Dynamic of the Disablement Process in Ageing Populations

Mahdi Ben Jelloul, Antoine Bozio, Elsa Perdrix, Audrey Rain and Léa Toulemon

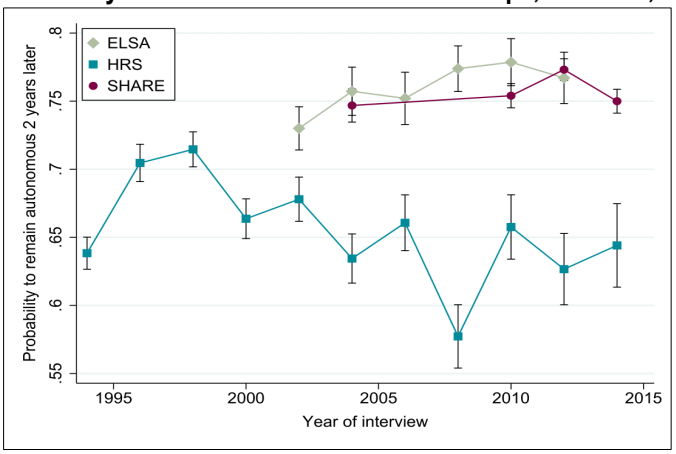
Online Appendix

S1 – Credibility of the Change in the Probability to Remain Autonomous

Is an increased probability to remain autonomous plausible? Among the several hypothesis tested, the probability to remain autonomous (P0,0) has the most important impact on morbidity in the future. However, the stagnation of morbidity require a very high growth of P0,0. In comparison, we graph in Figure S1 the observed past evolution of the probability to remain autonomous in Europe, England and in the US. We respectively measure those probabilities relying on SHARE, ELSA and HRS data. We show that the past probability to remain autonomous was relatively smooth in the last 20 years: it respectively increased by 0.23 and 0.28 percentage points in England and in Europe. To maintain a constant DFLE/LE ratio in the future, we thus estimate that this probability increase should be five times larger than what is observed in the recent years.

It is thus very likely that a stagnation of morbidity would require a change of several other transition probabilities at the same time. Possible combinations are numerous and could, for example, include increases of P1,1 P1,0 P2,2 P2,1, P3,2 and decreases of P0,1, P1,2 P2,3. Thus, public policies that intend to prevent from having a morbidity expansion need to favor an increase in P0,0 (policies that decrease the risk of entering in an autonomy loss process) but cannot only rely on this parameter.

Figure S1 – **Probability to Remain Autonomous in Europe, the USA, and England**



Notes: All point estimates are from multinomial Logit estimation, including controls for age and sex. Point estimates in SHARE slightly differ from the transition matrix results because the transition are computed every two years while in our main model, every years.
Sample: All elderly aged 60 and over, living in the community, respondent to the health questionnaire in HRS for the USA, in ELSA for England, and in SHARE for Europe.
Sources: Harmonized data from Gateway to global aging data. SHARE, wave 1 to 7 except wave 3; ELSA, wave 1 to 7 and HRS, wave 2 to 16.

S2 – Data Details

1. Sample in SHARE

Table S2-1 provides descriptive statistics of our sample. The mean age is 72 years old and the sample contains 43% of men. 62.53% of observations correspond to autonomous individuals (State 0), 20.55% are slightly disabled (State 1), 7.06% are in State 2 (medium dependency) and 5.51% are highly dependent (State 3). Table S2-1 presents the characteristics of our final sample.

Table S2-1 – **Descriptive Statistics**

Country	Age	Men share	Disability State 0 Autonomy	State 1 Low Disability	State 2 Medium Disability	State 3 High Disability	State 4 Death
Austria	71.92	39.46	63.19	20.03	7.16	5.73	3.90
Belgium	72.32	48.43	61.38	19.61	7.03	7.95	4.03
Czech Republic	71.24	38.05	62.72	20.12	7.13	5.32	4.71
Denmark	71.81	43.94	70.18	14.60	5.30	3.54	6.39
Estonia	72.61	34.10	52.02	25.08	9.84	8.38	4.69
France	72.93	44.09	63.43	19.46	8.19	5.18	3.74
Germany	71.01	49.47	69.86	18.48	5.13	4.41	2.13
Italy	72.04	44.57	56.18	25.33	7.19	6.43	4.87
Netherlands	70.75	44.96	68.98	18.86	6.32	3.03	2.81
Slovenia	71.69	42.21	56.96	27.19	8.09	5.51	2.24
Spain	74.01	43.67	51.64	25.23	9.20	7.52	6.41
Sweden	72.27	47.14	74.15	14.08	4.25	1.66	5.86
Switzerland	71.73	47.85	79.69	12.75	3.05	1.69	2.82
Total	72.15	43.11	62.53	20.55	7.06	5.51	4.35

Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2), respondent at least in two consecutive waves, and having completed the health questionnaire. We exclude respondents' spouses from the sample.
Sources: SHARE wave 4, 5 and 6.

2. Surveyed Countries

We include 13 countries in our sample. Selected countries are either in all waves, with a large refreshment sample in wave 4 (Austria, Belgium, Denmark, France, Germany, Italy, Spain, Sweden and Switzerland), or in waves 4, 5 and 6 (Estonia, Slovenia), or in the five waves (Czech Republic and the Netherlands). Each country represents between 4 and 12 percent of the total sample (Table S2-2).

Table S2-2 – **Surveyed Countries**

Country	Number	%
Austria	6,386	7.92
Belgium	7,664	9.51
Czech Republic	7,629	9.46
Denmark	4,604	5.71
Estonia	9,383	11.64
France	6,639	8.24
Germany	5,169	6.41
Italy	6,269	7.78
Netherlands	3,198	3.97
Slovenia	5,079	6.30
Spain	7,642	9.48
Sweden	6,264	7.77
Switzerland	4,683	5.81
Total	80,609	100

Sample: All elderly aged 60 and over, in one of the 13 countries included, respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE Waves 4, 5 and 6.

3. Disability Definition in SHARE and CARE

Available information in SHARE and CARE-M regarding dependency levels (functional limitations, IADL and ADL) slightly diverge. In SHARE data, the possible answers to the questions "do you have difficulties in doing the followings activities" are "yes" or "no" while in CARE-M, it is "no difficulty at all"; "I have small difficulties"; "I have huge difficulties"; "I cannot perform this task at all". We consider the equivalent to the "no" in SHARE is "I cannot perform this task at all". This choice is the one that minimizes prevalence differences by age and gender between the two data. Moreover, there is one question differently asked in SHARE and CARE-M. In CARE-M, the question is about the ability to walk 500 meters while it is 100 meters in SHARE.

S3 – Robustness Checks

1. Transitions Matrix for Specific Individuals

Table S3-1 – **Probabilities of transition between disability states, estimated with SHARE data, for a 70 years old individual**

A – Man

	Autonomy	Disability			Death
	S0	Funct. Lim (S1)	Medium (S2)	High (S3)	S4
S0	0.82	0.17	x	x	0.01
S1	0.39	0.40	0.18	x	0.03
S2	x	0.46	0.30	0.18	0.05
S3	x	x	0.41	0.49	0.11

Notes: The estimated probability to remain autonomous is 82%. An individual with functional limitations has 39% chances to recover, 40% to remain with functional limitations and 18% to become more disabled.

B – Woman

	Autonomy	Disability			Death
	S0	Funct. Lim (S1)	Medium (S2)	High (S3)	S4
S0	0.88	0.10	x	x	0.02
S1	0.43	0.38	0.13	x	0.07
S2	x	0.42	0.24	0.18	0.16
S3	x	x	0.33	0.46	0.21

Notes: The estimated probability to remain autonomous is 88%. An individual with functional limitations has 43% chances to recover, 38% to remain with functional limitations and 13% to become moredisabled.
Sample: Men (resp. women) aged 70, in one of the 13 countries included (cf. Table S2-2), respondent at least in two consecutive waves, and respondent to the health questionnaire. Respondent's spouses are excluded from the sample.
Sample: SHARE waves 4, 5 and 6.

2. Robustness Checks Regarding the Surveyed Countries

Estimating transitions between five disability states requires a large sample size to reach an acceptable statistical power. Thus, we use European data instead of French data only. As a robustness check, we restrict our sample to French individuals and estimate the same transitions on this new sample. The estimated probabilities of transition are presented in Table S3-2 and probabilities with the confidence intervals is in Figures S3-I. It shows that the only statistically significant difference between both samples is the probability to move from state 1 to 2 and from state 2 to 1. We also check whether the projections using both transition matrices show statistically significant differences in the number of disabled in each state. Figures S3-IIa and S3-IIb show that we forecast 14.5 million autonomous elderly

in 2060 in Europe, and 14.5 million using only France.

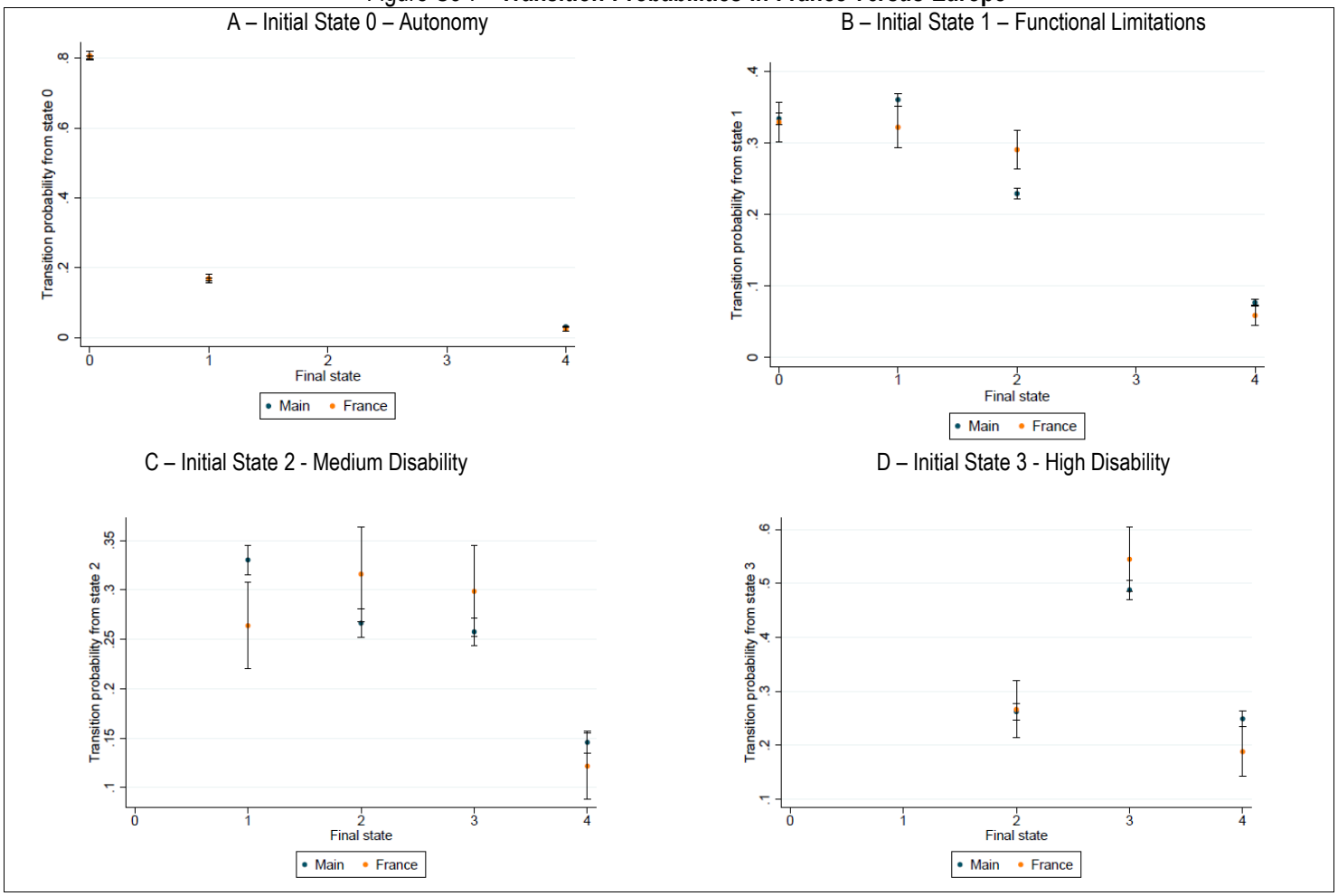
Table S3-2 – **Transition Matrix by Country – France *versus* Main Sample**

A – Baseline Transitions					
	S0	S1	S2	S3	S4
S0	0.83	0.15	x	x	0.02
S1	0.34	0.32	0.30	x	0.05
S2	x	0.26	0.33	0.31	0.20
S3	x	x	0.30	0.54	0.17

B – Transitions, France					
	S0	S1	S2	S3	S4
S0	0.82	0.16	x	x	0.02
S1	0.34	0.36	0.23	x	0.07
S2	x	0.33	0.27	0.26	0.13
S3	x	x	0.27	0.50	0.23

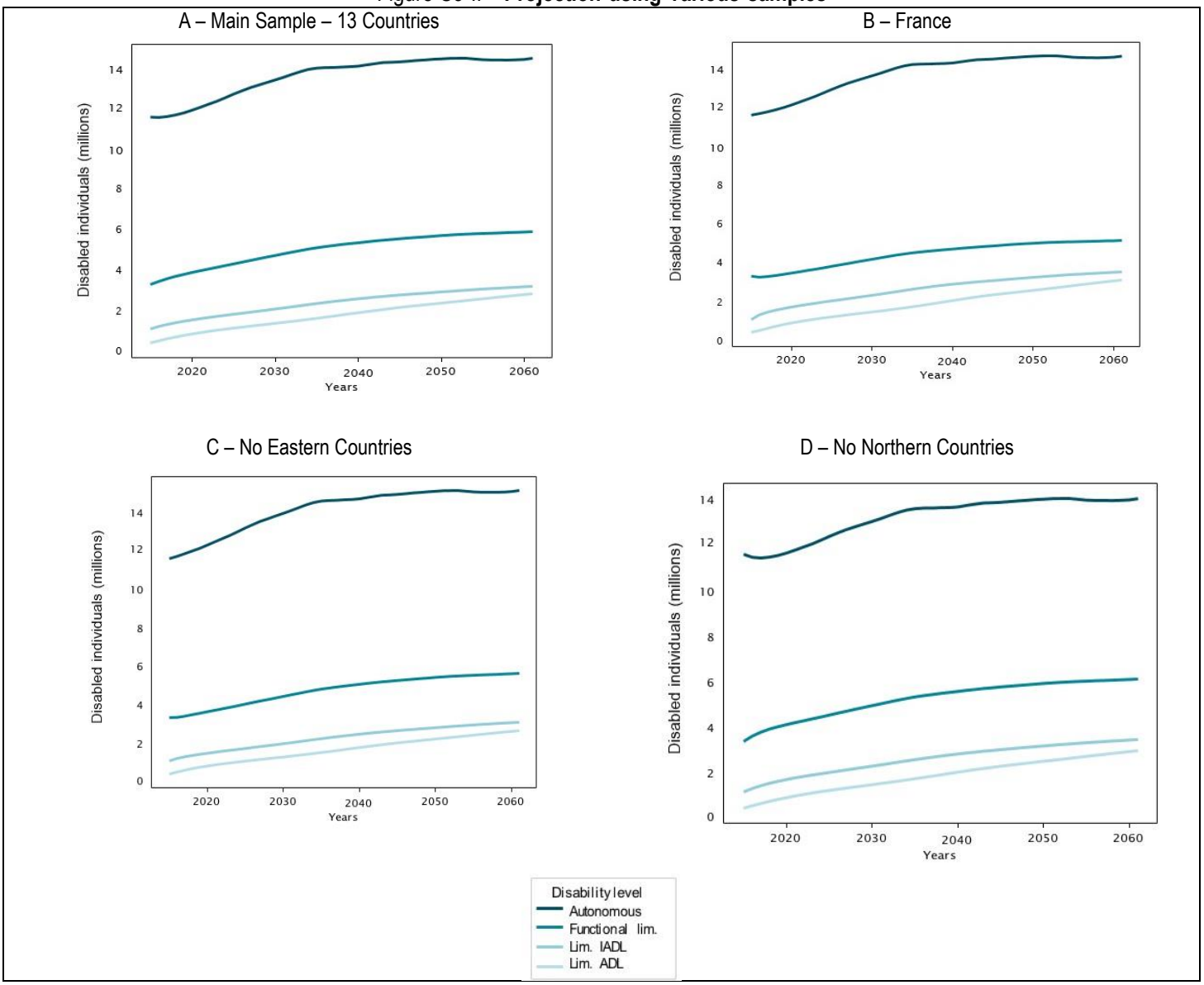
Notes: S0, autonomy. S1, functional limitations. S2, IADL limitations. S3, ADL limitations. S4, death.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2), respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE waves 4, 5 and 6.

Figure S3-I – **Transition Probabilities in France *versus* Europe**



Notes: First graph shows the transition probability from state 0 - autonomous to state 0, 1 - functional limitations and 4 - death. The probability to stay autonomous is slightly higher than 0.8 for the main sample, and the French sample.
Sample: All elderly aged 60 and over, respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample. The main sample includes individuals from 13 countries (Austria, Czech Republic, Slovenia, Estonia, Denmark, Netherlands, Sweden, France, Germany, Spain, Italy, Switzerland, Belgium). The second sample includes only individuals from France.
Sources: SHARE, waves 4, 5, 6.

Figure S3-II – **Projection using various samples**



Notes: All the projection are based on our main scenario.
Sample: All elderly aged 60 and over, respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample. The main sample includes individuals from 13 countries (Austria, Czech Republic, Slovenia, Estonia, Denmark, Netherlands, Sweden, France, Germany, Spain, Italy, Switzerland, Belgium). The second sample includes only individuals from France. The third one excludes eastern countries (Austria, Czech Republic, Estonia and Slovenia) and the last one northern countries (Denmark, the Netherlands and Sweden).
Sources: SHARE, waves 4, 5, 6.

3. Sensitivity to the Number of European Countries in the Sample

A potential concern is that our selection criteria for creating our sample lead us to build a very heterogeneous sample, as health and health systems may differ a lot across countries. Thus, we compare our baseline transition probabilities with estimates from alternative samples. First, we construct a sample excluding Northern European countries (Denmark, the Netherlands and Sweden) and another

excluding Eastern European countries (Austria, Czech Republic, Estonia and Slovenia) (Table S3-3). Figure S3-III shows that transition probabilities do not significantly differ when considering those alternative sample.

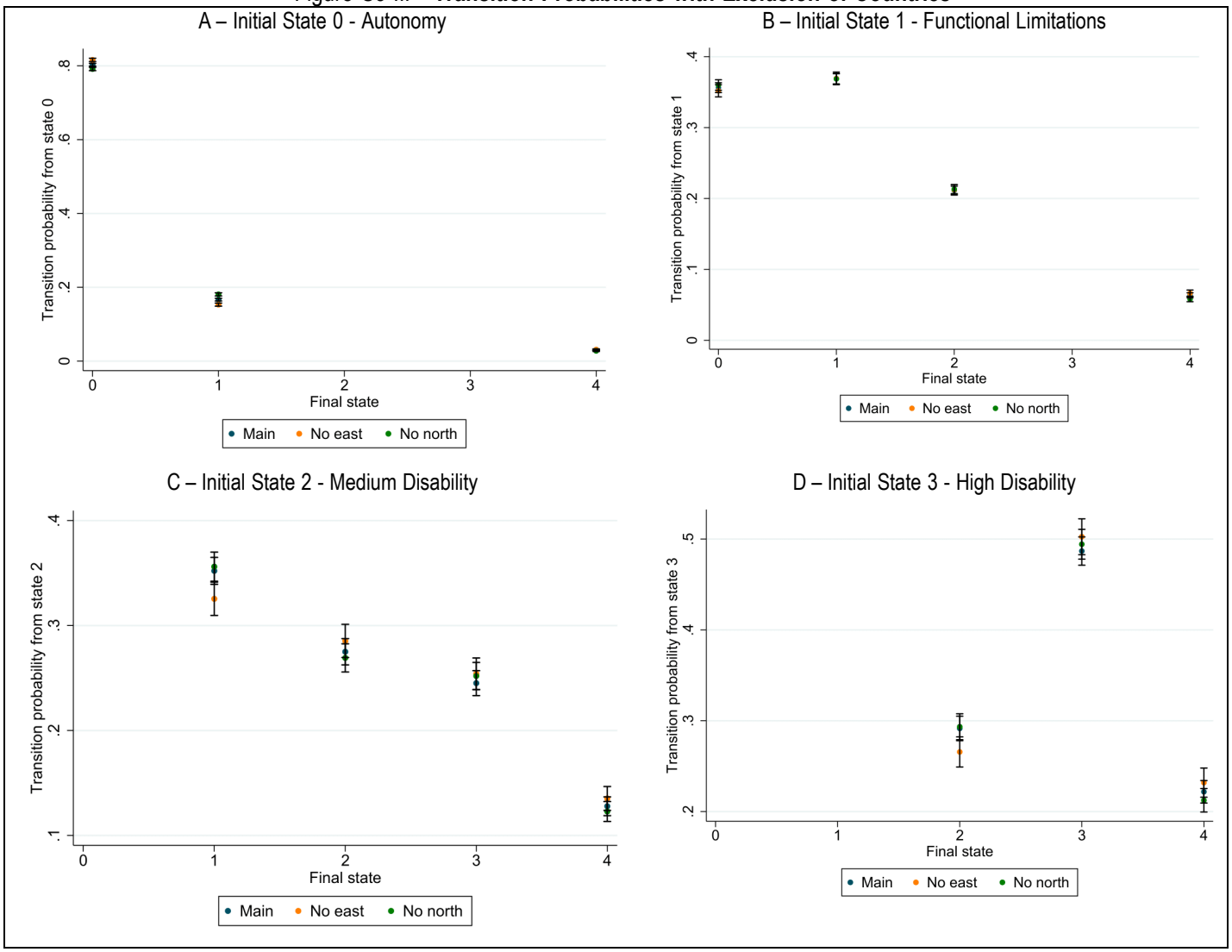
Table S3-3 – **Transition Matrix by Country – Northern and Eastern Europe Exclusion**

A – without Eastern Countries					
	S0	S1	S2	S3	S4
S0	0.84	0.14	x	x	0.02
S1	0.34	0.36	0.23	x	0.07
S2	x	0.31	0.29	0.27	0.13
S3	x	x	0.25	0.53	0.23

B – without Northern Countries					
	S0	S1	S2	S3	S4
S0	0.80	0.17	x	x	0.02
S1	0.34	0.36	0.23	x	0.06
S2	x	0.34	0.27	0.27	0.13
S3	x	x	0.27	0.50	0.22

Notes: S0, autonomy. S1, functional limitations. S2, IADL limitations. S3, ADL limitations. S4, death.
Sample: Cf.Table S3-2
Sources: SHARE waves 4, 5 and 6.

Figure S3-III – **Transition Probabilities with Exclusion of Countries**



Notes: First graph shows the transition probability from state 0 - autonomous to state 0, 1 - functional limitations and 4 - death. It shows the probability to stay autonomous is slightly higher than 0.8 for the main sample, the sample excluding eastern Europe countries and the sample excluding northern Europe countries.
Sample: All elderly aged 60 and over, respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample. The main sample includes individuals from 13 countries (Austria, Czech Republic, Slovenia, Estonia, Denmark, Netherlands, Sweden, France, Germany, Spain, Italy, Switzerland, Belgium). The sample without eastern countries excludes individuals from Austria, Czech Republic, Slovenia and Estonia. The sample without northern Europe excludes individuals from Denmark, Netherlands and Sweden.
Sources: SHARE, waves 4, 5, 6.

4. Results with and without Control Variables

In our main specification, we control for age, gender, and country. We assess the sensitivity of our estimated transition probabilities to the inclusion of more control variables. Table S3-4a presents our main results while Table S3-4b presents the estimated transition probabilities when controlling for education, occupational group, marital status, and the number of children. As transition probabilities are almost identical, it confirms that controlling for a more restricted set of control variables will not affect

our projections while allowing us to avoid making any assumption on the evolution of potential socio-demographic characteristics.

Table S3-4 – **Transition Probabilities with and without Control Variables**

A – Baseline Transitions					
	S0	S1	S2	S3	S4
S0	0.82	0.16	x	x	0.02
S1	0.34	0.36	0.23	x	0.07
S2	x	0.33	0.27	0.26	0.13
S3	x	x	0.27	0.50	0.23

B – Transitions with Controls					
	S0	S1	S2	S3	S4
S0	0.82	0.16	x	x	0.02
S1	0.34	0.37	0.23	x	0.07
S2	x	0.33	0.27	0.27	0.13
S3	x	x	0.27	0.50	0.22

Notes: S0, autonomy. S1, functional limitations. S2, IADL limitations. S3, ADL limitations. S4, death.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2), respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample. Matrix (A) includes only controls for age, sex and country while Matrix (B) includes also controls for education, marital status, children, occupational group.
Sources: SHARE waves 4, 5 and 6.

5. Sensitivity to the Re-assignment Process

Several individuals switch to a dependency level which is not thought as possible in our model: for the sake of simplicity we assume that individuals can either move to the closest dependency level or to death. For example in raw data some individuals switch from state 0 to 2 or switch from 1 to 3. This issue mainly arises among individuals initially in an autonomous state or presenting functional limitations (they represent 70% of individuals with such "forbidden" transitions). Instead of dropping those individuals, which would create a selection bias in our sample, we re-assign their transitions toward "allowed" transitions (Table S3-5).

To test the sensitivity of our estimated probabilities to this choice, we present in Table S3-6 the transition matrix without re-assigning any individual. It shows small significant changes for few transitions. Figure S3-IV shows that these differences are only significant for transitions from state 0 to 1; from 1 to 2; from 2 to 1; and from 3 to 2. Thus, this re-assignment process may overestimate the remission probabilities of the most dependent, and slightly decrease the probability to move from low to medium disability. Unfortunately, the consequences of this change on the projection cannot be assessed since there is statistical power limitation at projecting so many possible transitions. However, we can assume that if our re-assignment process leads to significant differences in the projection, it would be an overestimation of the autonomous individuals.

Table S3-5 – **Share of Changes in Final State through Re-assignment Process**

In the Data	After Re-assignment	Number of Observations	Share of Observations (in %)
0 → 2	0 → 1	844	1.05
0 → 3	0 → 1	1,037	1.29
1 → 3	1 → 2	1,243	1.54
2 → 0	2 → 1	501	0.621
3 → 0	3 → 2	351	0.435
3 → 1	3 → 2	548	0.680
TOTAL		4,524	5.61

Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2) main surveyed in SHARE, respondent at least in two consecutive waves, and respondent to the health questionnaire.
Sources: SHARE waves 4, 5 and 6.

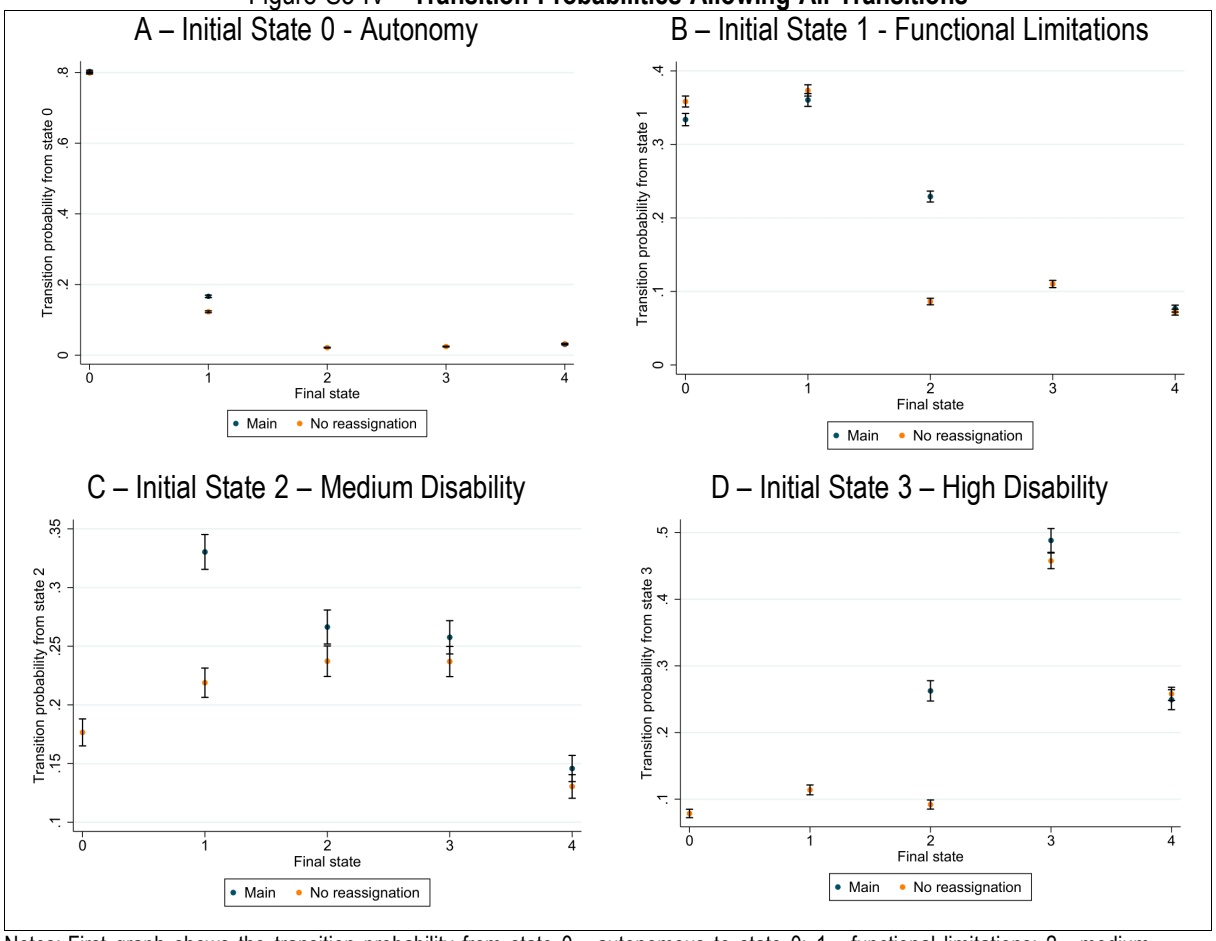
Table S3-6 – **Transition Matrix with and without Re-assignment Process**

A – Baseline Transitions					
	S0	S1	S2	S3	S4
S0	0.82	0.16	x	x	0.02
S1	0.34	0.36	0.23	x	0.07
S2	x	0.33	0.27	0.26	0.13
S3	x	x	0.27	0.50	0.23

B – Without Re-Assignation					
	S0	S1	S2	S3	S4
S0	0.81	0.12	0.02	0.02	0.03
S1	0.36	0.38	0.09	0.11	0.07
S2	0.18	0.22	0.24	0.24	0.11
S3	0.08	0.11	0.09	0.46	0.25

Notes: S0, autonomy. S1, functional limitations. S2, IADL limitations. S3, ADL limitations. S4, death.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2), respondent at least in two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE waves 4, 5 and 6.

Figure S3-IV – **Transition Probabilities Allowing All Transitions**



Notes: First graph shows the transition probability from state 0 - autonomous to state 0; 1 - functional limitations; 2 - medium disability; 3 - high disability and 4 - death.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf.Table S2-2), respondent in at least two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample. The dependency states are corrected using a re-assignment process for the main sample (blue circles). The sample without re-assignment (orange squares) allows all transitions.
Sources: SHARE, waves 4, 5, 6.

S4 – Additional Results

1. Transition Matrix by Gender

Table S4-1 – **Transition Matrix by Gender**

A – Women					
	S0	S1	S2	S3	S4
S0	0.79	0.20	x	x	0.02
S1	0.33	0.37	0.26	x	0.05
S2	x	0.34	0.29	0.28	0.10
S3	x	x	0.27	0.52	0.21

B – Men					
	S0	S1	S2	S3	S4
S0	0.85	0.12	x	x	0.03
S1	0.36	0.36	0.18	x	0.11
S2	x	0.30	0.22	0.22	0.27
S3	x	x	0.28	0.43	0.29

Notes: S0, autonomy. S1, functional limitations. S2, IADL limitations. S3, ADL limitations. S4, death.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2), respondent in atleast two consecutive waves, and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE waves 4, 5 and 6.

2. Transition matrix by Waves

Table S4-2 – **Transition Matrix using Alternative SHARE Waves**

A – Transitions using Waves 1&2					
	S0	S1	S2	S3	S4
S0	0.81	0.17	x	x	0.02
S1	0.36	0.40	0.19	x	0.05
S2	x	0.42	0.25	0.25	0.07
S3	x	x	0.27	0.54	0.19

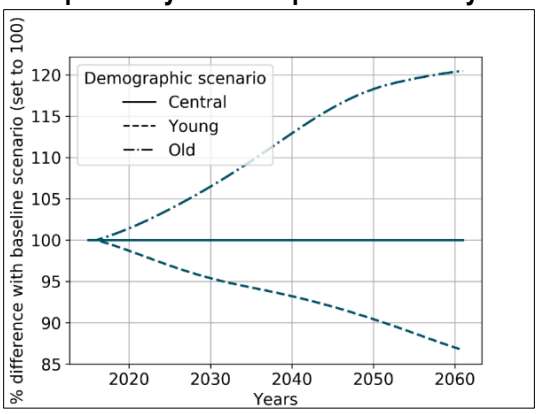
B – Baseline Transitions					
	S0	S1	S2	S3	S4
S0	0.82	0.16	x	x	0.02
S1	0.34	0.36	0.23	x	0.07
S2	x	0.33	0.27	0.26	0.13
S3	x	x	0.27	0.50	0.23

Notes: S0. autonomy. S1. functional limitations. S2. IADL limitations. S3. ADL limitations. S4. death.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2). respondent at least in two consecutive waves. and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE waves 1. 2. 4. 5 and 6.

3. Projections of the Disabled Population by Demographic Assumptions

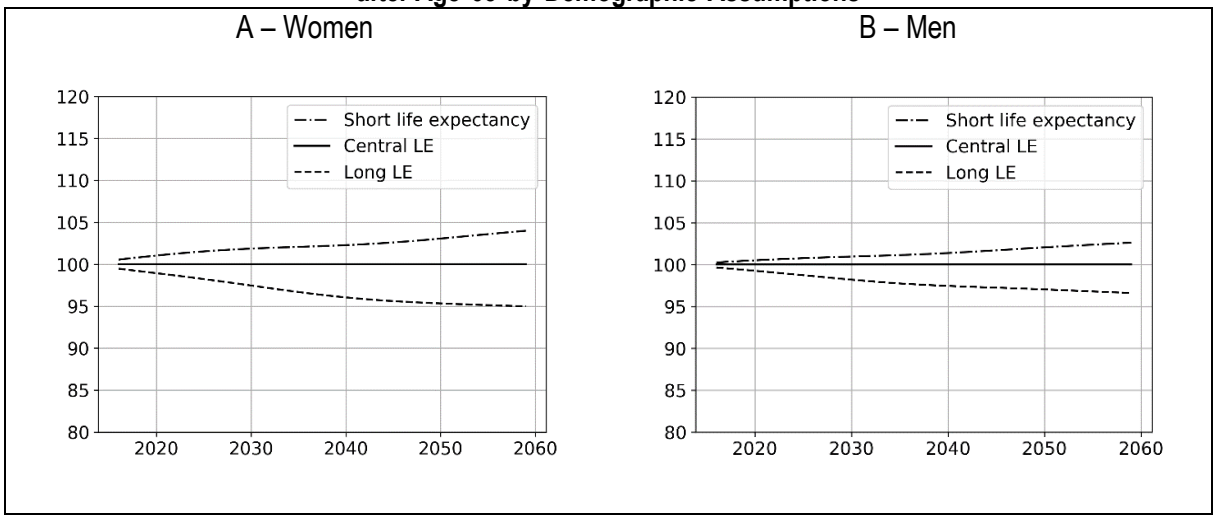
Figure S4-I provides a comparison of the projected number of disabled individuals by demographic assumptions. In particular. we compare projections corresponding to assumptions leading to a "young" and an "old" population as presented in Table 2. As a reference. we set the baseline scenario at 100. which correspond to central demographic assumptions. such that any divergence in projections corresponds to the difference between demographic assumptions. We consider here as disabled individuals those who present IADL only or ADL and IADL limitations. i.e. level 2 and 3 of the disability process in our model. We show that relying on demographic assumptions linked to an "old" population leads projecting 20% more disabled individuals in 2060 compared to the baseline scenario. Relying on demographic assumptions associated to a "young" population implies projecting 15% less disabled individuals than in the baseline scenario.

Figure S4-I – **Evolution of Dependency in the Population 60+. by Demographic Assumptions**



Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2). respondent at least in two consecutive waves. and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE waves 4. 5 and 6.

Figure S4-II – **Ratio Disability-free Life Expectancy over Total Life Expectancy after Age 65 by Demographic Assumptions**



Notes: In 2060. among women. the ratio DFLE/LE is expected to be 5% higher in the old Insee scenario than in the central scenario.
Sample: All elderly aged 60 and over, in one of the 13 countries included (cf. Table S2-2). respondent at least in two consecutive waves. and respondent to the health questionnaire. We exclude spouses from the sample.
Sources: SHARE waves 4. 5 and 6.