Third Assignment

15 November 2014

Contents

1 Research question and methodology

As stated in previous assignment, our research project aims to look at the impact of decentralization on health provision in Benin. Access to basic health-related services has been one of the core Millenium Development Goals; it is also regarded as basic human rights. For the past decade, governments and policymakers in developing countries have invested in improving basic sanitation and health-related facilities in urban and rural areas. Decentralization and devolution of public administration are two important channels through which these governments, and development agencies, achieve these goals.

In Benin, legal provisions on decentralization has transfered part of health provision competencies to subnational entities (districts and municipalities. Since the year 2002, municipal governments are increasingly responsible for providing basic services and infrastructures such as water access. To offset the vertical imbalance of subnational governments, the central government have conceded some tax raising powers and has also use intergovernmental transfers through the National Commission on Local Finances.

Proponents of decentralization share the view that public services delivery is more efficient at the local level. Yet, as stated from previous paper, there are many controversies with regards to the efficiency of decentralization mechanisms on public goods delivery. In this project, we want to draw from theories and empirical approaches in public finances to investigate the following question: **What impact does decentralization have on the provision of health-related services and infrastructures in Benin?**.

Studying the relationship between decentralization and health provision is a very challenging exercise as it requires consistent and reliable microeconomic data which are, very often, not openly avaible or not consistent. For this reason, we have decided to broaden our approache by first looking at aggregate health-related data of Benin, such as health public expenditures over the past few years. In addition to the macroeconomic overview, we explore microeconomic and subnational data on health provision.

This paper is divided into three sections. The first one bring a general overview on health-related expenditures and provision in Benin over the years 2005 to 2010. The datasets are obtained from the World Bank (WB)

and World Health Organization (WHO). The second part looks at the microeconomic effect of decentralization on basic health-related facilities. For this purpose, we compute an indicator for decentralization, and we use health-related indicators provided in Benin's Integrated Modular Households Survey (EMICoV). Because we have missing values in the households survey, we have decided to restrict our model to only two years: 2010 and 2011, for which we have a balanced panel. The final section present our basic regression models and some potential issues that we might need to solve in the final paper.

2 Macroeconomic Overview

In this section, we use data analytics tools to scrape openly available datasets on Benin's health-related expenditures and services. The first dataset is obtained from the World Bank (WB) and include the following indicators:

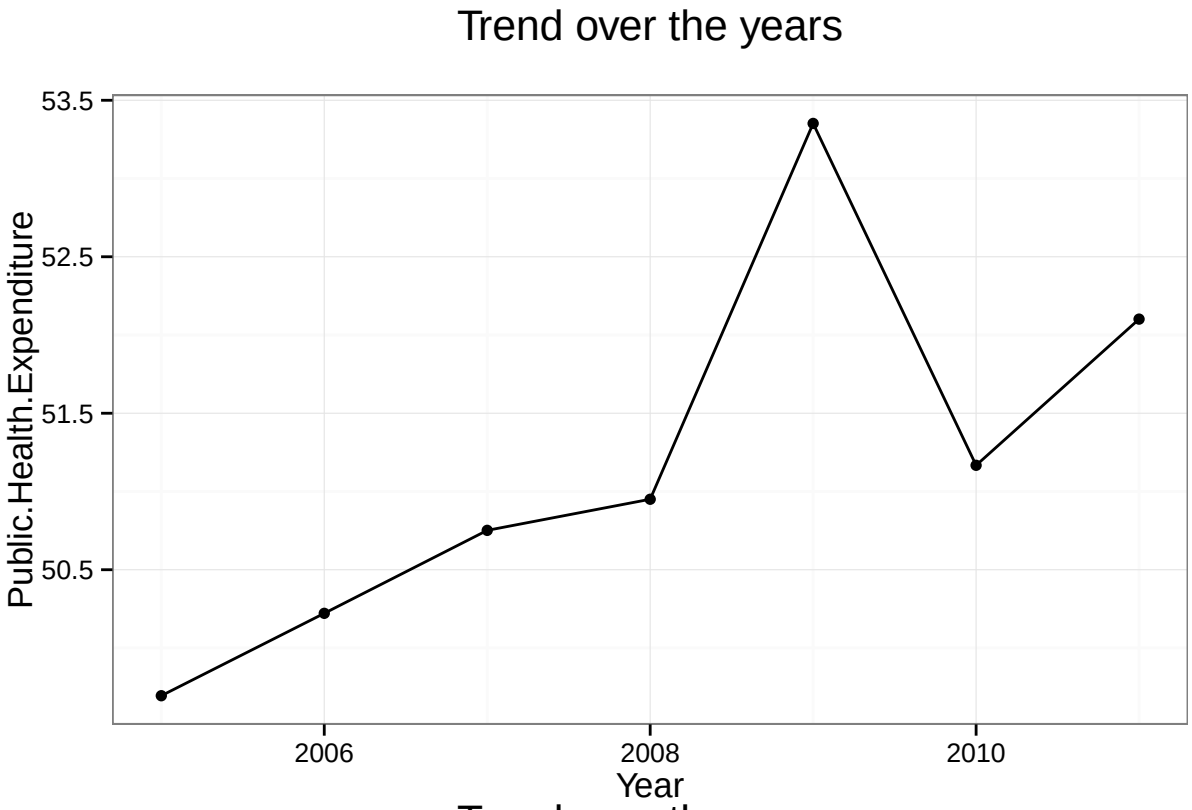
2.1 World Bank Indicators

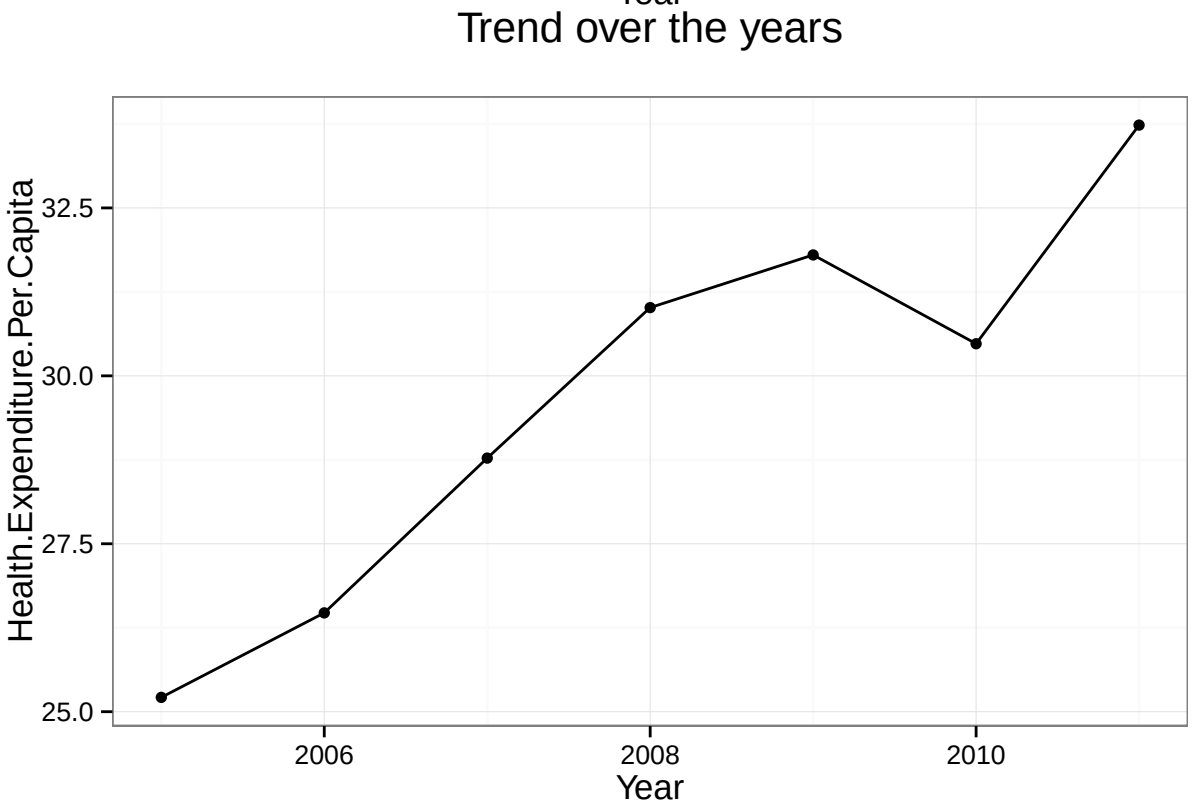
(i) health expenditure per capita (SH.XPD.PCAP): sum of public and private health expenditures as a ratio of total population. This indicator covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation. Data are in current U.S. dollars.

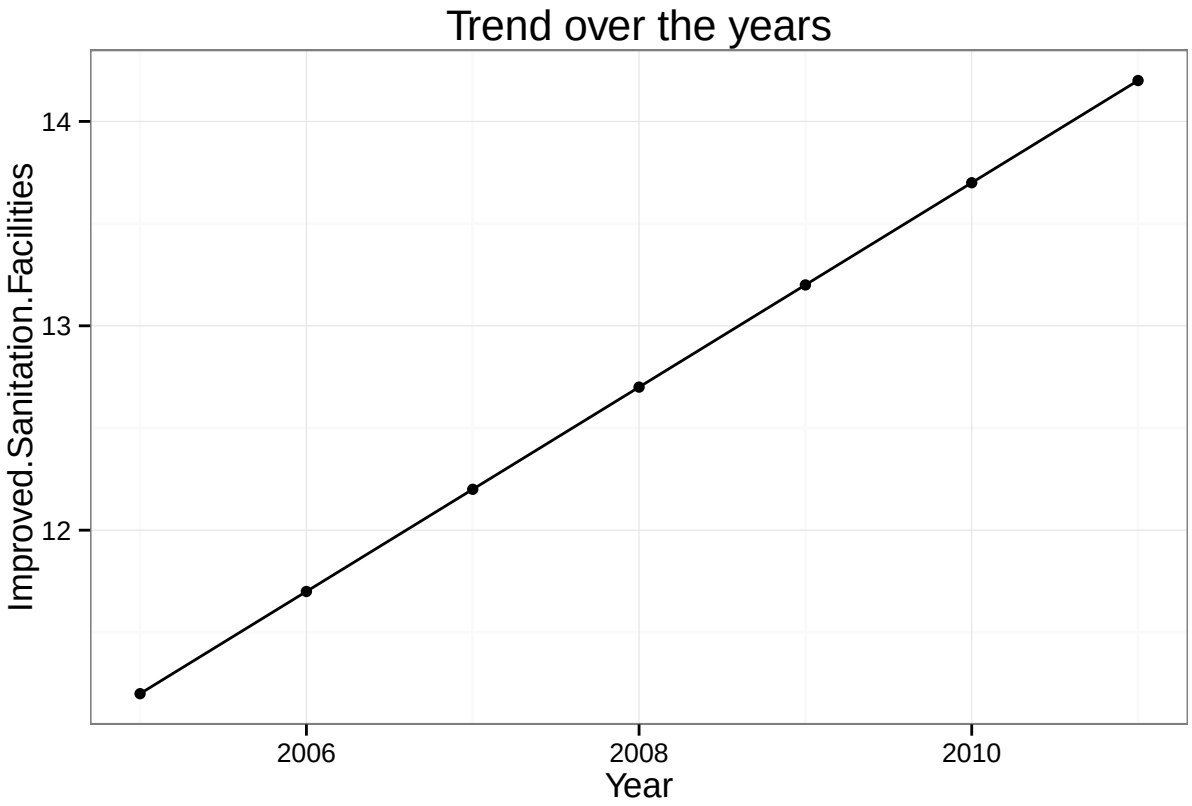
(ii) public health expenditure (SH.XPD.PUBL): recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds.

(iii) improved sanitation facilities(SH.STA.ACSN): access to improved sanitation facilities as the percentage of the population using improved sanitation facilities. This indicator includes flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

```
## Loading required package: RJSONIO
```


Trend over the years
Public.Health.Expenditure
53.5
52.5
51.5
50.5
2006
2008
2010
Year


Trend over the years
Health.Expenditure.Per.Capita
32.5
30.0
27.5
25.0
2006
2008
2010
Year



The above graphs suggest that all three elements: public health expenditure, health expenditure per capita, and improved sanitation, have considerably increased over the timespan 2005 to 2011. As mentionned above and in our research proposal, the central government in Benin (alike other developing countries in West-Africa) have used decentralization as a mechanisms to reacht he targets of the Millenium Development Goal. Therefore, since health expenditure is highly decentralized, we could potentially argue that the macroeconomic overview is related to the outcome on a micro level. The microeconomic approach in section 2 will therefore help us testing this assumption.

2.2 World Health Organization Indicators

The second dataset is taken from the WHO databases, particularly from the Global Health Obervatory Data which provides information on health infrastructures per 100,000 population in Benin including:

(i) Health posts, that are either community centres or health environments with a very limited number of beds with limited curative and preventive care resources normally assisted by health workers or nurses,

(ii) Health centers,which includes the number of health centres from the public and private sectors, per 100,000 population

(iii) Number of district/rural hospitals from the public and private sectors, per 100,000 population,

(iv) Number of provincial hospitals from the public and private sectors, per 100,000 population,

(v) Number of specialized hospitals delivering mainly tertiary care from the public and private sectors, per 100,000 population. These specialized hospitals could be regional, specialized, research hospitals or Federal/National Institutes.

(vi) Number of specialized hospitals delivering mainly tertiary care from the public and private sectors, per 100,000 population. These specialized hospitals could be: regional, specialized, research hospitals or Federal/National Institutes.

Unlinke the dataset from the World Bank, this datasets only provide Benin-related indicators for the years 2010 and 2013, which we extracted for this project.

2.3 Merging WB and WHO datasets

Once we have our datasets, it is useful to merge them together so as to work easily and quickly with one dataset that would include all the needed variables.

3 Microeconomic Analysis

In this section, we explore provision of health-related services and infrastructures on a local level. Particularly, we look at the impact of decentralization on the access to basic health-related sercices and infrastructure.The datasets on local finances are obtained from the National Commission on Local Finances of Benin. Health-related expenditures and provision are from Benin's Integrated Modular Surveys on Household Living Conditions (EMICoV) and the Demographic and Health Survey.

3.1 Description of Variables

3.1.1 Independent variable: Decentralization

Decentralization typically defined in public planning, management and decision making, as the transfer of authority and power from higher to lower levels of governing, or from national to sub-national levels[@rondinelli1983collins]. It has different characteristics for different writers which often describe it as either delegation, devaluation,de-concentration,and privatization of responsibility and authority of tasks to lower level of administration. Yet, decentralization is a very complex mechanism. In general, its measurement involves two elements: the level and the degree where the degree can be regarded as the distribution of power over the decision made inside the system, whereas the level takes into account sociological and political aspects.

The definition and measurement of decentralizaiton has led to long academic debate, with several authors proposing new indicators as the most reliable proxy, giving birth to a multiplicity of indicators using different approaches. Due to this high degree of complexity, which encompasses a number of political, fiscal and administrative dimensions, it is difficult to assess and measure the outcome of decentralization mechanisms in an empirical study.

A large part of the debate on decentralization measurement regards the choice between revenue versus expenditure decentralization. Because decentralized health provision implies both decentralized revenues and expenditure, fwe propose here to use the Revenue authonomy(RA) indicator used by [@akai2002sakata] and [@habibi2003etal] to proxy for decentralization. This indicator is defined as the ratio of own-source revenues over the total expenditures of a subnational entity.

```
## Loading required package: bitops
```

```
##       Cities ID Year decentralization population Density pubexp.c
## 1  Banikoara  1 2010            0.447     197137      45     2954
## 2   Gogounou  2 2010            0.256     103754      21     2659
## 3      Kandi  3 2010            0.323     123455      36     5193
## 4   Karimama  4 2010            0.081      51323       8     5748
## 5 Malanville  5 2010            0.363     131783      44     4194
## 6    Segbana  6 2010            0.144      68258      15     4020
```

```
## [1] "Cities"           "ID"               "Year"
## [4] "decentralization" "population"       "Density"
## [7] "pubexp.c"
```

```
##         Cities ID Year decentralization population Density pubexp.c
## 149       Cove 72 2011           0.3756      44658      85     5083
## 150     Djidja 73 2011           0.3641     109692      50     4178
## 151     Ouinhi 74 2011           0.1198      49689     103     6678
## 152  Zagnanado 75 2011           0.2745     112913     276     1992
## 153   Za-Kpota 76 2011           0.1755      47663      64     5970
## 154 Zogbodomey 77 2011           0.1768      93801     114     4300
```

```
## [1] 0
```

```
       Cities          ID          Year      decentralization

Abomey : 2 Min. : 1 Min. :2010 Min. :0.0198
Abomey-Calavi: 2 1st Qu.:20 1st Qu.:2010 1st Qu.:0.1786
Adja-Ouere : 2 Median :39 Median :2010 Median :0.2757
Adjarra : 2 Mean :39 Mean :2010 Mean :0.3378
Adjohoun : 2 3rd Qu.:58 3rd Qu.:2011 3rd Qu.:0.4391
Agbangnizoun : 2 Max. :77 Max. :2011 Max. :1.4227
(Other) :142
population Density pubexp.c
Min. : 34559 Min. : 8 Min. : 207
1st Qu.: 74154 1st Qu.: 40 1st Qu.: 2408
Median : 98058 Median : 154 Median : 3344
Mean :114007 Mean : 441 Mean : 4695
3rd Qu.:121855 3rd Qu.: 333 3rd Qu.: 4627
Max. :862445 Max. :10917 Max. :72654
```

```
##
## Please cite as:
##
##  Hlavac, Marek (2014). stargazer: LaTeX code and ASCII text for well-formatted regression and summary
##  R package version 5.1. http://CRAN.R-project.org/package=stargazer
```

% Table created by stargazer v.5.1 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harvard.edu
% Date and time: Gio, Nov 13, 2014 - 15:33:07

Table 1: Descriptive statistics/selected variables

Statistic	N	Mean	St. Dev.	Min	Max
decentralization	154	0.34	0.24	0.02	1.42
population	154	114,007.00	101,641.00	34,559	862,445
Density	154	440.70	1,377.00	8	10,917

3.1.2 Dependent variables

Like decentralization, it is very challenging to find a composite proxy for health provision. We have therefore decided to focus on some key variables which data is only available on a macro level. These variables are drawn

from Benin's EmiCoV (2010,2011) and are defined as follwos: (i) access to water: defined as the percentage of households in the municipality that have access to water (ii)access to toilet facilities: percentage of households in the municipality that have access to toilet facilities (iii)water provision infrastructure: percentage of households in that municipality that are connected to SONEB (water pipeline) (iv) hospital: the number of existing hospital or public healthcare center in the municpality.

3.1.3 Explanatory variables

In addition to decentralization, we use a set of variables to account for heterogeneity accross the municipalities, such as population, population density, per capita consumption, public expenditure per capita, households health consumption, indicators on monetary poverty, average literacy rate of the head of households, as well as monetary poverty indice, all of them obtained from Benin's EmiCov (2010, 2011). We assume that these variables might have some impact either on health health-related expenditures on municipal or households level, and also some impact on decentralization process per se. The basic econometric model will be further specified in the final paper.

```
##       Cities ID Year  X pop.1. pop_nowateraccess cons_health
## 1  Banikoara  1 2010 NA     41                NA           2
## 2   Gogounou  2 2010 NA     34                NA           1
## 3      Kandi  3 2010 NA     44                NA           1
## 4   Karimama  4 2010 NA     59                NA           2
## 5 Malanville  5 2010 NA     34                NA           2
## 6    Segbana  6 2010 NA     38                NA           2
##   pop_wateraccess pop_toiletacess ind_pauv_mon ind_pauv_nonm gini
## 1              40              21           27            38    0
## 2              73              37           32            22    0
## 3              76              38           30            21    0
## 4              67              35           54            60    0
## 5              58              30           39            34    0
## 6              77              39           47            28    0
##   educ_adult pubhosp consump.c for_dentr. connect_soneb connec_pomp
## 1         30      18    202252         83             3          97
## 2         16       8     21832         86             0         100
## 3          8      21    197891         96            19          81
## 4         14       0    144130         83             0         100
## 5         20      13    212984         92            16          69
## 6         34      16    223327         49             8         100
##   X.casesantep X.medprive X.clinpriv X.dispens X.hospital X.nursing.room
## 1            7          1          2        10          1             1
## 2            0          0          1         8          0            11
## 3            2          0          3        11          8             8
## 4            0          0          0         0          0             0
## 5            1          0          4         6          6             4
## 6            8          0          0         5          3             0
##   X.smi
## 1    16
## 2     4
## 3    11
## 4     1
## 5     5
## 6     6
```

```
##  [1] "Cities"           "ID"               "Year"
```

```
##  [4] "X"                "pop.1."           "pop_nowateraccess"
##  [7] "cons_health"      "pop_wateraccess"  "pop_toiletacess"
## [10] "ind_pauv_mon"     "ind_pauv_nonm"    "gini"
## [13] "educ_adult"       "pubhosp"          "consump.c"
## [16] "for_dentr."       "connect_soneb"    "connec_pomp"
## [19] "X.casesantep"     "X.medprive"       "X.clinpriv"
## [22] "X.dispens"        "X.hospital"       "X.nursing.room"
## [25] "X.smi"
```

```
##         Cities ID Year  X pop.1. pop_nowateraccess cons_health
## 149       Cove 72 2011 NA     58                NA           3
## 150     Djidja 73 2011 NA     73                NA           5
## 151     Ouinhi 74 2011 NA     78                NA           4
## 152  Zagnanado 75 2011 NA     86                NA           3
## 153   Za-Kpota 76 2011 NA     82                NA           7
## 154 Zogbodomey 77 2011 NA     69                NA           3
##     pop_wateraccess pop_toiletacess ind_pauv_mon ind_pauv_nonm gini
## 149              90              46           55            15    0
## 150              71              38           38            37    0
## 151              72              38           44            36    0
## 152              51              27           49            44    0
## 153              32              19           46            43    0
## 154              95              49           41            33    0
##     educ_adult pubhosp consump.c for_dentr. connect_soneb connec_pomp
## 149         50       3    200797         95            48          10
## 150         61      13    147755         94             2          50
## 151         55       5    140811         97             3          69
## 152         59       8    139640         97            28           5
## 153         42      12    127986         85             1          11
## 154         45       0    142318         87             1          58
##     X.casesantep X.medprive X.clinpriv X.dispens X.hospital X.nursing.room
## 149            0          0          2         0          3              0
## 150            2          0          5         0         11             14
## 151            0          0          0         1          4              1
## 152            1          0          0         2          5              1
## 153            1          0          1         9          2             23
## 154            0          0          0         0          0              0
##     X.smi
## 149     0
## 150     1
## 151     2
## 152     1
## 153    12
## 154     0
```

```
## [1] 308
```

% Table created by stargazer v.5.1 by Marek Hlavac, Harvard University. E-mail: hlavac at fas.harvard.edu
% Date and time: Gio, Nov 13, 2014 - 15:33:07

4 Basic Regression models

In our basic mode, we regress decentralization our independent variables as above-mentionned.

Table 2: Descriptive statistics of dependent variables

Statistic	N	Mean	St. Dev.	Min	Max
pop_wateraccess	154	70.31	17.07	32	100
pop_toiletacess	154	36.51	8.44	19	53
pubhosp	154	12.55	12.97	0	60
connect_soneb	154	16.53	21.37	0	100

4.0.4 Model estimations

Effect of Decentralization on Water Access

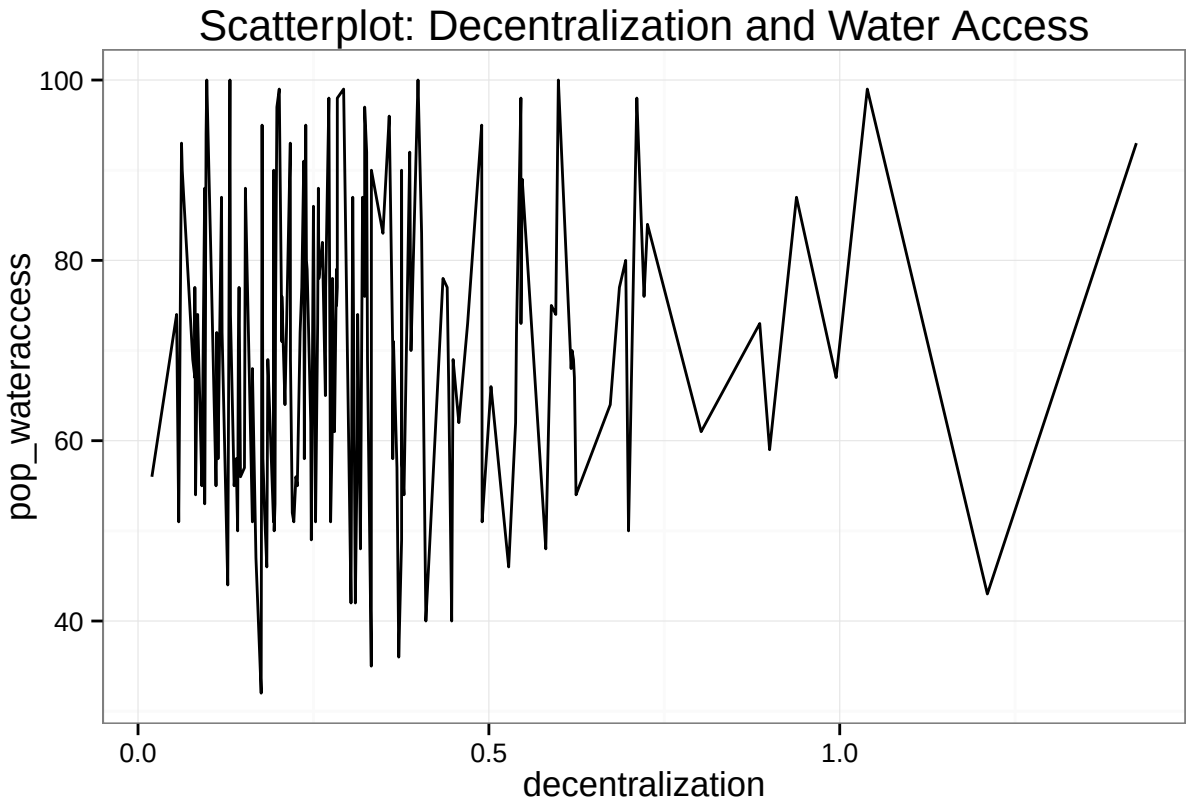


Figure 1: plot of chunk unnamed-chunk-11

```
R1water <- lm(pop_wateraccess ~ decentralization, data = decenthealth)
summary(R1water)
```

```
##
## Call:
## lm(formula = pop_wateraccess ~ decentralization, data = decenthealth)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -37.5  -13.7    0.3   12.3   30.9
##
```

```
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)         68.54       2.40    28.5   <2e-16 ***
## decentralization     5.24       5.83     0.9     0.37
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 17.1 on 152 degrees of freedom
## Multiple R-squared:  0.00528,    Adjusted R-squared:  -0.00126
## F-statistic: 0.808 on 1 and 152 DF,  p-value: 0.37
```

```
confint(R1water)
```

```
##                    2.5 % 97.5 %
## (Intercept)      63.794  73.29
## decentralization -6.281  16.76
```

```
R2water <- lm(pop_wateraccess ~ decentralization + population + Density, data = decenthealth)
summary(R2water)
```

```
##
## Call:
## lm(formula = pop_wateraccess ~ decentralization + population +
##     Density, data = decenthealth)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -36.01 -13.53   0.52  12.02  32.52
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       6.63e+01   3.13e+00   21.20   <2e-16 ***
## decentralization  2.96e-01   6.19e+00    0.05     0.96
## population        3.51e-05   2.61e-05    1.35     0.18
## Density          -1.87e-04   1.92e-03   -0.10     0.92
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 16.9 on 150 degrees of freedom
## Multiple R-squared:  0.039,  Adjusted R-squared:  0.0198
## F-statistic: 2.03 on 3 and 150 DF,  p-value: 0.112
```

```
confint(R2water)
```

```
##                        2.5 %    97.5 %
## (Intercept)       6.012e+01 7.247e+01
## decentralization -1.194e+01 1.253e+01
## population       -1.641e-05 8.655e-05
## Density          -3.976e-03 3.602e-03
```

```
R3water <- lm(pop_wateraccess ~ decentralization + population + Density + log(pubexp.c) + log(consump.c)
summary(R3water)
```

```
##
## Call:
## lm(formula = pop_wateraccess ~ decentralization + population +
##     Density + log(pubexp.c) + log(consump.c) + cons_health +
##     educ_adult + ind_pauv_mon, data = decenthealth)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -36.02 -13.16   0.76  11.21  36.48
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       5.96e+01   2.41e+01    2.48    0.014 *
## decentralization -4.13e-01   6.46e+00   -0.06    0.949
## population        3.85e-05   2.68e-05    1.44    0.153
## Density          -1.10e-03   1.95e-03   -0.56    0.574
## log(pubexp.c)    -1.62e+00   1.81e+00   -0.90    0.370
## log(consump.c)    9.16e-01   1.54e+00    0.60    0.552
## cons_health      -1.43e+00   7.85e-01   -1.82    0.070 .
## educ_adult        1.79e-01   7.40e-02    2.42    0.017 *
## ind_pauv_mon      7.12e-02   1.38e-01    0.52    0.606
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 16.6 on 145 degrees of freedom
## Multiple R-squared:  0.101,  Adjusted R-squared:  0.0518
## F-statistic: 2.05 on 8 and 145 DF,  p-value: 0.045
```

```
confint(R3water)
```

```
##                        2.5 %    97.5 %
## (Intercept)       1.207e+01 1.072e+02
## decentralization -1.318e+01 1.235e+01
## population       -1.449e-05 9.153e-05
## Density          -4.946e-03 2.754e-03
## log(pubexp.c)    -5.195e+00 1.947e+00
## log(consump.c)   -2.123e+00 3.955e+00
## cons_health      -2.985e+00 1.190e-01
## educ_adult        3.257e-02 3.252e-01
## ind_pauv_mon     -2.014e-01 3.438e-01
```

In this model, decentralization reveals to be insignificant, while household consumption ratio on health and average literacy rate of household's head result to be slightly significant. This may be due to mispecification of the model.

Effect of decentralization on access to toilet facilities

Call: lm(formula = pop_toiletacess ~ decentralization, data = decenthealth)

Residuals: Min 1Q Median 3Q Max -17.489 -6.683 0.029 6.277 17.170

Table 3: Effect of decentralization on water access

	Dependent variable:		
	pop_wateraccess		
	(1)	(2)	(3)
(Intercept)	5.24	0.30	−0.41
	(5.83)	(6.19)	(6.46)
Decentralization		0.0000	0.0000
		(0.0000)	(0.0000)
Population		−0.0002	−0.001
		(0.002)	(0.002)
Population Density			−1.62
			(1.81)
Log Public Expenditure per capita			0.92
			(1.54)
Log Consumption per Capita			−1.43*
			(0.79)
Average Households Health Consumption Ratio			0.18**
			(0.07)
Average Literacy Rate of Head of Households			0.07
			(0.14)
Monetary Poverty Index	68.54***	66.30***	59.62**
	(2.40)	(3.13)	(24.06)
Observations	154	154	154
R^2	0.01	0.04	0.10
Adjusted R^2	−0.001	0.02	0.05
Residual Std. Error	17.08 (df = 152)	16.90 (df = 150)	16.63 (df = 145)
F Statistic	0.81 (df = 1; 152)	2.03 (df = 3; 150)	2.05** (df = 8; 145)
Note:			*p<0.1; **p<0.05; ***p<0.01

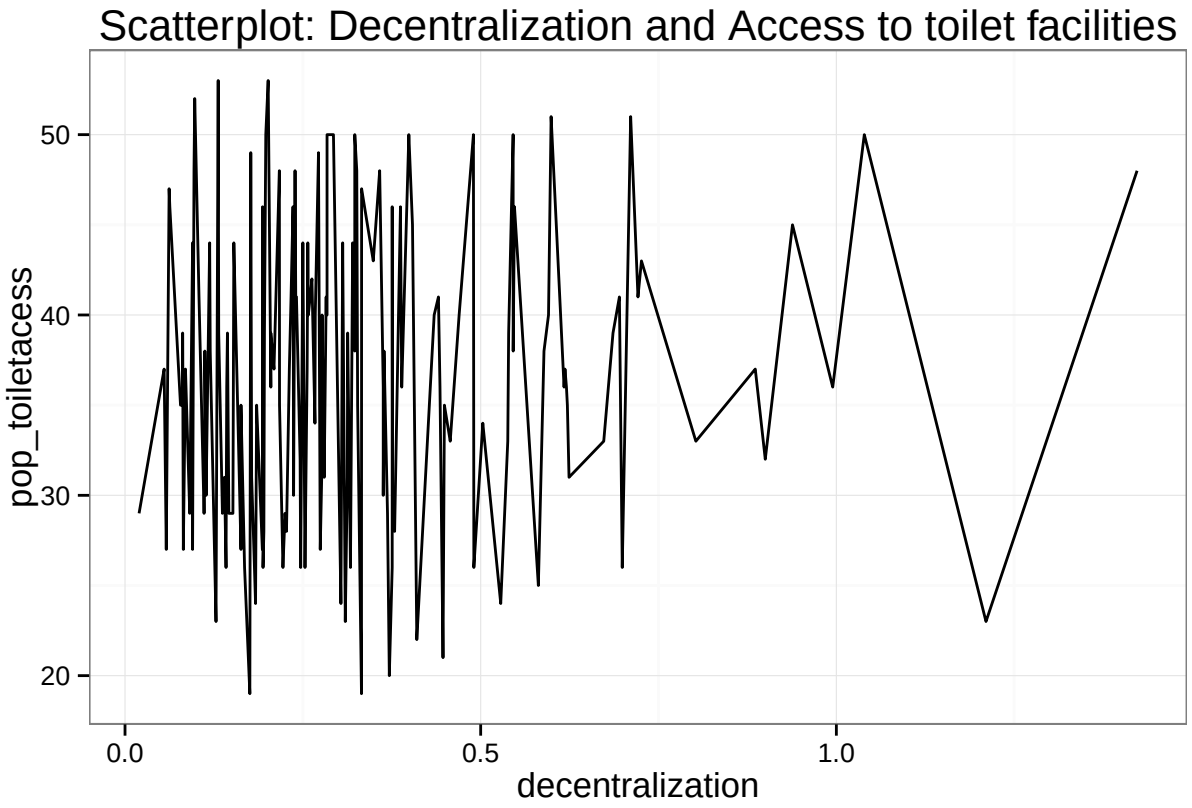


Figure 2: plot of chunk unnamed-chunk-14

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) 35.40 1.19 29.83 <2e-16 *** decentralization 3.27 2.88 1.14 0.26
— Signif. codes: 0 ‘’ ***0.001*** ’’ *0.01* ’’ 0.05 ‘.’ 0.1 ‘’ 1

Residual standard error: 8.44 on 152 degrees of freedom Multiple R-squared: 0.00841, Adjusted R-squared: 0.00188 F-statistic: 1.29 on 1 and 152 DF, p-value: 0.258

```
2.5 % 97.5 %
```

(Intercept) 33.06 37.747 decentralization -2.42 8.958

Call: lm(formula = pop_toiletacess ~ decentralization + population + Density, data = decenthealth)

Residuals: Min 1Q Median 3Q Max -17.129 -6.684 -0.017 5.796 18.065

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.43e+01 1.54e+00 22.18 <2e-16 *** decentralization 8.55e-01 3.06e+00 0.28 0.78
population 1.77e-05 1.29e-05 1.38 0.17
Density -1.37e-04 9.47e-04 -0.15 0.88
— Signif. codes: 0 ‘’ ***0.001*** ’’ *0.01* ’’ 0.05 ‘.’ 0.1 ‘’ 1

Residual standard error: 8.35 on 150 degrees of freedom Multiple R-squared: 0.0417, Adjusted R-squared: 0.0226 F-statistic: 2.18 on 3 and 150 DF, p-value: 0.0931

```
2.5 %    97.5 %
```

(Intercept) 3.120e+01 3.731e+01 decentralization -5.188e+00 6.899e+00 population -7.688e-06 4.316e-05 Density -2.009e-03 1.734e-03

Call: lm(formula = pop_toiletacess ~ decentralization + population + Density + log(pubexp.c) + log(consump.c) + cons_health + educ_adult + ind_pauv_mon, data = decenthealth)

Residuals: Min 1Q Median 3Q Max -17.635 -6.752 0.571 5.671 18.864

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) 3.06e+01 1.20e+01 2.56 0.011 *decentralization -1.84e-01 3.21e+00 -0.06 0.954*
population 1.91e-05 1.33e-05 1.43 0.155
Density -5.35e-04 9.68e-04 -0.55 0.581
log(pubexp.c) -8.14e-01 8.98e-01 -0.91 0.366
log(consump.c) 3.96e-01 7.64e-01 0.52 0.605
cons_health -2.43e-01 3.90e-01 -0.62 0.535
educ_adult 8.94e-02 3.68e-02 2.43 0.016 ind_pauv_mon 3.51e-02 6.86e-02 0.51 0.609
— Signif. codes: 0 ‘’ ***0.001*** ’’ *0.01* ’’ 0.05 ‘.’ 0.1 ‘’ 1

Residual standard error: 8.27 on 145 degrees of freedom Multiple R-squared: 0.092, Adjusted R-squared: 0.0419 F-statistic: 1.84 on 8 and 145 DF, p-value: 0.0747

```
                2.5 %    97.5 %
```

(Intercept) 6.978e+00 5.426e+01 decentralization -6.530e+00 6.162e+00 population -7.282e-06 4.543e-05 Density -2.449e-03 1.379e-03 log(pubexp.c) -2.590e+00 9.610e-01 log(consump.c) -1.115e+00 1.907e+00 cons_health -1.015e+00 5.286e-01 educ_adult 1.669e-02 1.622e-01 ind_pauv_mon -1.004e-01 1.706e-01

Alike the model on water access, decentralization seems to not have a particular effect on the access to toilet facilities, while average literacy rate of head of households results to be significant.

Effect of decentralization on water pipeline connection

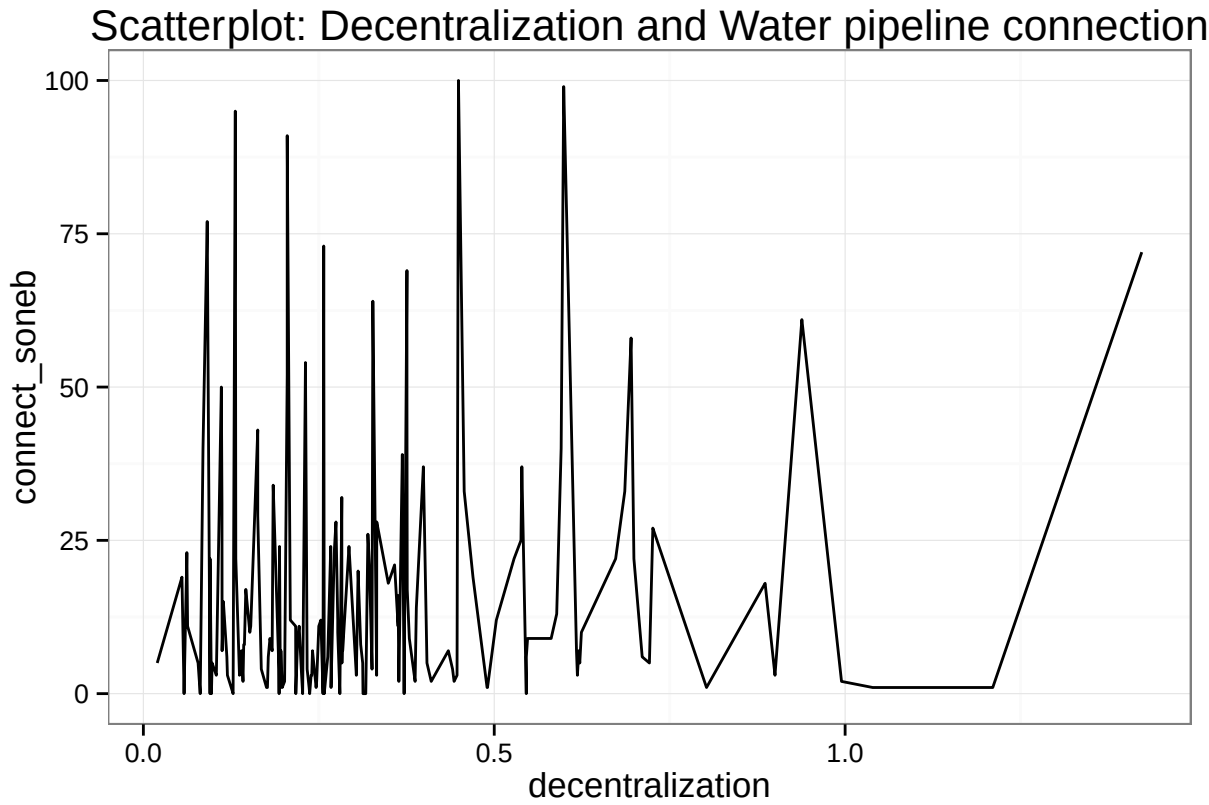


Figure 3: plot of chunk unnamed-chunk-17

Table 4: Effect of decentralization on toilet access

	Dependent variable:		
	pop_toiletacess		
	(1)	(2)	(3)
(Intercept)	3.27	0.86	−0.18
	(2.88)	(3.06)	(3.21)
Decentralization		0.0000	0.0000
		(0.0000)	(0.0000)
Population		−0.0001	−0.001
		(0.001)	(0.001)
Population Density			−0.81
			(0.90)
Log Public Expenditure per capita			0.40
			(0.76)
Log Consumption per Capita			−0.24
			(0.39)
Average Households Health Consumption Ratio			0.09**
			(0.04)
Average Literacy Rate of Head of Households			0.04
			(0.07)
Monetary Poverty Index	35.40***	34.26***	30.62**
	(1.19)	(1.54)	(11.96)
Observations	154	154	154
R^2	0.01	0.04	0.09
Adjusted R^2	0.002	0.02	0.04
Residual Std. Error	8.44 (df = 152)	8.35 (df = 150)	8.27 (df = 145)
F Statistic	1.29 (df = 1; 152)	2.18* (df = 3; 150)	1.84* (df = 8; 145)
Note:			*p<0.1; **p<0.05; ***p<0.01

Call: lm(formula = connect_soneb ~ decentralization, data = decenthealth)

Residuals: Min 1Q Median 3Q Max -25.15 -13.69 -7.90 6.04 82.24

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) 12.81 2.99 4.28 3.3e-05 *** decentralization 11.02 7.26 1.52 0.13
— Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 21.3 on 152 degrees of freedom Multiple R-squared: 0.0149, Adjusted R-squared: 0.00845 F-statistic: 2.3 on 1 and 152 DF, p-value: 0.131

```
                2.5 % 97.5 %
```

(Intercept) 6.895 18.72 decentralization -3.326 25.37

Call: lm(formula = connect_soneb ~ decentralization + population + Density, data = decenthealth)

Residuals: Min 1Q Median 3Q Max -23.91 -11.61 -6.54 5.20 85.25

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.51e+01 3.49e+00 4.34 2.6e-05 ***decentralization -4.48e+00 6.90e+00 -0.65 0.51697***
population -6.01e-06 2.90e-05 -0.21 0.83643
Density 8.17e-03 2.14e-03 3.82 0.00019 — Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 18.8 on 150 degrees of freedom Multiple R-squared: 0.238, Adjusted R-squared: 0.223 F-statistic: 15.6 on 3 and 150 DF, p-value: 6.99e-09

```
                  2.5 %    97.5 %
```

(Intercept) 8.241e+00 2.202e+01 decentralization -1.812e+01 9.156e+00 population -6.339e-05 5.138e-05 Density 3.951e-03 1.240e-02

Call: lm(formula = connect_soneb ~ decentralization + population + Density + log(pubexp.c) + log(consump.c) + cons_health + educ_adult + ind_pauv_mon, data = decenthealth)

Residuals: Min 1Q Median 3Q Max -27.50 -10.77 -4.32 5.90 83.38

Coefficients: Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.80e+01 2.51e+01 -1.91 0.0581 .
decentralization -9.98e+00 6.74e+00 -1.48 0.1409
population 2.21e-05 2.80e-05 0.79 0.4321
Density 5.45e-03 2.03e-03 2.68 0.0082 ** log(pubexp.c) 4.42e+00 1.89e+00 2.34 0.0206 *
log(consump.c) 9.71e-01 1.61e+00 0.60 0.5463
cons_health -1.55e+00 8.20e-01 -1.89 0.0604 .
educ_adult 3.44e-01 7.73e-02 4.46 1.7e-05 *** ind_pauv_mon -6.40e-03 1.44e-01 -0.04 0.9646
— Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 17.4 on 145 degrees of freedom Multiple R-squared: 0.375, Adjusted R-squared: 0.34 F-statistic: 10.9 on 8 and 145 DF, p-value: 6.26e-12

```
                  2.5 %    97.5 %
```

(Intercept) -9.762e+01 1.6626222 decentralization -2.331e+01 3.3432044 population -3.328e-05 0.0000774 Density 1.431e-03 0.0094686 log(pubexp.c) 6.889e-01 8.1444996 log(consump.c) -2.202e+00 4.1429871 cons_health -3.172e+00 0.0684739 educ_adult 1.917e-01 0.4972528 ind_pauv_mon -2.910e-01 0.2781658

```r
labels <- c('(Intercept)', 'Decentralization', 'Population', 'Population Density', 'Log Public Expenditu

stargazer::stargazer(R1soneb, R2soneb, R3soneb, covariate.labels = labels,
                     title = 'Effect of decentralization on water delivery infrastructure',
                     digits = 2, type = 'latex', header = FALSE)
```

```
##
## \begin{table}[!htbp] \centering
##   \caption{Effect of decentralization on water delivery infrastructure}
##   \label{}
## \begin{tabular}{@{\extracolsep{5pt}}lccc}
## \\[-1.8ex]\hline
## \hline \\[-1.8ex]
##  & \multicolumn{3}{c}{\textit{Dependent variable:}} \\
## \cline{2-4}
## \\[-1.8ex] & \multicolumn{3}{c}{connect\_soneb} \\
## \\[-1.8ex] & (1) & (2) & (3)\\
## \hline \\[-1.8ex]
##  (Intercept) & 11.02 & $-$4.48 & $-$9.98 \\
##   & (7.26) & (6.90) & (6.74) \\
##   & & & \\
##  Decentralization &  & $-$0.0000 & 0.0000 \\
##   &  & (0.0000) & (0.0000) \\
##   & & & \\
##  Population &  & 0.01$^{***}$ & 0.01$^{***}$ \\
##   &  & (0.002) & (0.002) \\
##   & & & \\
##  Population Density &  &  & 4.42$^{**}$ \\
##   &  &  & (1.89) \\
##   & & & \\
##  Log Public Expenditure per capita &  &  & 0.97 \\
##   &  &  & (1.61) \\
##   & & & \\
##  Log Consumption per Capita &  &  & $-$1.55$^{*}$ \\
##   &  &  & (0.82) \\
##   & & & \\
##  Average Households Health Consumption Ratio &  &  & 0.34$^{***}$ \\
##   &  &  & (0.08) \\
##   & & & \\
##  Average Literacy Rate of Head of Households &  &  & $-$0.01 \\
##   &  &  & (0.14) \\
##   & & & \\
##  Monetary Poverty Index & 12.81$^{***}$ & 15.13$^{***}$ & $-$47.98$^{*}$ \\
##   & (2.99) & (3.49) & (25.12) \\
##   & & & \\
## \hline \\[-1.8ex]
## Observations & 154 & 154 & 154 \\
## R$^{2}$ & 0.01 & 0.24 & 0.37 \\
## Adjusted R$^{2}$ & 0.01 & 0.22 & 0.34 \\
## Residual Std. Error & 21.28 (df = 152) & 18.84 (df = 150) & 17.36 (df = 145) \\
## F Statistic & 2.30 (df = 1; 152) & 15.60$^{***}$ (df = 3; 150) & 10.87$^{***}$ (df = 8; 145) \\
## \hline
## \hline \\[-1.8ex]
```

```
## \textit{Note:}  & \multicolumn{3}{r}{$^{*}$p$<$0.1; $^{**}$p$<$0.05; $^{***}$p$<$0.01} \\
## \end{tabular}
## \end{table}
```

In this model, our key explanatory variable 'decentralization' seems to have no impact of connection to water delivery infrastrucure. In reverse, population density, public expenditures per capita, households health consumption and average literacy rate of heads of households reveal to be significant, with education highly significant.

Effect of decentralization on availability of public health infrastructure

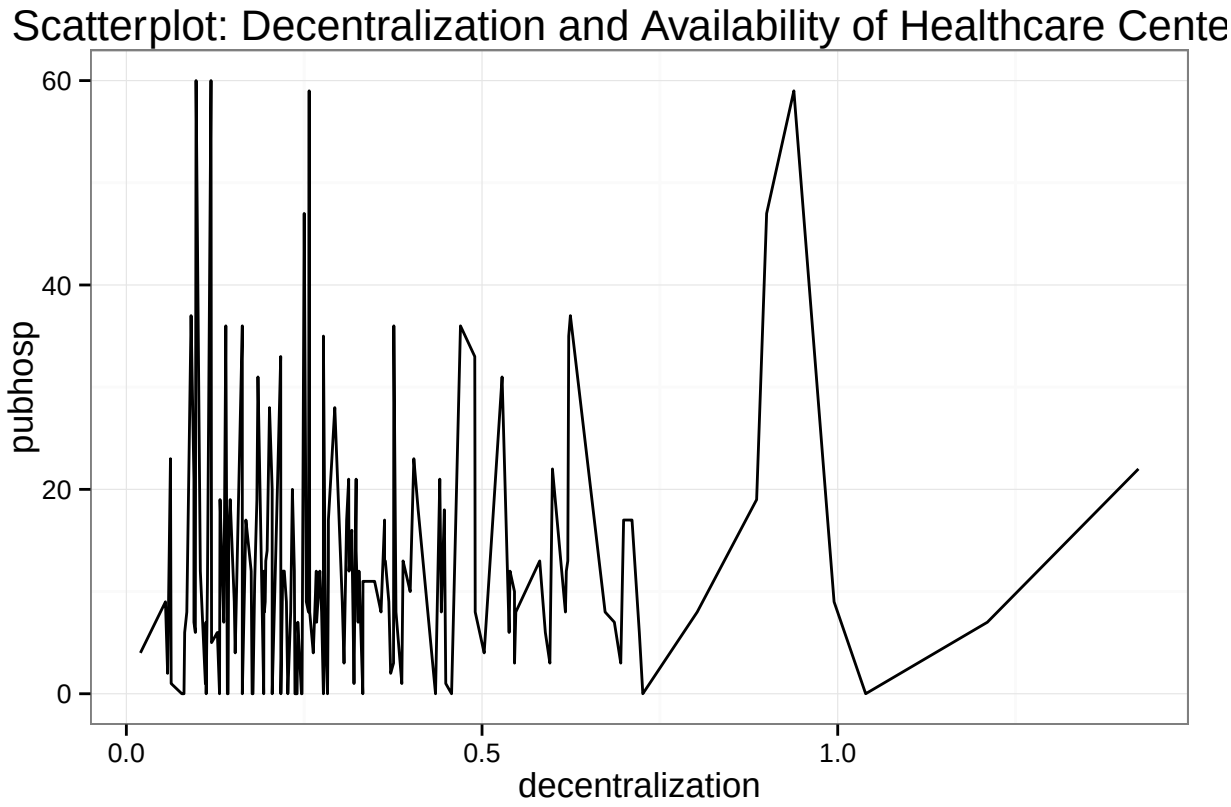


Figure 4: plot of chunk unnamed-chunk-20

```
##                       2.5 %     97.5 %
## (Intercept)      -0.0386116  8.9900644
## decentralization -5.0453759 12.8320360
## population        0.0000406  0.0001158
## Density          -0.0076730 -0.0021371
```

```
##                       2.5 %     97.5 %
## (Intercept)      -7.145e+01 -6.5563190
## decentralization -8.223e+00  9.1956769
## population        6.718e-05  0.0001395
## Density          -9.035e-03 -0.0037816
## log(pubexp.c)     7.967e-01  5.6694814
## log(consump.c)   -2.749e+00  1.3972265
## cons_health      -4.188e-01  1.6990890
## educ_adult        1.096e-01  0.3093151
## ind_pauv_mon      7.470e-02  0.4466711
```

Table 5: Effect of decentralization on availability of healthcare centers

	Dependent variable:		
	pubhosp		
	(1)	(2)	(3)
(Intercept)	5.90	3.89	0.49
	(4.42)	(4.52)	(4.41)
Decentralization		0.0001***	0.0001***
		(0.0000)	(0.0000)
Population		−0.005***	−0.01***
		(0.001)	(0.001)
Population Density			3.23***
			(1.23)
Log Public Expenditure per capita			−0.68
			(1.05)
Log Consumption per Capita			0.64
			(0.54)
Average Households Health Consumption Ratio			0.21***
			(0.05)
Average Literacy Rate of Head of Households			0.26***
			(0.09)
Monetary Poverty Index	10.55***	4.48*	−39.00**
	(1.82)	(2.28)	(16.42)
Observations	154	154	154
R^2	0.01	0.11	0.28
Adjusted R^2	0.01	0.09	0.24
Residual Std. Error	12.94 (df = 152)	12.35 (df = 150)	11.34 (df = 145)
F Statistic	1.79 (df = 1; 152)	6.29*** (df = 3; 150)	6.89*** (df = 8; 145)
Note:			*p<0.1; **p<0.05; ***p<0.01

Like the previous models, decentralization does not seem to be a significant elements in the availability of healthcare centers at the subnational level. With regards to the explanatory variables: population, population density, and average literacy rate of the head of households seem to be strongly determinants of the existence of healthcare centers. Public expenditures per capita and poverty level result to be significant as well.

5 Potential Issues

The macroeconomic overview suggests that Benin's has experienced an improvement on health-services delivery over the past few years. Given that health-related services is highly decentralized, we have tested the impact of decentralization on some key health-related variables, issued from Benin's Households Survy. The microeconomic analysis, however, did not find any significant imapct of decentralization (proxied by the

ratio of own-revenue to total expenditures) on the provision of health-related services and infrastructures. Given that exisiting literatures provide various decentralization indicators, the significance found in the microeconomic analysis might be the result of a misleading indicator. Moreover, because public services in Benin is highly financed by intergovernmental (rather than own-source revenues), it might be more reliable to consider an indicator or a model that takes into account this factor. Therefore, we propose to revise our proxy for decentralization and to further work on our model specification.