Did the COVID-19 pandemic impact income mobility and distribution?

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Overview

- Goal of the investigation (what, how, general results)
- Literature – state of the art
- Description of data and empirical methodology
- Results and discussion
- Possible improvements

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Aim of the investigation

What: measuring employee income mobility during the first year of COVID-19 and, as a further result, offering evidence of the progressive effect of short-term work schemes.

- Pertains to the stream or research devoted to the income distribution dynamics during the pandemic (and the effect of monetary measures to counteract the regressive effects of COVID-19);
- Offers very granular information about the change in income status of employees.

Source of novelty: innovative use of the Labour Force Survey (LFS) database and peculiar use and interpretation of income mobility.

Strengths: simple replicability and extensions of the results.

General results: the analysis, carried on up to the quintile level, provides evidence of the progressivity of the cushioning measures, particularly the short-term work schemes. Six EU Member States are being examined, and the research compares the first year of COVID-19 to a baseline scenario (2019). The COVID-19-induced crisis is also compared to prior financial and sovereign debt crises.

Literature – state of the art

- Ad hoc survey-based literature (Clark et al. 2021; Menta 2021)
- Microsimulation model-based literature (Almeida et al. 2020 and 2021; Christl et al. 2021 and 2022; Cantò et al., 2021)
- Eurostat experimental statistics for poverty and inequality

Methodology (I)

- **Data**: EU Labour Force Survey (LFS) for the pre-Covid-19 scenario (2019 or 2018) and for the Covid-19 scenario (2020)
  - UpToDate data;
  - Including, among others, information on the activity status, and the position of the individuals within the income distribution;
  - Long time series that allows for comparison with the financial and sovereign debt crisis;
  - Rotational structure that permits, for each wave (i.e., within the same year), some longitudinal analysis (Mack et al. 2016);
  - Main variable of interest is INCDECIL, which is based on the monthly net (take-home) pay of employees (i.e., self-employed and family workers are excluded) belonging to the age bracket 16-74.
- **Selection of the EU Member States:** Greece, Ireland, Italy, and Portugal, particularly hit also by the sovereign debt crisis, Denmark as representative of the Northern countries and Estonia as representative of the Baltic countries.

Methodology (II)

- **Transition matrices**: The availability of the INCDECIL variable, together with the 'within wave' longitudinal dimension of LFS, allows for an analysis of income mobility from one quarter to another within a specific year by using transition matrices.

Indicating with k the possible 'status' that the individual can belong to and indicating with nij, where i, j = 1… k, the number of individuals who in the sample belong to class i at time t and to class j at time t + 1, a transition matrix P of order (e.g. 5) is defined as:

where each element of the matrix pij is calculated as $\left[\frac{n_{ij}}{n_i}\right] \in [0,1]$

$$P \equiv \begin{vmatrix} p_{11} & p_{12} & p_{13} & p_{14} & p_{15} \\ p_{21} & p_{22} & p_{23} & p_{24} & p_{25} \\ p_{31} & p_{32} & p_{33} & p_{34} & p_{35} \\ p_{41} & p_{42} & p_{43} & p_{44} & p_{45} \\ p_{51} & p_{52} & p_{53} & p_{54} & p_{55} \end{vmatrix}$$

The rows are the origin (t) and the columns are the destination (t+1).

The pij is estimated from the empirically observed frequencies, or by the proportion of individuals passing from i to j. The main diagonal of the transition matrix describes the 'stayers'. Out of the diagonal, there are the 'movers'.

Methodology (III)

- **Mobility indexes**:

$$IR = \frac{trace\ (P)}{k} = \frac{1}{k}\sum_{i=j}^{k} p_{ij} \qquad (1)$$

$$M_{BB} = 1 - \frac{trace\ (P)}{k} \qquad (2)$$

$$M_B = \frac{1}{k}\sum_{i=1}^{k}\sum_{i=1}^{k}\left|i-j\right| p_{ij} \qquad (3)$$

$$M_P = \frac{\frac{2}{k(k+1)}\sum_{i=1}^{k}(k+1-i)\sum_{i\neq j}^{k}|\,i-j\,|^{\alpha}\ p_{ij}}{\left(\frac{2}{k}\right)\sum_{i=1}^{(k-1)/2}\left|i-k\right|^{\alpha} + \left(\frac{1}{k}\right)\left(\frac{k-1}{2}\right)^{\alpha}} \qquad (4)$$

Methodology (IV)

- **Mobility indexes**:

$$M_{BB} = M_{BB_U} + M_{BB_D} \qquad (5)$$

$$M_{BB_U} = \frac{1}{k}\sum_{i=1}^{k-1}\sum_{j=i+1}^{k} p_{ij} \qquad (5.1)$$

$$M_{BB_D} = \frac{1}{k}\sum_{i=2}^{k}\sum_{j=1}^{i-1} p_{ij} \qquad (5.2)$$

$$M_{B} = M_{B_U} + M_{B_D} \qquad (6)$$

$$M_{B_U} = \frac{1}{k}\sum_{i=1}^{k-1}\sum_{j=i+1}^{k} p_{ij}\left|i-j\right| \qquad (6.1)$$

$$M_{B_D} = \frac{1}{k}\sum_{i=2}^{k}\sum_{j=1}^{i-1} p_{ij}\left|i-j\right| \qquad (6.2)$$

Methodology (V)

- **Mobility indexes**:

$$M_P = M_{P_U} + M_{P_D} \qquad (7)$$

$$M_{P_U} = \frac{\sum_{i=1}^{k-1} \tilde{w}_i \sum_{j=1+i}^{k} |\mathrm{i}-\mathrm{j}|^{\alpha}\ \mathrm{p}_{ij}}{\left(\frac{2}{k}\right)\sum_{i=1}^{(k-1)/2} |i-k|^{\alpha} + \left(\frac{1}{k}\right)\left(\frac{k-1}{2}\right)^{\alpha}} \qquad (7.1)$$

$$M_{P_D} = \frac{\sum_{i=2}^{k} \tilde{w}_i \sum_{i=1}^{i-1} |\mathrm{i}-\mathrm{j}|^{\alpha}\ \mathrm{p}_{ij}}{\left(\frac{2}{k}\right)\sum_{i=1}^{(k-1)/2} |i-k|^{\alpha} + \left(\frac{1}{k}\right)\left(\frac{k-1}{2}\right)^{\alpha}} \qquad (7.2)$$

Results (I)

- **First result:** the quantile mobility of employees tends to be higher in the COVID-19 scenario (2020) compared to the pre-COVID-19 scenario (2019). The higher overall mobility is likely to be a mix of the 'pure' pandemic-crisis effect, which negatively impacted the incomes, and of the cushioning effects.

- **Second result:** employee income mobility in 2020 is generally higher than it was during the financial crisis. The explanation for this disparity is, among others, related to the different nature of the impacts the two crises had on labour market outcomes.

Results (Table 1)

Table 1. Mobility indices, employee population 16-74-year-olds, 2019, 2020 and percentage points 2019-2020

	Bibby index			Bartholomew index		
	2019	2020	pp 2019-2020	2019	2020	pp 2019-2020
DK	31.9	31.8	-0.12	40.85	40.90	0.05
EE	38.2	40.6	2.40	50.26	54.69	4.43
EL	4.2	15.4	11.22	5.67	18.41	12.74
IE	13.1	13.3	0.19	15.74	16.81	1.07
IT	37.4	42.1	4.75	50.07	58.54	8.47
PT	30.0	31.5	1.52	34.02	35.29	1.27

Source: Authors' calculation on Eurostat EU LFS data 2019 and 2020.

Note: The Bibby index varies between 0 and 1 (with 0 maximum immobility and 1 maximum mobility). Bartholomew index has the same lower bound (with 0 maximum immobility), but the upper bound may exceed 1. Here the indices are expressed between 0 and 100.

Results (Table 2)

Table 2. Mobility indices, employee population 16-74-year-olds, 2009, 2010, 2011, 2012 and 2020

	Bibby index					Bartholomew index				
	2009	**2010**	**2011**	**2012**	**2020**	**2009**	**2010**	**2011**	**2012**	**2020**
DK	34.57				31.8	45.25				40.9
EE	29.65				40.61	38				55
EL	4.27	1.64	3.16		15.39	4.86	1.85	3.69		18.41
IE	9.28		7.75		13.3	11.24		9.25		16.81
IT	41.28			43.79	42.14	57.72			60.71	58.54
PT	n.a.		27.43		31.51	n.a.		31.84		35.29

Source: Authors' calculation on EU LFS data, 2009, 2010, 2011, 2012, 2019 and 2020.
Note: The Bibby index varies between 0 and 1 (with 0 maximum immobility and 1 maximum mobility). Bartholomew index has the same lower bound (with 0 maximum immobility), but the upper bound may exceed 1. Here the indices are expressed between 0 and 100.

Results (Table 3)

Table 3. Unemployment rate and transitions rate from employment to unemployment, 2009-2020

	Transition employment - unemployment expressed as the percentage of total employment											
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
DK	n.a.	n.a.	3.30	3.10	3.10	3.00	2.60	2.60	2.50	2.50	2.30	2.70
EE	n.a.	n.a.	3.30	2.40	3.10	2.50	2.40	2.70	2.20	2.40	2.10	3.50
EL	n.a.	n.a.	5.90	7.80	5.50	2.90	2.50	2.60	2.20	1.60	1.50	2.80
IE	n.a.	n.a.	4.20	3.80	2.80	2.80	2.20	2.00	1.80	n.a.	1.40	2.30
IT	n.a.	n.a.	2.20	2.80	3.10	2.70	2.30	2.50	2.30	2.20	2.00	2.30
PT	n.a.	n.a.	n.a.	6.60	6.00	3.90	3.80	3.50	2.50	2.40	2.40	3.00
	Unemployment Rate (15-74, y.o.) expressed as the percentage of the population in the labour force											
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
DK	6.40	7.70	7.80	7.80	7.40	6.90	6.30	6.00	5.80	5.10	5.00	5.60
EE	13.50	16.60	12.30	9.90	8.60	7.30	6.40	6.80	5.80	5.40	4.50	6.90
EL	9.80	12.90	18.10	24.80	27.80	26.60	25.00	23.90	21.80	19.70	17.90	17.60
IE	12.60	14.60	15.40	15.50	13.80	11.90	9.90	8.40	6.70	5.80	5.00	5.90
IT	7.90	8.50	8.50	10.90	12.40	12.90	12.00	11.70	11.30	10.60	9.90	9.30
PT	11.20	12.60	13.50	16.60	17.20	14.60	13.00	11.50	9.20	7.20	6.70	7.00

Source: Eurostat, codes [une_rt_a] and [lfsi_long_a]

Note: The transition from employment to the unemployment rate is not ideal as it includes not only employees but also self-employed and other types of workers, but it does provide relevant information about the direction of the dynamics.

Results (II)

- **Third set of results:** the joint analysis of the four mobility indices indicated suggests that, in general, the quantile mobility of employees recorded during the first year of COVID-19 is higher than the one registered during the pre-pandemic. Nevertheless, for most of the Member States, the number of income quintiles crossed by the employees tends to stay limited. Furthermore, there is evidence supporting a positive effect of the cushioning measures, especially for those employees belonging to the lowest quintiles and, thus, of progressivity of the cushioning measures.

- **Fourth result:** based on the analysis of the upward and the downward components of the mobility indices, there is evidence of the progressivity of the cushioning measures adopted during the pandemic because the overall mobility is driven by downward mobility, whereas the upward mobility either decreases or increases less than the downward mobility.

Results (Table 4)

Table 4. Mobility indices, employees (16-74 y.o.), 2019, 2020, and percentage points 2019-2020

	Immobility ratio			Bibby index			Bartholomew index			Mobility index by Paul (2020)		
	2019	2020	pp 19-20	2019	2020	pp 19-20	2019	2020	pp 19-20	2019	2020	pp 19-20
DK	68.1	68.2	0.12	31.9	31.8	-0.12	40.85	40.90	0.05	12.79	12.82	0.03
EE	61.8	59.4	-2.40	38.2	40.6	2.40	50.26	54.69	4.43	15.92	17.07	1.14
EL	95.8	84.6	-11.22	4.2	15.4	11.22	5.67	18.41	12.74	1.80	6.35	4.54
IE	86.9	86.7	-0.19	13.1	13.3	0.19	15.74	16.81	1.07	4.90	5.08	0.18
IT	62.6	57.9	-4.75	37.4	42.1	4.75	50.07	58.54	8.47	15.50	18.39	2.89
PT	70.0	68.5	-1.52	30.0	31.5	1.52	34.02	35.29	1.27	12.30	12.38	0.07

Source: Authors' calculation on Eurostat EU LFS data 2019 and 2020.

Note: The Bibby index varies between 0 and 1 (with 0 maximum immobility and 1 maximum mobility). Bartholomew index has the same lower bound (with 0 maximum immobility), but the upper bound may exceed 1. The mobility index by Paul is normalized so it varies between 0 and 1. Here the indices are expressed between 0 and 100.

Results (Table 5)

Table 5. Index of upward and downward mobility as components of the Bibby and Bartholomew indices and mobility index by Paul (2020) 2019, 2020 and percentage points 2019-2020.

	Bibby upward			Bibby downward		
	2019	**2020**	**pp 19-20**	**2019**	**2020**	**pp 19-20**
DK	17.86	16.31	-1.54	14.07	15.49	1.42
EE	19.56	18.92	-0.64	18.65	21.68	3.03
EL	2.93	5	2.06	1.24	10.39	9.16
IE	5.79	7.02	1.23	7.32	6.28	-1.04
IT	19.58	21.28	1.7	17.81	20.86	3.05
PT	15.49	13.56	-1.93	14.49	17.95	3.45
	Bartholomew upward			**Bartholomew downward**		
	2019	**2020**	**pp 19-20**	**2019**	**2020**	**pp 19-20**
DK	22.74	21.36	-1.38	18.11	19.55	1.43
EE	25.49	25.89	0.4	24.76	28.8	4.03
EL	3.66	6.09	2.43	2.01	12.32	10.31
IE	7.36	8.91	1.55	8.38	7.91	-0.47
IT	26.22	29.87	3.65	23.85	28.67	4.82
PT	17.59	15.32	-2.28	16.43	19.97	3.54
	Mobility Index by Paul (2020) upward			**Mobility Index by Paul (2020) downward**		
	2019	**2020**	**pp 19-20**	**2019**	**2020**	**pp 19-20**
DK	8.77	8.4	-0.37	4.02	4.43	0.41
EE	10.12	10.68	0.56	5.81	6.39	0.58
EL	1.42	2.83	1.41	0.38	3.52	3.14
IE	2.87	3.51	0.64	2.03	1.57	-0.46
IT	10.27	11.96	1.69	5.23	6.43	1.2
PT	7.52	6.65	-0.87	4.78	5.73	0.95

Results (III)

Fifth set of results: when comparing the first year of COVID-19 with the baseline year it can be seen that, generally, a positive change in upward mobility limitedly affects only the first and, to some extent the second quintile, whereas the changes in the downward mobility are more pronounced as progressing towards higher quintiles. Thus, the dynamics recorded in the specific quintiles, and in particular in the first and the fifth quintiles, point towards a progressive design of the short-term work schemes for employees.

-in this case, is provided directly by referring to the transition matrices and by pattern, in this context, is meant the way the proportion of employees is distributed in a specific quintile;

1. The mobility of the first quintile shows the same or a better pattern in all the Member States. In Denmark, the pattern is very similar in the two years, the remaining countries show all-in-all, better patterns, while the only exception is represented by Portugal whose pattern is worse.
2. The mobility of the fifth quintile shows a worse pattern for all the Member States, without any exception.

- Conclusion similar to those in Christl et al.

Results (IV)

- Third quintile: The pattern of the third quintile tends to be similar as the proportion of downward movers tends to be higher in 2020 compared to 2019 across the Member States considered. As anticipated, this may be the result of the specific design of the measures, inter alia, the rate of wage replacement, as well as the presence of caps to the level of wage replacement. Example: Italy is generally said that 80 % of the gross salary is covered, nevertheless, the coverage is capped, implying that, de facto, the replacement rate may be substantially below 80 % for most workers. Indeed, the 'Cassa Integrazione Guadagni' ('in deroga'), that, in the explanation of Ceriani et al. (2020, p. 29), is a wage supplementation scheme 'for softening the impact of economic cycles on the labour market, allowing firms to keep their full workforce, who can work shorter hours while waiting for better economic conditions' in 2020, has a threshold of EUR 2 159. Income below the threshold can be compensated to a maximum of EUR 939, while incomes

- Second quintile: As regards the second quintile, the results are mixed and, overall, the proportion of upward movers is not that different when comparing 2020 and 2019;

- **Fourth quintile:** the proportion of downward movers tends to be higher in 2020 compared to 2019.

Results (Table 6)

Table 6. Transition matrices, 2019 and 2020

DENMARK (DK)

From Q_t to Q_{t+1} 2019					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.81**	0.13	0.03	0.02	0.01
2	0.09	**0.62**	0.21	0.05	0.03
3	0.03	0.17	**0.56**	0.2	0.04
4	0.02	0.04	0.16	**0.61**	0.17
5	0.01	0.02	0.03	0.14	**0.8**

From Q_t to Q_{t+1} 2020					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.8**	0.13	0.03	0.02	0.01
2	0.13	**0.61**	0.19	0.06	0.02
3	0.03	0.18	**0.58**	0.16	0.04
4	0.01	0.04	0.16	**0.63**	0.15
5	0.01	0.02	0.04	0.15	**0.78**

ESTONIA (EE)

From Q_t to Q_{t+1} 2019					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.72**	0.19	0.05	0.03	0.02
2	0.19	**0.57**	0.16	0.06	0.02
3	0.05	0.18	**0.48**	0.24	0.05
4	0.04	0.05	0.2	**0.54**	0.17
5	0.02	0.02	0.05	0.14	**0.78**

From Q_t to Q_{t+1} 2020					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.69**	0.19	0.05	0.03	0.03
2	0.19	**0.55**	0.19	0.05	0.02
3	0.06	0.2	**0.51**	0.19	0.04
4	0.02	0.06	0.25	**0.52**	0.15
5	0.03	0.02	0.07	0.19	**0.69**

GREECE (EL)

From Q_t to Q_{t+1} 2019					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.95**	0.03	0.01	0	0
2	0.01	**0.95**	0.03	0.01	0
3	0	0.01	**0.97**	0.01	0.01
4	0	0.01	0.01	**0.95**	0.04
5	0	0.01	0.01	0.01	**0.97**

From Q_t to Q_{t+1} 2020					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.82**	0.15	0.02	0	0
2	0.08	**0.88**	0.02	0.01	0
3	0.04	0.29	**0.65**	0.01	0.01
4	0.01	0.01	0.05	**0.91**	0.02
5	0	0.01	0.01	0.03	**0.96**

Results (Table 6 cont.)

Table 6. Transition matrices, 2019 and 2020

IRELAND (IE)

From Q_t to Q_{t+1} 2019					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.93**	0.04	0.02	0.01	0
2	0.06	**0.85**	0.07	0.02	0.01
3	0.01	0.1	**0.82**	0.06	0.01
4	0.01	0.01	0.09	**0.83**	0.06
5	0	0	0.01	0.08	**0.91**

From Q_t to Q_{t+1} 2020					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.91**	0.06	0.02	0.01	0
2	0.05	**0.84**	0.08	0.02	0.01
3	0.01	0.03	**0.85**	0.09	0.02
4	0.01	0.01	0.07	**0.86**	0.05
5	0.01	0.01	0.02	0.1	**0.86**

ITALY (IT)

From Q_t to Q_{t+1} 2019					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.76**	0.16	0.05	0.03	0.01
2	0.14	**0.57**	0.19	0.07	0.03
3	0.04	0.18	**0.52**	0.2	0.07
4	0.02	0.07	0.19	**0.53**	0.18
5	0.01	0.03	0.06	0.15	**0.75**

From Q_t to Q_{t+1} 2020					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.71**	0.17	0.06	0.04	0.02
2	0.18	**0.51**	0.19	0.08	0.04
3	0.06	0.21	**0.46**	0.2	0.07
4	0.03	0.08	0.2	**0.5**	0.19
5	0.01	0.04	0.07	0.17	**0.72**

PORTUGAL (PT)

From Q_t to Q_{t+1} 2019					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.63**	0.3	0.05	0.01	0
2	0.26	**0.57**	0.15	0.02	0
3	0.05	0.16	**0.67**	0.12	0
4	0.01	0.02	0.13	**0.73**	0.12
5	0	0	0.01	0.1	**0.89**

From Q_t to Q_{t+1} 2020					
Quintiles	**1**	**2**	**3**	**4**	**5**
1	**0.66**	0.28	0.05	0.01	0
2	0.3	**0.54**	0.14	0.01	0
3	0.06	0.19	**0.67**	0.08	0
4	0.01	0.01	0.17	**0.71**	0.1
5	0	0	0	0.15	**0.85**

Limitations and improvements

- Limitation in terms of disentangling and quantifying the effect of short-term work schemes → exploit additional LFS variables by constructing additional mobility indices on the basis of breakdowns of employees by:
  - Whether the numbers of worked hours changed/not changed
  - Whether they were absent/not absent from work for a specific reason linked to economic reasons while still receiving their income.
  - Furthermore, an in-depth analysis of the short-term work schemes under their different dimensions (i.e., the eligibility criteria, the replacement wage rates, the caps, the maximum duration, etc.) can help in the reading of the transition matrices.
- New release of LFS can extend the analysis to other Member States and to 2021;
- Extending the analysis to a sample including the self-employed exploiting imputation techniques;
- Improvements in the construction of indices of mobility by referring to a 'Bartholomew-type' of indicators, by adding a normalisation/decomposition procedure as the one suggested in Paul (2020).

Additional tables (I)

Table A.1 1 Availability of INCDECIL variable and the maximum number of observations for the same individual in the yearly LFS files, 2009, 2010, 2011, 2012, 2018, 2019, and, 2020.

	INCDECIL variable available							Maximum number of individual observation in yearly dataset						
	2009	2010	2011	2012	2018	2019	2020	2009	2010	2011	2012	2018	2019	2020
DK	yes	yes	yes	yes	yes	yes	yes	4	4	4	4	4	4	4
EE	yes	yes	yes	yes	yes	yes	yes	2	2	2	2	2	2	2
EL	yes	yes	yes	yes	yes	yes	yes	4	4	4	4	4	4	4
IE	yes	yes	yes	yes	yes	yes	yes	4	4	4	4	4	4	4
IT	yes	yes	yes	yes	yes	yes	yes	3	2	2	2	2	2	2
PT	yes	yes	yes	yes	yes	yes	yes	4	4	4	4	4	4	4

Additional tables (II)

Table A.1 2 Structure of the observations collected for the same individual in a specific year.

Groups with a maximum of two observations per individual or groups with two observations in an MS with a maximum of four observations						
Observations in	Q1 and Q2	Q1 and Q3	Q1 and Q4	Q2 and Q3	Q2 and Q4	Q3 and Q4
Groups with three observations per individual in an MS with a maximum of four observations per individual						
Observations in	Q1, Q2 and Q3	Q1, Q2 and Q4	Q1, Q2 and Q3	Q2, Q3 and Q4		
Groups with a maximum of four observations per individual						
Observations in	Q1, Q2, Q3 and Q4					

Table A.1 3 Structure of the observation of the observations collected for the same individual in a specific year and transformation of the specific quarters in generic quarters Q_t and Q_{t+1}.

Groups with a maximum of two observations per individual or groups with two observations in the MS with a maximum of four observations						
Observations in	Q1 and Q2	Q1 and Q3	Q1 and Q4	Q2 and Q3	Q2 and Q4	Q3 and Q4
Transformation in	$Q1 = Q_t$ $Q2 = Q_{t+1}$	$Q1 = Q_t$ $Q3 = Q_{t+1}$	$Q1 = Q_t$ $Q4 = Q_{t+1}$	$Q2 = Q_t$ $Q3 = Q_{t+1}$	$Q2 = Q_t$ $Q4 = Q_{t+1}$	$Q3 = Q_t$ $Q4 = Q_{t+1}$
Groups with three observations per individual in the MS with a maximum of four observations per individual						
Observations in	Q1, Q2 and Q3	Q1, Q2 and Q4	Q1, Q3 and Q4	Q2, Q3 and Q4		
Transformation in	$Q1 = Q_t$ $Q2 = Q_{t+1}$	$Q1 = Q_t$ $Q4 = Q_{t+1}$	$Q3 = Q_t$ $Q4 = Q_{t+1}$	$Q2 = Q_t$ $Q4 = Q_{t+1}$		
Groups with a maximum of four observations per individual						
Observations in	Q1, Q2, Q3 and Q4					
Transformation in	$Q1 = Q_t$ $Q4 = Q_{t+1}$					

THANK YOU

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