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Interstate Disparity of Infant Mortality rates & Its Determinants in India: Evidence from Cross Sectional Data in 2012-13

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Abstract: *The present paper is the analysis of the situation of Infant mortality rate in India in terms of disparities, which persists among eighteen selected states. The paper deals with the determinants of Infant Mortality rate (IMR) that cause to create inequality among the Indian States. Some demographic, socio-economic, Environmental and other factors of IMR are analysed for the fulfilment of the purpose. Maternal literacy rate, sex ratio, households with toilet facility, households with safe drinking water facilities, women's complication in time of birth and delivery, women with full antenatal care and the other determinants taken under consideration in this study. Vaccinated infants' percentage, households with drinking water facilities, percentage of institutional and home delivery are among the determinants that are most significant in our study. Mainly how these determinants affect IMR and why the disparities among states persist is most important part of the paper. In the end of the paper, we have recommended some policy suggestions to reduce the disparities.*

I. Introduction

Having more than 1.2 billion people and the world's fourth-largest economy, India's recent growth and development has been one of the most significant achievements of our times. India's Agricultural Growth, Industrial growth, increase in Life Expectancy, increase in literacy rate, having the largest youngest labour force, etc. all representing India's current Economic, Social and Cultural status. As India seeks to become a global power, there is nothing more important than the health and well-being of its citizens. "If we want to achieve MDG 4 [Millennium Development Goal regarding child mortality] by 2015, we have to focus on ensuring survival on the first day of birth," Thomas Chandy, CEO 'Save the Children', India. (Published in "The Hindu", 26th Feb 2014). Over the years, India has attained impressive achievements in child survival. A fast decline in Infant mortality rate (IMR) of country has been observed in recent past. However, at the current pace, it is seemed to that, the country will miss the target to achieve the MDG-4, which aims to reduce under-five mortality rate and IMR by two-thirds between 1990 and 2015. Thus, India will need to more proactive and explicit in improving health care. Although India's health indicators have improved, infant, maternal and child mortality rates remain very low in some States, but in few states, these health indicators are so large that they are comparable to those in the world's poorest countries. Therefore, this paper seeks to examine the interstate disparity in infant mortality rate (IMR) and its important determinants in some selected States in India, which will reflect the health status of the country as a whole. Altogether, the eighteen States and Union Territories would be taken up for the detailed study. These States are Andhra Pradesh, Arunachal Pradesh, Haryana, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Sikkim, Tamil Nadu, Goa, Chandigarh, Tripura, and West Bengal.

In this paper, we have taken Infant Mortality Rate (IMR) as a most important indicator of health status of country, region and community. IMR is widely accepted as important indicator of health status of people by Governments as well as international health organizations such as World Health Organization (WHO). It is also taken as a proxy of life expectancy at the birth to construct HDI by UNDP (1995). Infant Mortality Rate is the number of deaths of infants (below one year of age) under one year of age per 1,000 live births. The interrelationship between the causes of infant mortality and other factors are likely to affect the health status of whole populations as well as their economic Development. The IMR always reflect the overall health scenario of a country. The rate is low in developed countries and high in developing and underdeveloped countries. If health infrastructure of a region of a country is very good, the IMR is always good.

We have selected the period 2012, as it is just preceded by Indian Census 2011 as well as the country's twelfth five-year plan started from this year (2012-17). The then prime Minister, Dr. Manmohan Singh announced to increase public spending from 1.0% to 2.5% of GDP, showing a specific emphasis on health in the country's twelfth five-year plan from this year.

Drooping out the other States from our study is mainly due to non-availability of all relevant data and to keep the data sets analytically and logistically manageable. The paper investigates the disparities and determinants of IMR of these States of India. As major part of the population belonging to these States, therefore covering these can show a better result for the country as a whole. The next section of this paper explains the review of available literature, which is relevant to our study.

II. Review of literature in brief

Interstate variations in the content and quality of governance, degree of efforts towards mobilization of resources, level of effectiveness of decentralized institutions and community-based organizations have now emerged as factors strongly influencing the movement of the concerning state towards achieving higher level of human development (Dreze and Sen, 1995).

According to The Sample Registration System (SRS), in 2010 the child mortality scenario varies widely across the states in India. In some states, the rates were moderate but in some others, it was too high. out of the total deaths reported, infant deaths were 14.5% , 3.9% are deaths of 1 - 4 years children, 18.4% are deaths of children of 0 - 4 years and deaths pertained to children of 5 -14 years were 2.7%. This percentage varies substantially across the states too. From low level of 2.8% in Kerala, 5.0% in Tamil Nadu to as high as 21.8% in Rajasthan , 21.2% in Uttar Pradesh, 20.4% in Madhya Pradesh with other states figuring in between these states. The under five deaths to total deaths percentage ranges from 3.2% in Kerala, 5.9% in Tamil Nadu to 27.6% in Uttar Pradesh, 26.6% in Rajasthan, 26.4%in Madhya Pradesh, 26.7% in Bihar while other states figure in between these states.

At the All India level, the percentage share of infant deaths to total deaths in rural areas was 15.8%, whereas in urban areas, it was 9.7%. The lowest share of infant deaths 3% in rural and 2.3% in urban areas was registered in Kerala that was just followed by Tamil Nadu 5% in rural and 5% in urban areas. The percentage share of infant deaths to total deaths is 24.5 % in rural Rajasthan and 11.9% in urban part, 21.9% in rural Uttar Pradesh, and 17.1% in urban areas, 21.6% in rural Madhya Pradesh and 14.1% in urban part. However, the Urban and Rural gap in infant mortality has declined over the years, still it is very significant. Therefore, it is evident that there are severe disparities [Sample Registration System (SRS) -2010 data].

According to UNICEF (Unite of children), In India, in several dimensions child health inequalities exist. There are huge differences across the states and socio-economic groups in terms of accessibility and utilization of health services. Therefore, though a general decline in child mortality has been observed throughout the states over time, but disparities in level of child mortality remains.

Deepti Gupta (2009) in her findings shows that there are wide variations among various states of India, regarding different indicators, such as Income Poverty, Total Literacy Rate, Infant Mortality Rate, Sex Ratio, and many more.

There are many literatures and paper works regarding the determinants of infant mortality rate and causes of disparities among the states. According to UNICEF (2012) (Unite of children) the main factors affecting child mortality are Age of mother at the time of birth, preference of sex of new born, maternal malnutrition, birth intervals, maternal education, antenatal care, standard of living, area of resident and so on. Here all the factors were grouped as demographic factors, Socio-economic factors, Environmental factors and Programme factors. Mosley and Chen (1984) have identified a set of 14 variables to influence directly the rate of morbidity and mortality. They grouped 14 variables into five factors. Maternal factor, environmental factor, nutrient deficiency, injury and personal illness.

Sanmeving, I. et al. (2013) studied to categorized and explain determinants of inequality in maternal and reproductive health in India. The result of the study shows India is making progress towards reduced maternal mortality (as well as infant mortality) and improved access to reproductive health care. However, evidence shows that the progress made is uneven and inequitable.

The objective this review was to describe the evidence in terms of structural determinants of infant mortality and reproductive health in India. The collective picture is that structural determinants prevent reduced infant mortality and increased access to reproductive health. Interventions that target infant mortality and increased access to reproductive health care need to take into account how these structural determinants operate in the Indian society and how this may influence access to health care disparities in Indian States.

III. Objective of This Article

In keeping with the above considerations, the broad study is to highlight nature and extent of disparity in infant mortality in the selected Indian states. Especially, the study is conducted to answer the three most important questions:

i. Why the disparities exist in IMR amongst the selected States in India?
ii. What are the factors influencing the IMR mostly?
iii. What policy (s) should be taken up to improve the overall situation?

IV. Data, Methodology and Econometric Model

The entire dataset used for the study is collected from secondary sources like NFHS (1, 2 and 3 round), SRS. The Census data of 2001 and data books for PC, 2014 have been used also for the present study.
For the purpose to show the disparities of IMR in selected States, Bar Diagrammatic approach has been used.
Finally, OLS method has been applied for the study especially with some selected socio-economic and demographic variables of health that may influence IMR. The variables taken under consideration along with the OLS Model used are as follows:

IMR=f(PCMWS,SRB,PHISDW,PHITF,PWFAC,PID,PDH,APC,ADC,PCAV,PCHA,NSDP,U)
Where

IMR : Infant Mortality Rate
PCMWS : Percentage of currently married women with 10 or more years of schooling
SRB : Sex ratio at birth (Males per 100 female)
PHISDW : Percentage of households with improved sources of drinking water
PHITF : Percentage of Households having access to improved toilet facility
PWFAC : Percentage of pregnant women who had full antenatal care
PID : Percentage of institutional delivery
PDH : Percentage of home delivery
APC : Percentage of women who had any pregnancy complication
ADC : Percentage of Women who had any delivery complication
PCAV : Percentage of children who have received all Recommended doses of vaccination
PCHA : Percentage of children having anaemia
NSDP : Net national Product at factor cost at constant prices (2004-05 Prices)
U : Error Term

OLS is very useful econometric method for running regression. Before running the regression, we have checked the pair wise correlation coefficients among explanatory variables and with its dependent variables.

V. Results and Discussion

Interstate disparities in IMR: A Bar diagrammatic Analysis

For descriptive analysis we have used the Bar diagrammatic approach. Bar diagram represents the disparities of IMR for the chosen period and for the selected States in India. Table 1 is used to draw the Bar diagram.

There are wide variations among various states of India, regarding different indicators, such as Income, Poverty, Total Literacy Rate, Sex Ratio, and many more. This is true for Infant Mortality Rate too. The overall infant mortality rate in India has declined from 47 in 2010 to 42 in 2012, said a report released by the Union Health Ministry. The report, The National Health Profile-2013, which focuses on health care standards and quality of medical infrastructure in the country (U Anand Kumar , Published: 18th July 2014 the new Indian express). The average IMR of India is 42 in 2012 and there is only one Indian state that has IMR at more than this level in the present study. All the other states have lower IMR than the average. The lowest IMR is in Goa at 09. The diversity in the states regarding this variable is visible from the fact that, on the one hand, there are states like Goa, Manipur, and Kerala and on the other, there is Meghalaya, Andhra Pradesh, Haryana.

It is seen from the bar diagram that, IMR is highest in Meghalaya (47) and lowest in Goa in 2012-13. It is mostly considered that Leading causes of infant mortality are malformations, sudden infant death syndrome, maternal complications during pregnancy, and accidents and unintentional injuries. However, here we can see from Table-2 that in case of Meghalaya PCMWS is at low (21.1) level whereas PCMWS is at high level (58.9) in case of Goa. Therefore, we can say that maternal education has a negative impact on IMR. From the same table it is obvious in the study that PHITF, PWFAC, PID, APC, ADC, PCAV all are negatively related to IMR whereas PDH is positively related. That means the more the access to drinking water, toilet facility, antenatal care, institutional delivery, vaccination facilities leads to low IMR and more home delivery causes to high rate of infant mortality. Here we have an ambiguity regarding the result that low delivery complication and low pregnancy complication leading to high IMR. It may be because of the fact that, pregnant women are not able to receive others medical facilities as well as environmental and social barriers may prevent them to access to basic medical resources.

Table-2: Showing the level of different determinants in case of lowest and highest IMR in our study

States	Imr	Pcmws	Phitf	Pwfac	Pid	Apc	Pcav	Adc	Pdh
Meghalaya	47	21.1	69	21.4	47.3	18.3	48.9	6.3	52.2
Goa	09	58.9	87.6	71	97.1	36.2	89.1	24.4	2.7

Source: NFHS-1, NFHS-2 and NFHS-3 data

Inter-correlation among several variables in respect of IMR

Before running, the multiple Regressions (robust), below the correlation between IMR and different explanatory variables (PCMWS, SRB, PHISDW, PHITF, PWFAC, PID, PDH, APC, ADC, PCAV, PCHA and NSDP) have been examined. It is also tested empirically the statistical significance of this correlation coefficients among all the explanatory variables include in the model at 5% level of significance which is shown in the triangular matrix in Table-3 in appendix.

From the profiles of inter correlation coefficient (Table-3) it is obvious that there is a negative degree of association between IMR and PCMWS (i.e.: Percentage of currently married women with 10 or more years of schooling) at 5% level of significance. Therefore, we can strongly support the argument that in developing countries, mothers' education is a strong determinant of mortality (Das and Dey 2003, Khasakhala 2003).

We also found that there is a negative degree of association between IMR and PHITF (Percentage of Households having access to improved toilet facility), PWFAC (Percentage of pregnant women who had full antenatal care), PID (Percentage of institutional delivery) and PCAV (Percentage of children of age 12-23 months who have received all recommended doses of vaccination) at 5%level of significance and their values are respectively -0.3563, -0.4184, -0.2522 and -0.3137. PDH (Percentage of home delivery) here has positive association with IMR with significance value of 0.2703.

More improved toilet facility always reflects the socio-economic status of a society. Children in households' lack of such access may suffer from various diseases, which may cause of high IMR. The results show here, high socio-economic status as well as high level of hygienic environment always help to reduce IMR.

"Children delivered at medical facilities are likely to experience lower mortality than home delivery because of hygienic environment, and appropriate care for prevention of complication" (UNICEF: Unite of children 2012). According to Pandey et al., (1998), Hospital delivery can reduce the rate of neonatal mortality. Both the observations matches our result here as PID here is negatively related to IMR as well as PDH is associated positively.

IMR has positive degree of association with PCHA (percentage of children having anaemia). Anaemia reflects poor nutrition status of the children. Poor nutrition of children leads to high risk of birth. The low social and economic status of children limits their access to education, appropriate nutrition, as well as health and family planning services. The negative association of PCHA with PCMWS represents that mothers with less education can give birth to unhealthier child.

We observed some degrees of association among the chosen explanatory variables in our models. Here PCMWS is negatively correlated with PDH but Positively with PHITF, PWFAC and PID (correlation coefficients respectively are -0.6013, 0.4826, 0.4909 and 0.5960) at 5% level of significance. This is explaining by the fact that more education leads to more vaccination of child, more institutional delivery and less home delivery, which will cause IMR to be reduced. PDH is also negatively correlated to PCAV at the same level of significance. This can be explained by the fact that those who seek for home delivery, do not bother about vaccination, which lead to high IMR. Same way, PID has positive association with PCMWS and PWFAC that reflects that those who are literate, cares for full antenatal care and this leads to low IMR.

In order to capture the interstate variability of IMR, a relative measure of dispersion namely, co-efficient of variation has been computed and shown in Table-4. Mean VIF here is at very high level. In terms of multiple coefficient of determination (R squared) the overall goodness of fit of the chosen model is satisfactory as it is observed to be 0.7382. Hence about 74% of the variations in Infant Mortality Rate (IMR) (dependent variable) can be explained in terms of the explanatory variables included in the model. The observed F value also points to an overall satisfactory performance of the multiple regressions. Further as the variance inflation factor (VIF) is more than ten (10), the model also suffers from sever multicollinearity effect. However, this cannot reduce impact factor of our study as we may cote Blanchard- when students run their first OLS Regression, the first problem that they usually counter is that multicollinearity. But, this is not a problem with OLS or statistical technique in General (The Do nothing School of Thought: O.J. Blanchard comment, Journal of Business and Economic Statistics. Vol. 5, 1967, pp 449-451).

VI. Summary and Conclusion

The present study has primarily examined the Interstate Disparity of Infant Mortality rates & Its Determinants in India: Evidence from Cross Sectional Data in 2012-13. The impact of Socio-economic factors (like sex ratio, Net State Domestic Product), Environmental factors (like Households having toilet facility, Households having drinking water facility), Demographic factors (maternal education) as well as other factors like institutional delivery, antenatal care etc on IMR has been analysed in the present paper. In recent time, the infant mortality rate (IMR) has been criticised as a measure of population health because of its narrow base. A more comprehensive measure, disability-adjusted life expectancy (DALE) has come into favour as alternatives. However, it is yet to prove empirically that DALE is better measurement of population health than IMR.

Therefore, for the purpose of our study we have selected IMR of different States. The paper has proved that there are interstate disparities among the Indian States considered for the purpose of the study.

However, maternal education does not have a significant effect on IMR in our study but the negative correlation between them shows States with more currently married women with 10^{th} level or more schooling have lower level of IMR. Children born in the households with fewer facilities of Toilets and drinking water have a significant and higher risk of mortality than the others do.

Sex ratio at birth i.e. number of male birth out of 100 female, does not has any significant level of effect on IMR in this study. Though association of NSDP and IMR is not much significant in this study but there are many literatures showing that the more will be the level of income, the less will be the rate of IMR.

Percentages of Institutional delivery, percentage of children receiving vaccination have inverse relation with the rate of Infant mortality. Whereas more home delivery leads to high rate of IMR. Generally, women with pregnancy complication or Delivery complication have positive impact on IMR but in this study both the components showing some ambiguous results.

Percentage of women with full antenatal care affects adversely with IMR. Still, among the causes of the high Mortality Ratio across India the absence of a skilled birth attendant at delivery is not to be omitted. Nevertheless, every skilled birth attendant needs the back up of drugs, modern medical equipments and obviously improved infrastructural facilities.

It is indeed positive to note that India's health outcomes have improved over time, as revealed in the decline of IMRs. States vary enormously in their health outcomes such as Infant mortality rates. They also differ in their levels of health system efficiency, infrastructure, which results in varied health system performance. Differences in access to educational attainment, providing medical facilities, sanitary conditions, level of income, differences in the numbers of well-facilitated govt hospitals, differences in availability of skilled attendant, health worker, differences in socio-economic structure, differences in vaccination, immunisation account for much of such disparities. Although disparities increased among Indian States, there is little consensus on what can or should be done to reduce these disparities. For that, we must think for raising public and private awareness, expansion health coverage, increasing Public health expenditure, strengthening the relation between the professional (especially private) bodies and the Government on health issues, providing more infrastructures in the Govt Health Institutions, enhancing the management capacity in each levels, improving skills and efficiency by providing training for different public-health workers (including Nurse, Officers, Professionals, and even for ASHA workers), and to encourage active participation of all to achieve our Goals.

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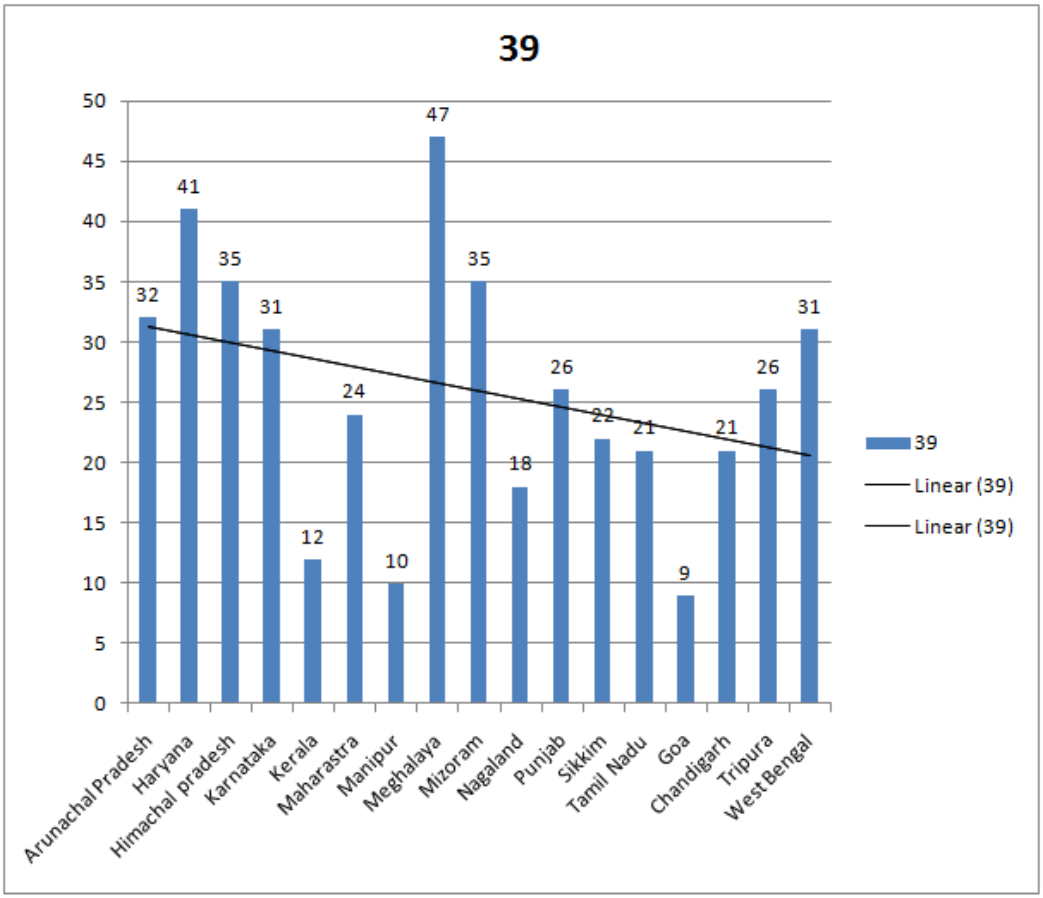
Appendix

Table-1: Showing the level IMR in the selected States and UTs in our study

States	IMR
Andhra Pradesh	39
Arunachal Pradesh	32
Haryana	41
Himachal Pradesh	35
Karnataka	31
Kerala	12
Maharastra	24
Manipur	10
Meghalaya	47
Mizoram	35
Nagaland	18
Punjab	26
Sikim	22
Tamil Nadu	21
Goa	09
Chandigarh	21
Tripura	26
West Bengal	31

Source: NFHS-1, NFHS-2 and NFHS-3 data

Bar Diagram 1: Inter-State Disparities in IMR in India



Source: Authors' Own Computation from Stata-11.1

Table-2 : Mean Standard deviation and Co-efficient of Variation of IMR among different States and UTs in 2012-13.

Mean	26.67
SD	10.71
CV	40.16

Source: Authors' own Computation

Table-3: Pair Wise Correlation Coefficient between IMR & All Explanatory Variables in the Model

```
. pwcorr  imr pcmws srb phisdw phitf pwfac pid pdh apc adc pcav pcha,star(5)
```

	imr	pcmws	srb	phisdw	phitf	pwfac	pid
imr	1.0000						
pcmws	-0.4688*	1.0000					
srb	0.0537	0.2322	1.0000				
phisdw	0.2796	0.3545	0.2646	1.0000			
phitf	-0.3563	0.4826*	0.4611	-0.1349	1.0000		
pwfac	-0.4184	0.4909*	-0.3934	0.1785	0.2336	1.0000	
pid	-0.2522	0.5960*	-0.0472	0.6405*	0.0049	0.6741*	1.0000
pdh	0.2703	-0.6013*	0.0440	-0.6334*	-0.0073	-0.6779*	-0.9994*
apc	-0.3549	0.2374	-0.0320	0.1268	0.0600	0.1175	0.3473
adc	0.2419	0.0569	0.3748	0.3451	0.0750	-0.0234	0.0692
pcav	-0.3137	0.5182*	0.0129	0.4161	0.3110	0.7843*	0.7342*
pcha	0.1951	-0.4489	-0.2272	-0.0836	-0.3648	0.2030	0.0041

	pdh	apc	adc	pcav	pcha
pdh	1.0000				
apc	-0.3473	1.0000			
adc	-0.0626	0.4001	1.0000		
pcav	-0.7292*	0.1158	0.0351	1.0000	
pcha	0.0036	-0.3985	-0.0406	0.2910	1.0000

Source: Authors' Own Computation from Stata-11.1

Table 4: Multiple Regressions Model (Pooled) of IMR and its determinants

```
. reg imr pcha pcav adc apc pdh pid phisdw nsdp,robust

Linear regression                               Number of obs =      18
                                                F(  8,     9) =   25.50
                                                Prob > F      =  0.0000
                                                R-squared     =  0.7382
                                                Root MSE      =  7.5309
```

imr	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
pcha	.3066866	.2057511	1.49	0.170	-.1587546	.7721278
pcav	-.508804	.138923	-3.66	0.005	-.8230697	-.1945383
adc	.127999	.188606	0.68	0.514	-.2986575	.5546554
apc	-.4681636	.2558781	-1.83	0.101	-1.047	.1106729
pdh	6.729997	1.843402	3.65	0.005	2.559931	10.90006
pid	6.594796	1.70188	3.88	0.004	2.744875	10.44472
phisdw	.4740995	.1923543	2.46	0.036	.038964	.9092351
nsdp	-.0012126	.0013502	-0.90	0.393	-.004267	.0018417
_cons	-643.9982	175.8804	-3.66	0.005	-1041.867	-246.1291

```
. vif
```

Variable	VIF	1/VIF
pid	962.90	0.001039
pdh	927.33	0.001078
pcav	4.53	0.220832
phisdw	2.92	0.342610
nsdp	2.52	0.397137
pcha	2.36	0.424001
apc	2.17	0.459975
adc	1.79	0.558688
Mean VIF	238.31	

Source: Authors' Own Computation from Stata-11.1