Total factor productivity in the Swiss nursing home industry: the impact of the 2011 reform of the financing system

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Introduction

- The cost for the provision of elderly care services is growing steadily with the aging population and the increasing impact of chronic illnesses.
- The total expenditure for nursing homes (NHs) and home care services is currently approaching 1.7% of GDP.
- Thus, nursing home efficiency and productivity become more and more crucial to limit growth of elderly care costs (medical and non-medical care).
- In this context the regulation of nursing homes plays an important role.
- In 2011, the Swiss federal government reformed the financing system of long term care (LTC) (nursing homes and home care).

The financing system reform for Swiss nursing homes

Costs of a nursing home: cost of providing health care services (HCSC) and cost of food, logging and care services (FLCC).

Before the reform:

- HCSC mainly covered by (compulsory) health insurance.
- FLCC covered by patients and local public authorities.

After the reform:

- HCSC covered by the health insurance companies (cap that limits coverage), patients and local authorities.
- FLCC coverage unchanged.

Goals: To limit the expenditure for insurance companies.

Timing of policy adoption

Table 1: Timing of policy adoption.

Year	Cantons
2011	AG, AI, AR, BL, BS, GE, GL, GR, JU, LU, NE, NW, OW, SG, SH, SO, SZ, TI, UR, VD, ZG
2012	TG
after 2012	BE, FR, VS, ZH

Source: our elaboration on data from Trageser et al. (2018).

The quasi-experiment

Table 2: Financing system of LTC health care service costs

Group	2007-2010	2011-2012
Treated	Insurer	Insurer (∼65%)
(adoption in 2011)	Patient	Patient (max 20%)
		Cantons (residual costs)
		Homogeneous dependency level scale
Control	Insurer	Insurer
(adoption after 2012)	Patient	Patient

Focus on public NHs: after the reform, private NHs become eligible for public subsidies → this may the confound results.

Research questions

- How did total factor productivity (TFP) develop over time?
- What is the impact of the reform on TFP growth?

Previous literature

Nursing home efficiency and productivity:

- Main focus on efficiency analysis and nursing home heterogeneity (e.g. Christensen, 2004, Vitaliano and Toren, 1994)
- Generally cross-sectional data (e.g. McKay, 1988, Yu and Bradford, 1995) or short panels (e.g. Chattopadhyay and Ray, 1996, Di Giorgio et al., 2016)
- Productivity analysis lacking in the nursing home sector, but it is crucial for firm survival (Syverson, 2011).

Productivity measurement and policy evaluation

- Filippini et al. (2017) and Borghi et al. (2016) use a two-stage approach to estimate policy impact on and determinants of TFPC, respectively.
    - Inconsistent std. errors and estimation bias if omitted variables in first stage:
        - Mattsson et al. (2018): Tornqvist index
        - Harris and Trainor (2005): estimate policy outcome in the production function.

Methodological approach

Analysis of the impact of the reform using 3 approaches:

- two-stage approaches:
  - TFPC derived from a cost function
  - use of the Tornqvist approach

- including the policy variable directly in the cost function

Contribution

- Measurement of TFP change (TFPC) in the nursing home industry.
- Comparison of different policy evaluation strategies for productivity analysis.

Data

- Yearly administrative data from 380 public nursing homes from 25 cantons for the period 2007-2012 provided by the Swiss Federal Office for Statistics (SOMED A data).
  - Detailed information on revenues, costs, inputs and patients' characteristics.
  - Private nursing homes excluded because they become eligible for public funds, which may confound the results.
- 231 treated and 149 control nursing homes.

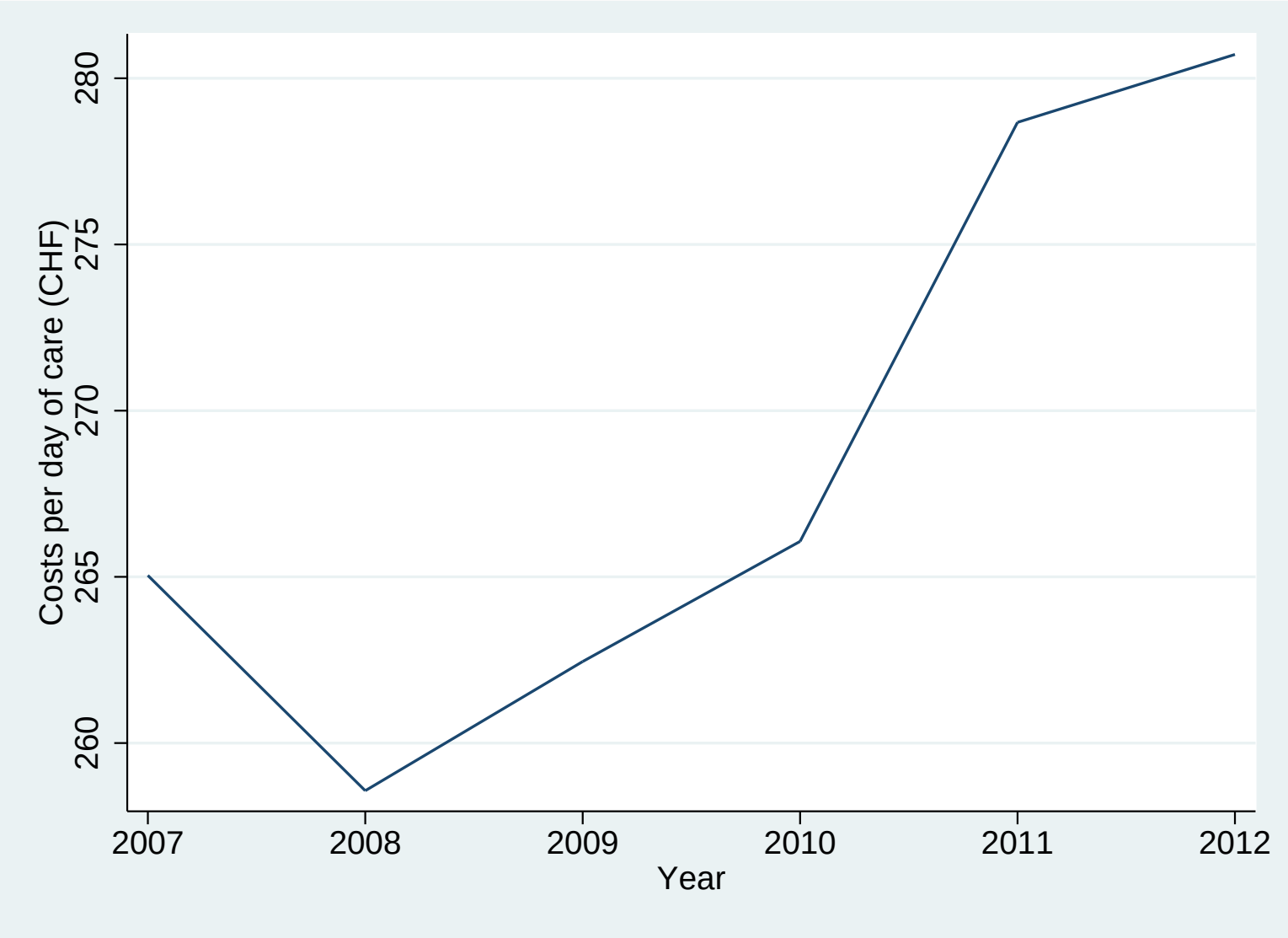
Cost function: Variables

Cost function: $TC = f(Y, P_L, P_K, P_M, D, Q, t)$

- **Output** (Y): days of care
- **Inputs:**
  - Price of labor (P_L): yearly salary per full-time equivalent nurse/doctor
  - Price of capital (P_K): costs of borrowings, amortization and depreciation per bed
  - Price of materials (P_M): residual costs per meal (used to impose linear homogeneity)
- **Output characteristics:**
  - Dependency level (D)
  - Share of patients covered by mandatory insurance (Q)

Trend in unit costs

Figure 1: Costs per day of care over time.



Cost function: Descriptive statistics

Table 3: Descriptive statistics.

	Obs.	Mean	Std. Dev.	Min	Max
Days of care	10342	22388.9	16344.3	762	242563
Price of labor	10342	65938.3	10609.5	37221.4	121306.4
Price of capital	10342	9690.3	7430.6	0	118552.2
Price of materials	10342	23.52	9.389	0.340	70.63
Dependency level	10342	2.236	0.576	0.00870	3.964
Share of LAMal patients	10342	95.37	9.862	0.870	100

Cost function: Translog specification

$$
\begin{aligned}
ln(TC) = {} & \beta_Y \, ln\, Y + \sum_w \beta_w \, ln\, w + \sum_q \beta_q \, ln\, q + \beta_t \, t \\
& + \frac{1}{2} \beta_{YY} \, (ln\, Y)^2 + \frac{1}{2} \sum_w \beta_{ww} \, (ln\, w)^2 + \frac{1}{2} \sum_q \beta_{qq} \, (ln\, q)^2 + \frac{1}{2} \beta_{tt} \, t^2 \\
& + \sum_w \beta_{Yw} \, (ln\, Y) \, (ln\, w) + \sum_q \beta_{Yq} \, (ln\, Y) \, (ln\, q) \\
& + \beta_{LK} \, (ln\, L) \, (ln\, K) + \sum_w \sum_q \alpha_{wq} \, (ln\, w) \, (ln\, q) \\
& + \beta_{QD} \, ln\, Q \, ln\, D + \beta_{Yt} \, ln\, Y \, t + \sum_w \beta_{wt} \, (ln\, w) \, t + \sum_q \beta_{qt} \, (ln\, q) \, t \\
& + \alpha_i + \varepsilon_{it}
\end{aligned}
\tag{1}
$$

with $w = \{P_L, P_K\}$, $q = \{D, Q\}$. All variables normalized and P_M as the numeraire to impose linear homogeneity.

Cost function: Regression results

Table 4: Fixed effects cost function estimation results.

	Coef.	Std. err.		Coef.	Std. err.
Days of care (β_Y)	0.740***	(0.0730)	(β_{YL})	0.0777***	(0.0198)
Labor price (β_L)	0.811***	(0.0297)	(β_{YK})	-0.00285	(0.00545)
Capital price (β_K)	0.0579***	(0.0109)	(β_{YQ})	-0.150**	(0.0557)
Share of LAMal patients (β_Q)	-0.0701	(0.0941)	(β_{YD})	0.0321	(0.106)
Dependency level (β_D)	0.0752	(0.0814)	(β_{LK})	-0.0166***	(0.00414)
Time trend (β_t)	-0.0169	(0.0104)	(β_{LQ})	0.0462	(0.0742)
(β_{YY})	0.0604	(0.0486)	(β_{LD})	0.0790	(0.0664)
(β_{LL})	0.0724***	(0.0167)	(β_{KQ})	-0.00269	(0.0221)
(β_{KK})	0.0120***	(0.00263)	(β_{KD})	0.0316	(0.0205)
(β_{QQ})	-0.0533	(0.123)	(β_{QD})	0.0840	(0.254)
(β_{DD})	0.183	(0.222)	(β_{Yt})	0.00939	(0.00572)
(β_{tt})	0.00390**	(0.00134)	(β_{Lt})	-0.0105*	(0.00522)
			(β_{Kt})	-0.00187	(0.00152)
			(β_{Qt})	0.0207	(0.0180)
			(β_{Dt})	-0.00743	(0.0175)
Obs.	2130				
Overall R-sq.	0.914				
Within R-sq.	0.917				
Between R.sq	0.919				

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Robust standard errors in parenthesis are clustered by nursing home.

TFPC Measurement: Cost function approach

$$
\begin{aligned}
TFPC_{it} &= ln\ TFP_{it} - ln\ TFP_{i,t-1} \\
&= \underbrace{\frac{1}{2}[(1 - e_{it}^{Y}) + (1 - e_{i,t-1}^{Y})](ln\ Y_{it} - ln\ Y_{i,t-1})}_{\text{SEC}} \\
&\quad \underbrace{-\frac{1}{2}\left(\frac{\partial\ ln\ TC_{it}}{\partial t} + \frac{\partial\ ln\ TC_{i,t-1}}{\partial t}\right)}_{\text{TC}} \\
&\quad \underbrace{-\frac{1}{2}\sum_{q}(e_{it}^{q} + e_{i,t-1}^{q})(ln\ q_{it} - ln\ q_{i,t-1})}_{\text{OCC}}
\end{aligned}
\tag{2}
$$

with $e_{it}^{J} = \partial\ ln\ TC_{it} / \partial\ ln\ J_{it}$, $J_{it} \in \{Y_{it}, q_{it}\}$, and q being a set of output characteristics.

TFPC Measurement: Tornqvist index

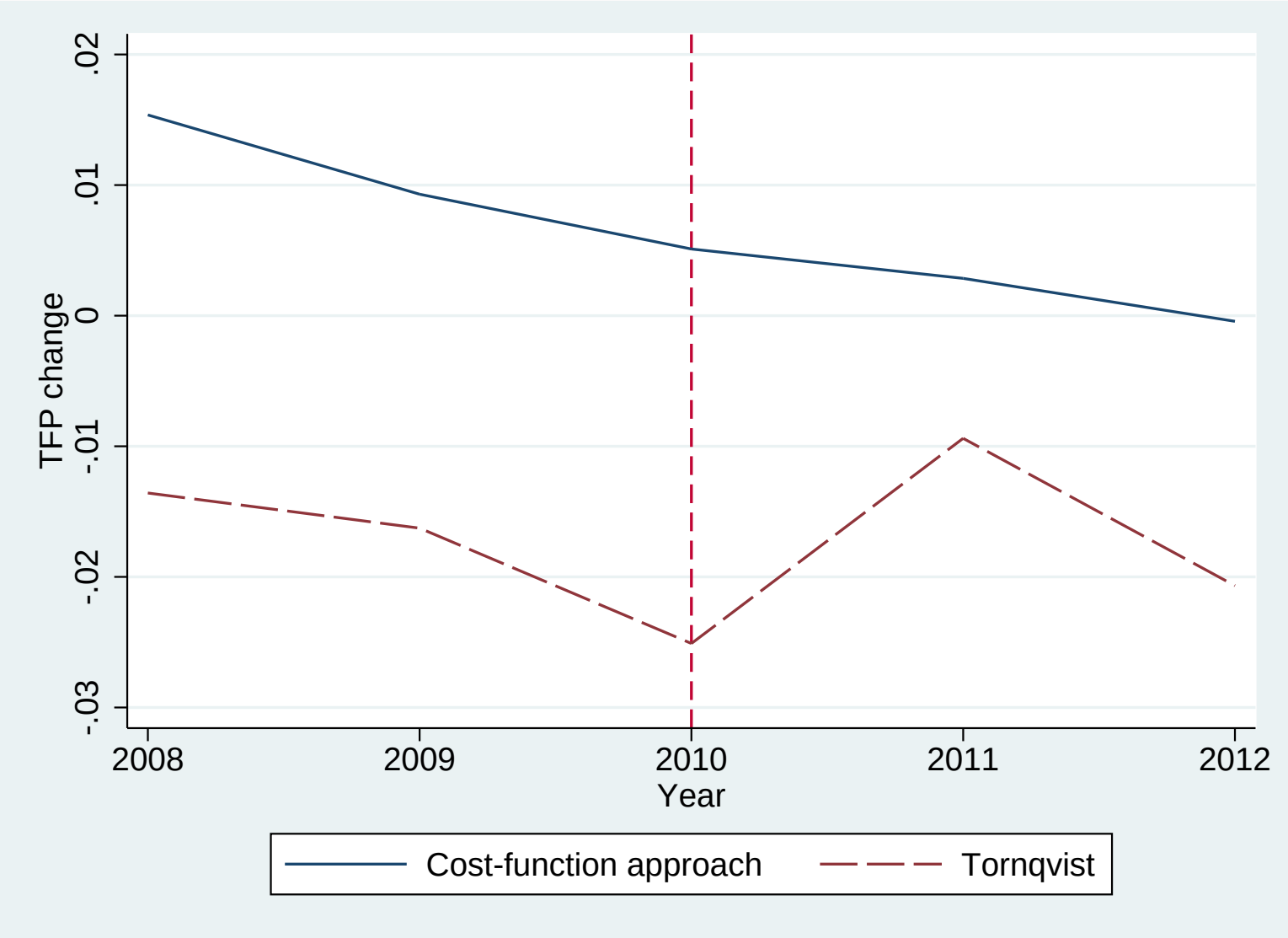
$$
\begin{aligned}
TFPC_{it} &= ln\ TFP_{it} - ln\ TFP_{i,t-1} \\
&= \frac{ln\ Y_{it} - ln\ Y_{i,t-1}}{\sum_w 0.5(s_{it}^w + s_{i,t-1}^w)(ln\ w_{it} - ln\ w_{i,t-1})}
\end{aligned} \tag{3}
$$

with $w = \{P_L, P_K, P_M\}$ and s_{it}^w being the cost share of input w.

- The Tornqvist index does not account for output characteristics.
- The empirical strategy should account for that.

TFPC: Results

Figure 2: TFP change over time.



DiD model

We specify the following DiD model of productivity change:

$$TFPC_{it} = \beta\ Policy_i \times Post_t + \alpha_i + \theta_t + q'_{it}\gamma + \varepsilon_{it} \qquad (4)$$

with $Policy_i = 1$ for nursing homes subject to the reform since 2011 and $Post_t = 1$ for $t \geqslant 2011$. α_i are NH fixed effects and θ_t year fixed effects. q'_{it} are output characteristics (included only with Tornqvist index).

Similarly, we estimate the impact of policy adoption on the cost function:

$$ln(TC_{it}) = \beta\ Policy_i \times Post_t + \alpha_i + x'_{it}\gamma + \varepsilon_{it} \qquad (5)$$

with x'_{it} being the controls on the right-hand side of Eq. 1.

Under the assumptions of parallel trends, $\hat{\beta}$ provides a causal estimate of the reform's impact on TFPC and total costs.

DiD: Testing for parallel trends

	(1)	(2)	(3)
	TFPC		Cost function
	Cost function	Tornqvist	Total cost
Treated × Time trend	-0.00381	-0.00581	0.00595
	(0.00346)	(0.00728)	(0.00885)
Time trend	-0.00312	-0.00271	-0.0533*
	(0.00274)	(0.00596)	(0.0224)
Nursing home fixed effects	Yes	Yes	Yes
Output characteristics	No	Yes	No
Cost function controls	No	No	Yes
Obs.	1069	1069	1443
Overall R-sq.	0.00924	0.00720	0.887
Within R-sq.	0.0187	0.00642	0.928
Between R-sq.	0.000777	0.0117	0.880

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Robust standard errors in parenthesis are clustered by nursing home.

DiD: Results

	(1)	(2)	(3)
	TFPC		Cost function
	Cost function	Tornqvist	Total cost
Treated × Post	0.00119	0.0116	-0.000197
	(0.00383)	(0.00829)	(0.0150)
Nursing home fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	No
Output characteristics	No	Yes	No
Cost function controls	No	No	Yes
Obs.	1750	1750	2130
Overall R-sq.	0.0190	0.00799	0.914
Within R-sq.	0.0318	0.00970	0.917
Between R-sq.	0.0245	0.00713	0.919

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Robust standard errors in parenthesis are clustered by nursing home. Private NHs Leave-one-out

Conclusions

- TFPC continuously decreases in Swiss nursing homes between 2007 and 2012.
- The reform has a positive impact on productivity change using both the cost function approach and the Tornqvist index, but the effect is not significant. Moreover, total costs decrease not significantly.
  - Costs shifted from insurance companies to public authorities without affecting efficiency and productivity.
  - Lack of incentives in policy measures (Karmann and Roesel, 2017).
- Addressing the effectiveness of public funding systems is crucial for policy makers.

Thanks for the attention!

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Appendix

Robustness checks: Private nursing homes

Back

	(1)	(2)	(3)
	TFPC		Cost function
	Cost function	Tornqvist	Total cost
Treated × Post	0.000135	0.0163**	0.0191*
	(0.00227)	(0.00556)	(0.00946)
Nursing home fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	No
Output characteristics	No	Yes	No
Cost function controls	No	No	Yes
Obs.	3884	3884	4723
Overall R-sq.	0.0293	0.00438	0.925
Within R-sq.	0.0642	0.00767	0.868
Between R-sq.	0.134	0.0158	0.941

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Robust standard errors in parenthesis are clustered by nursing home.

Robustness checks: Leave-on-out

Back

(1)	(2)	(3)	(4)
	TFPC		Cost function
Excluded canton	Cost function	Tornqvist	Total cost
AG	0.00103	0.00956	-0.00447
AI	0.00106	0.0112	0.000215
AR	0.00132	0.0149^{+}	-0.00546
BE	-0.00360	0.0213*	-0.0140
BL	0.00102	0.0115	0.0000318
BS	0.000603	0.00991	0.00366
FR	0.00217	0.00796	0.00486
GE	0.00164	0.0119	0.000912
GL	0.000908	0.0116	0.00405
GR	0.00117	0.0112	-0.000294
JU	0.00146	0.0119	-0.000507
LU	0.000304	0.0108	-0.000631
NE	0.00119	0.0116	-0.000185
NW	0.00124	0.0118	-0.000158
OW	0.00118	0.0112	0.000234
SG	0.00242	0.0136	0.00280
SH	0.000676	0.0128	-0.00358
SO	0.00150	0.0113	0.00314
SZ	0.000975	0.0123	0.000949
TI	0.00139	0.0101	-0.00366
UR	0.00152	0.0121	-0.00199
VD	0.00122	0.0116	-0.000339
VS	0.00129	0.0110	-0.000565
ZG	0.00123	0.0115	-0.000371
ZH	0.00473	0.00594	0.00511

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.1$. Robust standard errors in parenthesis are clustered by nursing home.

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