بسم الله الرحمن الرحیم

Physician induced demand for knee replacement surgery in Iran

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Physician induced demand for knee replacement surgery in Iran

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Background

- **Knee osteoarthritis:** a chronic and age-related condition with pain and disability,
- **Incidence:** 10% of men and 13 % of women over the age of 60,

  19.3% of rural and 15.3% of urban
- **Burden:** loss of 19-34 % of HRQoL
- **Treatment:** Knee Replacement Surgery (KRS); effective, expensive, invasive for severe and end-stage knee arthritis resulting from post-traumatic arthritis, and inflammatory arthritis
- **Complications:** a significant proportion of postoperative patients report persistent knee pain, poor knee function, and patient dissatisfaction
- **Risk factors:** Age and obesity
- **Increased demand reasons:** Technology advances, changing lifestyle, health knowledge and access

Background

- **KRS and PID in Iran**

✓ population-adjusted rate has doubled in the last five years,

✓ The mean age of patients undergoing KRS (65 years) is lower than in developed countries,

✓ Surgeon to population ratio has increased,

✓ Health system structural factors: 1- Physicians have a very high degree of freedom of action

2- FFS reimbursement system

3- Fixed tariffs of health services

4- The health insurances cover > 90 % of population.

Methods

- **Dataset**

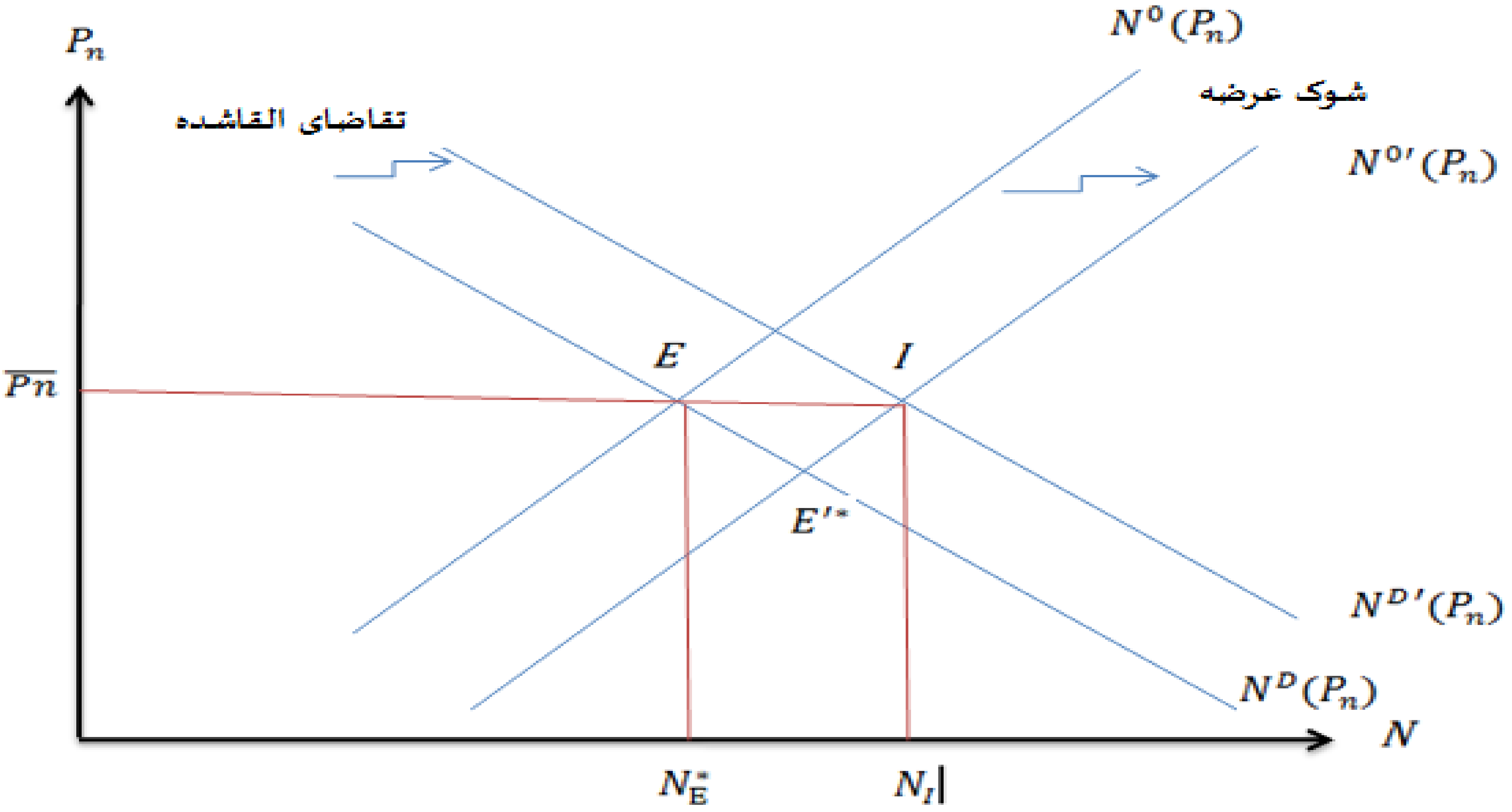
✓ **Microeconomic data** for the monthly average number of KRS activities by each orthopedic specialist over 2014 to 2019, compiled from the AFIO at the provincial level,

✓ The **unbalanced individual panel data** covers the steady-state 15,729 surgeries performed by 995 surgeons,

✓ **Population data** (population size over 50 years and income) are extracted from the census results for 2011 and 2016 years.

✓ Average annual growth: 0.021

Methods



P_n
تقاضای القاشده
$N^0(P_n)$
شوک عرضه
$N^{0\prime}(P_n)$
$\overline{Pn}$
E
I
E'^*
$N^{D\prime}(P_n)$
$N^D(P_n)$
N
N_E^*
N_I

Methods

- **Demand drivers**

✓ Increasing access to the services

✓ Increasing income

✓ Improving the level of health insurance coverage

✓ Raising the level of public health awareness

✓ Increasing the elderly population

✓ Disease outbreak

✓ **PID**

Methods

- **Variables**

D_{it} : Density variable

- The changes in the supply of KRS services are measured by D_{it} of orthopedic surgeons,
- Equal to the ratio of surgeons to every 100,000 population over 50 years of age

N_{it} : Average number of performed KRS by each physician

- Show changes in the number of surgeries over time,
- It is crucial variable, but has four drawbacks

1) not able to identify the **access effect**
2) not show the content of the service
3) not depict the **initiating effect**
4) not consider the practice style/preferences of physicians

Methods

▪ Variables

S_{it} **: The size of performed KRS by each physician**

- Is obtained by multiplying the N_{it} by the cost of each operation, which is paid by the patient and the health insurance: $S_{it} = N_{it} * F_{it}$

- A significant increase in the mean of S_{it} over time clearly indicates a change in the **type of operation**, a rise in the **price of the material** used, or a combination of both.
- It can relatively eliminate all four weaknesses of N_{it} The variables N_{it} and S_{it} represent the demand factors, and their changes indicate the demand shock.

F_{it} **:** Relative value of the cost of each surgery

- = Service cost / 100000

Methods

▪ Judgment logic

1) In the absence of PID:

- **Supply rationing** will arise: the patient quota of each physician will decrease, and therefore the microeconomic elasticity of N_{it} will be negative.

2) In the presence of PID:

- Surgeons can freely increase the S_{it} , and therefore the microeconomic elasticity of S_{it} will be Positive.

❖ The sufficient conditions for the existence of PID for KRS are;

1) The elasticity of S_{it} > 0

2) The elasticity of S_{it} > The elasticity of N_{it}

Methods

The models

- We applied a dynamic panel data (**DPD**) based on logarithmic supply-and-demand models,
- The estimations are based on the elasticity of the KRS demands in response to changing D_{it}
- **DPD** consider both random, constant, and permanent unobserved heterogeneities,

- To test the PID, we need three separate econometric models that are exactly the same, but their dependent variables include N_{it} , S_{it} , and F_{it} :

$$\log(n_{it}) = \alpha \log(d_{it}) + \gamma \log(inc_{it}) + Z'_{t[1,k]}\ \theta_{[k,1]} + \xi_{\delta} + v_i + \varepsilon_{it}$$

$$t = m4 - 2014, \ldots, m3 - 2019;\ i = 1, 2, \ldots, 22$$

Methods

- **The models**

$$\log(n_{it}) = \alpha \log(d_{it}) + \gamma \log(inc_{it}) + Z'_{t[1,k]}\ \theta_{[k,1]} + \xi_{\delta} + v_i + \varepsilon_{it}$$

$$t = m4 - 2014, \ldots, m3 - 2019; i = 1, 2, \ldots, 22$$

- The constants V_i: fixed and inherent characteristics of the patients that are not obviously considered in the model:
  - Gender,
  - Age,
  - Disease severity,
  - Level of insurance coverage,
  - Level of earning,
  - Reputation effect.

Methods

- **The models**

$$\log(n_{it}) = \alpha \log(d_{it}) + \gamma \log(inc_{it}) + Z'_{t[1,k]}\ \theta_{[k,1]} + \xi_\delta + v_i + \varepsilon_{it}$$

$$t = m4 - 2014, \ldots, m3 - 2019;\ i = 1, 2, \ldots, 22$$

- $\boldsymbol{D}_{\mathbf{it}}$ is an aggregate variable
- It shows the intensity of competition between orthopedic surgeons to perform KRS at the provincial level, presence of a random term $\boldsymbol{\xi_\delta}$ in the perturbation.

Methods

- **The models**

$$\log(n_{it}) = \alpha \log(d_{it}) + \gamma \log(inc_{it}) + Z'_{t[1,k]}\ \theta_{[k,1]} + \xi_{\delta} + \mathrm{v}_{\mathrm{i}} + \varepsilon_{\mathrm{it}}$$

$$t = m4 - 2014, \ldots, m3 - 2019;\ i = 1, 2, \ldots, 22$$

- $\boldsymbol{Z_{t[1,k]}}$ is time-varying determinants that affect all surgeons alike
  - Supply of new technologies,
  - Economic growth,
  - Changes in demographic characteristics,
  - Lifestyle changes

Methods

- **The models**

$$\log(n_{it}) = \alpha \log(d_{it}) + \gamma \log(inc_{it}) + Z'_{t[1,k]}\ \theta_{[k,1]} + \xi_{\delta} + v_i + \varepsilon_{it}$$

$$t = m4 - 2014, \ldots, m3 - 2019; i = 1, 2, \ldots, 22$$

- In one-step estimator: the error term $\boldsymbol{\varepsilon_{it}}$ is assumed to be i.i.d. $(0, \delta^2)$ across provinces and time.
- In the two-step estimator: the residuals of the first step are applied to consistently estimate the variance-covariance matrix of the perturbation $\boldsymbol{\varepsilon_{it}}$, relaxing the homoscedasticity assumption.

Methods

- ## The models

- The constant effects of V_i and ξ_δ are eliminated by differencing the first order and our specification is optimized as follows:

$$n\dot{}_{it} = \alpha d\dot{}_{it} + \gamma inc\dot{}_{it} + \lambda n\dot{}_{it-1} + c_t + \varepsilon\dot{}_{it}$$

➢ In the resulted specification, the variables represent the **first difference of the corresponding logarithm forms**.

➢ The $Z_{t[1,k]}$ is reduced to fixed time effects C_t.

➢ To tackle with the endogeneity and addressing the unobserved heterogeneity, a **lagged dependent variable** added as an instrumental variable.

Methods

- **The models**

$$n^{\cdot}_{it} = \alpha d^{\cdot}_{it} + \gamma in^{\cdot}c_{it} + \lambda n^{\cdot}_{it-1} + c_t + \varepsilon^{\cdot}_{it}$$

$$s^{\cdot}_{it} = \alpha d^{\cdot}_{it} + \gamma in^{\cdot}c_{it} + \lambda s^{\cdot}_{it-1} + c_t + \varepsilon^{\cdot}_{it}$$

$$f^{\cdot}_{it} = \alpha d^{\cdot}_{it} + \gamma in^{\cdot}c_{it} + \lambda f^{\cdot}_{it-1} + c_t + \varepsilon^{\cdot}_{it}$$

Methods

- **Empirical specification and estimation**

- **OLS-Pool** is the standard approach to estimate the coefficient of a panel data model.
- Generalized Method of Moments System (**GMM-SYS**) is the best approach that is consistent, asymptotically efficient, and provide a strong instrument for **DPD,**
- **GMM-SYS** model uses the lagged dependent variable as an instrument,

❖ Validity tests:

- m1 & m2 tests: to check the conditions of first and second-order of serial correlation of the estimated residuals, respectively
- Sargan test : to checks the validity of the instruments used
- Hansen test: to test the overall effectiveness of all the instrumental variables
- Wald Chi-Squared test: to checks a possible heteroskedasticity of residuals

Results

Table 1 The monthly-province level population characteristics; 2014-2018 (*N*=15729)

Years	2014	2015	2016	2017	2018	Growth rate
Statistics	Mean (SE)					Mean
N	11.03 (2.59)	12.48 (2.66)	14.83 (2.71)	16.27 (3.05)	18.19 (3.19)	64.91%
P_n	1759.54 (75.02)	1793.20 (68.39)	1810.49 (77.04)	1884.47 (61.36)	1940.19 (55.51)	10.27%
P_p	0.19 (0.02)	0.23 (0.02)	0.26 (0.02)	0.32 (0.02)	0.37 (0.02)	94.74%
P_{ph}	1.39 (0.05)	1.44 (0.05)	1.53 (0.05)	1.65 (0.06)	1.88 (0.06)	35.25%

N number of KRS at monthly-province level, P_n cost of each surgery, P_p number of the surgery per 100,000 population, P_{ph} number of the surgery per active physician

Results

Table 2 Panel-data unit root test (Fisher type based on Augmented Dickey-Fuller)

Variables	Inverse chi-squared P	Inverse normal Z
n_{it-1}	665.66**	-22.50**
s_{it-1}	520.99**	-19.22**
f_{it-1}	395.89**	-15.85**
n_{it}	645.13**	-22.20**
inc	124.21**	-9.47**

**Indicate that the non-stationary null hypothesis is rejected at the 1% significance level

Results

Table 3 Estimates of OLS-Pool and Two-Step Difference GMM models

Independent Variables	OLS-Pool			Two-Step Difference GMM		
	$\dot{y}_{it} = \dot{n}_{it}$ (1)	$\dot{y}_{it} = \dot{s}_{it}$ (2)	$\dot{y}_{it} = \dot{f}_{it}$ (3)	$\dot{y}_{it} = \dot{n}_{it}$ (4)	$\dot{y}_{it} = \dot{s}_{it}$ (5)	$\dot{y}_{it} = \dot{f}_{it}$ (6)
$\dot{d}_{it}$)SE(	0.71[a] (0.03)	0.79[a] (0.03)	0.07 (0.01)	0.94[a] (0.05)	1.01[aa] (0.04)	0.06[a] (0.02)
$\dot{y}_{it-1}$)SE(	0.63[a] (0.02)	0.63[a] (0.02)	0.68[a] (0.03)	-0.04[a] (0.05)	0.07[a] (0.03)	0.11[a] (0.05)
$\dot{inc}$)SE(	0.15 (0.08)	0.09[a] (0.07)	-0.04 (0.02)	-1.25 (1.88)	0.80 (0.33)	0.54 (0.35)
Constant	7.96[a] (1.51)	13.06[a] (1.69)	4.35[a] (0.85)	36.18[a] (32.56)	11.85[a] (10.96)	0.84[a] (5.94)
N. observation	823	823	823	823	823	823
R-squared	0.826	0.805	0.473			
F-test (*p*-value)				0.000	0.000	0.036
Wald test				601.34	599.96	8.55
Hansen test				0.361	0.284	0.413
Sargan test				0.277	0.175	0.339
M2 test				0.671	0.589	0.712

[a]Indicate that the coefficients are significant at the 1% level

Discussion

- Both analytical models obtained the **significant** elasticity of $1 > N_{it} > 0$.
- This finding indicates **demand rationing** so that the average number of performed KRS by each surgeon has increased over time.
- The S_{it} elasticity in both static and dynamic equations > 0 and $> N_{it}$.
- Generally, the outcomes show that with increasing D_{it} , both the N_{it} and S_{it} of KR services were increased significantly at 1 % level.
- The F_{it} models confirmed the observed significant difference.
- The findings of **DPD** model shows all surgeons have compensated for all their reduced income with PID.
- The positive elasticity associated with N_{it} variable may be due to the availability effect, but the increase in S_{it} certainly cannot be related to this issue.

Discussion

- Finally, we concluded that we have a PID for the KRS in Iran, at least as much as the elasticity obtained for the $\boldsymbol{F}_{\mathbf{it}}$.
- If we accept the GMM-SYS model as an appropriate approach, **the minimum PID is about 6 %.**

- The observed positive association between $\boldsymbol{D}_{\mathbf{it}}$ and the $\boldsymbol{N}_{\mathbf{it}}$ KRS service is contrary to that of behavior of general an specialist physicians in France and among Unites States general physicians, but the final outcome was similar.
- In similar studies it does not observed an established PID among Norwegian primary care physicians
- These differences may be attributed to the difference in :

- Health system structure,
- Type of payment system,
- Health insurance performance,
- The existence of a fixed or flexible reimbursement fee,
- Type of services studied.

Discussion

The reasons of existing PID in Iranian health system

- Lack of a managed care system,
- Not using the clinical guidelines,
- Lack of adequate supervision of providers,
- The existence of Fee-For-Service payment system,
- Severe information asymmetry between the health insurances and the service providers.

ANY

Questions?