Estimating the Direct and Indirect Costs of Health Reduction: Evidence from Administrative Data

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Motivation

Figure: How Important Prevention Actions are?

Source: cool3c article 166427.

Motivation

- Growing health care spending has become a concern in many countries.
- A large proportion of health expenditure comes from those who suffer from lifestyle diseases that are more or less preventable or delayable
- One obvious way to reduce health expenditure is to invest in prevention and health promotion policies.
- Yet, comprehensive analysis on how do individuals react when their health is getting worse, both in the short-term and median-term, is surprisingly scarce and inconclusive.

Motivation

- When estimating the impact of health reduction, one usually encounters two major challenges.
- First, health is not only difficult to measure but it often deteriorates gradually.
- Second, estimating the medium/long-term effects leads to another complication because it typically requires control groups that are comparable to the treatment group.
- Unlike the literature usually refers to DID with matching, we address estimation issues by relying on
  (1) exploiting the arguably exogenous timing of the first-time stroke or heart attack
  (2) using individuals with the same age that have experienced the health events a few periods apart (Fadlon and Nielsen (2019, 2021)).

Why Taiwan?

- Data: National Health Insurance Research Database (NHIRD).
- Taiwanese data offer several ideal features to analyze the dynamic responses of patients to health reduction and its associated costs

1. Under a universal health coverage with a single payer system, we can abstract away from variations in the health care providers.
2. Without a gatekeeping system, frequency of health care utilization reflects patients' behavior and health needs, rather than care providers' decision.
3. NHIRD contains detailed clinical information and monthly labor statuses for the entire population, enabling us to analyze health and labor responses at a high frequency.

Methodology

- As in Fadlon and Nielsen (2019, 2021) by splitting the sample into treatment groups (individuals who have a shock) and control group (individuals from the same age cohorts that have the same shock in the future).
- Estimating the differences in within-individual changes between the treatment and control group as the effects of the health reduction.
- The estimation equations are as follows:

$$y_{it} = \alpha + \sum_{j=0}^{J} \delta_j Post_{i,t+j} \times treat_i + \mathbf{X}'_{it}\Gamma + \mu_i + \gamma_t + \epsilon_{it}, \tag{1}$$

where y_{it} is an outcome (i.e., the level and growth of health care utilization and labor market outcomes) for patient i in month t, vector $\mathbf{X_{it}}$ is a set of baseline control variables that includes the patient's age in month t, μ_i represents the individual fixed effect, γ_t is the time fixed effect (calendar year and calendar month dummies), and ϵ_{it} is the error term. The term $Post_{i,t+j}$ captures the dynamic effect of the health event.

Data and Summary Statistics

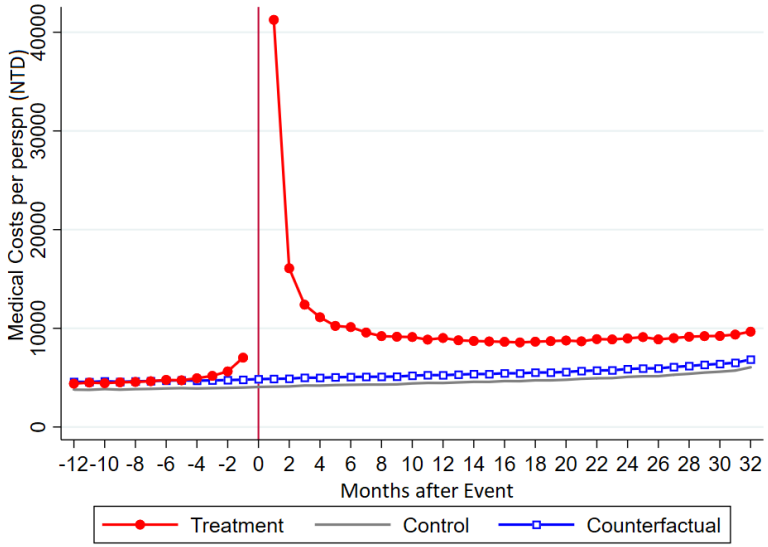
Table: Sample Universe (First-Time Stroke or Heart-Attack)

	Treatment (2010-2011)		Control (2013-2014)	
No. of Observations	135,843		153,938	
Female (%)	40.12%		39.87%	
Average Age at the Event	65.4		67.7	
Age Distribution				
0-19	759	(0.6%)	706	(0.5%)
20-29	858	(0.6%)	696	(0.5%)
30-39	3,573	(2.6%)	3,402	(2.2%)
40-49	11,497	(8.5%)	11,387	(7.4%)
50-59	27,701	(20.4%)	26,574	(17.3%)
60-69	33,197	(24.4%)	35,180	(22.9%)
70-79	36,870	(27.1%)	40,237	(26.1%)
80-89	19,761	(14.5%)	30,828	(20.0%)
over 90	1,627	(1.2%)	4,928	(3.2%)
Acute Health Shock (%)				
Stroke	51.6		49.9	
Heart Attack	48.4		50.1	

Source: The Taiwanese NHI data.

Surge in medical cost

Figure: Responses to the Health Events (Costs per Person)



Source: Calculations by the authors using the Taiwan NHI data.

- After several months of decrease, the treatment outcomes run in parallel to the counterfactual outcomes but at a higher level.
- This indicates that medical costs increase semi-permanently and that the post-treatment trend becomes similar to the pre-treatment trend in the medium/long run.

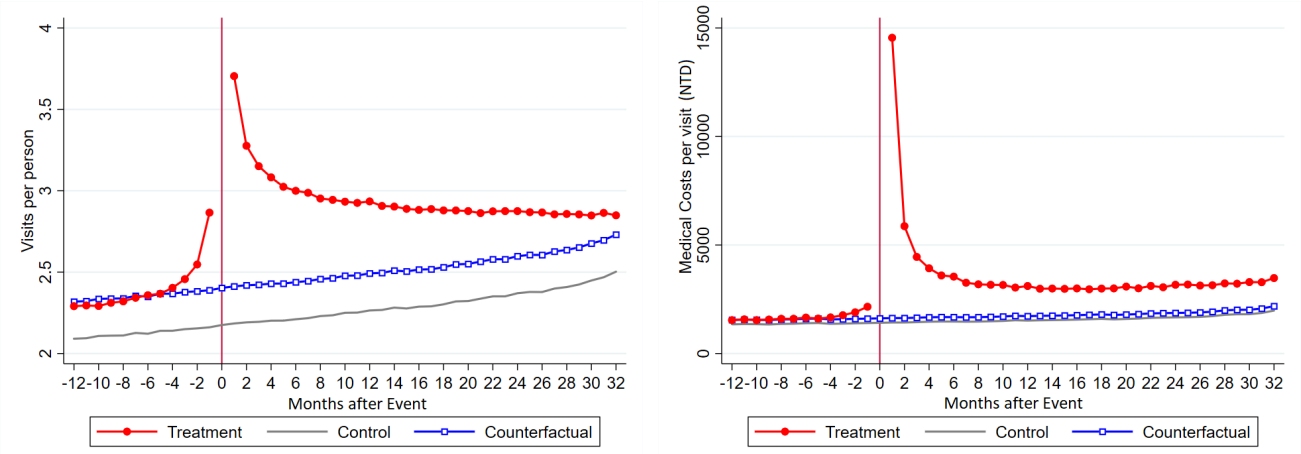
Surge in medical cost

Table: Effects on Individual Medical Costs

	OLS	OLS	OLS	FE	FE
Panel A					
Dependent Variable:			**Individual Medical Costs**		
	(1)	(2)	(3)	(4)	(5)
$Treat \times Post_1$	5,363***	5,370***	5,369***	5,417***	5,355***
(2-12 months)	(45.44)	(89.15)	(70.56)	(50.59)	(50.59)
$Treat \times Post_2$	3,166***	3,178***	3,175***	3,192***	3,148***
(13-32 months)	(40.91)	(70.26)	(58.22)	(46.98)	(47.52)
R^2	0.028	0.030	0.056	0.021	0.021
No. Unique IDs				289,781	286,164
No. Obs.	12,877,380	12,877,380	12,877,380	13,040,145	12,877,380
Panel B					
Dependent Variable:			**Δ Individual Medical Costs**		
	(1)	(2)	(3)	(4)	(5)
$Treat \times Post_2$	-76.64	-77.79***	-77.83***	-76.68***	-79.36***
(13-32 months)	(52.34)	(15.05)	(11.30)	(10.96)	(11.14)
R^2	0.003	0.004	0.004	0.003	0.004
No. Unique IDs				289,781	286,164
No. Obs.	12,591,216	12,591,216	12,591,216	12,750,364	12,591,216
Individual FE	No	No	No	Yes	Yes
Hospital FE	No	Yes	No	No	No
Doctor FE	No	No	Yes	No	No
Control (individual)	Yes	Yes	Yes	No	Yes

Surge in medical visit

Figure: Responses to the Health Events



Source: Calculations by the authors using the Taiwan NHI data.

- Results demonstrate that the medium/long-term growth for visits is more negative than the counterfactual growth, but the medium/long-term growth for costs per visit is the same as the counterfactual one.
- If cost per visit represents the health of a person, we documents behavioral changes even after one's health is back to a stable state.

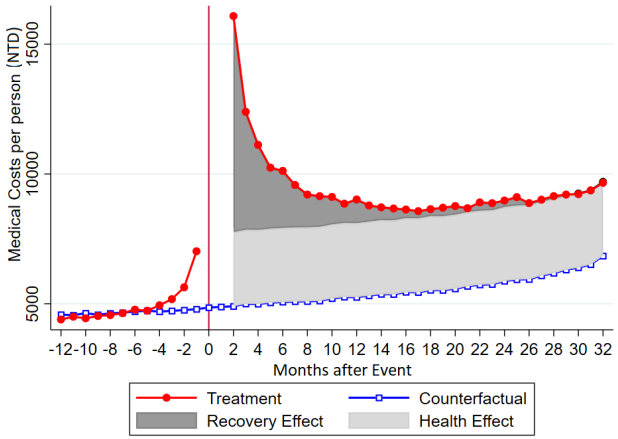
Surge in medical visit

Table: Effects on Frequency of ΔVisits and ΔCosts per visit

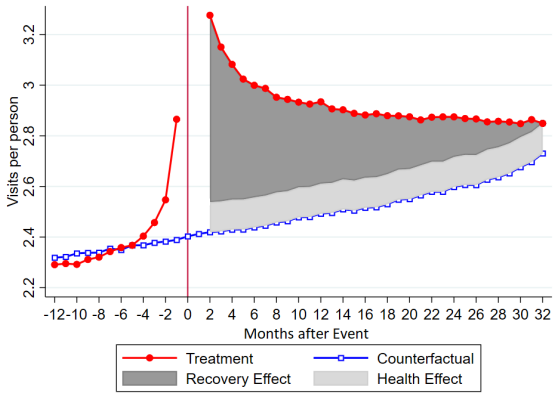
	OLS	OLS	OLS	FE	FE
Dep. Var.			**Δ Visits**		
	(1)	(2)	(3)	(4)	(5)
$Treat \times Post_2$	-0.0205***	-0.0205***	-0.0205***	-0.0203***	-0.0207***
(13-32 months)	(0.00367)	(0.00150)	(0.00139)	(0.00137)	(0.00139)
R^2	0.008	0.008	0.008	0.001	0.008
Dep. Var.			**Δ Costs per visit**		
	(1)	(2)	(3)	(4)	(5)
$Treat \times Post_2$	-5.404	-6.003	-6.002	-5.692	-6.922
(13-32 months)	(27.20)	(6.013)	(5.952)	(5.960)	(5.941)
R^2	0.002	0.002	0.002	0.002	0.002
No. unique IDs				289,781	286,164
No. Obs.	12,591,216	12,591,216	12,591,216	12,750,364	12,591,216
Individual FE	No	No	No	Yes	Yes
Hospital FE	No	Yes	No	No	No
Doctor FE	No	No	Yes	No	No
Control	Yes	Yes	Yes	No	Yes

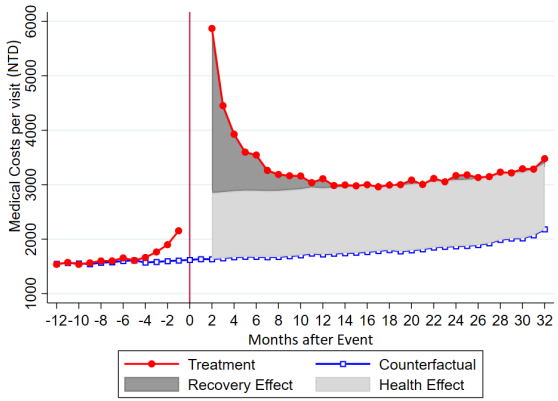
Dynamic Effect

Costs per person



Visits per person (left) and Costs per visit (right)





Source: Calculations by the authors using the Taiwan NHI data.

Heterogeneous Effect

Table: Heterogeneous Effects by Age and Pre-treatment Inpatient Care

	Men			Women		
	FE	FE	FE	FE	FE	FE
Dep. Var.	Costs	Visits	Costs/visit	Costs	Visits	Costs/visit
	(1)	(2)	(3)	(4)	(5)	(6)
Treat$\times Post_2$	3,325***	1.150***	1,489***	4,347***	1.139***	2,151***
(13-36 months)	(432.7)	(0.0309)	(264.4)	(712.9)	(0.0505)	(381.9)
Treat$\times Post_2\times$ Age (40-54)	70.11	0.0589*	225.7	-620.3	0.234***	-530.0
	(456.7)	(0.0305)	(276.8)	(734.9)	(0.0463)	(392.0)
Treat$\times Post_2\times$ Age (55-64)	108.5	0.0949***	211.6	-502.7	0.332***	-409.6
	(454.8)	(0.0305)	(276.9)	(731.5)	(0.0447)	(387.6)
Treat$\times Post_2\times$ Age (over 65)	170.6	0.0247	394.2	-409.7	0.268***	-148.2
	(455.1)	(0.0302)	(278.5)	(724.2)	(0.0423)	(384.0)
Treat$\times Post_2\times$ inpatient	-1,111***	-0.386***	170.9	-597.0**	-0.428***	339.3**
(nonzero, below median)	(232.1)	(0.0279)	(131.5)	(292.5)	(0.0320)	(164.6)
Treat$\times Post_2\times$ inpatient	-11,057***	-0.548***	-2,972***	-10,990***	-0.501***	-2,921***
(above median)	(426.2)	(0.0341)	(292.8)	(424.9)	(0.0338)	(274.1)
R^2	0.025	0.023	0.009	0.019	0.019	0.006
No. unique IDs	171,313	171,313	171,313	114,689	114,689	114,689
No. Obs.	7,709,085	7,709,085	7,709,085	5,161,005	5,161,005	5,161,005

Heterogeneous Effect

Table: Heterogeneous Effects by Pre-treatment Income

	Men age 25-64			Women age 25-64		
	FE	FE	FE	FE	FE	FE
Dep. Var.	Costs	Visits	Costs/visit	Costs	Visits	Costs/visit
	(1)	(2)	(3)	(4)	(5)	(6)
Treat $\times Post_2$	3,670***	0.561***	1,301***	3,664***	0.355***	1,348***
(13-36 months)	(158.5)	(0.0161)	(94.84)	(237.8)	(0.0243)	(127.8)
Treat $\times Post_2 \times$ Income	-536.0***	-0.0463**	-166.7	-1,101***	-0.0960***	-423.0***
(below median)	(186.3)	(0.0200)	(108.0)	(281.0)	(0.0297)	(153.6)
Treat $\times Post_2 \times$ Income	-997.5***	-0.0843***	-395.9***	-911.9***	-0.0580*	-304.6*
(above median)	(193.9)	(0.0190)	(103.7)	(353.1)	(0.0316)	(174.3)
R^2	0.028	0.023	0.011	0.020	0.017	0.006
No. unique IDs	82,559	82,559	82,559	35,884	35,884	35,884
No. Obs.	3,715,155	3,715,155	3,715,155	1,614,780	1,614,780	1,614,780

Heterogeneous Effect

- The effect heterogeneity by age disappears in the medium/long run, the effect heterogeneity by pre-treatment inpatient care is large and persistent, indicating variance of health becomes smaller after the health events.
- The effect heterogeneity by pre-treatment inpatient care may also reflect the fact that utilizing health care may have functioned as preventive measurement by helping in early detection and mitigating complications due to the presence of other diseases
- The degree of health reduction is negatively associated with income, indicating the presence of social gradients in health.

Labor Outcome

Table: Effects on Employment Status

Dep. Var.	Employment							
Sample	Men 25-64				Women 25-64			
	(1)	(2)	(3)	(4)	(3)	(4)	(7)	(8)
Treat$\times Post$	-0.0233***	0.0792***	-0.112***	-0.102***	-0.0187***	0.0862***	-0.117***	-0.0725***
(2-36 months)	(0.00162)	(0.00606)	(0.00175)	(0.00676)	(0.00240)	(0.00927)	(0.00289)	(0.0127)
Treat$\times Post\times$ Age (40-54)		0.00381		0.0101*		-0.00584		3.56e-05
		(0.00539)		(0.00541)		(0.00790)		(0.00824)
Treat$\times Post\times$ Age (55-64)		-0.0132**		-0.0162***		-0.0166**		-0.0119
		(0.00545)		(0.00563)		(0.00782)		(0.00847)
Treat$\times Post\times$ inpatient		-0.0102*		-0.0129*		-0.00591		-0.00115
(below median)		(0.00577)		(0.00782)		(0.00665)		(0.0105)
Treat$\times Post\times$ inpatient		-0.0217***		-0.0217**		-0.0179**		-0.0179
(above median)		(0.00619)		(0.00903)		(0.00705)		(0.0119)
Treat$\times Post\times$ Income		-0.122***				-0.112***		
(below median)		(0.00295)				(0.00392)		
Treat$\times Post\times$ Income		-0.176***		-0.0460***		-0.188***		-0.0754***
(above median)		(0.00285)		(0.00306)		(0.00468)		(0.00509)
R^2	0.029	0.049	0.069	0.072	0.039	0.061	0.083	0.090
No. unique IDs	84,022	84,022	56,172	56,172	36,381	36,381	21,419	21,419
No. Obs.	3,780,990	3,780,990	2,527,740	2,527,740	1,637,145	1,637,145	963,855	963,855

Labor Outcome

- Results indicate that the degree of decline in labor income is roughly similar to the one in employment.
- Our result show that the effect of health reduction is similar between Taiwan and studies in other country (i.e. Trevisan and Zantomio (2016)).
- The estimates also show that employment rates increase by 7.92 (8.62) percentage points for men (women) in the reference group, which consists of the young individuals who earned zero and utilized no inpatient care before the health event.
- It indicates that the net effects are positive for the groups who were not previously employed and negative for those who were previously employed, regardless of differences in age or pre-treatment inpatient care utilization.

Policy Implications

1. Demand for health care (visits) increases after the health shock indicates the importance of providing alternative assistance to reduce the overuse of medical resource.
2. The existence of health inequalities by labor income when all individuals are covered by health insurance emphasizes the importance of factors other than health insurance coverage.
3. Non-employed workers are more likely to start working after the health shock, for better or worse, implies that health insurance premium payments may serve as a tool for providing work incentive.
4. Simple back-of-the-envelope calculations show that preventing one incident of stroke is almost equivalent to saving two representative individual per year..

Literature

1. Control and treament groups: Fadlon and Nielsen (2021).
2. The effects of health reduction on labor market outcomes: Bradley et al. (2002), Bradley et al. (2005), Garcia-Gomez et al. (2013), Heinesen and Kolodziejczyk (2013), Heinesen et al. (2018)).
3. Medical literature: Saka et al. (2009); Greenberg et al. (2014)).

Conclusion

- If the government is willing to invest a little bit on health prevention, the total social welfare of the society calculated by direct medical cost and indirect labor cost could be improved significantly.
- Our heterogeneous analysis informs us of those who are more likely to consume more health care, partly because their health is worse and partly because they are more willing to visit hospitals.
- Our research provide some guideline on how does the serious life event (i.e. acute health attack) might effect the job seeking decision on different labor in different geographical characteristics.