Functional disability with systematic trends and uncertainty:
A comparison between China and the U.S.

Online Appendix

A Supplementary Exploratory Data Analysis Results

A.1 Crude transition rates by time

Figure A.1 and Figure A.2 show the crude transition rates by time. We are motivated by the autoregressive features in the crude rates to model the frailty factor as an AR(1) process.

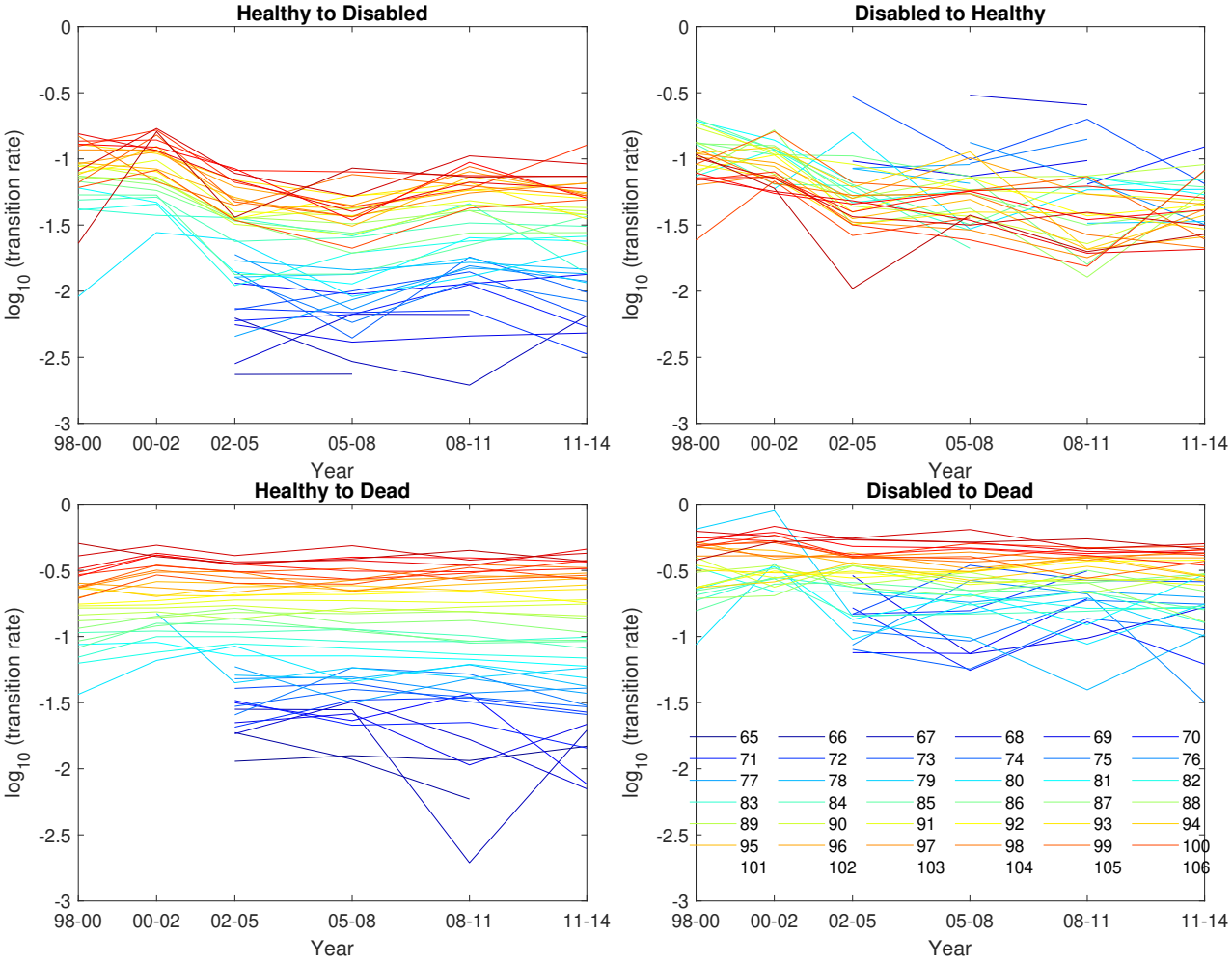

Figure A.1. Crude health transition rates for both genders based on the selected CLHLS sample.

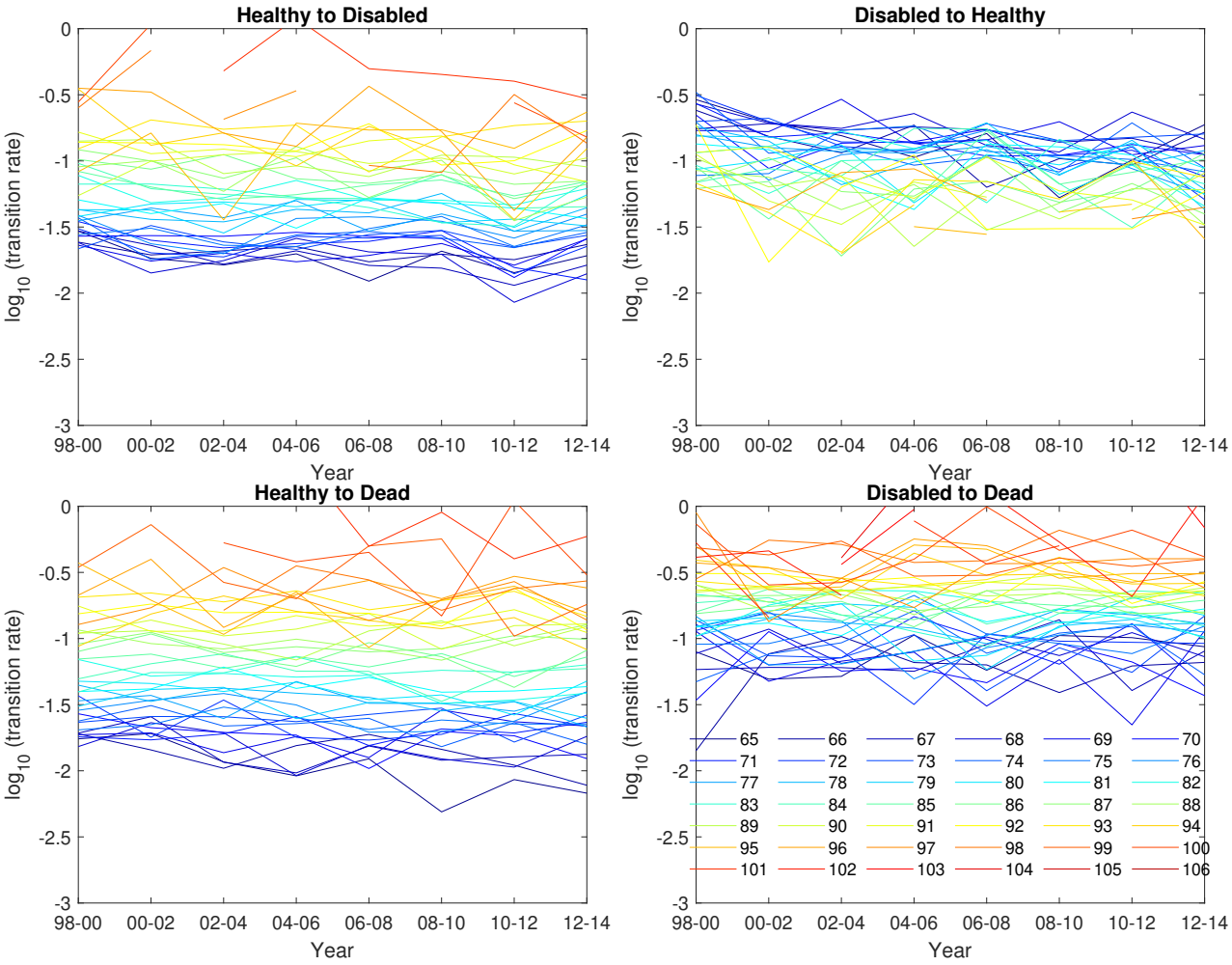

Figure A.2. Crude health transition rates for both genders based on the selected HRS sample.

A.2 Delay in death reporting

Table A.1 displays the number of deaths reported in each wave based on the full CLHLS sample between 1998 to 2014, i.e. before any data cleaning. We can see that most of the deaths occurred in the second half of a survey year were reported in the next interview wave. Table A.2 shows that the delay in death reporting also exists in the HRS data.

Table A.1. The number of deaths reported in each wave of the full CLHLS sample.

Year of death	Month of death											
	1	2	3	4	5	6	7	8	9	10	11	12
Wave 2 (survey year 2000)												
1998	0	0	0	15	62	83	101	130	84	109	115	124
1999	179	147	154	143	121	123	145	122	147	163	147	188
2000	153	169	145	87	82	61	38	6	1	3	2	2
Wave 3 (survey year 2002)												
2000	0	0	0	0	0	2	43	120	110	140	139	147
2001	166	178	204	150	144	112	143	144	149	185	197	256
2002	173	181	124	85	43	7	1	0	0	0	0	0
Wave 4 (survey year 2005)												
2002	0	0	2	19	42	99	85	100	81	114	115	157
2003	184	170	158	197	155	161	183	197	145	228	211	257
2004	197	215	221	163	155	125	154	142	125	198	165	216
2005	182	187	136	83	29	9	1	2	2	0	3	2
Wave 5 (survey year 2008-09)												
2005	7	1	14	23	48	63	67	76	58	90	103	151
2006	127	131	169	122	173	158	177	175	133	212	180	195
2007	124	129	157	128	134	143	136	170	131	183	168	207
2008	154	153	143	100	86	66	27	17	3	4	2	5
Wave 6 (survey year 2011-12)												
2008	0	0	2	3	2	19	61	106	143	109	134	172
2009	186	182	143	113	121	124	143	160	134	181	193	221
2010	204	168	169	151	144	115	141	140	132	148	159	167
2011	188	177	158	102	100	84	81	50	27	23	22	35
2012	23	15	24	21	8	8	2	2	1	0	0	1
Wave 7 (survey year 2014)												
2011	6	4	3	2	4	7	9	18	41	34	44	74
2012	103	109	92	60	56	79	83	68	59	91	96	129
2013	118	104	88	81	64	82	61	62	64	94	86	105
2014	110	108	74	64	43	16	15	7	4	3	2	4

Table A.2. The number of deaths reported in each wave of the HRS.

Year of death	Month of death											
	1	2	3	4	5	6	7	8	9	10	11	12
Wave 4 (survey year 1998)												
1995	1	1	2	0	0	0	2	0	3	2	2	13
1996	14	30	26	39	28	38	33	27	30	33	35	45
1997	50	49	45	53	47	44	54	37	27	49	39	36
1998	39	53	40	20	21	8	11	8	6	4	3	5
Wave 5 (survey year 2000)												
1998	0	2	10	12	23	27	31	33	38	44	40	42
1999	58	45	56	52	58	54	57	56	66	53	56	62
2000	57	48	49	28	22	14	10	9	5	2	0	1
Wave 6 (survey year 2002)												
2000	1	1	6	11	15	20	18	33	34	51	37	47
2001	55	43	47	49	39	57	68	73	62	81	62	66
2002	51	44	58	41	51	27	28	27	13	12	11	4
Wave 7 (survey year 2004)												
2002	1	1	0	0	4	10	20	28	20	31	42	44
2003	46	50	57	46	58	55	62	51	45	45	53	68
2004	52	60	55	46	41	27	25	8	12	7	5	0
Wave 8 (survey year 2006)												
2004	0	1	1	9	8	19	31	28	39	32	48	40
2005	46	43	67	44	45	37	45	58	58	51	67	64
2006	60	47	56	32	36	22	31	14	13	11	7	10
Wave 9 (survey year 2008)												
2006	0	0	1	8	6	16	32	22	38	36	43	42
2007	39	47	35	43	57	42	50	47	43	61	50	57
2008	54	63	56	53	29	28	28	13	14	11	6	1
Wave 10 (survey year 2010)												
2008	1	3	3	5	9	19	34	28	22	30	40	43
2009	38	38	45	48	45	46	47	53	63	68	62	74
2010	71	68	54	40	50	36	44	37	40	52	35	24
2011	23	13	11	5	2	0	0	0	0	0	0	0
Wave 11 (survey year 2012)												
2010	0	0	0	2	5	6	2	8	9	16	11	23
2011	34	23	42	33	40	47	44	49	43	67	70	58
2012	67	48	61	56	30	25	36	27	10	22	10	5
2013	6	7	3	0	0	0	0	0	0	0	0	0
Wave 12 (survey year 2014)												
2012	0	0	0	0	0	7	12	22	18	29	41	44
2013	45	49	60	54	37	53	32	48	61	63	66	53
2014	67	57	51	49	32	24	20	19	15	17	8	5

Note: The years in each wave with less than 10 deaths are omitted from the table.

A.3 List of variables

This section introduces the variables selected from the CLHLS and the HRS. The CLHLS data downloaded from Zeng et al. (2017) contains seven datasets (Table A.3). Most variable names in each dataset follow the convention of a name followed by an underscore and one or two digits denoting the interview year (Table A.4). Some variable names, especially those related to interview dates, lack consistency and need to be cleaned. After cleaning the variable names, the seven datasets are combined into one longitudinal dataset for our analysis. The code along with the accompanying documentation on the data cleaning process is available at `https://sites.google.com/view/mxu/code`.

Table A.3. The CLHLS dataset downloaded from Zeng et al. (2017).

Dataset name	No. of observations	No. of new subjects
DS1 1998-2014 Longitudinal Data, Version 1	9,093	9,093
DS2 2000-2014 Longitudinal Data, Version 1	11,199	6,368
DS3 2002-2014 Longitudinal Data, Version 1	16,064	9,749
DS4 2005-2014 Longitudinal Data, Version 1	15,638	7,463
DS5 2008-2014 Longitudinal Data, Version 1	16,954	9,482
DS6 2011-2014 Longitudinal Data, Version 1	9,765	1,340
DS7 2014 Cross-Sectional Data, Version 1	7,192	1,125
Total	85,905	44,620

Table A.4. The interview wave suffix used in variable names in the CLHLS.

Interview year	1998-99	2000	2002	2005	2008-09	2011-12	2014
Suffix*	9899	_0	_2	_5	_8	_11	_14

* If there is no year digit suffix, the variable corresponds to the earliest interview wave in that particular dataset.

Table A.5 shows the variable names selected from the CLHLS dataset. Note that not all variables are listed as some variable names vary by the datasets. We refer the readers to the accompanying documentation of the data cleaning code for a complete list.

Table A.5. Variables selected from the CLHLS datasets.

Variable	Description
ID	Unique identifier of each individual
A1	Gender
RESIDENC*	Residence
V_BIRTHMO	Birth month
V_BIRTHYR	Birth year
DTHxx_yy†	Status of survival, death, or lost to follow-up from xx to yy waves
Interview date	
YEARIN*	Interview year
MONTHIN*	Interview month
DAYIN*	Interview day
Death date‡	
DyVYEAR	Death year
DyMONTH	Death month
DyVDAY	Death day
Activities of daily living§	
E1	Need assistance: Bathing
E2	Need assistance: Dressing
E3	Need assistance: Toileting
E4	Need assistance: Transferring
E5	Need assistance: Continence
E6	Need assistance: Feeding

* Not all variables are listed due to space limit. See the accompanying documentation of the code (available at https://sites.google.com/view/mxu/code) for more details.

† $(\texttt{xx}, \texttt{yy}) \in \{(98, 00), (00, 02), (02, 05), (05, 08), (08, 11), (11, 14)\}$.

‡ y in the following three variables take the value of $0, 2, 5, 8, 11,$ or 14 depending on the interview wave in which the death was reported.

§ The following six variables have suffix that follows the rule in Table A.4.

The HRS data downloaded from RAND HRS Longitudinal File 2016 (V2) (2020) is a single dataset that contains cleaned variables with consistent naming conventions. We selected the variables listed in Table A.6 for our analysis.

Table A.6. Variables selected from RAND HRS Longitudinal File 2016 (V2) (2020).

Variable	Description
Time independent	
`HHIDPN`	Unique identifier of each individual
`RABYEAR`	Birth year
`RABMONTH`	Birth month
`RABDATE`	Birth date
`RADYEAR`	Death year
`RADMONTH`	Death month
`RADDATE`	Death date
`RAGENDER`	Gender
Time dependent*	
`RxIWSTAT`	Interview status
`RxIWEND`	Interview end date
`RxWALKRA`	Some difficulty: Walking across room
`RxDRESSA`	Some difficulty: Dressing
`RxBATHA`	Some difficulty: Bathing, shower
`RxEATA`	Some difficulty: Eating
`RxBEDA`	Some difficulty: Get in/out bed
`RxTOILTA`	Some difficulty: Using the toilet

* `x` in the following variables represents the interview wave. For example, `x = 4` in the 1998 survey, which is the fourth wave.

A.4 Summary statistics

Table A.7. Summary statistics of the selected data samples. The Gender column shows the proportion of females. The Health State columns show the proportion of individuals in each health state.

Survey	Gender	Health State			Age		No. of
year	Female	Healthy (%)	Disabled (%)	Dead (%)	Mean	Std	individuals
Selected CLHLS sample*							
1998	0.60	76.13	23.87	0.00	92.36	7.68	8,140
2000	0.59	59.77	15.57	24.67	92.62	7.77	13,533
2002†	0.58	67.25	14.20	18.55	88.21	11.39	17,976
2005	0.58	60.57	10.45	28.98	88.52	11.63	19,846
2008-09	0.58	64.02	10.15	25.83	88.82	11.47	20,073
2011-12	0.57	52.06	9.72	38.23	89.17	11.34	14,665
2014	0.54	58.26	9.59	32.15	87.87	10.93	8,277
Selected HRS sample*							
1998	0.58	89.89	10.11	0.00	67.05	10.53	19,156
2000	0.58	84.57	9.62	5.81	68.99	10.55	19,168
2002	0.58	83.44	9.86	6.70	70.15	10.10	18,095
2004	0.58	84.11	9.62	6.26	70.18	10.28	18,010
2006	0.58	82.40	10.54	7.05	71.39	9.87	16,872
2008	0.58	82.05	10.54	7.41	72.58	9.50	15,765
2010	0.58	78.69	11.80	9.51	73.52	9.28	15,360
2012	0.58	80.70	11.81	7.49	74.33	8.80	13,954
2014	0.58	78.30	12.52	9.18	75.48	8.49	12,632

* Deaths occurred in 2014 are included in the sample.

† The survey expanded to those aged 65 and above in 2002.

A.5 Proportional hazard assumption

Figure A.3 plots the crude transition rates by urban-rural residence in the CLHLS sample and confirms the reasonableness of the proportional hazard assumption.

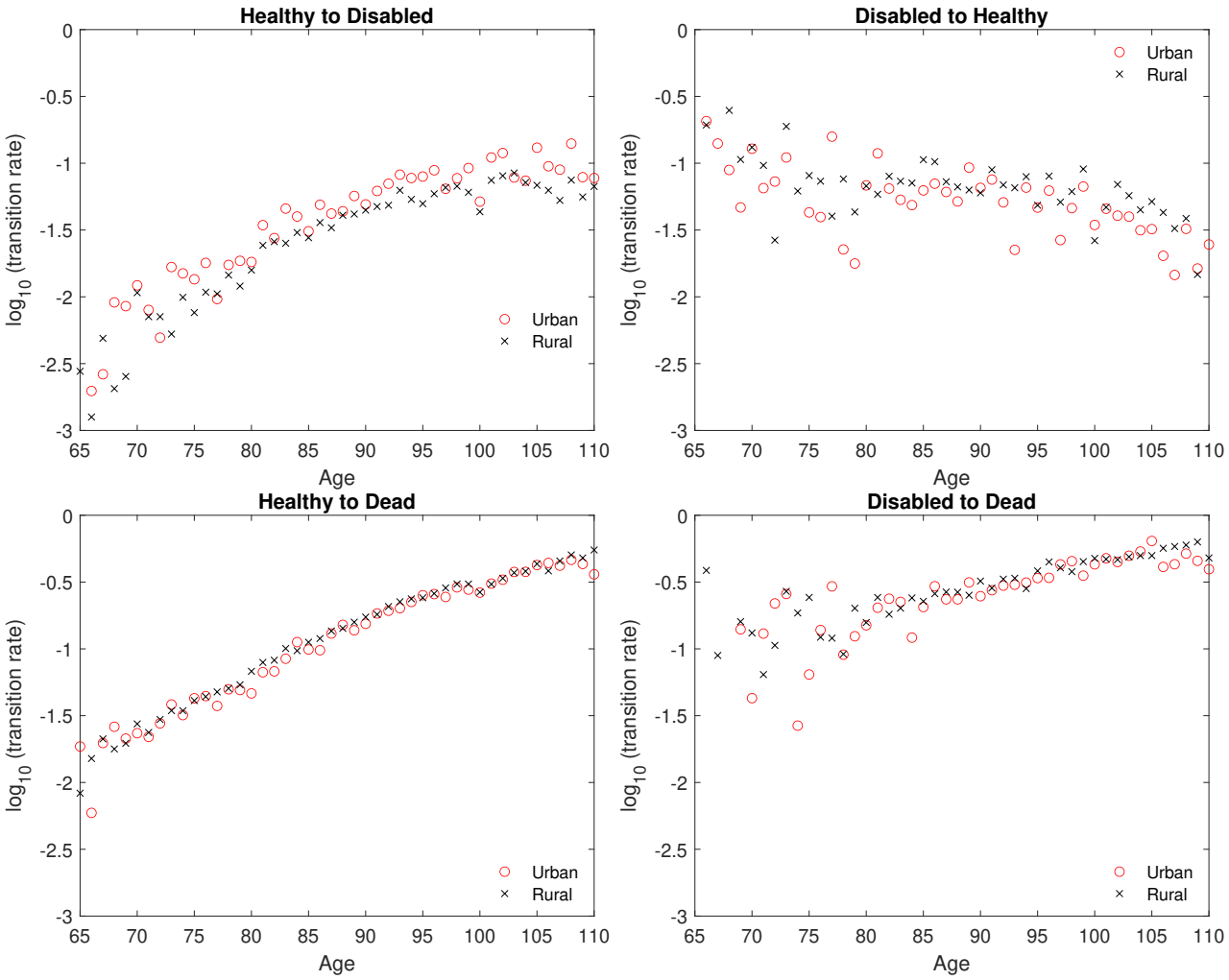

Figure A.3. Crude health transition rates by urban-rural residence in the selected CLHLS sample.

B Supplementary Model Comparison Results

B.1 Health transition rates

Figure B.1 compares the fitted rates with those in Li et al. (2017) and Sherris and Wei (2021) for males based on the HRS data.

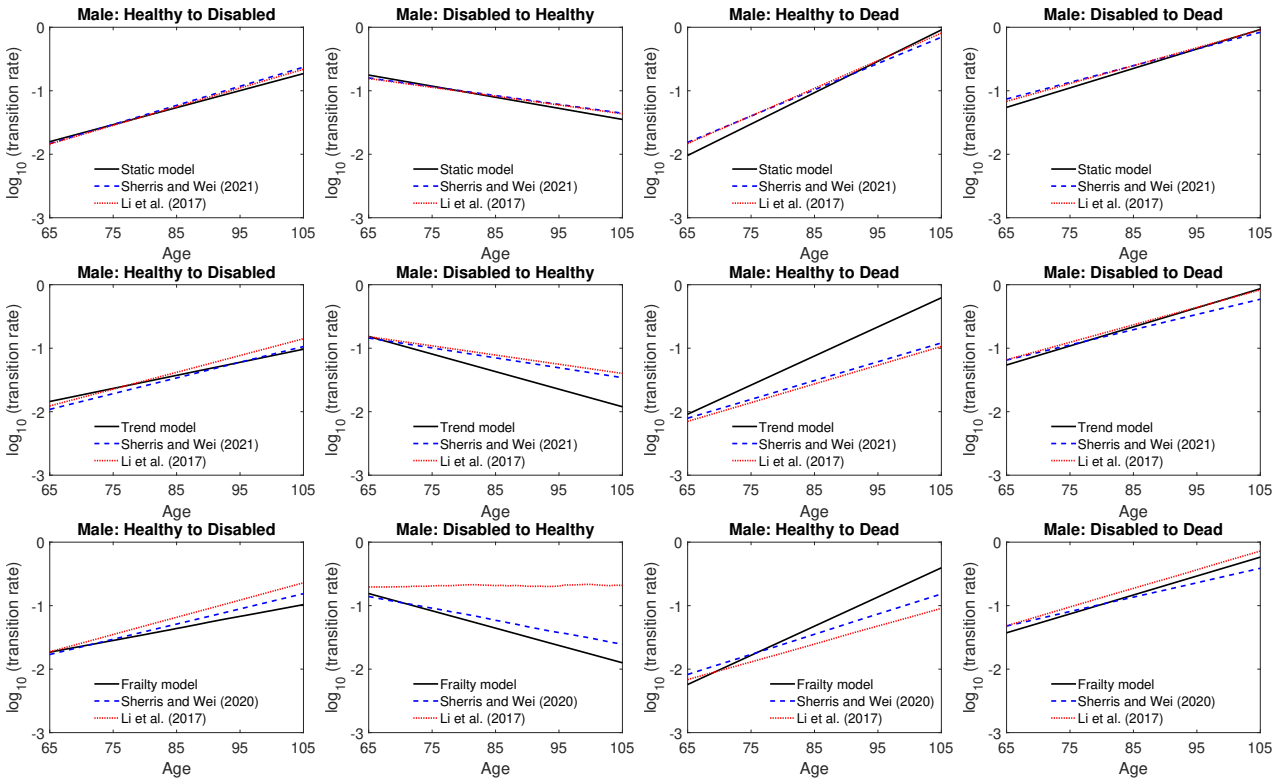

Figure B.1. Compare the estimated transition rates with Sherris and Wei (2021) and Li et al. (2017). The average transition rate is shown for the frailty model. The rates apply to a cohort of males in the U.S. who were 65 in 2010.

B.2 Life expectancy

We have compared our estimated transition rates with prior studies in Section 5. This section compares the implied life expectancy derived from our estimated transition model to quantify the impact of these differences. Table B.1 compares the life expectancy with the United Nations (2019) estimates. The United Nations (2019) estimates are based on the period life tables and average out over people of different health status, so for comparison we use our estimates from the static model and take a weighted average across initially healthy and disabled individuals. Allowing for the time period of the estimation, Table B.1 shows that the static life expectancy estimates for the U.S. population match well to the United Nations (2019) estimates, while those for the Chinese population, especially the male population, appear higher than the United Nations (2019) estimates would suggest.

To understand the reason for this difference, we show the disability prevalence rates from different Chinese data sources in Table B.2. The studies in Table B.2 vary slightly in definition of disability, but overall it is defined as having difficulty in performing at least one of the ADLs, similar to our definition. Among the three studies in Table B.2, Zimmer et al. (2015) use the CLHLS and find the lowest disability prevalence rates controlling for age and gender. This shows that the individuals in the CLHLS have lower disability prevalence rates than the population. The young- to middle-old in the CLHLS are healthier than the general population in China. This accounts for the higher Chinese life expectancy for our model, estimated based on the CLHLS, compared with the population.

Table B.1. Life expectancy of the static model compared to the United Nations (2019) estimates.

	65				75			
	China		U.S.		China		U.S.	
	Female	Male	Female	Male	Female	Male	Female	Male
Static model†	16.76	15.02	20.17	17.69	10.86	9.51	12.73	10.68
United Nations (2019) estimates‡								
1995-2000	15.40	12.82	19.09	15.78	8.92	7.36	12.04	9.68
2000-2005	15.58	13.36	19.35	16.50	9.03	7.56	12.14	10.10
2005-2010	16.02	13.54	20.12	17.47	9.38	7.70	12.74	10.84
2010-2015	16.80	13.86	20.66	18.09	10.03	8.00	13.16	11.37
2015-2020	17.80	14.68	20.94	18.37	10.80	8.59	13.42	11.68

† The life expectancy is a weighted average across initially healthy and disabled individuals, weighted by the exposure years in healthy and disabled states at age 65 or 75 in each gender category.

‡ Accessed 13 October 2020. `https://population.un.org/wpp/Download/Standard/Mortality/`

Table B.2. Estimated disability prevalence rates among the Chinese elderly.

Liang et al. (2014)†	1997	2000	2004	2006
	Both genders combined			
60 – 69	7.4%	6.0%	5.3%	4.6%
70 – 79	16.6%	18.1%	15.2%	13.1%

Zhang and Wei (2015)‡	2010	
	Female	Male
60 – 64	5.3%	6.9%
65 – 69	7.9%	7.8%
70 – 74	13.62%	10.50%
75 – 79	16.54%	15.57%

Zimmer et al. (2015)§	2002-05		2008-11	
	Female	Male	Female	Male
65 – 69	2.8%	4.4%	3.3%	3.5%
70 – 74	7.1%	5.1%	6.5%	5.6%
75 – 79	10.7%	9.6%	9.0%	8.5%

† Liang et al. (2014) use the data from China Health and Nutrition Survey. Someone who requires assistance or is unable to perform at least one of the five ADLs is considered disabled. The five ADLs are bathing, dressing, toileting, feeding, and transferring.

‡ Zhang and Wei (2015) use the data from the Sample Survey of the Aged Population in Urban/Rural China (SSAPUR) and China Health and Retirement Longitudinal Study (CHARLS). Someone who is unable to conduct one or more of the five ADLs is considered disabled. The five ADLs are bathing, dressing, toileting, getting up from a bed and chair, and eating

§ Zimmer et al. (2015) use the data from the CLHLS. Someone who requires assistance or is unable to perform at least one of the six ADLs is considered disabled. The five ADLs are eating, continence, transferring, toileting, dressing, and bathing.

Table B.3 compares our estimated Chinese life expectancy with Hanewald et al. (2019). For the same reasons as when comparing transition rates, we choose our trend model with the residence covariate for comparison. We do not compare results for initially disabled individuals as Hanewald et al. (2019) assume no recovery from the disabled state, whereas our health transition model does.

Table B.3 shows that our life expectancy estimates are similar to, but generally lower, than those in Hanewald et al. (2019). Some of these differences reflect differences in our estimated disability rates which are higher at younger ages (Figure 9) when disabled mortality is much greater than the healthy mortality.

Table B.3. Comparison of total life expectancy (TLE), healthy life expectancy (HLE), and the ratio of healthy life expectancy over total life expectancy (HLE/TLE) between the trend model and Hanewald et al. (2019).

	Trend model with residence				Hanewald et al. (2019)			
	Urban		Rural		Urban		Rural	
	Female	Male	Female	Male	Female	Male	Female	Male
Healthy at 65 in the year 1998								
TLE	17.06	15.26	17.01	15.07	18.24	16.18	17.45	15.75
HLE	15.65	14.32	16.03	14.41	16.85	15.16	16.26	15.03
HLE/TLE	0.918	0.938	0.942	0.956	0.924	0.937	0.932	0.954
Healthy at 65 in the year 2011								
TLE	17.69	15.78	17.45	15.47	18.80	16.52	17.70	16.05
HLE	16.63	15.05	16.70	14.98	17.36	15.16	16.68	15.17
HLE/TLE	0.940	0.954	0.957	0.968	0.923	0.918	0.942	0.945
Healthy at 65 in the year 2020								
TLE	18.04	16.00	17.70	15.66	19.10	16.81	17.83	16.25
HLE	17.25	15.42	17.15	15.24	17.66	15.16	16.93	15.25
HLE/TLE	0.956	0.963	0.969	0.973	0.925	0.902	0.950	0.938

Table B.4 compares our U.S. life expectancy estimates with Li et al. (2017) and Sherris and Wei (2021). Using the static model, we have higher estimates for life expectancy because our static model estimates lower mortality (Figure 10). Our results are consistent with external sources such as United Nations (2019) shown in Table B.1 and Center for Disease Control and Prevention (2016) who report that U.S. life expectancy at 65 years old in the year 2010 was 17.7 for male and 20.3 for female. Using the trend and frailty models, we produce lower estimates because our trend model has a faster estimated growth in mortality with age as explained earlier and shown in Figure 10. Differences are within a reasonable range. Model assumptions and estimation have been improved since the estimation in Li et al. (2017) whose model parameter estimates produce higher estimates from the frailty model, reflecting higher estimated recovery rates and higher uncertainty in these transition rates. The estimation was also improved in Sherris and Wei (2021).

Table B.4. Comparing total life expectancy (TLE), healthy life expectancy (HLE), and the ratio of healthy life expectancy over total life expectancy (HLE/TLE) with Li et al. (2017) and Sherris and Wei (2021). The results apply to a cohort of healthy individuals who were 65 years old in 2010.

	Female			Male		
	Static	Trend	Frailty	Static	Trend	Frailty
TLE	20.41	21.53	21.50	17.87	18.87	18.83
HLE	17.24	18.38	18.33	16.11	17.11	17.04
HLE/TLE	0.845	0.854	0.853	0.902	0.906	0.905
Sherris and Wei (2021)†						
TLE	18.68	22.50	22.13	16.13	19.99	19.57
HLE	15.89	19.50	18.92	14.65	18.22	17.72
HLE/TLE	0.851	0.867	0.855	0.908	0.911	0.905
Li et al. (2017)‡						
TLE	18.96	22.68	23.70	16.23	20.16	21.23
HLE	16.19	19.43	20.79	14.72	18.33	19.56
HLE/TLE	0.854	0.857	0.877	0.907	0.909	0.921

† Sherris and Wei (2021) uses the HRS data from 1998 to 2014.
‡ Li et al. (2017) uses the HRS data from 1998 to 2012.

C Algorithms

Algorithm 1: Simulate health states

Input: Starting age (x) and the maximum attainable age (y)
Transition rate matrices from age x to age y
Required number of simulations, N

Output: N simulated health state paths from age x to age y

initialise the health state at age x;

initialise $\mathbf{S}$; `/* a matrix of size` $(y - x + 1) \times N$ `*/`

for $age = x + 1$ **to** y **do**

Transition probability matrix $\mathbf{P} \leftarrow$ Matrix exponential of the transition rate matrix at $age - 1$;

$\mathbf{s}_{\text{old}} \leftarrow N$ simulated health states at $age - 1$;

$n \leftarrow$ an $N \times 1$ matrix of ones;

$p \leftarrow$ a matrix with N rows where the n^{th} row of p is the k^{th} row of $\mathbf{P}$ where k is the n^{th} element in $\mathbf{s}_{\text{old}}$;

$\mathbf{S}_{\text{tmp}} \leftarrow$ simulated multinomial random numbers with parameters n (number of trials) and p (multinomial probabilities);

$\mathbf{S}[age, :] \leftarrow$ the index of 1 in each row of $\mathbf{S}_{\text{tmp}}$;

end

return $\mathbf{S}$;

Algorithm 2: Simulate the future lifetime (random variable) spent in each state

Input: Starting age (x) and the maximum attainable age (y)
N simulated health state paths from age x to age y, $\mathbf{S}$

Output: Future lifetime spent in each state for age x

// *Note:* each column of $\mathbf{S}$ is one simulated path

$\mathbf{s}_0 \leftarrow$ the first row of $\mathbf{S}$; /* initial health states in the simulation */

$\boldsymbol{s} \leftarrow$ unique values in the simulated health state paths ; /* a vector of health states, the first being healthy and the last being dead */

$M \leftarrow$ length of $\boldsymbol{s}$; /* number of health states, including the dead state */

initialise ℓ_m for $m = 1, 2, \cdots, M-1$; /* each ℓ_m is a vector of size N */

for $m = 1$ **to** $M - 1$ **do**

  // ℓ_m (a vector of size N) is the future lifetime in state m

  $\ell_m \leftarrow$ number of elements in each column of $\mathbf{S}$ equal to m;

  // adjust for the assumption that the transition occurs at the middle of the year

  $\ell_m \leftarrow \ell_m - \frac{1}{2} \times (\mathbf{s}_0 == m)$; /* $\mathbf{s}_0 == m$ gives a vector of zeros and/or ones */

end

// $\ell_{\texttt{total}}$ is the total future lifetime

$\ell_{\text{total}} \leftarrow \sum_{m=1}^{M-1} \ell_m$;

return $\ell_1, \ldots, \ell_{M-1}$, ℓ_{total};

D Supplementary Simulation Results

D.1 Estimated transition rates: a cohort comparison

Figure D.1 and Figure D.2 compare the estimated transition rates between the two simulated cohorts (aged 65 in 1998 and aged 65 in 2014) based on the CLHLS sample and the HRS sample, respectively. For the trend model, the mortality rates at age 65 and thereafter are similar for the two cohorts. The impact of trends is more significant for the disability and recovery rates which differ between the two cohorts. This reflects our estimation results in Table 8 that disability and recovery rates show stronger time trends than mortality rates.

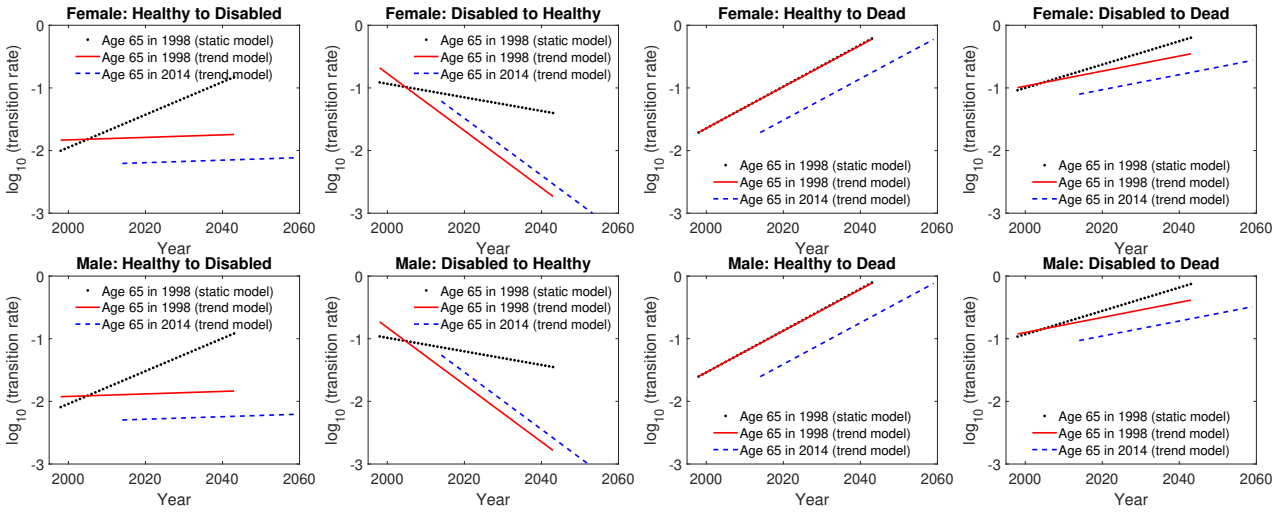

Figure D.1. Comparison of the estimated transition rates between the simulated cohorts assumed age 65 in 1998 and age 65 in 2014. The transition rates are assumed to follow the static model or the trend model. The parameters are estimated based on the CLHLS sample.

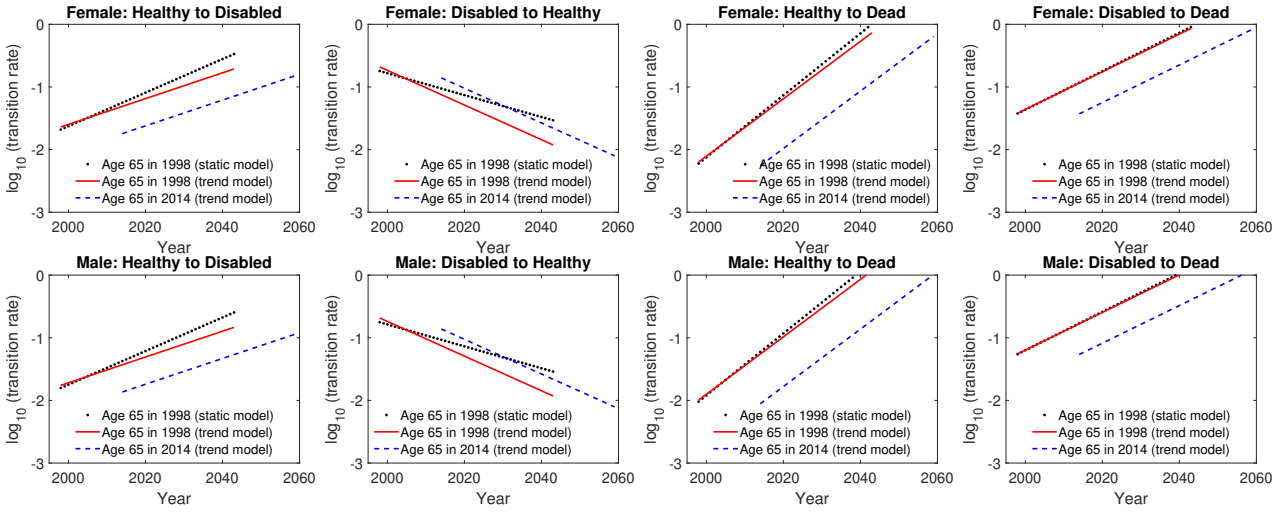

Figure D.2. Comparison of the estimated transition rates between the simulated cohorts assumed age 65 in 1998 and age 65 in 2014. The transition rates are assumed to follow the static model or the trend model. The parameters are estimated based on the HRS sample.

D.2 Survival curves

Figure D.3 to Figure D.6 display the survival curves for the healthy 75-year-old. Table D.1 to Table D.4 display the simulated future lifetime statistics using the frailty model.

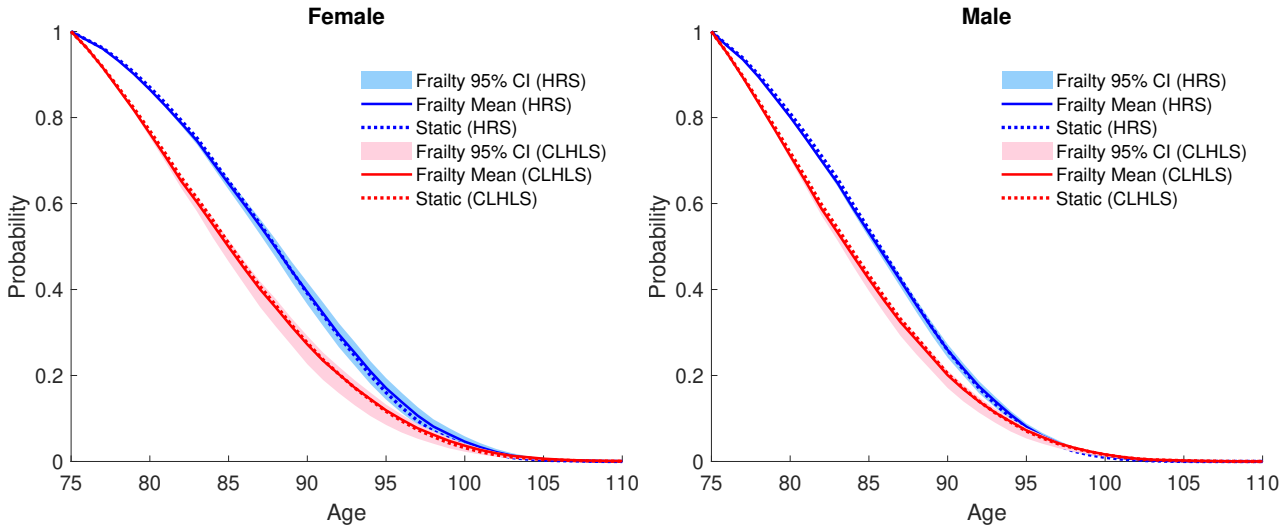

Figure D.3. Survival curves of the static and frailty models for a cohort of individuals who were healthy at age 75 in the year 1998. Survival curve of the trend model virtually overlaps with the mean of the frailty model. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated survival curves from the frailty model. Frailty Mean is determined by the sample mean of the simulated survival curves from the frailty model.

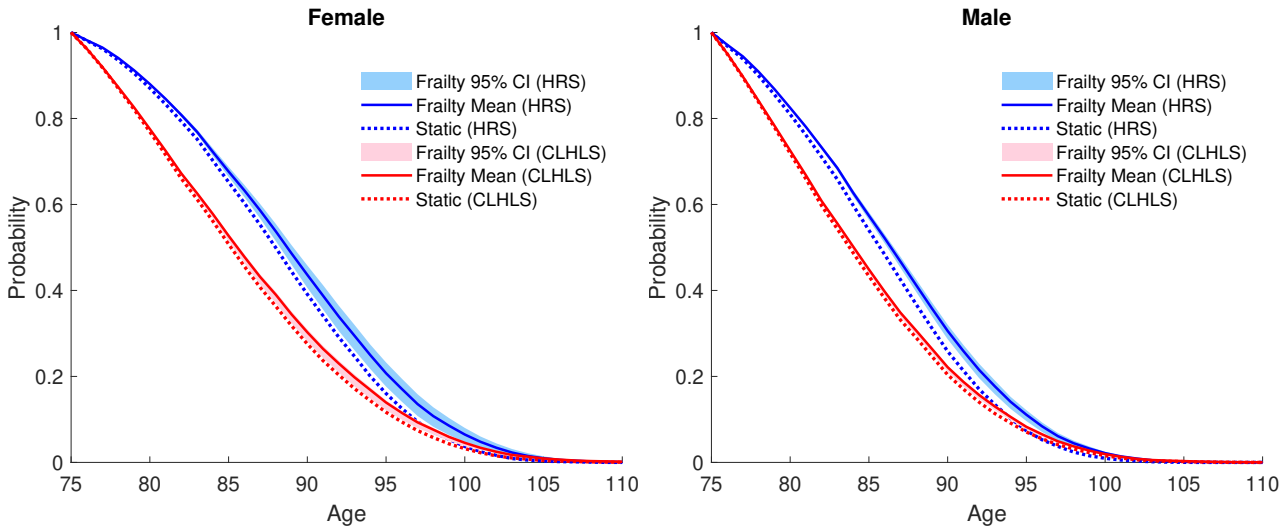

Figure D.4. Survival curves of the static and frailty models for a cohort of individuals who were healthy at age 75 in the year 2014. Survival curve of the trend model virtually overlaps with the mean of the frailty model. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated survival curves from the frailty model. Frailty Mean is determined by the sample mean of the simulated survival curves from the frailty model.

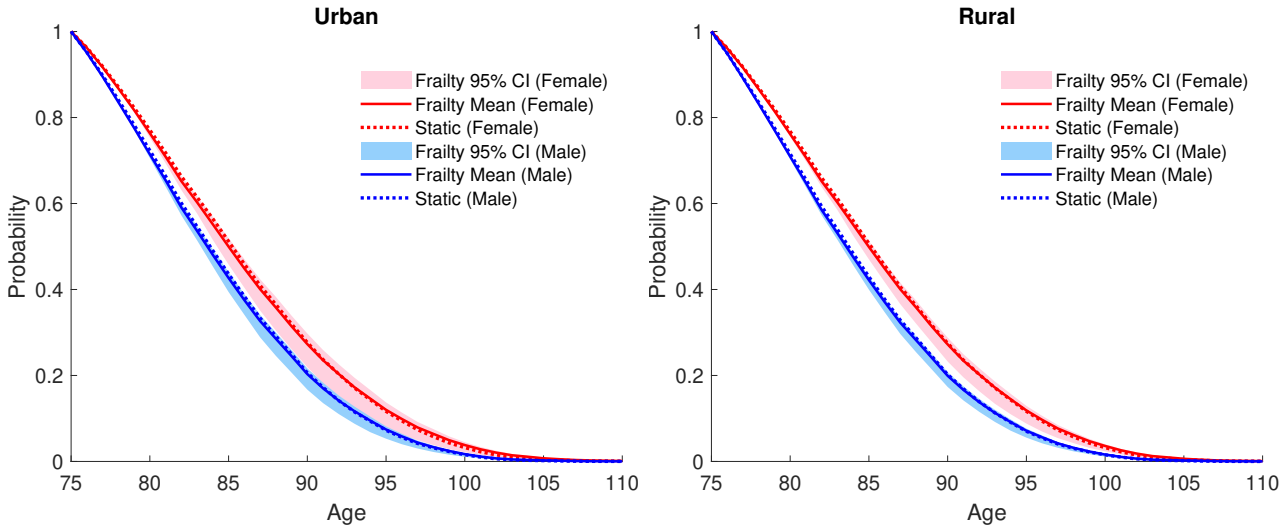

Figure D.5. Survival curves of the static and frailty models (with the residence covariate) for a cohort of individuals who were healthy at age 75 in the year 1998. Survival curve of the trend model virtually overlaps with the mean of the frailty model. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated survival curves from the frailty model. Frailty Mean is determined by the sample mean of the simulated survival curves from the frailty model.

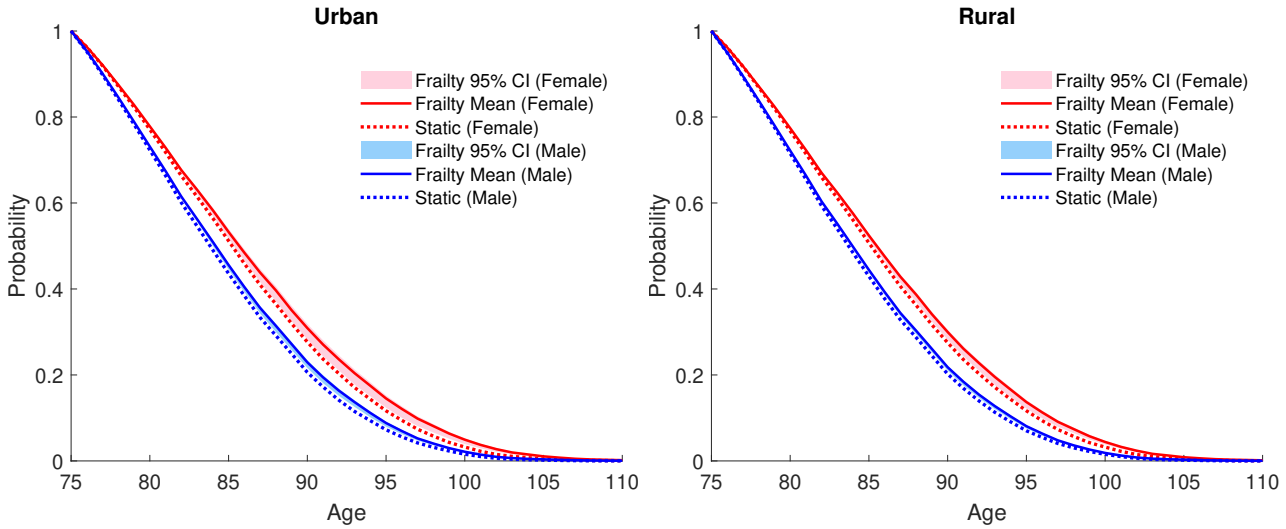

Figure D.6. Survival curves of the static and frailty models (with the residence covariate) for a cohort of individuals who were healthy at age 75 in the year 2014. Survival curve of the trend model virtually overlaps with the mean of the frailty model. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated survival curves from the frailty model. Frailty Mean is determined by the sample mean of the simulated survival curves from the frailty model.

Table D.1. Frailty model: future lifetime statistics for 65-year-old healthy individuals in 1998 and 2014, including mean, 95% confidence interval of the mean in square brackets, standard error of the mean in round brackets, and standard deviation (Std). The maximum attainable age is 110.

	CLHLS		HRS	
	Female	Male	Female	Male
1998				
Total future lifetime				
Mean	16.87 [15.76, 17.26] (0.0030)	15.04 [14.29, 15.30] (0.0027)	20.85 [20.01, 21.50] (0.0028)	18.19 [17.70, 18.53] (0.0026)
Std	9.35	8.69	8.94	8.33
Healthy future lifetime				
Mean	15.66 [13.37, 16.65] (0.0029)	14.22 [12.64, 14.87] (0.0027)	17.74 [16.09, 19.13] (0.0028)	16.46 [15.45, 17.22] (0.0026)
Std	9.21	8.59	8.70	8.24
Disabled future lifetime				
Mean	1.21 [0.58, 2.34] (0.0010)	0.82 [0.39, 1.64] (0.0008)	3.10 [2.37, 3.92] (0.0014)	1.73 [1.31, 2.25] (0.0010)
Std	3.16	2.49	4.48	3.19
Healthy future lifetime over total future life time				
Mean	0.929 [0.870, 0.962] (5E-5)	0.946 [0.902, 0.971] (5E-5)	0.855 [0.815, 0.888] (6E-5)	0.905 [0.877, 0.927] (5E-5)
Std	0.170	0.152	0.202	0.173
Age at onset of disability conditional on becoming disabled				
Mean	75.52 [71.32, 79.52] (0.0052)	74.85 [71.12, 78.76] (0.0055)	79.37 [78.38, 80.32] (0.0037)	78.41 [77.43, 79.32] (0.0041)
Std	7.09	6.56	8.47	7.82
2014				
Total future lifetime				
Mean	17.47 [16.97, 17.63] (0.0030)	15.53 [15.26, 15.62] (0.0028)	21.81 [20.91, 22.52] (0.0029)	19.11 [18.58, 19.51] (0.0027)
Std	9.53	8.85	9.14	8.58
Healthy future lifetime				
Mean	16.59 [14.95, 17.18] (0.0030)	14.92 [13.93, 15.24] (0.0028)	18.78 [17.10, 20.19] (0.0029)	17.46 [16.45, 18.26] (0.0027)
Std	9.49	8.81	9.27	8.67
Disabled future lifetime				
Mean	0.88 [0.36, 1.99] (0.0010)	0.61 [0.26, 1.34] (0.0008)	3.02 [2.32, 3.81] (0.0015)	1.65 [1.24, 2.13] (0.0010)
Std	3.21	2.57	4.63	3.25
Healthy future lifetime over total future life time				
Mean	0.953 [0.901, 0.979] (5E-5)	0.964 [0.928, 0.983] (4E-5)	0.860 [0.823, 0.891] (7E-5)	0.911 [0.886, 0.931] (6E-5)
Std	0.153	0.136	0.209	0.176
Age at onset of disability conditional on becoming disabled				
Mean	76.18 [71.43, 81.17] (0.0077)	75.03 [70.90, 79.77] (0.0077)	80.54 [79.43, 81.59] (0.0041)	79.32 [78.17, 80.32] (0.0045)
Std	7.36	6.56	8.95	8.20

Table D.2. Frailty model: future lifetime statistics for 75-year-old healthy individuals in 1998 and 2014, including mean, 95% confidence interval of the mean in square brackets, standard error of the mean in round brackets, and standard deviation (Std). The maximum attainable age is 110.

	CLHLS		HRS	
	Female	Male	Female	Male
1998				
Total future lifetime				
Mean	10.91 [10.26, 11.20] (0.0022)	9.55 [9.12, 9.71] (0.0020)	13.12 [12.70, 13.47] (0.0022)	10.90 [10.68, 11.06] (0.0019)
Std	7.01	6.38	6.82	6.15
Healthy future lifetime				
Mean	9.86 [8.50, 10.60] (0.0021)	8.85 [7.94, 9.31] (0.0020)	10.59 [9.78, 11.32] (0.0020)	9.55 [9.09, 9.94] (0.0019)
Std	6.77	6.22	6.42	5.95
Disabled future lifetime				
Mean	1.05 [0.60, 1.75] (0.0008)	0.69 [0.38, 1.18] (0.0006)	2.52 [2.15, 2.93] (0.0012)	1.35 [1.13, 1.59] (0.0008)
Std	2.61	2.02	3.73	2.61
Healthy future lifetime over total future life time				
Mean	0.910 [0.858, 0.944] (6E-5)	0.933 [0.894, 0.958] (6E-5)	0.819 [0.790, 0.846] (8E-5)	0.883 [0.864, 0.901] (7E-5)
Std	0.200	0.178	0.249	0.216
Age at onset of disability conditional on becoming disabled				
Mean	82.62 [79.94, 85.02] (0.0036)	82.08 [79.66, 84.48] (0.0039)	84.20 [83.71, 84.68] (0.0026)	83.47 [82.87, 83.99] (0.0029)
Std	5.30	4.89	5.89	5.36
2014				
Total future lifetime				
Mean	11.44 [11.16, 11.54] (0.0023)	9.92 [9.79, 9.96] (0.0021)	13.86 [13.40, 14.24] (0.0022)	11.66 [11.42, 11.85] (0.0020)
Std	7.28	6.55	7.08	6.41
Healthy future lifetime				
Mean	10.68 [9.74, 11.12] (0.0022)	9.45 [8.89, 9.67] (0.0020)	11.44 [10.57, 12.19] (0.0022)	10.37 [9.87, 10.76] (0.0020)
Std	7.10	6.46	6.89	6.34
Disabled future lifetime				
Mean	0.76 [0.37, 1.42] (0.0008)	0.46 [0.25, 0.89] (0.0006)	2.43 [2.04, 2.84] (0.0012)	1.29 [1.08, 1.54] (0.0008)
Std	2.61	1.93	3.82	2.65
Healthy future lifetime over total future life time				
Mean	0.944 [0.900, 0.970] (5E-5)	0.961 [0.929, 0.977] (5E-5)	0.831 [0.803, 0.857] (8E-5)	0.892 [0.872, 0.908] (7E-5)
Std	0.171	0.147	0.248	0.213
Age at onset of disability conditional on becoming disabled				
Mean	83.19 [79.95, 86.49] (0.0053)	82.29 [79.62, 85.54] (0.0057)	85.10 [84.49, 85.66] (0.0030)	84.26 [83.62, 84.83] (0.0033)
Std	5.54	4.96	6.36	5.82

Table D.3. Frailty model with residence: future lifetime statistics for 65-year-old healthy individuals in 1998 and 2014, including mean, 95% confidence interval of the mean in square brackets, standard error of the mean in round brackets, and standard deviation (Std). The maximum attainable age is 110.

	Urban		Rural	
	Female	Male	Female	Male
1998				
Total future lifetime				
Mean	16.88 [15.56, 17.39] (0.0030)	15.13 [14.22, 15.46] (0.0028)	16.87 [15.90, 17.18] (0.0030)	14.98 [14.36, 15.18] (0.0027)
Std	9.37	8.73	9.33	8.68
Healthy future lifetime				
Mean	15.42 [12.67, 16.69] (0.0029)	14.13 [12.21, 14.95] (0.0027)	15.83 [13.81, 16.66] (0.0029)	14.28 [12.90, 14.80] (0.0027)
Std	9.20	8.61	9.18	8.57
Disabled future lifetime				
Mean	1.46 [0.68, 2.81] (0.0011)	1.01 [0.48, 2.00] (0.0009)	1.04 [0.47, 2.11] (0.0009)	0.69 [0.32, 1.42] (0.0007)
Std	3.49	2.79	2.87	2.25
Healthy future lifetime over total future life time				
Mean	0.915 [0.844, 0.956] (6E-5)	0.934 [0.881, 0.964] (5E-5)	0.940 [0.886, 0.969] (5E-5)	0.955 [0.915, 0.976] (4E-5)
Std	0.186	0.167	0.154	0.138
Age at onset of disability conditional on becoming disabled				
Mean	75.56 [71.56, 79.34] (0.0049)	74.86 [71.00, 78.70] (0.0051)	75.81 [71.44, 80.06] (0.0057)	75.14 [71.10, 79.18] (0.0061)
Std	7.13	6.59	7.14	6.73
2014				
Total future lifetime				
Mean	17.65 [17.01, 17.85] (0.0030)	15.73 [15.35, 15.85] (0.0028)	17.40 [16.97, 17.55] (0.0030)	15.43 [15.22, 15.52] (0.0028)
Std	9.62	8.93	9.52	8.83
Healthy future lifetime				
Mean	16.54 [14.46, 17.33] (0.0030)	14.96 [13.68, 15.39] (0.0028)	16.61 [15.11, 17.11] (0.0030)	14.90 [14.02, 15.17] (0.0028)
Std	9.55	8.87	9.46	8.79
Disabled future lifetime				
Mean	1.11 [0.41, 2.50] (0.0011)	0.76 [0.35, 1.69] (0.0009)	0.80 [0.32, 1.83] (0.0010)	0.53 [0.22, 1.22] (0.0007)
Std	3.58	2.90	3.02	2.34
Healthy future lifetime over total future life time				
Mean	0.942 [0.876, 0.975] (5E-5)	0.956 [0.911, 0.978] (5E-5)	0.958 [0.908, 0.981] (5E-5)	0.969 [0.935, 0.985] (4E-5)
Std	0.169	0.150	0.145	0.126
Age at onset of disability conditional on becoming disabled				
Mean	76.22 [71.42, 81.24] (0.0070)	75.25 [71.04, 80.04] (0.0072)	76.33 [71.33, 81.45] (0.0080)	75.23 [71.23, 80.09] (0.0083)
Std	7.40	6.74	7.36	6.63

Table D.4. Frailty model with residence: future lifetime statistics for 75-year-old healthy individuals in 1998 and 2014, including mean, 95% confidence interval of the mean in square brackets, standard error of the mean in round brackets, and standard deviation (Std). The maximum attainable age is 110.

	Urban		Rural	
	Female	Male	Female	Male
1998				
Total future lifetime				
Mean	10.94 [10.15, 11.31] (0.0022)	9.60 [9.09, 9.80] (0.0020)	10.90 [10.34, 11.13] (0.0022)	9.51 [9.15, 9.64] (0.0020)
Std	7.04	6.40	7.00	6.37
Healthy future lifetime				
Mean	9.67 [8.06, 10.58] (0.0021)	8.78 [7.67, 9.34] (0.0020)	9.99 [8.79, 10.61] (0.0021)	8.93 [8.12, 9.30] (0.0020)
Std	6.72	6.21	6.77	6.22
Disabled future lifetime				
Mean	1.27 [0.71, 2.09] (0.0009)	0.83 [0.44, 1.43] (0.0007)	0.91 [0.51, 1.57] (0.0008)	0.58 [0.31, 1.03] (0.0006)
Std	2.88	2.22	2.40	1.83
Healthy future lifetime over total future life time				
Mean	0.893 [0.832, 0.934] (7E-5)	0.921 [0.874, 0.951] (6E-5)	0.922 [0.875, 0.952] (6E-5)	0.944 [0.908, 0.965] (5E-5)
Std	0.216	0.192	0.185	0.162
Age at onset of disability conditional on becoming disabled				
Mean	82.64 [79.98, 84.86] (0.0034)	82.08 [79.58, 84.43] (0.0036)	82.80 [80.09, 85.35] (0.0039)	82.32 [79.84, 84.79] (0.0043)
Std	5.35	4.90	5.41	5.02
2014				
Total future lifetime				
Mean	11.57 [11.20, 11.71] (0.0023)	10.07 [9.90, 10.13] (0.0021)	11.38 [11.14, 11.46] (0.0023)	9.85 [9.75, 9.88] (0.0021)
Std	7.36	6.62	7.25	6.53
Healthy future lifetime				
Mean	10.63 [9.45, 11.20] (0.0023)	9.47 [8.75, 9.76] (0.0021)	10.70 [9.82, 11.09] (0.0022)	9.44 [8.94, 9.62] (0.0020)
Std	7.12	6.50	7.08	6.44
Disabled future lifetime				
Mean	0.94 [0.47, 1.76] (0.0009)	0.59 [0.32, 1.15] (0.0007)	0.68 [0.32, 1.32] (0.0008)	0.41 [0.21, 0.81] (0.0006)
Std	2.92	2.20	2.45	1.80
Healthy future lifetime over total future life time				
Mean	0.932 [0.877, 0.963] (6E-5)	0.950 [0.910, 0.971] (5E-5)	0.949 [0.908, 0.973] (5E-5)	0.965 [0.936, 0.981] (4E-5)
Std	0.186	0.166	0.162	0.138
Age at onset of disability conditional on becoming disabled				
Mean	83.37 [80.30, 86.47] (0.0050)	82.43 [79.54, 85.65] (0.0053)	83.24 [80.06, 86.71] (0.0055)	82.42 [79.76, 85.73] (0.0060)
Std	5.73	5.20	5.54	5.01

D.3 Health distribution

Figure D.7 to Figure D.10 show the probability of being disabled for a cohort of 75-year-old healthy individuals.

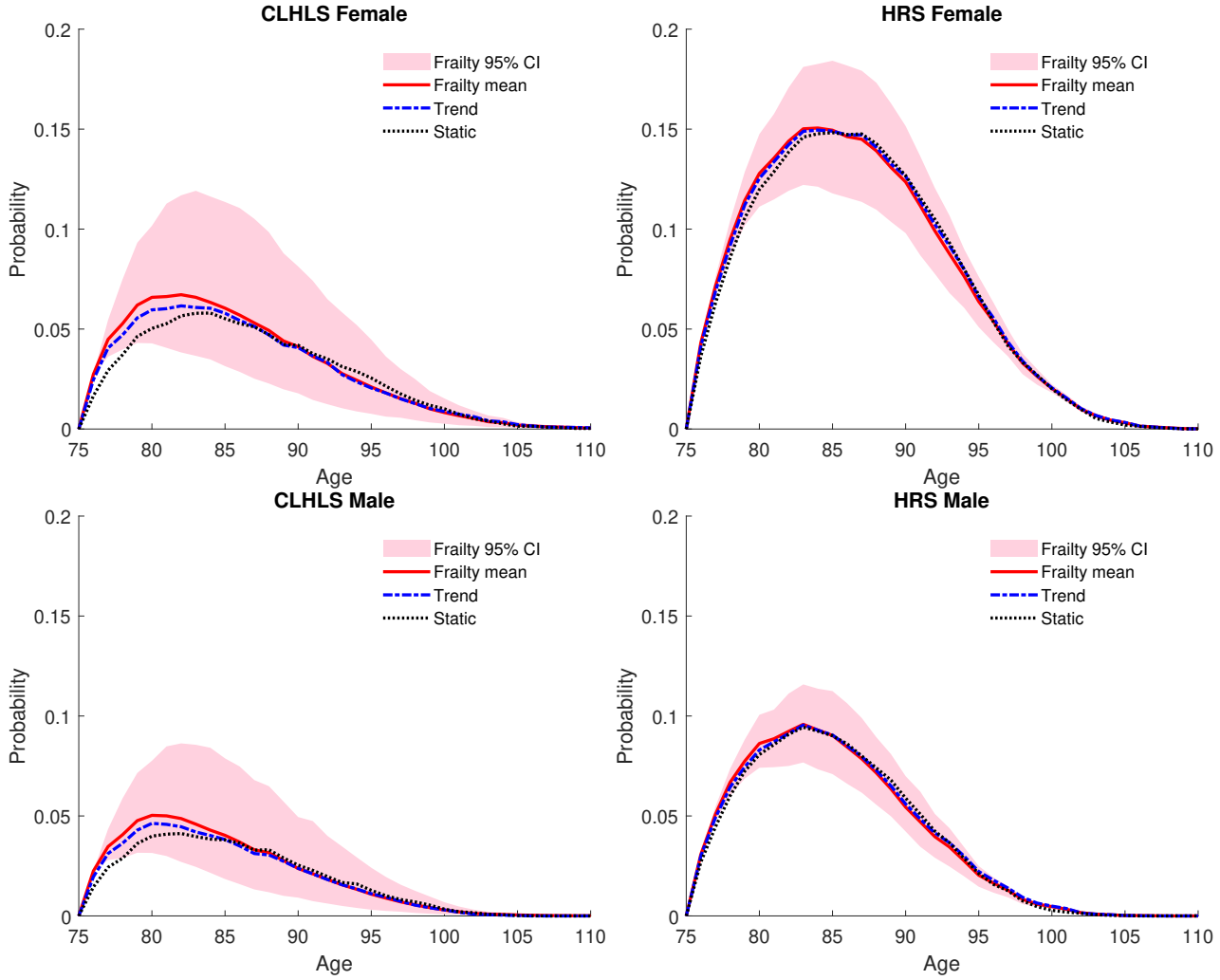

Figure D.7. Probability of being in the disabled state for a cohort of individuals who were healthy at age 75 in the year 1998. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated probabilities from the frailty model. Frailty mean is determined by the sample mean of the simulated probabilities from the frailty model.

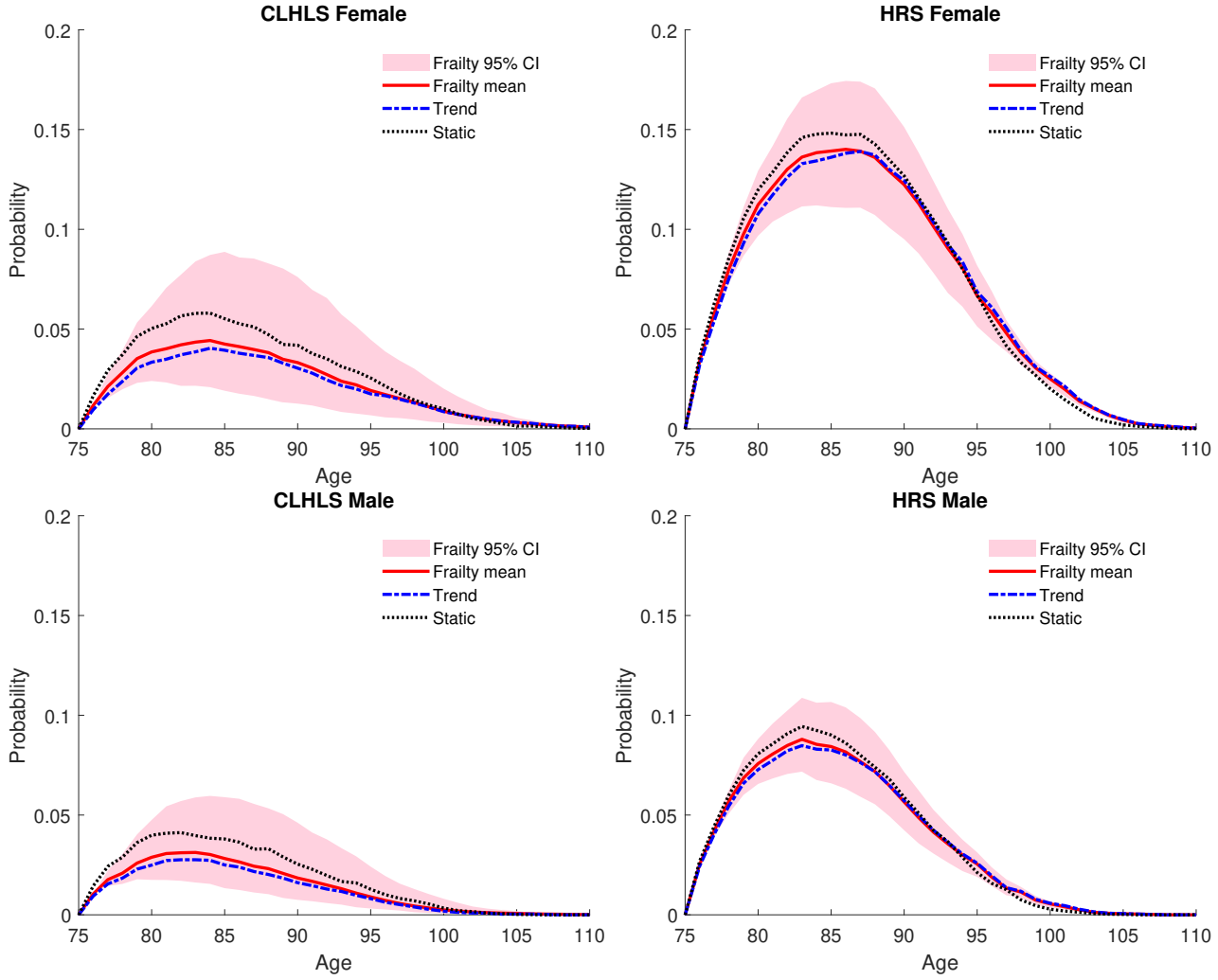

Figure D.8. Probability of being in the disabled state for a cohort of individuals who were healthy at age 75 in the year 2014. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated probabilities from the frailty model. Frailty mean is determined by the sample mean of the simulated probabilities from the frailty model.

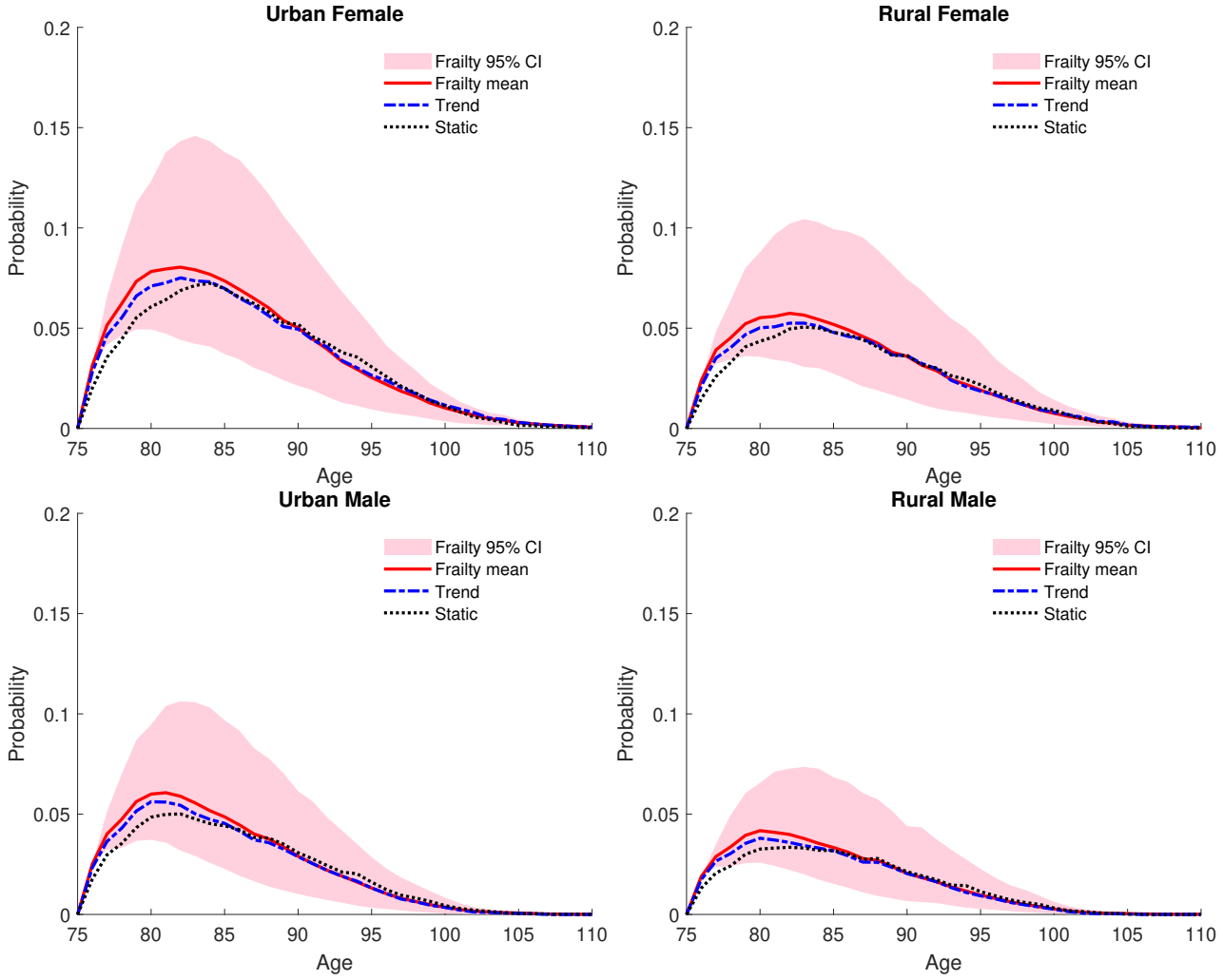

Figure D.9. Probability of being in the disabled state for a cohort of individuals who were healthy at age 75 in the year 1998. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated probabilities from the frailty model. Frailty mean is determined by the sample mean of the simulated probabilities from the frailty model.

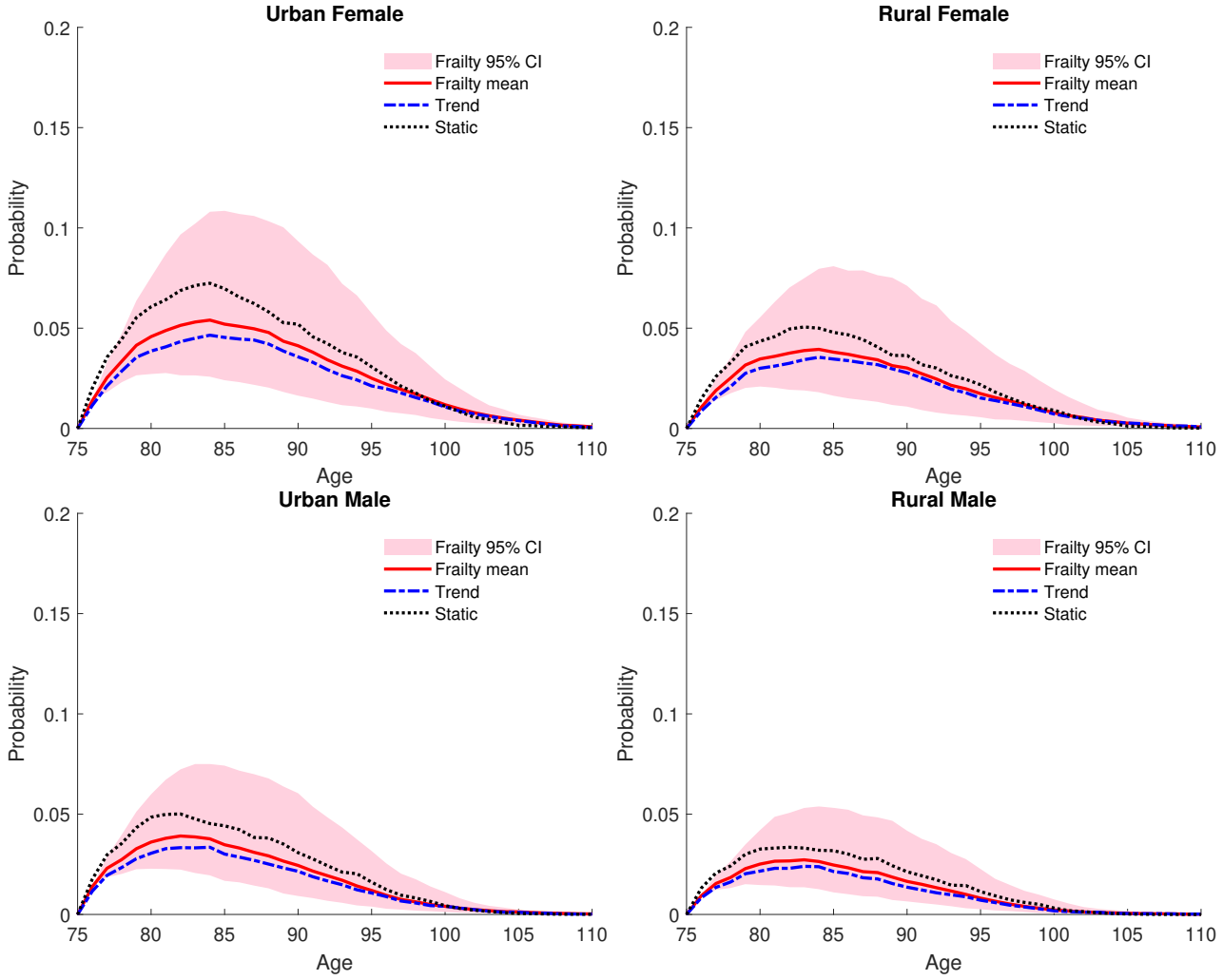

Figure D.10. Probability of being in the disabled state for a cohort of individuals who were healthy at age 75 in the year 2014. Frailty 95% CI is determined by the 2.5^{th} and 97.5^{th} percentiles of the simulated probabilities from the frailty model. Frailty mean is determined by the sample mean of the simulated probabilities from the frailty model.

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