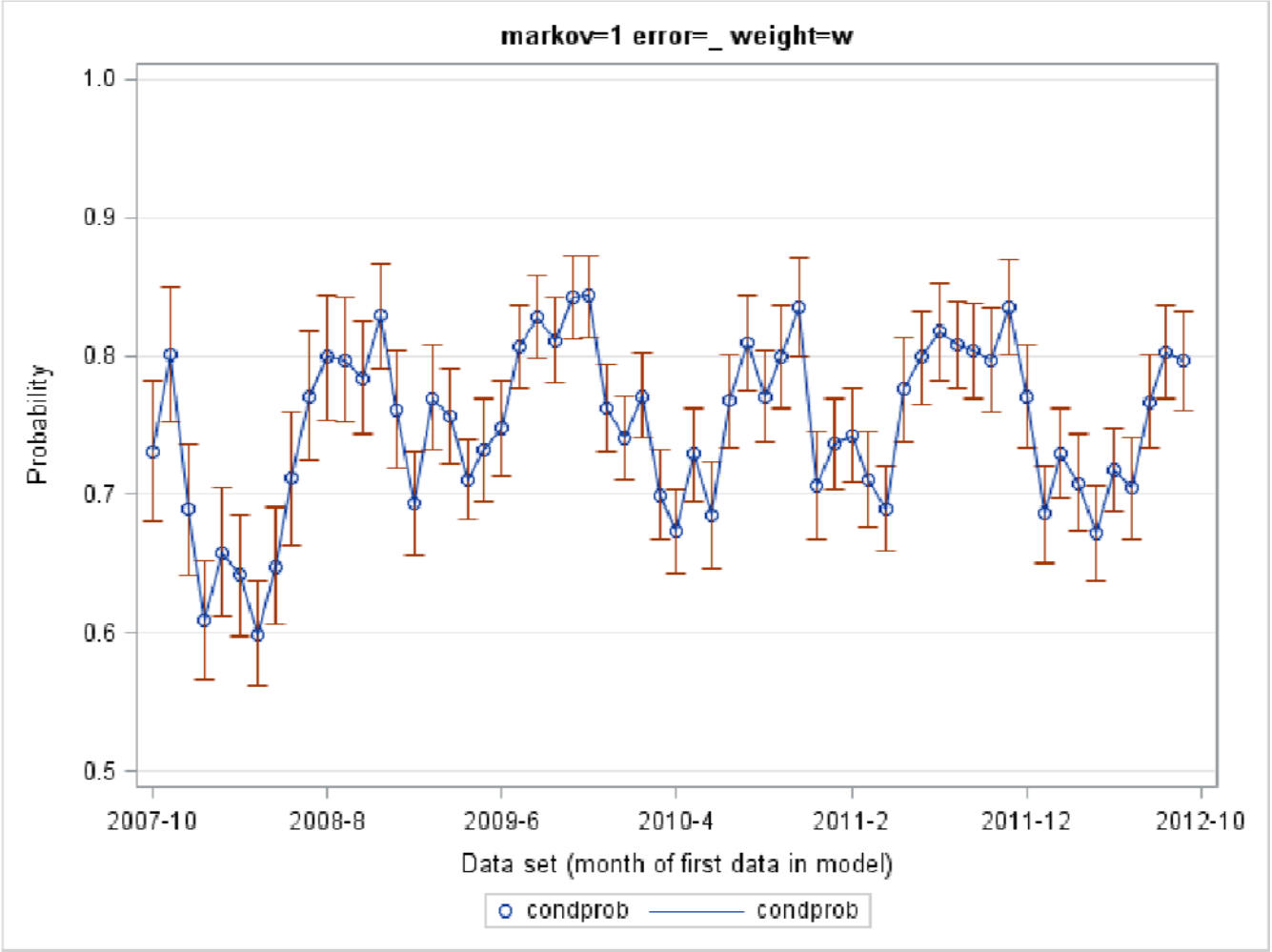
The transition probabilities from time 1 to time 2 might be different from the transition probabilities from time 2 to time 3. The classification probabilities are the same at the three time points.
Assumptions:
First order Markov property, i.e. the state a person is in at time 3 depend on the state it was in at time 2 but not the state it was in time 1.
The classifications of a person at two time points are independent.

lEM program was used for estimating the markov latent class models. Vermunt, J.K. (1997). LEM: A General Program for the Analysis of Categorical Data. Department of Methodology and Statistics, Tilburg University"

Remarks

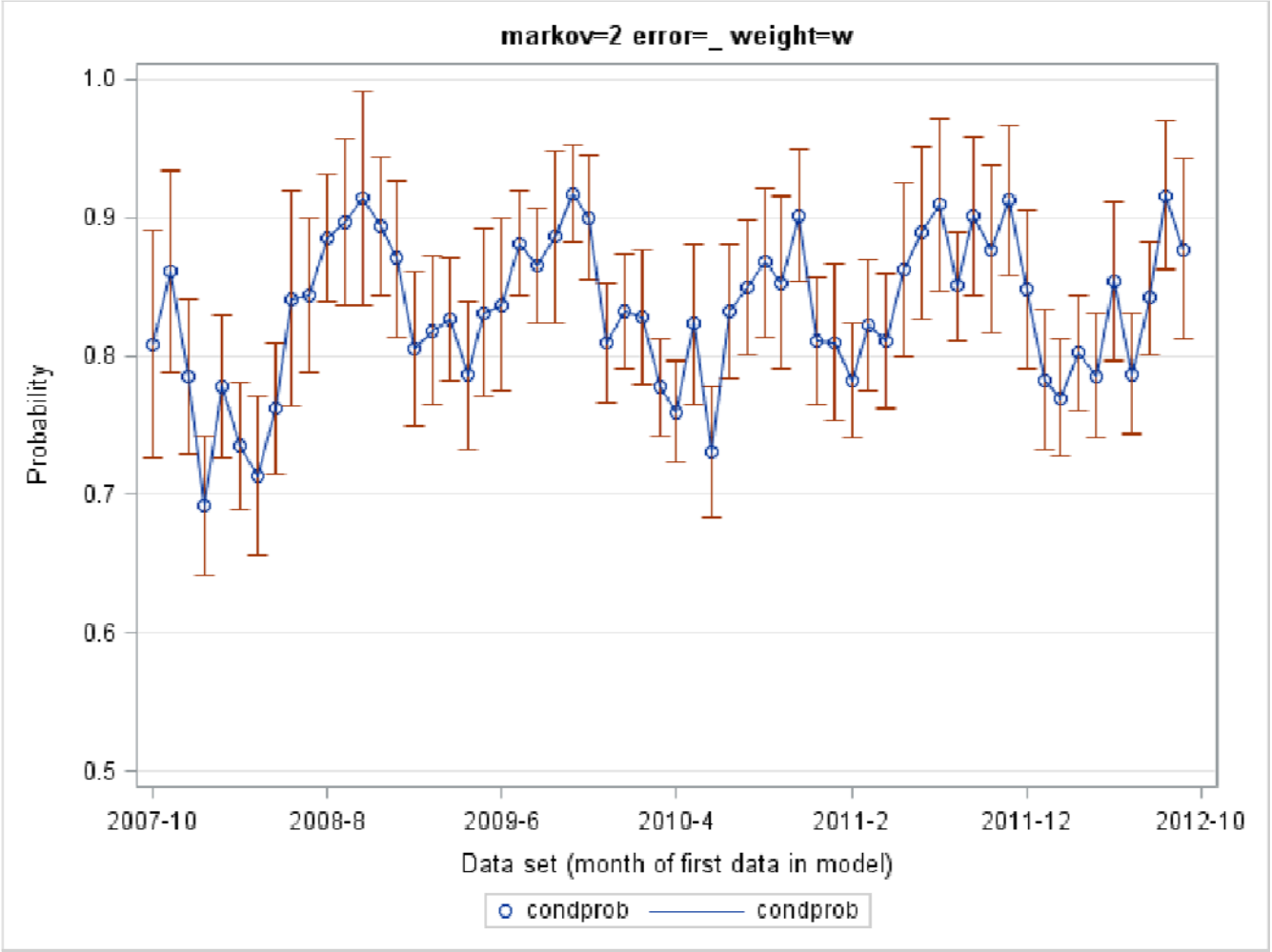
- The classification probabilities are similar to the reinterview study

LFS: Weighted data, 1st order markov; time homogeneous classification probabilities



lEM program was used for estimating the markov latent class models. Vermunt, J.K. (1997). LEM: A General Program for the Analysis of Categorical Data. Department of Methodology and Statistics, Tilburg University"

LFS: Weighted data, 2nd order markov; time homogeneous classification probabilities



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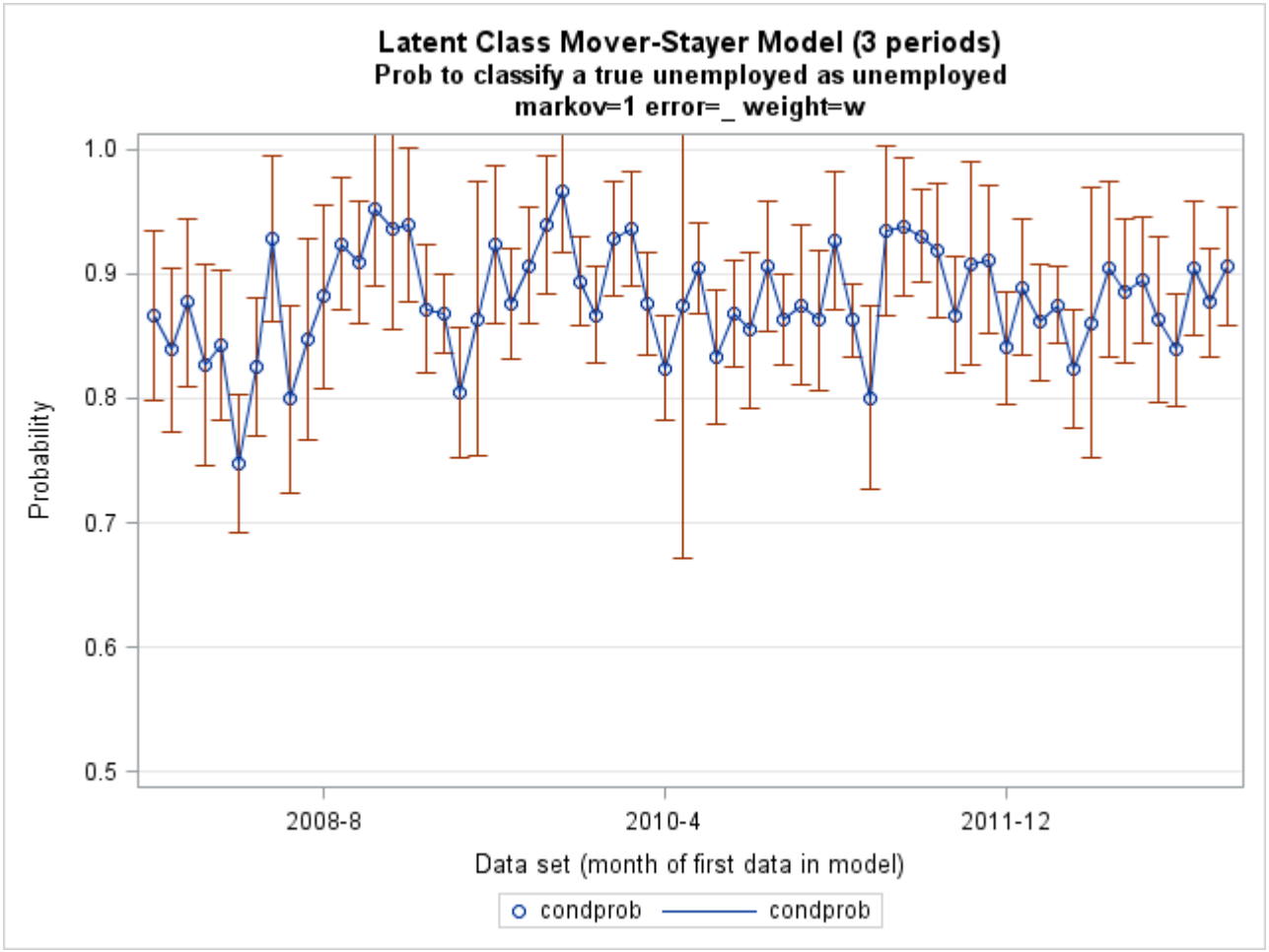
Remarks

- A second order markov latent class model fits the data better, and gives higher classification probabilities for classifying an unemployed as unemployed

- Still there is a visible 12 months cycle

LFS: 3 periods Mover stayer model Probability to correct classify an unemployed



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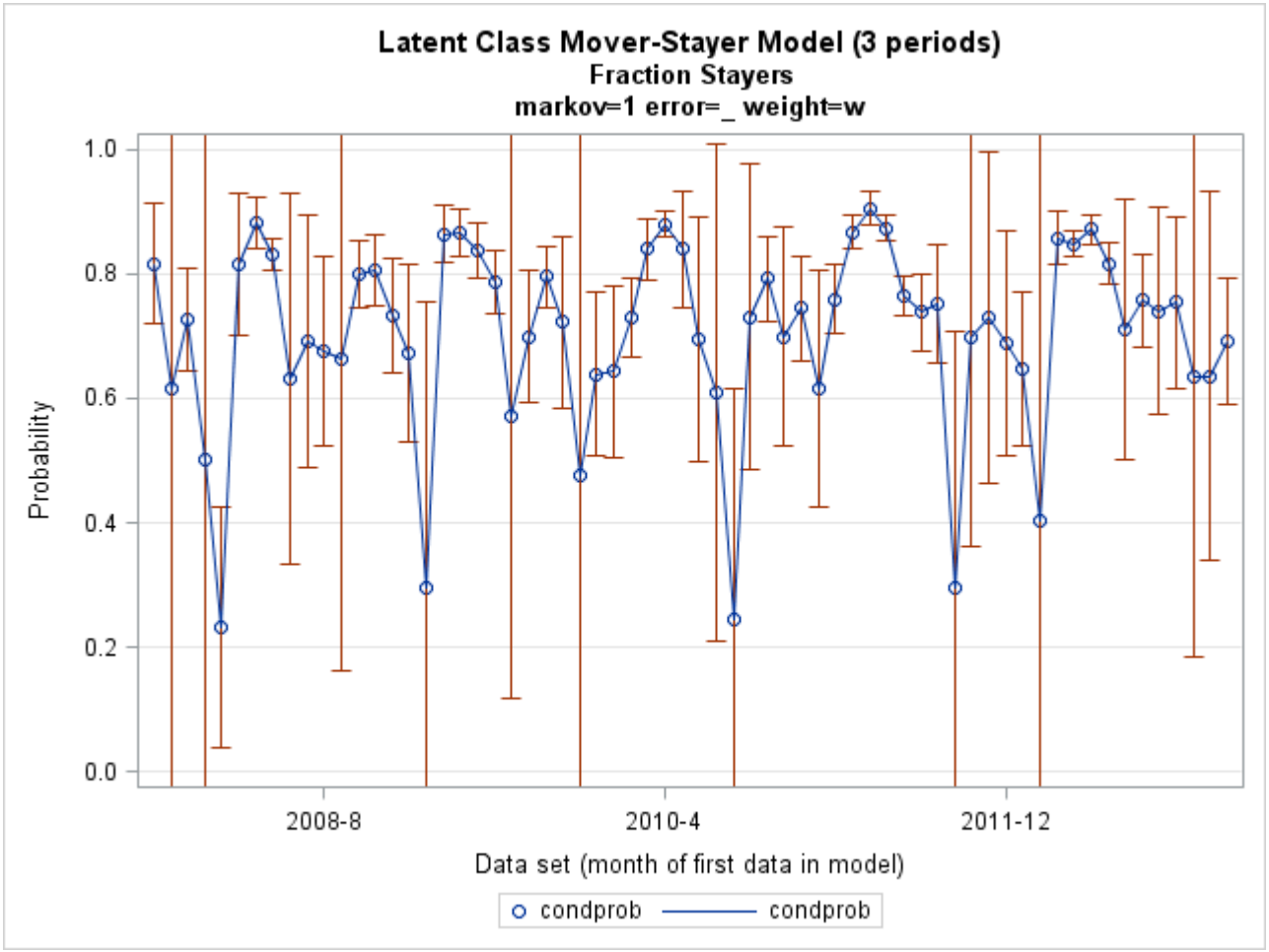
LFS: 3 periods Mover stayer model Estimated fraction stayer



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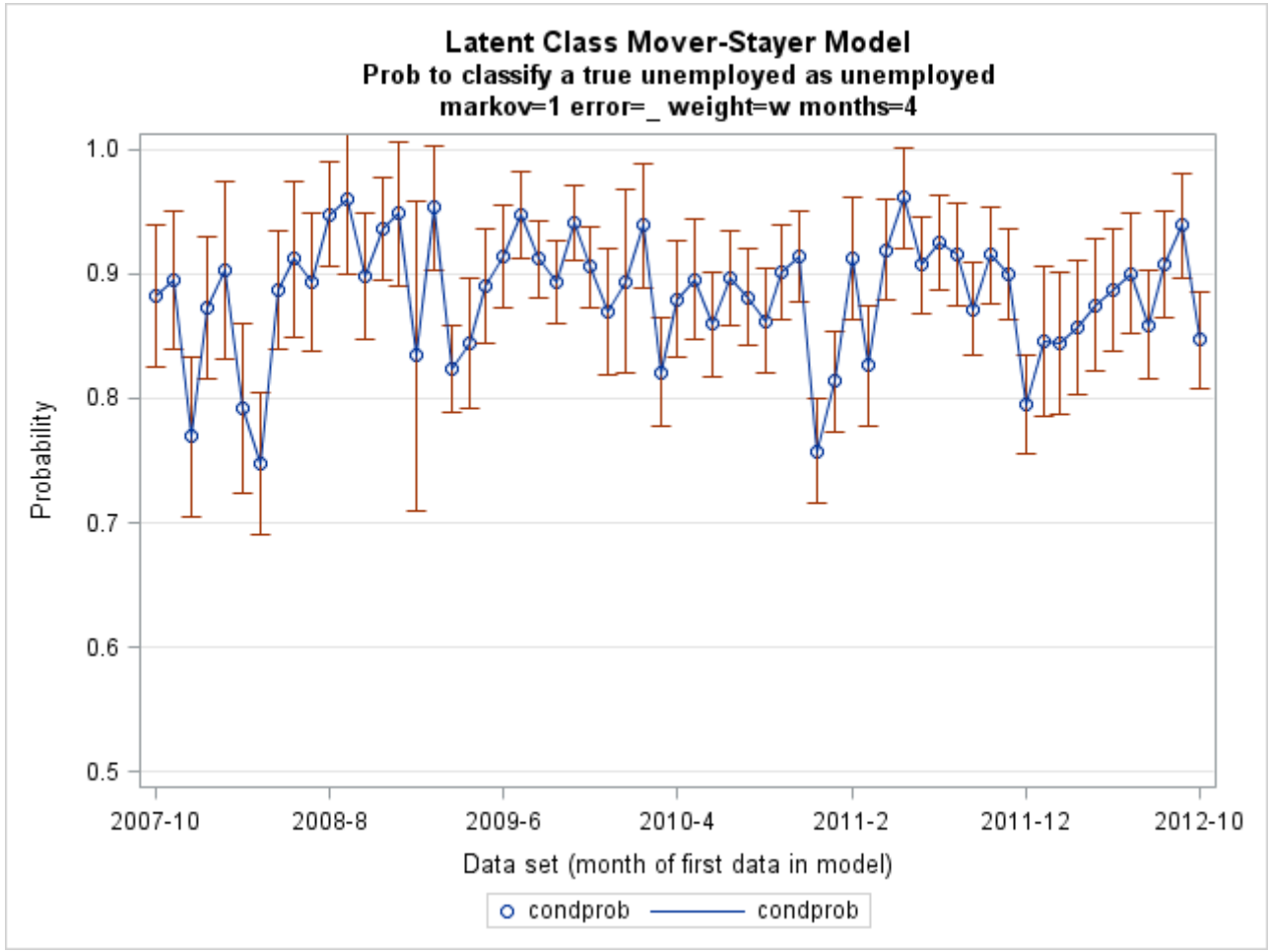
LFS: 4 periods 1st Markov Mover stayer model Probability to correct classify an unemployed



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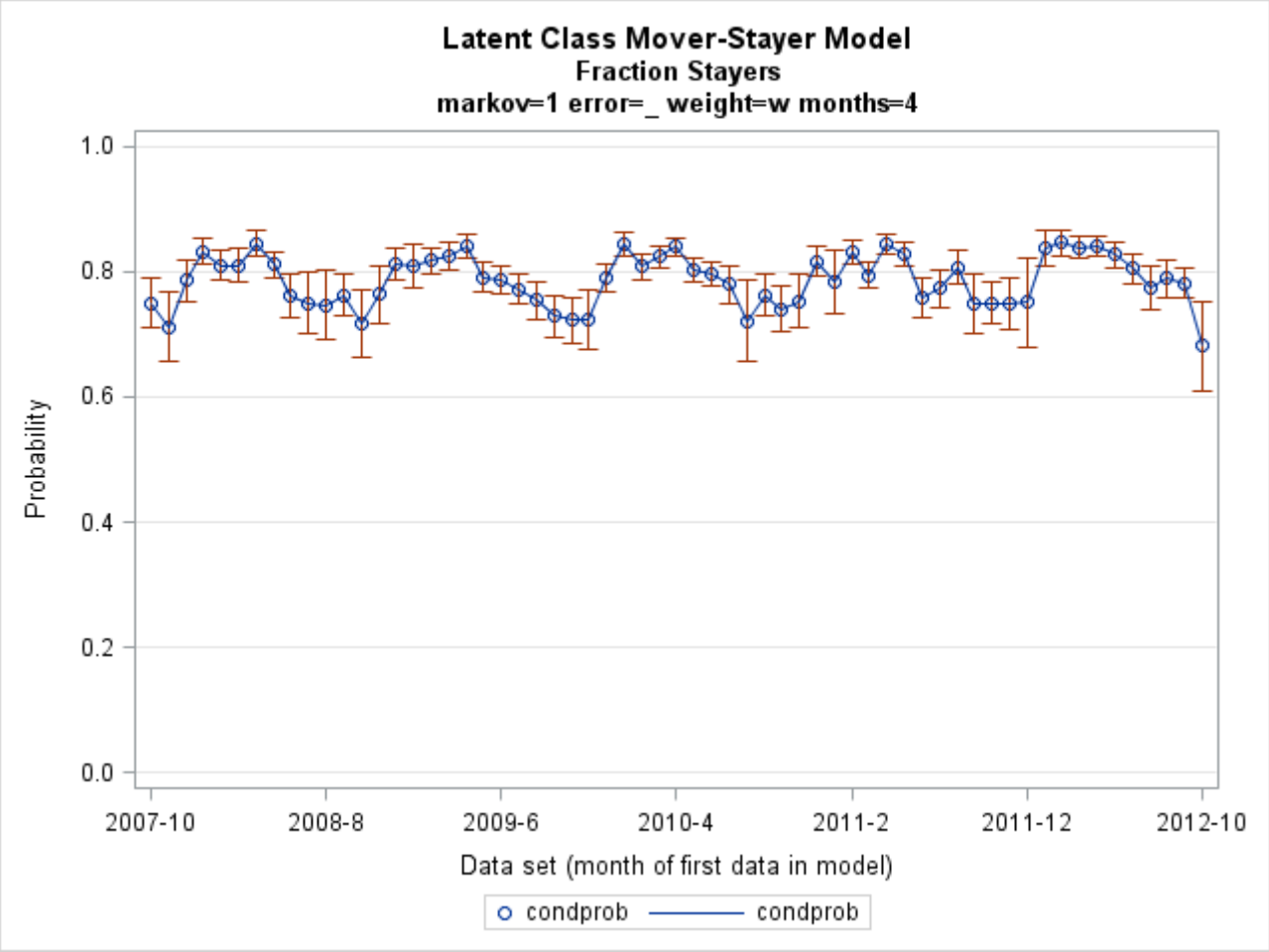
LFS: 4 periods 1st Markov Mover stayer model Estimated fraction stayer



lEM program was used for estimating the markov latent class models. Vermunt, J.K. (1997). LEM: A General Program for the Analysis of Categorical Data. Department of Methodology and Statistics, Tilburg University"

Remarks

- At least 4 time period are needed in order to stabilize the estimation of the mover stayer model

Conclusions

- The Markov quasi-simplex model could pick up an effect of editing
- The Markov quasi-simplex model is sensitive to
  - seasonal effects
  - extra within object variability

- A simple three time points Markov latent class model did not fit the labor status data. A mover stayer model over 4 time points seems better