Analysis of the Effect of Rural Residents Serious Illness Medical Insurance on Relieving the Economic Burden of Rural Residents in China:A Case Study in Jinzhai County

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Research article

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Abstract

Background

In 2003, China established a New Rural Cooperative Medical System(NRCMS) for rural residents, which had alleviated the burden of medical expenses of rural residents, but the reimbursement for high medical was insufficient. Therefore, China had gradually established a Serious Illness Insurance System (SIMIS) on the basis of NRCMS. After the payment of NRCMS, patients who met the requirements of SIMIS policy would be given a second payment to further alleviate the economic burden of patients with high medical expenses in rural areas. The purpose of this study is to analyze the effect of the implementation of SIMIS on alleviating the economic burden of rural residents in Jinzhai County.

Methods

Based on the inpatient reimbursement data of NRCMS in Jinzhai County, Anhui Province from 2013 to 2016. We adopt descriptive and regression discontinuity (RD) method to analyze the payment effect of SIMIS. The RD analysis object (n = 7353) was the patients whose annual serious illness expenses were between CNY 10,000 and CNY 30,000, and the descriptive analysis object (n = 2720) was the patients compensated by SIMIS.

Results

The results of RD showed that the actual medical insurance payment proportion (AMIPP) increased by about 2.5% (Iwald = 0.025, P < 0.01), inside medical insurance self-payment proportion (IMSPP) increased by about 2% (Iwald = 0.020, P < 0.10), outside medical insurance self-payment proportion (OMISPP) decreased by about 1.6% (Iwald = -0.016, P < 0.05). The descriptive results showed that the serious illness patients mostly chose to go to hospital outside the county. The annual average number of hospitalizations was 3.64. The reimbursement mainly came from the NRCMS. The payment amount of SIMIS was relatively small, and the out of pocket medical expenses were still high.

Conclusion

The medical technology level of Jinzhai County could not meet the needs of seriously illness patients, the number of beneficiaries of SIMIS was small, and the ability to relieve the burden of medical expenses of rural residents was insufficient. The high out of pocket expenses increased the possibility that people with good economic conditions could enjoy the reimbursement of SIMIS, resulting in inequity.

Background

After years of development, China's medical security system had gradually established a New Rural Cooperative Medical System（NRCMS）, which was a system arrangement for rural residents[1]. The establishment of the NRCMS had alleviated the burden of medical expenses of rural residents in China, but the reimbursement for high medical expense was insufficient [2]. In order to further improve the reimbursement level of rural residents, China has established a Serious Illness Medical Insurance System（SIMIS） on the basis of NRCMS. There are two forms of payment: the first one is to pay for the high expense in proportion to the expenses exceeding the specified amount after the payment of NRCMS; the second one is to pay for some diseases in proportion after the payment of NRCMS. In this study, people who enjoy SIMIS were collectively referred to as serious illness patients.

There were few empirical studies on the reimbursement effect of China's SIMIS, which focused more on the payment of SIMIS and lack of analysis of patients' out of pocket costs. Based on the inpatient reimbursement data of NRCMS from 2013 to 2016 after the implementation of SIMIS provided by Jinzhai medical insurance management center of Anhui Province, this study analyzed the policy effect after the implementation of SIMIS and provided basis for policy adjustment.

Jinzhai County is located in the west of Anhui Province, China, with a registered population of 683,000 in 2017, including 572,000 in rural areas. There were about 40,000 poverty people in rural areas, of which about 20,000 were due to illness [3]. Therefore, it was very important to established medical security for rural residents to reduce poverty. Jinzhai County had gradually established a multi-level medical security system composed of NRCMS, SIMIS and other policies to prevent residents from poverty due to illness by improving the basic medical institutions [4]. Jinzhai County's SIMIS adopted the first form of payment for high expenses and the payment mode was as follows (Figure 1):

The total medical expense can be divided into two parts: Inside medical insurance part and outside medical insurance part.

1. Inside medical insurance: NRCMS payment and SIMIS payment.

- NRCMS payment. According to the policy, the total expenses for an inpatient is split into two tiers, includes total self-payment and NRCMS payment. NRCMS payment include the threshold to trigger the NRCMS fund, self-payment under the NRCMS, NRCMS fund payment, and ceiling self-payment.
- SIMIS payment. The expenses inside the SIMIS are called serious illness expenses. It comes from self-payment under the NRCMS, ceiling self-payment and clinical necessary treatment cost in total self-payment. If the annual serious illness expenses of inpatients exceed CNY 20,000, the SIMIS fund shall be paid in proportion without ceiling limit. If not the reimbursement still in NRCMS payment.

2.Outside medical insurance: total self-payment which the medical insurance cannot be reimbursement.

Methods

This study intent to use two methods to analyze the reimbursement effect of SIMIS.

First, descriptive analysis was carried out on the inpatient situation of the serious illness patients, describing the different types of inpatient expenses and reimbursement situation in the year, and analyzing the reimbursement effect. In this paper, the hospitalization types could be divided into five categories: County hospitalization refers to the inpatient in Jinzhai County, City hospitalization refers to the inpatient outside Jinzhai County and in Lu'an City, Provincial hospitalization refers to the inpatient outside Lu'an City and in Anhui Province, and outside Anhui Province hospitalization refers to the inpatient outside Anhui Province, and cross regional hospitalization refers to the inpatient cross regional.

Second, the regression discontinuity (RD) method [5,6,7] was used to analyze the relief of medical expenses of rural residents after the implementation of SIMIS. RD method made use of the discontinuous characteristics of policy, that was, when the specific index of the research object was greater than the critical value specified by the policy, it would be treated by the policy, and the critical value was the breakpoint (C). As the policy of SIMIS in Jinzhai was to compensate the inpatients whose annual serious illness expenses were more than CNY 20,000, we

could choose C = CNY 20,000 as the breakpoint in this study. The subjects whose annual serious illness expenses was more than CNY 20,000 would be included in the experimental group, and the subjects whose annual serious illness expenses was less than or equal to CNY 20,000 would be included in the control group. It could be considered that the basic situation of the objects near the breakpoint was similar. Whether they could enjoy the compensation treatment of SIMIS was the result of the random allocation of policies and systems. It could be regarded as a quasi-experiment. Because of the existence of random grouping, the average treatment effect of SIMIS near the breakpoint can be estimated.

In this study, STATA 15.0 RD statistical software package was used for data statistical analysis. The analysis process was as follows:

1. The average and frequency indexes were used to describe the inpatient characteristics and payment status of serious illness patients.
2. Determine the optimal bandwidth (H). The best distance from the breakpoint location. Generally speaking, the smaller the H was, the smaller the deviation of objects on both sides of the breakpoint was, but it may lead to less observation objects, resulting in excessive variance; otherwise, the larger the H was, the smaller the variance was, but it included objects far away from the breakpoint, resulting in excessive deviation of objects. Therefore, this study uses the method proposed by imbens and kalyanaraman (IK method) [8] to select the optimal bandwidth by minimizing the mean square error of two regression functions at the breakpoint.
3. RD analysis. The dependent variables were actual medical insurance payment proportion (AMIPP), inside medical insurance payment proportion (IMIPP), inside medical insurance self-payment proportion (IMSPP) and outside medical insurance self-payment proportion (OMISPP). The independent variable (grouping variable) was Serious illness expenses. Covariates were age, hospital stay, total medical expenses, gender and inpatient type. Table1 showed variable definition and basic information. In the two intervals (C-H, C] and (C, C + H), the weighted least square method was used for linear regression, and the weight was determined by the trigonometric kernel function. The difference between the estimates of dependent variables of the two functions at point C was called local average treatment effect (LATE), which was also known as "local Wald estimator" (lwald).
4. Validity test. When doing RD, we should also pay attention to the possibility of "endogenous grouping". For example, the patients whose serious illness expenses were less than CNY 20,000 had known the grouping rules in advance, they may take the initiative to make their serious illness expenses reached CNY 20,000 and enjoy the compensation policy, resulting in endogenous grouping rather than random grouping of patients near the breakpoint.

For the possibility of endogenous grouping, this study used the method proposed by McGrary (2008) [9]to test whether the density function of grouping variable was discontinuous at the breakpoint. First, the grouping variables were subdivided equidistantly on both sides of breakpoint C, the group distance was B, the center position of each group was noted as variable X_j, and then the standardization frequency of each group was calculated, which was noted as Y_j. By using trigonometric kernel and local linear regression on both sides of breakpoint C, the estimated value and standard error of density function could be obtained according to the value of grouped variable. By comparing the estimated values of the density function at the breakpoint, we could judge whether the density function was continuous at the breakpoint.

In addition, if the conditional density function of covariates at breakpoint C also had a jump, it was not appropriate to attribute all policy effects to the implementation of policies. In fact, the implicit assumption of RD was that the conditional density of covariates was continuous at the breakpoint. In order to test this hypothesis, we took each covariate as the dependent variable and the serious illness expenses as the independent variable, and then carried out RD again to investigate whether there was a jump in its distribution at the breakpoint.

Table 1
Basic information of variables

Variable	Variable definition	C ≤ 20,000(n = 5984)		C > 20,000(n = 1370)	
		Mean	SD	Mean	SD
Dependent variable (%)					
AMIPP	Proportion of total medical insurance payment to total medical expenses	48.16	13.52	51.93	11.47
IMIPP	Proportion of total medical insurance payment to total inside medical insurance expenses	59.48	13.19	61.39	11.93
IMSPP	Proportion of inside medical insurance self-payment to total expenses	32.69	11.96	32.81	11.14
OMISPP	Proportion of outside medical insurance self-payment to total expenses	19.15	10.99	15.26	10.71
Independent variable (grouping variable)					
Serious illness expenses	Total of ceiling self-payment,Clinical Necessary treatment cost□self-payment under the NRCMS	1.38	0.27	2.41	0.28
Covariates					
Age	Age of inpatients	49.82	18.39	50.45	17.15
Hospital stay	Length of hospital stay	23.26	29.38	26.46	36.34
Total expenses	Total annual inpatient medical expenses	4.78	2.42	7.49	3.27
Gender	Female = 1	0.58	0.49	0.57	0.49
Inpatient type	Inpatient grade(1–5)	4.06	1.06	4.24	1.16

Sample

The research data came from the medical insurance management center of Jinzhai County, Anhui Province, covering the hospitalization reimbursement data of NRCMS from 2013 to 2016 (n = 293871). Case information included: basic information of inpatients, hospitalization and medical expenses payment. According to the research idea, RD focused on the objects near both sides of the breakpoint. In order to ensure the same span on both sides of the breakpoint, the patients whose serious illness expenses was between CNY 10,000 and CNY

30,000 were selected as the analysis objects (n = 7353). And descriptive analysis of SIMIS reimbursement objects (n = 2720). Table 2 showed the distribution of serious illness expenses.

Table 2
Distribution of serious illness expenses in Jinzhai County from 2013 to 2016

Expenses	Frequency	Frequency ratio(%)
0.0 ~	285501	97.15
1.0~	5983	2.03
2.0 ~	1370	0.47
3.0 ~	493	0.17
4.0 ~	221	0.08
5.0 ~	303	0.10

Results

SIMIS payment

Table 3 showed the descriptive statistics of serious illness patients in Jinzhai county.

The serious illness patients were often transferred to other hospitals in different regions. The average number of annul hospitalization was 3.64. The annual average medical expenses for serious illness patients were CNY 96,100, annual average NRCMS payment was CNY 48,000, annual average SIMIS payment was CNY 7,600, annual average inside medical insurance self-payment was CNY 26,200, annual average outside medical insurance self-payment was CNY 14300. The average annual expenses of inpatients at County was CNY 86,500,City was CNY 91,100, Province was CNY 90,500, Outside province was CNY 97,600, Cross regional was CNY 97,400. The proportion of NRCMS payment to the total medical expenses was 49.90%, proportion of SIMIS payment to the total medical expenses was 7.92%, inside medical insurance self-payment to the total medical expenses was 27.26%, outside medical insurance self-payment to the total medical expenses was 14.92%.

Table 3

Annual average inpatients expenses of seriously illness patients in Jinzhai County from 2013 to 2016

Items	Total	County	City	Province	Outside province	Cross regional
Hospitalization						
proportion(%)	100	2.08	5.61	12.23	27.57	52.51
Annual per capita hospital stays	3.64(2.72)	1.73(1.65)	2.26(1.96)	2.12(1.65)	2.58(2.41)	4.77(2.66)
Medical expenses(CNY Ten thousand)						
NRCMS payment	4.80(3.01)	5.11(3.01)	5.09(3.09)	4.83(2.83)	4.33(3.38)	4.99(2.79)
SIMIS payment	0.76(0.11)	0.55(1.40)	0.60(0.83)	0.57(0.63)	0.87(1.50)	0.76(0.96)
Inside medical insurance self-payment	2.62(1.17)	2.33(1.16)	2.35(0.90)	2.36(0.72)	2.78(1.28)	2.61(1.01)
Outside medical insurance self-payment	1.43(1.37)	0.66(0.57)	1.07(0.42)	1.31(1.19)	1.77(2.36)	1.37(1.98)
Total	9.61(5.77)	8.65(4.58)	9.11(4.67)	9.05(4.62)	9.76(7.59)	9.74(4.97)
Payment proportion (%)						
NRCMS payment	49.90(10.46)	59.08(16.25)	55.89(9.09)	53.34(9.37)	44.41(10.86)	51.30(9.21)
SIMIS payment	7.92(5.49)	6.36(5.00)	6.57(5.20)	6.03(4.80)	8.96(5.93)	7.85(5.32)
Inside medical insurance self-payment	27.26(10.85)	26.94(18.49)	25.80(9.35)	26.07(9.95)	28.52(11.64)	26.79(10.36)
Outside medical insurance Self-payment	14.92(11.06)	7.63(7.76)	11.73(9.22)	14.56(10.76)	18.11(11.50)	14.06(10.92)
Note: the values inside and outside the brackets represent the mean and standard deviation respectively.						

Analysis of RD

SIMIS effect

Table 4 showed the estimated effect of policy treatment. In the absence of covariates, the lwald estimate of the actual medical insurance payment proportion (AMIPP) at the breakpoint was 0.025, which was significant at the level of 1%. Figure 2 showed that the reimbursement on the right side of the breakpoint was slightly higher than that on the left side, indicating that the implementation of SIMIS has improved the actual payment level, about 2.5%. The lwald estimate of the inside medical insurance payment proportion (IMIPP) was 0.020, Fig. 3 showed that the reimbursement on the right side of the breakpoint was slightly higher than that on the left side, indicating that the implementation of SIMIS had improved the actual payment level to some extent, about 2%, but slightly lower than the actual payment level of medical insurance. The lwald estimate of inside medical insurance self-payment proportion (IMSPP) was − 0.006, and it's not significant, Fig. 3 showed that the level of self-payment inside medical insurance was almost the same on the left and right sides of the breakpoint, indicating that the implementation of SIMIS has little impact on the level of self-payment inside medical insurance. The lwald estimate of outside medical insurance self-payment proportion (OMISPP) was − 0.016, which was significant at the level of 5%, Fig. 3 showed that the level of self-payment outside medical insurance on the right side of the breakpoint was slightly lower than that on the left side of the breakpoint, indicating that the implementation of SIMIS reduced the level of self-payment outside medical insurance to a certain extent, about 1.6%. After adding covariates, the results of RD were consistent.

Table 4
RD results of SIMIS

lwald	AMIPP (H = 0.6581)	IMIPP (H = 0.5345)	IMSPP (H = 0.5949)	OMISPP (H = 1.079)
Not add Covariate	0.025***(0.010)	0.020*(0.011)	-0.006(0.009)	-0.016**(0.006)
Add covariates	0.022***(0.008)	0.014**(0.006)	-0.006(0.009)	-0.011**(0.005)

Note: * * * * represents significant at the level of 1%, * * represents significant at the level of 5%, and * represents significant at the level of 10%. H represents the optimal bandwidth. The value in brackets is SD of lwald.

Validity test

Independent variable continuity test

McGrary (2008) method was used to test whether the probability density function of independent variable was continuous at the breakpoint. The results showed =-0.054, standard error was 0.11, so the assumption of continuity of independent variable density function at the breakpoint could be accepted. Figure 5 showed that the confidence intervals of the estimated values of the independent variable probability density functions on both sides of the breakpoint were mostly overlapped, indicating that patients were randomly assigned on both sides of the breakpoint, and there was no endogenous grouping problem.

Covariate continuity test

Table 5 showed that the estimated value lwald was not significant for Age, Gender, Hospital stay,

Total expenses, Gender and Inpatient type, which showed that the effect of SIMIS had no impact on covariates, and the policy effect could be attributed to the implementation of SIMIS.

Table 5
Covariate continuity test results

lwald	AMIPR H = 0.6581	IMIPR H = 0.5345	IMSPR H = 0.5949	OMISPR H = 1.079
Age	1.690(14.516)	3.008(16.197)	2.355(15.300)	-2.93(11.38)
Total expenses	606.16(1971.54)	1209.01(2135.78)	968.03(2045.23)	-907.36(1581.57.)
Hospital stay	0.943(2.897)	2.082(3.241)	1.433(3.058)	2.176(2.225)
Inpatient type	-0.041(0.083)	-0.033(0.094)	-0.037(0.089)	-0.052(0.066)
Gender	0.035(0.039)	0.031(0.043)	0.0358(0.041)	0.035(0.030)
Note: The dependent variables are age, total expenses, hospital stay, inpatient type and gender. The independent variables are serious illness expenses. The value outside the bracket is the estimated value of lwald, and the value inside the bracket is the estimated value of standard error.				

Discussion

The RD results showed that the SIMIS has improved the AMIPP and IMIPP. The treatment effect values(lwald) were 0.025 and 0.020 respectively, the proportion of payments increased by only 2.5% and 2%. It could also be seen from the figure that the gap between the two sides of the breakpoint was not very large after the implementation of SIMIS. Although the SIMIS reduced the actual out of pocket expenses of patients, the descriptive results showed that the reimbursement of serious illness patients was more from the NRCMS. The average annual NRCMS payment was CNY 48,000, and the SIMIS payment was CNY 7,600. The SIMIS reimbursement accounts for about 14% of the total reimbursement. The average annual actual out of pocket expenses were about CNY 40,500. In 2016, the average annual income of rural families in Anhui Province was about CNY 32,000[10], which meant that the annual income of serious illness patients' families was lower than the actual self-paid medical expenses. And the SIMIS cannot play a role in preventing the catastrophic health expenditure of the people. In addition, the study found that the SIMIS reduced the OMISPR at the breakpoint, and the treatment effect value was − 0.0016, self-payment decreased by about 1.6%. It could be seen from the figure that the gap between the two sides of the breakpoint was very small, indicating that although the coverage of the SIMIS has been expanded compared with that of the NRCMS, but the range was small The per capita outside medical insurance for the serious illness patients was about CNY 14300, which was relatively high. This study also found that the inpatients who enjoy the compensation of SIMIS account for about 0.93% of the total inpatient population, with a narrow range of benefits.

The study found that about 45.41% of the serious illness patients in rural areas directly chose to be hospitalized outside Jinzhai County, about 52.51% of the patients chose to be transferred to hospitals outside the county. There were two explanations for the results. On the one hand, it may be related to the fact that the medical level in Jinzhai County cannot meet the medical needs of seriously illness patients; on the other hand, it may be related to

the fact that there were more migrant workers in Jinzhai County. The study found that annual per capita hospital stays of serious illness patients was 3.64, and the annual per capita hospital stays across regions was 4.77. The results may be related to the fact that most of the serious illness patients were chronic and critically ill.

In addition, the study found that the NRCMS payment were related to the type of hospitalization. The result was related to the policy orientation of medical insurance, that was, the reimbursement for hospitalization in different places was lower than that of hospitalization in local areas, so as to guide patients to seek medical treatment in local areas. However, serious illness patients chose to go to hospital outside the county more, which showed that the guidance of NRCMS had little impact on patients with serious illness. It can be concluded that serious illness patients pay more attention to the level of medical technology rather than the economic condition. Some research results also showed that most of the rural patients who chose to go out to see a doctor have better economic condition, so they paid more attention to the level of hospital medical technology [11, 12]. It was reported that about 22% of rural residents in Jinzhai County work across provinces all the year round [13]. Meanwhile, relevant research showed that the economic condition of migrant workers was relatively good, which may also lead to more patients choose to go to different places for medical treatment [14]. Therefore, it could be considered that people with better economic conditions were more likely to enjoy the SIMIS, while patients with poor economic conditions may choose not to see a doctor, which also causes unfairness to some extent [15, 16].

Although this study analyzed the payment effect of SIMIS, there were still some limitations. RD only used part of the data on both sides of breakpoint to analyze the effect of SIMIS on relieving rural residents' economic burden, so it only reflected the policy effect near breakpoint. In addition, due to the fact that some of the poverty-stricken people determined by china have a serious illness expense higher than CNY 5000 could enjoy the SIMIS payment. It may affect the results of RD analysis, but the number of poverty people was very small, the impact on the results was limited.

Conclusion

As a further policy arrangement to alleviate the economic burden of patients with high medical expenses, the SIMIS has increased the reimbursement amount for some patients with high medical expenses. However, the local medical technology level of Jinzhai County cannot meet the needs of medical services for seriously ill patients, the range of beneficiaries of SIMIS was small, the ability to alleviate the economic burden o of rural residents was limited, and the high out of pocket medical expenses increased the possibility that people with better economic conditions can enjoy the reimbursement of SIMIS, resulting in inequity. Therefore, the policy of SIMIS should reduce the threshold payment, expand the scope of payment, improve the accuracy of payment, and promote the fairness of payment.

Abbreviations

NRCMS
New Rural Cooperative Medical System
SIMIS
Serious Illness Medical Insurance System
AMIPP
Actual Medical Insurance Payment Proportion

IMIPP
Inside Medical Insurance Payment Proportion
IMSPP
Inside Medical Insurance Self-payment Proportion
OMISPP
Outside medical insurance self-payment proportion
RD
Regression Discontinuity

Declarations

Consent for publication

Not applicable

Ethics approval and consent to participate

Not applicable

Availability of data and materials

All relevant data are within the paper.

Competing interests

The authors declare that they have no competing interests.

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Authors' Contributions

Yang Li, Fengguang Duan contributed equally to this work. Obtained the funding: PX. Conceived and designed the experiments: YL, FD. Performed the experiments, analyzed the data, and contributed reagents/materials/analysis tools: YL , PX. Drafted the manuscript: YL. All authors participated in discussion, revision and approved of the final manuscript.

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Figures

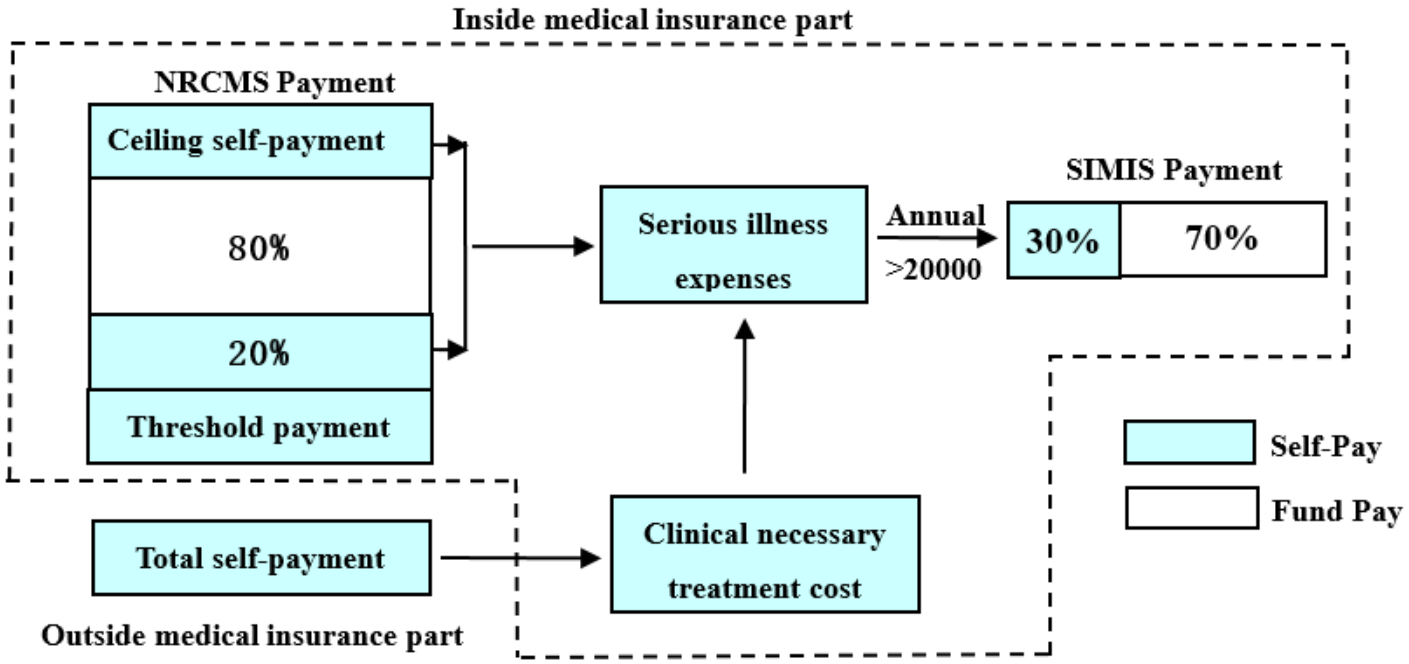

Figure 1

SIMIS Payment mode for hospitalization services in Jinzhai

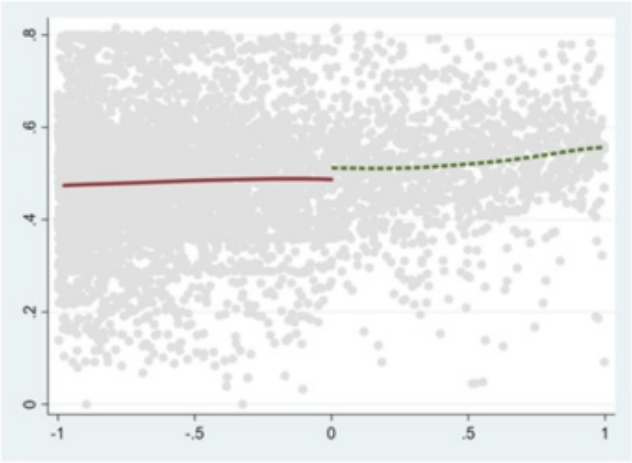

Figure 2

AMIPP on both side of breakpoint

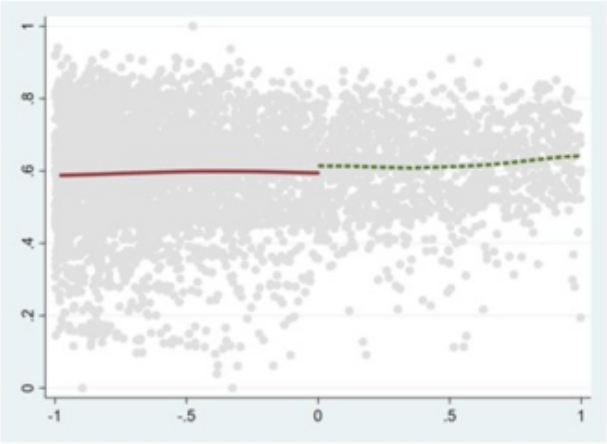

Figure 3

IMIPP on both side of breakpoint

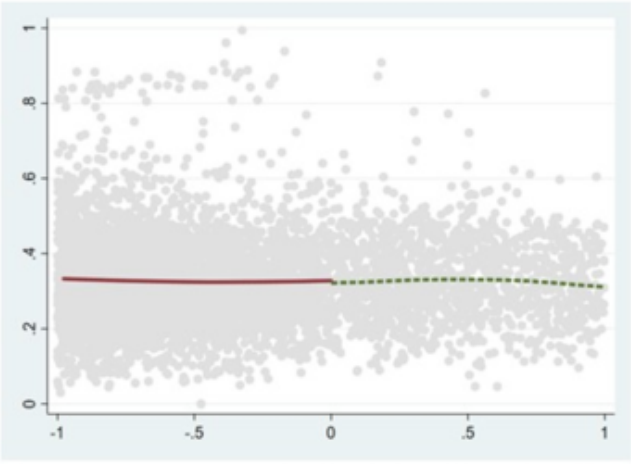

Figure 4

IMSPP on both side of breakpoint

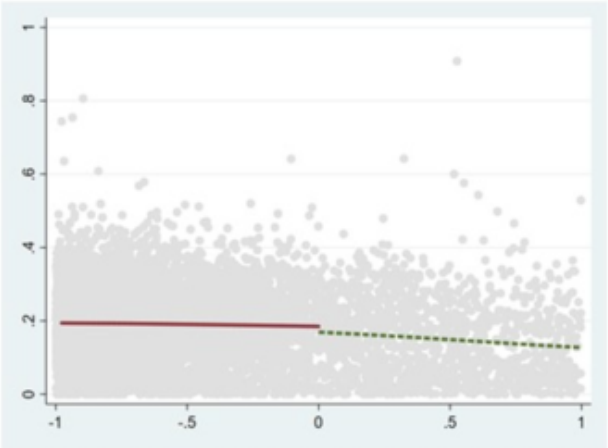

Figure 5

OMISPP on both side of breakpoint

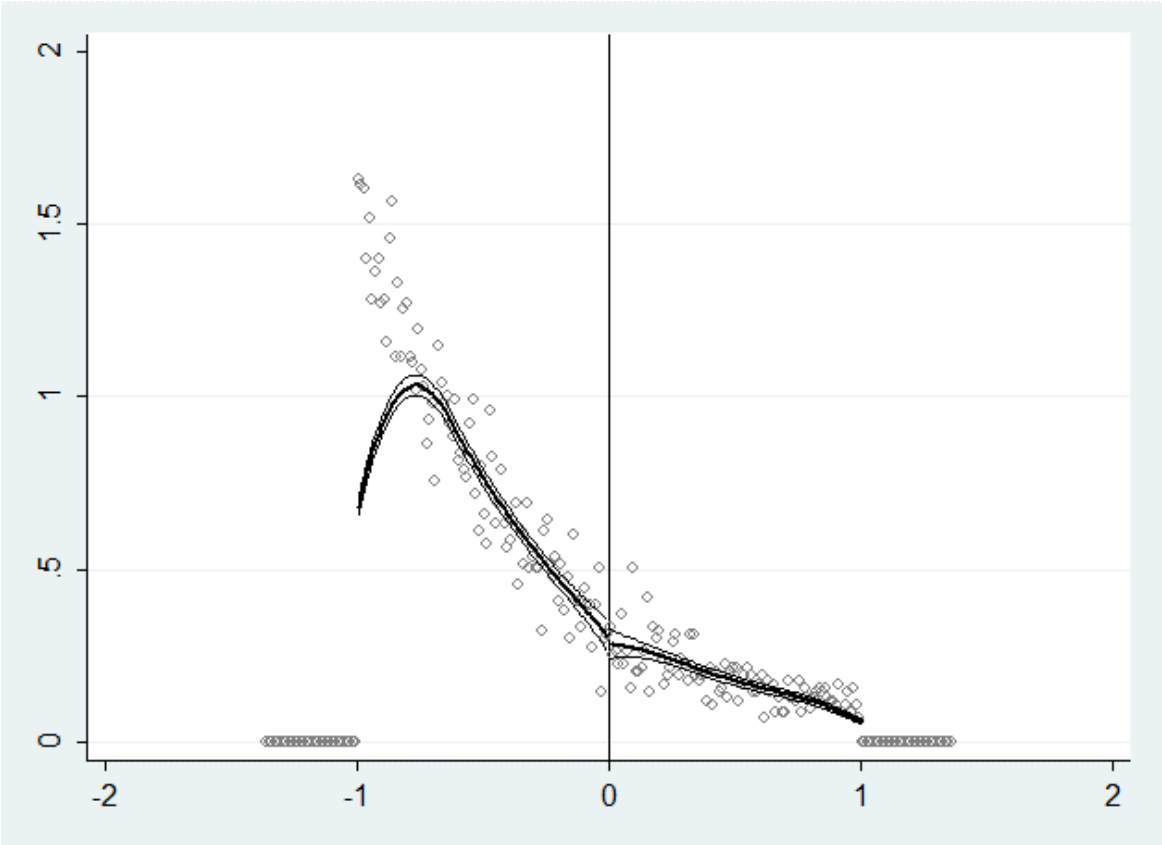

Figure 6

Independent variable McGrary test