

# Effects of Iranian Economic Reforms on Equity in Social and Healthcare Financing: A Segmented Regression Analysis

Hamed Zandian<sup>1,2</sup>, Amirhossein Takian<sup>2,3</sup>, Arash Rashidian<sup>2</sup>, Mohsen Bayati<sup>4</sup>, Telma Zahirian Moghadam<sup>5</sup>, Satar Rezaei<sup>6</sup>, Alireza Olyaeemanesh<sup>2,7\*</sup>

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<sup>1</sup>. Social Determinants of Health (SDH) Research Center, Ardabil University of Medical Sciences, Ardabil, Iran.

<sup>2</sup>. Department of Health Management and Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

E-mail: [Zandian.Hamed899@gmail.com](mailto:Zandian.Hamed899@gmail.com)

E-mail: [Arash.rashidian@gmail.com](mailto:Arash.rashidian@gmail.com)

<sup>3</sup>. Department of Global Health and Public Policy, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran.

E-mail: [Takiana@gmail.com](mailto:Takiana@gmail.com)

<sup>4</sup>. Health Human Resources Research Center, School of Management and Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

E-mail: [Bayatim66@gmail.com](mailto:Bayatim66@gmail.com)

<sup>5</sup>. Health Management and Economics Research Center, Iran University of Medical Sciences, Tehran, Iran

E-mail: [t.zahirian@gmail.com](mailto:t.zahirian@gmail.com)

<sup>6</sup>. Research Center for Environmental Determinants of Health, Kermanshah University of Medical Sciences, Kermanshah, Iran

E-mail: [satarrezaei@gmail.com](mailto:satarrezaei@gmail.com)

<sup>7</sup>. National Institute of Health Research, Group of Payment and Financial Resources of the Health System, Tehran University of Medical Sciences, Tehran, Iran

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**Corresponding author:** Alireza Olyaeemanesh, National Institute of Health Research, Group of Payment and Financial Resources of the Health System, Tehran University of Medical Sciences, Tehran, Iran. E-mail: [arolyaee@gmail.com](mailto:arolyaee@gmail.com)

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## Abstract

### Objectives

One of the main objectives of the Targeted Subsidies Law (TSL) in Iran was to improve equity in healthcare financing. This study aimed at measuring the effects of the TSL, which was implemented in Iran in 2010, on equity in healthcare financing.

### Methods

Segmented regression analysis was applied to assess the effects of TSL implementation on the Gini and Kakwani indices of outcome variables in Iranian households. Data for the years 1977-2014 were retrieved from formal databases. Changes in the levels and trends of the outcome variables before and after TSL implementation were assessed using STATA version 13.

### Results

In the 32 years before the implementation of the TSL, the Gini index decreased from 0.401 to 0.381. The Gini index and its intercept significantly decreased to 0.362 ( $P<.001$ ) 5 years after the implementation of the TSL. There was no statistically significant change in the GDP or inflation rate after TSL implementation. The Kakwani index significantly increased from  $-0.02$  to  $0.007$  ( $P<.001$ ) before the implementation of the TSL, while we observed no statistically significant change ( $P=.813$ ) in the Kakwani index after TSL implementation.

### Conclusions

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The TSL reform, which was introduced as part of an economic development plan in Iran in 2010, led to a significant reduction in households' income inequality. However, the TSL did not significantly affect equity in healthcare financing. Hence, while measuring the long-term impact of TSL is paramount, healthcare decision-makers need to consider the efficacy of the TSL in order to develop plans for achieving the desired equity in healthcare financing.

**Key words:** Equity, healthcare financing, income inequality, Social Justice, Targeted Subsidies Law (TSL), Segmented regression analysis.

## Introduction

Spiraling healthcare expenditures, due to expensive modern medical technologies and citizens' ever-increasing expectations, may lead to challenges such as catastrophic health expenditures and inequality in access to healthcare [1]. Health systems have been attempting to improve and maintain population welfare through contextually appropriate models of healthcare financing. Nevertheless, financial shortages have consistently hampered the achievement of these objectives [2]. Ensuring equity in health financing is an important objective of healthcare systems [3]. Many studies in recent years in developing countries, including Iran, have emphasized the importance of equity in healthcare financing [4, 5].

The main source of primary healthcare financing in Iran is the public sector. The private and public sectors simultaneously provide secondary and tertiary service delivery and financing [4]. Thus, healthcare financing in Iran is complex and

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multifaceted. Despite reforms to improve equity in healthcare financing, such as the implementation of a family physician program and, recently, the Health Transformation Plan [6], the proportion of out-of-pocket healthcare expenditures is still high [7, 8]. Healthcare financing indicators, such as out-of-pocket and catastrophic health expenditures, did not show a clear trend or status, and were not at appropriate levels in Iran during the last decades [9, 10]. For instance, approximately 58% of health expenditures were out-of-pocket in 2001, and 10 years later, in 2011, this figure decreased to 52% [8]. Moreover, several national-level studies have shown that the concentration index for capacity to pay and healthcare payments implied inequality [5, 11] and that annually, healthcare expenditures caused almost 1.8% percent of the society's population fall below the poverty line [12]. The fair financing contribution index in 2006 was approximately 0.854, and it dropped to 0.842 in 2011 [13]. In general, these measures indicate the complexity and multidimensionality of healthcare financing in Iran.

Recently, the Iranian government has focused attention on ensuring equitable healthcare financing by developing the Targeted Subsidies Law (TSL). The TSL was the most important economic reform in Iran after the Islamic Revolution in 1978, and made Iran the first major oil-exporting country to substantially reduce implicit energy subsidies [14]. The implementation of the TSL began in 2010, when the government eliminated energy subsidies (i.e., the subsidy for gas and oil) and replaced them with cash payments to eligible citizens. As a result of this reform,

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domestic energy and agricultural prices increased by up to 20 times [14]. In the first 12 months following TSL implementation (December 2011), approximately USD 30 billion in freely usable cash was distributed to Iranian households, and another USD 10-15 billion will have been advanced to enterprises to finance investment in restructuring aimed at reducing energy intensity. Additionally, during this time, the reform planned to raise only an estimated 200 trillion rials (USD 20 billion) in additional revenues from price increases [14, 15].

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One of the main purposes of the TSL was to reduce income inequality by decreasing the income gap across deciles, aiming to combat and reduce poverty [16]. Paragraph B of Article 7 of the TSL directly notes the government is bound to implement a comprehensive social security system for the targeted population, by taking measures such as: (i) providing and expanding social insurance and healthcare services, and ensuring and enhancing public health and medical coverage for special and difficult-to-cure diseases; (ii) providing assistance for financing housing costs, enhancing resistance of buildings, and creating employment; and (iii) empowering and implementing social support programs by allocating funds from rising prices for energy carriers to the health sector in order to ensure equity in healthcare financing [17].

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A qualitative study reported the challenges posed by the unpredictability of healthcare financing in Iran [18] to be one of the reasons for high out-of-pocket payments . The government of Iran introduced the TSL to ensure a more

sustainable and equitable healthcare financing system, among other goals. Little evidence is available to demonstrate the impact of the TSL on equity in healthcare financing in Iran. This study aimed to measure the effects of TSL implementation on income inequality and equity in healthcare financing in Iran.

## Methods and analysis

### Study setting

Iran is a middle-income country of almost 80 million citizens that is located in west Asia. The gross national income per capita for Iran is about 15 and total health expenditures account for approximately 6.9% of the gross domestic product (GDP). The total expenditure on health per capita (Intl \$, 2014) is 1.082 [19].

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Based on what is articulated in upstream documents, such as the Law of the Fourth Economic, Social, and Cultural Development Plan, improving equity in healthcare financing is one of the main goals of the Iranian health system [20]. The TSL, which was implemented in 2010, is considered to be one of the reforms that covered entire social sectors, such as the healthcare system, with the aim of ensuring equity.

### Study design

Segmented regression analysis, a powerful method of interrupted time series analysis [21], was conducted to estimate the effect of the TSL on income inequality and equity in healthcare financing. We used segmented regression analysis to assess the extent to which the TSL brought changes to these indicators immediately during the intervention period and over a longer time period (1977-2014). In this analysis,

the time of the intervention was considered to be the changing point. We assumed that the TSL implementation had positive effects on equity in healthcare financing in Iran.

### **Variables**

In this study, the Gini index and Kakwani index were the main outcome variables, while the GDP, inflation rate, infant mortality rate, and the proportion of the population 60 years old and above were the control variables. The data for the years 1977 to 2014 were retrieved from the annual household income-expenditures survey reports of the National Statistics Center of Iran, the Ministry of Health and Medical Education, and the World Bank's official website. The annual household income-expenditures survey data of the National Statistics Center of Iran are believed to be of the required quality. These data have also been used by other studies on healthcare equity and household expenditures on healthcare [4]. The data include detailed measures of household expenditures on goods and services such as healthcare, as well as household income. The healthcare expenditure data distinguish consumer co-payments from health insurance premiums, enabling us to calculate inequality measures for these 2 items separately, as well as together [4, 12].

The Gini index was computed using the annual household income-expenditures survey reports and the annual aggregated number of households from 1977 to 2014. This was carried out as a preliminary analysis to determine the effect of the TSL on

income inequality using segmented regression analysis. The Gini index can be mathematically expressed as follows:

$$(1) \quad GI = 1 - \sum_{i=0}^{k-1} (y_{i+1} + y_i)(x_{i+1} - x_i)$$

Where the Gini index represents the aggregated Gini index;  $y_i$  is the  $i^{\text{th}}$  decile of household income,  $y_{i+1}$  is the  $(i+1)^{\text{th}}$  decile of the next household income,  $x_i$  is the number of households, and  $x_{i+1}$  is the number of the next households in the  $(i+1)^{\text{th}}$  decile [22].

Furthermore, the Kakwani index, which shows the progressivity of healthcare financing, was calculated using the following formula.

$$KI = CI - GI;$$

Where CI is the concentration index and GI is the Gini index. The concentration index, which is a widely applied technique in health economic studies [23], was calculated to measure the inequality in total household expenditures on healthcare from 1988 to 2014. This period was used because household expenditures on healthcare data as deciles were available starting in 1988. This index corresponds to the area between the concentration curve and the perfect equality line ( $45^\circ$ ). A concentration index of 0 shows an absence of inequality between the rich and the poor; a positive value indicates that the concentration curve lies below the perfect equality line, implying a pro-rich inequality; and a negative value shows inequality



in favor of the poor [24]. Overall, the concentration index can be represented mathematically as follows [25]:

$$(2) \quad CI = (P_1L_2 - P_2L_1) + (P_2L_3 - P_3L_2) + \dots + (P_{t-1}L_t - P_tL_{t-1})$$

Where P represents the cumulative percentage declines in population income and L household expenditures on healthcare, respectively.

The Kakwani index was calculated from the Gini index and concentration index models presented in Equations 1 and 2, respectively, as a basis for the segmented regression analysis. The computed Kakwani index values range from -2 to 1. A value of -2 shows severely regressive healthcare financing and a value of 1 indicates strongly progressive healthcare financing [25]. Generally, the area between the concentration curve and the Lorenz curve represents the Kakwani index [25].

#### **Control variables**

The GDP is one of many macroeconomic indicators, and it usually has an effect on other economic variables [24]. The inflation rate is another independent variable that can affect other economic variables. The inflation rate in Iran has been very high during the past 3 decades [26]. High inflation can occur when there is an imbalance between the availability of commodities in society and the amount of cash in circulation. It can also be affected by economic reforms. Hence, the annual GDP and 12-month average inflation rates for the years 1977-2014 were used as control variables for the analysis.

Furthermore, the number of deaths among under-1-year-old children per 1000 live births (the infant mortality rate) for the years 1977-2014 and the proportion of people aged 60 years and above for the years 1988-2014 were included in our analysis as control variables related to health system outcome indicators.

### Modeling the segmented regression analysis

We used the backward approach to estimate the effect of the TSL on income inequality and equity in healthcare financing. Initially, the Gini index was calculated to estimate the effect of the TSL on total income inequality. This is mathematically presented as follows:

$$(3) \quad y_{GI,t} = \beta_0 + \beta_1 t_{before} + \beta_2 cc_{after} + \beta_3 tc_{after} + \beta_4 GDP + \beta_5 InR + e_t$$

Where  $y_{GI,t}$  represents the Gini index at year  $t$ ,  $t_{before}$  is the Gini index trend before the intervention,  $cc_{after}$  is the change in the intercept of the Gini index after intervention,  $tc_{after}$  is the trend change after the intervention,  $GDP$  represents the gross domestic product,  $InR$  is the inflation rate, and  $e_t$  is the random variability that is not explained by the model.

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Furthermore, the Kakwani index was calculated to determine the effect of the TSL on equity in healthcare financing. This is presented in the equation below.

$$(4) \quad y_{KI,t} = \beta_0 + \beta_1 t_{before} + \beta_2 cc_{after} + \beta_3 tc_{after} + \beta_4 IMR + \beta_5 PoU60 + \beta_6 GDP + \beta_7 InR + e_t$$

Where  $y_{Klt}$  is the Kakwani index as an indicator of healthcare financing equity at year  $t$ ;  $IMR$  is the infant mortality rate, and  $PoU60$  is the ratio of the population over the age of 60 years.

Furthermore, the absolute effect of the TSL intervention on income inequality (Gini index) (Equation 8) was calculated by subtracting the value of Equation 7 from the value of Equation 6. This is mathematically presented as follows.

$$(5) \quad y_{Gi,with\ intervention} = \beta_0 + \beta_1 t_{before} + \beta_2 CC_{after}$$

$$(6) \quad y_{Gi,without\ intervention} = \beta_0 + \beta_1 t_{before}$$

$$(7) \quad y_{Gi,with\ intervention} - y_{Gi,without\ intervention} = \beta_2 CC_{after}$$

#### **Statistical analysis**

A segmented regression analysis was carried out on the calculated values of the Gini index and Kakwani index to determine the effects of the TSL, which was implemented in 2010. The analysis was conducted to see whether there were changes in the level and trend of these variables during, before, and after the implementation of the TSL. The effect of the intervention was detected by comparing the value of the intercept and trend before and after the intervention [21]. To detect the effect of an intervention using segmented regression analysis, at least 3 time series observations before and 3 times series observations after are required [27]. Accordingly, this analysis applied 33 yearly Gini index observations before and 5 yearly Gini index observations after the intervention. Similarly, we used 22 yearly Kakwani index observations before and 5 yearly

Kakwani index observations after the intervention. The stepwise elimination method was used to exclude non-significant independent variable from the fitted model. Hence, the model from which all non-significant variables were removed could be considered parsimonious.

The final fitted model was assessed for autocorrelation, co-integration of the variables, and any spurious regression. Thus, the Durbin-Watson statistic was estimated on the residuals of the fitted model. Results closer to 2 indicate the absence of autocorrelation [28]. This test yielded nonstationary results for almost all the variables [Tables 2 and 3]. The Breusch-Pagan diagnostic test for heteroscedasticity was also done on the residuals. The null hypothesis ( $H_0$ ) of this test was that the variances of the variables were same, and the decision was made at  $P$  values less than .05. Finally, the Shapiro-Wilk  $W$  test was performed to assess the normality of the residuals.

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The findings are presented as numeric, percentage, and mean values and are presented graphically and in tables. All analyses were performed using STATA version 13 (StataCorp, College Station, TX, USA).

#### **Ethics statement**

The Research and Ethics Committee of Tehran University of Medical Sciences approved the protocol of this study on August 12, 2014 (No. 9021557003).

## **Results**

The Gini index during the time series period (1977 to 2014) had a negative trend (Table 1). The mean Gini index decreased from 0.401 in the 1980s to 0.381 in 2010, and then to 0.362 in 2014. The maximum level of the Gini index was 0.401 in the 1990s and the minimum level was 0.362 in 2014. The GDP increased over time between 1977 and 2014. The average inflation rate increased from 15.5% in 1977-1980 to 24.03% in 1990-2000, and then decreased to 12.42% during 2000-2010. The maximum and minimum inflation rates were 24.3% and 12.42%, respectively. The infant mortality rate decreased over time, while the proportion of people over the age of 60 years increased, from 3.03% in 1977 to 5.28% in 2014.

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Table 1. Trends of the Gini index, concentration index, Kakwani index, gross domestic product (GDP), inflation rate, infant mortality rate (IMR), and proportion of the population over 60 years, 1977-2014.

Furthermore, the concentration Index showed that inequality in healthcare expenditures decreased from 1988 to 2014. However, the trend of the concentration index showed considerable oscillation. The highest concentration index was in 2012 and the lowest was in 2014. The Kakwani index also showed fluctuating findings, although improvements in the indices were noted after 2012. The average Kakwani index of healthcare financing during the first 10 years (1990-2000) was more equitable ( $K=0.025$ ) than was observed in the last 10 years before the implementation of the TSL (2000-2009,  $K=-0.021$ ). We found no statistically significant effect ( $P>.05$ ) on equity in healthcare financing after the implementation

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of the TSL. Nevertheless, the general trend of the Kakwani index during the TSL implementation period showed an increase, from -0.05 to 0.001.

The segmented regression analysis estimated the Gini index of the different models, as shown in Table 2a. The most parsimonious model showing the effect of the TSL on income inequality was model D. The F statistic value (31.17) and adjusted coefficient of determination ( $R^2 = 73.3\%$ ) in this model were higher than in the other models. There was a statistically significant ( $P < .001$ ) decrease in the slope of the mean Gini index before the intervention (1977 to 2010). Immediately after the intervention of the TSL, the level of the mean Gini Index dropped by -0.032, showing a statistically significant ( $P < .001$ ) immediate reduction in income inequality, although there was no significant change in the slope of the mean Gini index during the period after the intervention (2010 to 2014,  $P = .08$ ) [Table 2b]. Thus, the TSL implementation led to a reduction of the Gini index by 0.08, but the effect of the TSL on reducing income inequality was very small [Fig. 1].

Table 2. Parameter estimates of segmented regression analysis ...

Figure 1. Distribution of the Gini index during the study period (1977-2014)...

### **Effect of the TSL on equity in healthcare financing**

The segmented regression analysis revealed that the TSL did not have any statistically significant effect on the level or trend of the Kakwani index in either of

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the models [Table 3]. The F statistic of the Kakwani index model D showed it to be a well-fitted model ( $F=31.17$ ,  $P<.001$ ) and the index before the intervention was decreasing to a significant extent ( $P<.001$ ), by 0.07 annually. Our study revealed no statistically significant ( $P = .36$ ) change in the trend of Kakwani index after the implementation of the TSL [Fig. 2]. Over time, there was a negligible but statistically significant ( $P<.001$ ) positive effect of the inflation rate on the Kakwani index.

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Table 3. Parameter estimates of segmented regression analysis ...

Figure 2. Distribution of the Kakwani index during the study period (1988-2014)...

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## Discussion

The TSL was a recent reform that was implemented in Iran in 2010 [29]. This reform was part of the economic development plan of the country, the fundamental aim of which was to reduce income inequality among Iranian households and to improve equity in healthcare financing by implementing comprehensive social security [14]. The Gini index, inflation rate, and GDP are indicators that are strongly influenced by economic conditions [30].

The findings of this study revealed that TSL implementation had a positive effect on the Gini index in Iran. The Gini index showed a negative trend in income inequality before the implementation of the TSL, which may indicate a gradual decline in income inequality over time. However, this was not statistically significant. Income inequality decreased immediately after the implementation of the TSL. Evidence has

been found of a correlation between income inequality and healthcare outcomes [31]. Another study likewise reported a relationship between income inequality and increased stroke mortality [32].

Our study found no statistically significant relationships between the Gini index and the inflation rate and GDP after the implementation of the TSL. Although previous studies have found an increasing inflation rate and a decreasing trend in the GDP [33], some have reported a positive association between inflation rate and income inequality [34]. However, the reduction in income inequality may be due to at least 2 reasons: the effects of the recently introduced TSL reform and the lag of the effect of the inflation rate on income inequality. The reduction in income inequality after the implementation of the TSL indicates the conformity of the reform with its planned objectives of redistributing wealth and reducing income inequality among citizens. Several other studies have reported that subsidies and reducing taxation resulted in equitable income distributions [23, 35].

Equity in healthcare financing is one of the main indicators of sound healthcare system performance [25]. Our study revealed a progressive healthcare financing trend over time, which is consistent with progressive healthcare insurance payments (positive slope of the Kakwani index) [4, 36]. Furthermore, a positive Kakwani index, indicating improvements in health expenditures, was also reported [3, 37]. In contrast, studies in Iran and other developing countries have



reported regressive healthcare financing, indicating that low-income households pay more for healthcare than others [36, 38].

The segmented regression analysis in our study did not show a significant effect of TSL on equity in healthcare financing (Kakwani index). However, this study revealed a positive trend in the Kakwani index before the introduction of the TSL. This may have been due to other health sector-related reforms introduced before the TSL implementation, as well as the lack of proper implementation of the TSL and insufficient funds paid to the health system [18]. Another study reported that equity-based healthcare reform significantly reduced income-related inequality [39]. Moreover, studies have shown positive effects of economic or health system reforms on equity in healthcare financing [40]. Hu et al., in a study of employment practices, taxation, and workers' health/welfare benefit coverage in China that evaluated the effects of the enterprise reform on workers' healthcare benefits and their financial burden due to medical expenses, concluded that the reform reduced workers' out-of-pocket expenditures [40]. These variations could be related to the focus of our study on the effects of general economic reforms on healthcare financing, whereas other studies assessed the effects of reforms that were primarily focused on the health sector.

This study was based on survey data from a large sample (31,000-36,000 households annually) retrieved from the reports of the Statistical Center of Iran and other national and international reports for the years 1977-2014. Hence, the

findings can be generalized to the entire population of Iran. The Kakwani index was used in this study, as it is a commonly used indicator for assessing equity in healthcare financing [4]. Using segmented regression analysis was a strength of this study, as it is a powerful method of interrupted time series analysis [21]. Segmented regression analysis requires multiple observations before and after a single intervention [27]. However, the presence of fewer observations after the TSL implementation might have limited the detection of the real effect of the TSL on income inequality and equity in healthcare financing. Additionally, several additional control variables could have been included in this study, but due to the lack of access to data on control variables or their incompleteness in the time frame of the present study (1977-2014), only the inflation rate and GDP were used as control variables for examining the effect of the TSL on the Gini coefficient, and the infant mortality rate and the proportion of the population over 60 years old were used as control variables for examining the effect of the TSL on the Kakwani index.

## **Conclusion**

The study investigated the effects of the TSL on equity in healthcare financing and on income inequality since 2010 in Iran. The segmented regression analysis revealed that the TSL did not show a significant effect on equity in healthcare financing, although income inequality decreased after the implementation of the TSL. The Kakwani index showed that the equity in healthcare financing has improved over time. This finding suggests that economic reforms, such as the TSL, may have a

progressive effect on equity in healthcare financing. Thus, considering the long-term effects of the TSL on equity in healthcare financing and other related health system indicators is of paramount importance for healthcare decision-makers.

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## **Authors' contribution**

Conceived and designed the experiments: HZ, AO, AR. Performed the experiments: HZ, AO, AT. Analyzed the data: HZ, MB, and AO. Contributed reagents/materials/analysis tools: HZ, AT, MB. Wrote the paper: HZ, MB, AT, AO.

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## References

1. Gerstl S, Sauter J, Kasanda J, Kinzelbach A. Who Can Afford Health Care? Evaluating the Socio-Economic Conditions and the Ability to Contribute to Health Care in a Post-Conflict Area in DR Congo. *PloS one* 2013;8(10):e77382.
2. Evans DB, Etienne C. Health systems financing and the path to universal coverage. *Bulletin of the World Health Organization* 2010;88(6):402-403.
3. Khan JA, Ahmed S, Evans TG. Catastrophic healthcare expenditure and poverty related to out-of-pocket payments for healthcare in Bangladesh—an estimation of financial risk protection of universal health coverage. *Health Policy and Planning* 2017
4. Hajizadeh M, Connelly LB. Equity of health care financing in Iran: the effect of extending health insurance to the uninsured. *Oxford Development Studies* 2010;38(4):461-476.
5. Mehrolhassani M, Najafi B, Yazdi Feyzabadi V, Haghdoost A, Abolhallaje M, Ansari M, et al. Total Health Expenditures and proportion of Out-of-Pocket payments in Iranian Provinces; 2008-2014. *Iranian Journal of Epidemiology* 2017;12(5):1-12.
6. Takian A, Rashidian A, Doshmangir L. The experience of purchaser–provider split in the implementation of family physician and rural health insurance in Iran: an institutional approach. *Health policy and planning* 2015:czu135.
7. Hajizadeh M, Nghiem HS. Out-of-pocket expenditures for hospital care in Iran: who is at risk of incurring catastrophic payments? *International journal of health care finance and economics* 2011;11(4):267-285.
8. Yazdi Feyzabadi V, Mehrolhassani M, Haghdoost A, Bahrapour M. The Trend of Impoverishing Effects of Out-Of-Pocket Health Expenditure in Iranian Provinces in 2008-2014. *Iranian Journal of Epidemiology* 2017;12(5):20-31.
9. Mostafavi H, Aghlmand S, Zandiyan H, Alipoori Sakha M, Bayati M, Mostafavi S. Inequitable Distribution Of Specialists And Hospital Beds In West Azerbaijan Province. *Payavard Salamat* 2015;9(1):55-66.
10. Zandiyan H, Ghiasvand H, Nasimi DR. Measuring Inequality of Distribution of Health Resources: A Case Study. *Payesh Journal* 2012;6:799- 805.
11. Yazdi Feyzabadi V, Bahrapour M, Rashidian A, Haghdoost A, Abolhallaje M, Najafi B, et al. Incidence and Intensity of Catastrophic Health Expenditures in Iranian Provinces; 2008-2014. *Iranian Journal of Epidemiology* 2017;12(5):40-54.
12. Davari M, Haycox A, Walley T. Health care financing in iran; is privatization a good solution? *Iranian journal of public health* 2012;41(7):14.
13. Kavosi Z, Rashidian A, Pourreza A, Majdzadeh R, Pourmalek F, Hosseinpour AR, et al. Inequality in household catastrophic health care expenditure in a low-income society of Iran. *Health policy and planning* 2012;27(7):613-623.
14. Guillaume DM, Zytek R, Reza Farzin M. Iran-The Chronicles of the Subsidy Reform: *International Monetary Fund*; 2011, p. 1-28.
15. Salehi-Isfahani D, Wilson Stucki B, Deutschmann J. The reform of energy subsidies in Iran: The role of cash transfers. *Emerging Markets Finance and Trade* 2015;51(6):1144-1162.
16. Abbasian E, Asadbaygi Z. Targeted communication of energy subsidies and social welfare through economic growth. *Social Welfare* 2010;12(44):143-173.
17. Zamanzadeh H. Targeted subsidies: Achievements, challenges and costs. *Tazehaye Egtasad* 2011;9(133):108-116.

- 18.Zandian H, Olyaeemanesh A, Takian A, Rashidian A, Hosseini M. Contribution of Targeted Subsidies Law to the Equity in Health Care Financing in Iran: Exploring the Challenges of Policy Process. *Electronic Physician* 2016;8(2)
- 19.Pourasghari H, Jafari M, Bakhtiari M, Keliddar I, Irani A, Afshari M. Analysis of equality in Iranian household healthcare payments during Iran's fourth development program. *Electronic physician* 2016;8(7):2645.
- 20.Doshmangir L, Doshmangir P, Abolhassani N, Moshiri E, Jafari M. Effects of targeted subsidies policy on health behavior in iranian households: A qualitative study. *Iranian journal of public health* 2015;44(4):570.
- 21.Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *Journal of clinical pharmacy and therapeutics* 2002;27(4):299-309.
- 22.Giles DE. Calculating a Standard Error for the Gini Coefficient: Some Further Results\*. *Oxford Bulletin of Economics and Statistics* 2004;66(3):425-433.
- 23.Yusuf AA, Resosudarmo BP. Is reducing subsidies on vehicle fuel equitable? A lesson from Indonesian reform experience. *Fuel Taxes and the Poor* 2011
- 24.Wagstaff A, O'Donnell O, Van Doorslaer E, Lindelow M. Analyzing health equity using household survey data: a guide to techniques and their implementation: World Bank Publications; 2007
- 25.O'Donnell OA, Wagstaff A. Analyzing health equity using household survey data: a guide to techniques and their implementation: World Bank Publications; 2008
- 26.Paya A, Raghfar H, Abdi A, Poor DM, Fadavi-Ardekani M. Social, Economic, Political, and Intellectual Changes in Iran Since 1960s. *The State of Social Progress of Islamic Societies*: Springer; 2016, p. 211-235.
- 27.Ramsay CR, Matowe L, Grilli R, Grimshaw JM, Thomas RE. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. *International journal of technology assessment in health care* 2003;19(04):613-623.
- 28.Hamilton JD. *Time series analysis*: Princeton university press Princeton; 1994
- 29.Hassanzadeh E. Recent developments in Iran's energy subsidy reforms. Policy Brief. International Institute for Sustainable Development. [www.iisd.org/gsi/sites/default/files/pb14\\_iran.pdf](http://www.iisd.org/gsi/sites/default/files/pb14_iran.pdf) 2012
- 30.Graeff P, Mehlkop G. The impact of economic freedom on corruption: different patterns for rich and poor countries. *European Journal of Political Economy* 2003;19(3):605-620.
- 31.Heshmati A. The World Distribution of Income and Income Inequality: A Review of the Economics Literature\*. *Journal of World-systems research* 2015;12(1):61-107.
- 32.Vincens N, Stafström M. Income Inequality, Economic Growth and Stroke Mortality in Brazil: Longitudinal and Regional Analysis 2002-2009. *PloS one* 2015;10(9):e0137332.
- 33.Farzanegan MR, Markwardt G. The effects of oil price shocks on the Iranian economy. *Energy Economics* 2009;31(1):134-151.
- 34.Monnin P. Inflation and income inequality in developed economies. *CEP Working Paper Series* 2014 35.
- 36.Hajizadeh M, Connelly LB. Equity of health care financing in Iran. *Australian Centre for Economic Research on Health* 2009;5:1-39.
- 37.Rezaei S, Fallah R, Kazemi Karyani A, Daroudi R, Zandiyan H, Hajizadeh M. Determinants of healthcare expenditures in Iran: evidence from a time series analysis. *Medical Journal of The Islamic Republic of Iran* 2016;30(1):6-14.
- 38.Munge K, Briggs AH. The progressivity of health-care financing in Kenya. *Health policy and planning* 2014;29(7):912-920.
- 39.Cabieses B, Cookson R, Espinoza M, Santorelli G, Delgado I. Did Socioeconomic Inequality in Self-Reported Health in Chile Fall after the Equity-Based Healthcare Reform of 2005? A Concentration Index Decomposition Analysis. *PloS one* 2015;10(9):e0138227.

40.Hu TW, Ong M, Lin ZH, Li E. The effects of economic reform on health insurance and the financial burden for urban workers in China. Health Economics 1999;8(4):309-321.

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Table 1. Trends of the Gini index, concentration index, Kakwani index, gross domestic product (GDP), inflation rate, infant mortality rate (IMR), and proportion of the population over 60 years, 1977-2014

Year	1977-1980	1980-1990	1990-2000	2000-2009	2010	2011	2012	2013	2014
Gini Index <sup>1</sup>	0.401	0.401	0.397	0.4014	0.381	0.372	0.365	0.365	0.362
GDP <sup>3</sup>	5273.66	14710.8	210864.5	2.10E+06	5.5e+06	5.80E+06	5.80E+06	5.30E+08	5.30E+08
Inflation rate <sup>4</sup>	15.51	19.53	24.03	14.75	12.42	21.53	30.51	34.74	27.53
IMR <sup>5</sup>	87.61	58.72	36.62	22.53	16.56	15.74	15.12	14.46	13.71
Population over 60 <sup>5</sup>	3.038	2.992	3.710	4.772	5.159	5.198	5.242	5.285	5.286
Concentration index <sup>2</sup>	-	-	0.371	0.381	0.388	0.368	0.389	0.388	0.370
Kakwani index <sup>2</sup>	-	-	0.025*	-0.021*	0.007	-0.001	0.024	0.023	0.008

\*Mean over 10 years.

1. Source: Iran Statistical Center report, 2014

2. Calculated by authors

3. World Bank Report 2014

4. Central Bank of Iran

5. Deputy of Treatment of Ministry of Health Report 2014

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cm



**Table 2. Parameter estimates of segmented regression analysis models of the effects of TSL implementation on income inequality (Gini index) in Iran, 1977-2014 (year of intervention, 2010)**

Models	Intercept	Explanatory variables					Goodness of fit			Residual tests				
		T before	CC after	TC after	IGDP	INF	F	R <sup>-2</sup>	R <sub>MST</sub>	DF	NO	DW	B-P	
<b>a.</b>	A	.374 <0.001	-.001 0.07	-.008 0.38	- .008 0.03	.003 0.12	-.000 0.76	19.58 <0.001	0.753	.00717	- 4.859	0.967 0.319	1.628	1.08 0.299
	B	.373 <0.001	-.001 0.06	-.008 0.394	- .008 0.02	.004 0.11		25.15 <0.001	0.753	.00707	- 4.793	0.964 0.259	1.604	1.06 0.304
	C	.405 <0.001	- .0002 0.145	-.017 0.046	- .003 0.11		-.000 0.704	22.83 <0.001	0.734	.00733	- 4.613	0.965 0.284	1.510	1.43 0.231
	D	.404 <0.001	- .0001 0.14	-.016 0.046	- .004 0.08			31.17 <0.001	0.733	.00723	- 4.513	0.964 0.266	1.473	1.34 0.246
<b>b.</b>	<b>Most parsimonious model</b>	.401 <0.001		-.032 <0.001				79.53 <0.001	0.688	.00761	- 3.770	0.886 <0.001	1.472	1.47 0.237

TSL, Targeted Subsidies Law;

DF, stationary of residuals with the Dicky-Fuler test;

NO, normality of residuals with the Shapiro-Wilk W test;

DW, Durbin-Watson test for autocorrelation;

B-P, Breusch-Pagan test for heteroscedasticity;

INF, inflation rate;

IGDP, log gross domestic product.

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**Table 3: Parameter estimates of segmented regression analysis models of the effects of TSL implementation on inequality in healthcare financing (Kakwani index) in Iran, 1988-2014 (year of intervention, 2010)**

Models	Explanatory variables								Goodness of fit			Residual tests			
	Intercept	T <sub>before</sub>	CC <sub>after</sub>	TC <sub>after</sub>	IGDP	IMR	Pop <sub>60</sub>	INF	F	R <sup>-2</sup>	R <sub>MST</sub>	ST	NO	DW	B-P
<b>A</b>	-0.018 0.95	0.009 0.33	0.009 0.67	-0.006 0.53	0.00 0.98	0.000 0.91	-0.06 0.17	0.000 0.13	5.95 <0.001	0.68 6	0.014	-5.199	0.785 <0.001	2.156	0.37 0.542
<b>B</b>	0.02 0.94	0.009 0.32	0.008 0.62	-0.006 0.37		0.000 0.91	-0.06 0.16	0.000 0.12	7.31 <0.001	0.59 2	.0142	-5.199	0.784 <0.001	2.156	0.38 0.540
<b>C</b>	0.48 0.57	0.008 0.06	0.009 0.55	-0.006 0.27			-0.06 0.14	0.000 0.11	9.20 <0.001	0.61 1	.0139	-5.187	0.778 <0.001	2.154	0.34 0.518
<b>D</b>	-0.07 <0.001	0.001 <0.001	0.015 0.36	-0.001 0.70				0.000 0.05	31.17 <0.001	0.73 3	.00723	-4.769	0.808 <0.001	1.967	0.56 0.454
<b>E</b>	-0.05 <0.001	0.001 <0.001	0.013 0.41	0.001 0.81					11.68 <0.001	0.55 2	.0149	-3.371	0.839 <0.001	1.624	0.33 0.564

TSL, Targeted Subsidies Law;

DF, stationary of residuals with the Dicky-Fuler test;

NO, normality of residuals with the Shapiro-Wilk W test;

DW, Durbin-Watson test for autocorrelation;

B-P, Breusch-Pagan test for heteroscedasticity;

INF, inflation rate;

IGDP, log gross domestic product;

Pop<sub>60</sub>, over-60 population;

IMR, infant mortality rate.

서식 있음: 아래 첨자

서식 있음: 글꼴 색: 텍스트

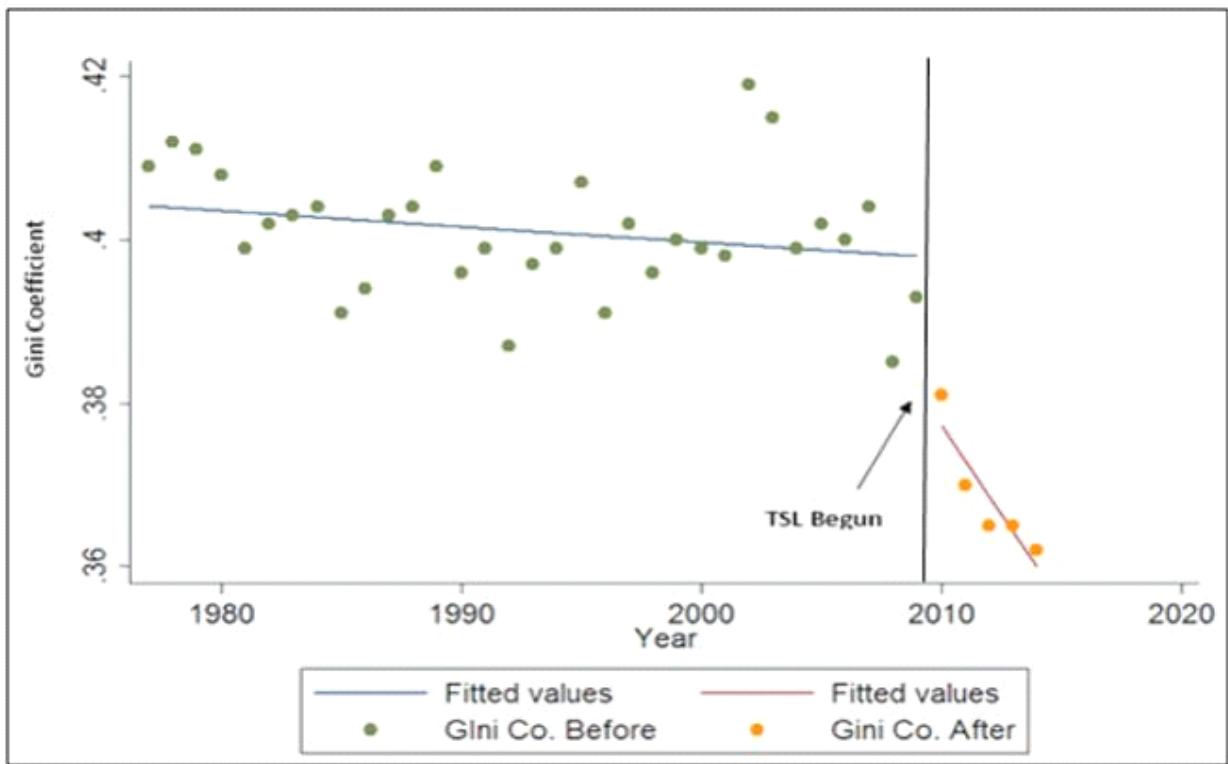


Figure 1: The Distribution of Gini Index (GI) during the study time (1977-2014), 33 years before and 5 years after TSL implementation (2010)

Fig 1

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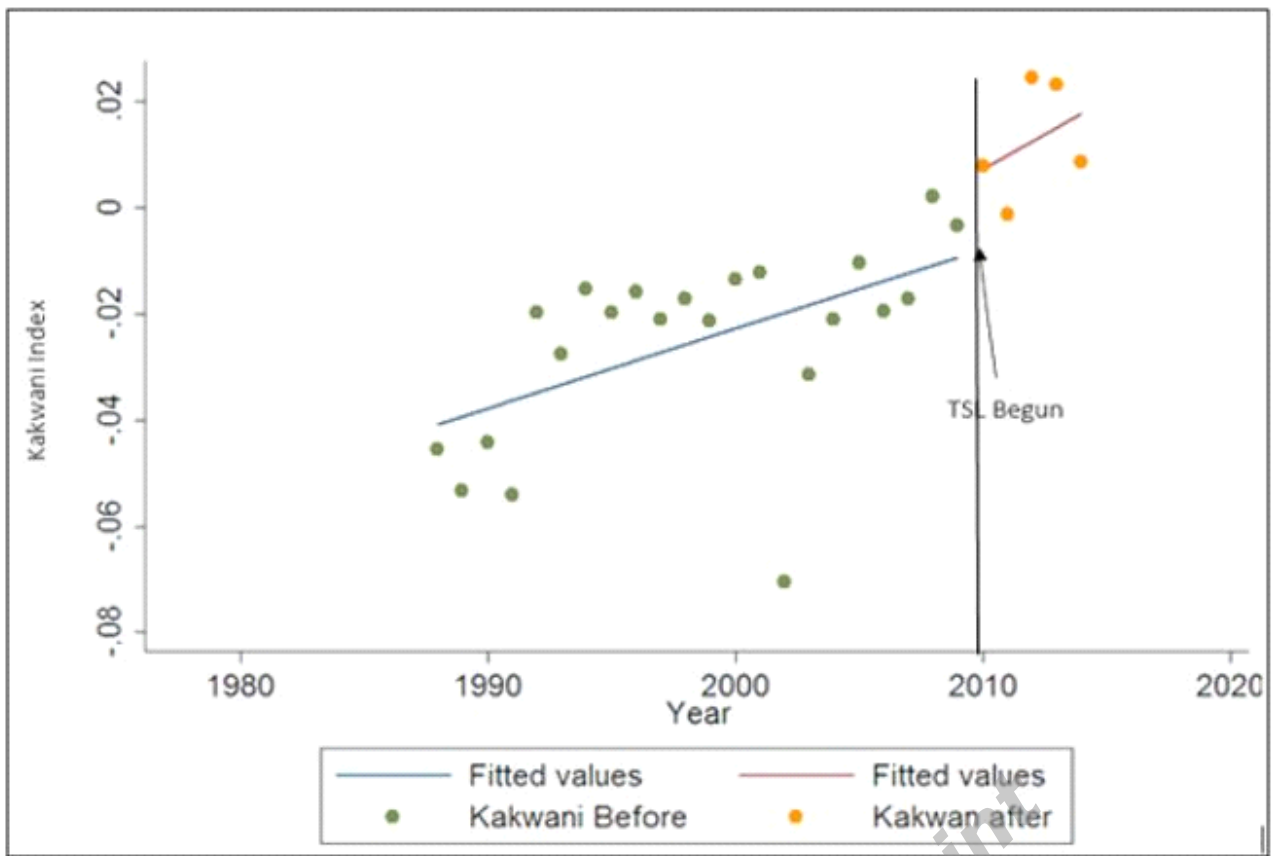


Figure 2: The Distribution of Kakwani Index (KI) during the study time (1988-2014), 22 years before and 5 years after TSL implementation (2010)

fig 2

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