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Does crime impact economic growth?

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Abstract
This paper examines the relationship between crime and economic growth at State level data of India. The study takes data for crime (homicide rate) from NCRB and for economic growth (SGDP per capita) RBI handbook of statistics from 2004 to 2019. So it is a panel data regression modeling. The data analysis starts with a simple fixed effect and random effect regression modeling. To remove the problem of joint endogeneity problem of economic growth and homicide rate, we use a reduced form fixed effect and random effect regression. By using this more of the joint endogeneity problem is wiped away. Our idea is that the crime affects economy negatively and our results confirm this.

Keywords: Crime, economic growth, SGDP

Introduction
Crime has been a matter of prime concern for social scientists, lawmakers, and policymakers. The existence of crime leads to distortions and uncertainty in the economy for various economic and social policies. This makes it crucial for social scientists to study the factors that influence total crimes and homicide rates. The primary objective of this paper is to delineate the relationship between crime and economic growth across states in India.
Crime can affect economic growth in two ways one is permanent that is growth that arises from forgone investment. Another is output that arises because of the loss of working days/lives in an economy (Kumar, 2013) [10]. Our idea is to trace the second one which is to say if crime increases in an economy then the potential workforce available in the economy will go down. In this way, crime will negatively affect the economy. So our idea is also to check the validity of this claim.
Crime imposes significant costs on society, both directly and indirectly. Direct costs include the loss of human lives, unbearable injuries suffered by victims, medical expenses related to injuries, private security guards, and installation of surveillance cameras. While a substantial number of resources is dedicated to addressing crime, particularly within the current economic context, it is important to consider that the link between crime and economic conditions may not be solely causal, and economic growth could potentially have a contrasting impact.
So within this context, this study will take the homicide rate as the proxy for crime, and for economic growth, this will take per capita SGDP at constant price across states in India. This study also incorporates data on education expenditure. The report incorporates data for homicide rate and SGDP from all Indian states and UTs from the year 2001 to 2019. Education expenditure data is from 2004-2013 due to technical constraints. So this is a panel data regression modeling.

Literature Review
Crime is a complex social phenomenon that harnesses many development indicators like the state's GDP, poverty, inequality, gender emancipation, etc. But here our idea is to check for economic growth only. The dynamics between the crime rate and these variables are crucial for effective policy-making, crime prevention strategies, and fostering safer communities.
Cantor and Land (1985) [11], in their study on the economic conditions of the United States, identified two effects regarding the relationship between crime and unemployment. They observed a positive relationship between crime and unemployment, which they referred to as

the "motivation effect", here, the individual has a motivating factor to engage in criminal activities. The financial strain and lack of income push individuals towards criminal behavior as a means to sustain. The other effect given by Cantor and Land is that there is a negative relationship between crime and unemployment, termed the "opportunity effect." This suggests that as unemployment rates increase, the number of individuals available for guardianship or supervision also rises. This increased presence of unemployed individuals acts as a deterrent to crime, leading to a decrease in total crimes. The opportunity to commit crimes diminishes due to the increased vigilance and surveillance by the unemployed population.

Scorcu and Cellini (1998) [12], titled "Economic Activity and Crime in the Long Run: An Empirical Investigation on Aggregate Data from Italy, 1951–1994" explores the relationship between economic activity and total crimes over a long-term period in Italy. The authors analyze aggregate data on various socioeconomic variables, including gross domestic product (GDP), unemployment rates, inflation, and total crimes. It reveals a positive long-term relationship between economic activity and total crimes in Italy. As economic activity increases, total crimes also tend to rise, indicating that economic growth and criminal behavior are positively associated.

Fajnzylber, Lederman, and Loayza's (2002) [1] article "Inequality and Violent Crime," examines the relationship between income inequality and violent total crimes. It provides empirical evidence to show the association between social inequality and violent crime. They suggest that income inequality can contribute to the creation of a highly unequal society, where a significant portion of the population faces limited economic opportunities and increased frustration, leading to higher total crimes.

Sarma (2013) [13], in his study, depicts the relationship between crime and economic growth across states in India. Where crime is measured as the robbery rate and homicide rate and economic growth is measured as the SGDP. The study incorporates data on robbery rate, homicide rate, and SGDP for the years 2000-2010 across states in India. To draw a relationship study Arellano and Bond's fixed effect panel regression and generalized method of moments (GMMs). The study uses triple lag variables of homicide rate and robbery rate, initially separately then adds the interaction term of robbery and homicide rate. The study presents the negative relationship between crime and economic growth.

Data Sources and Methodology

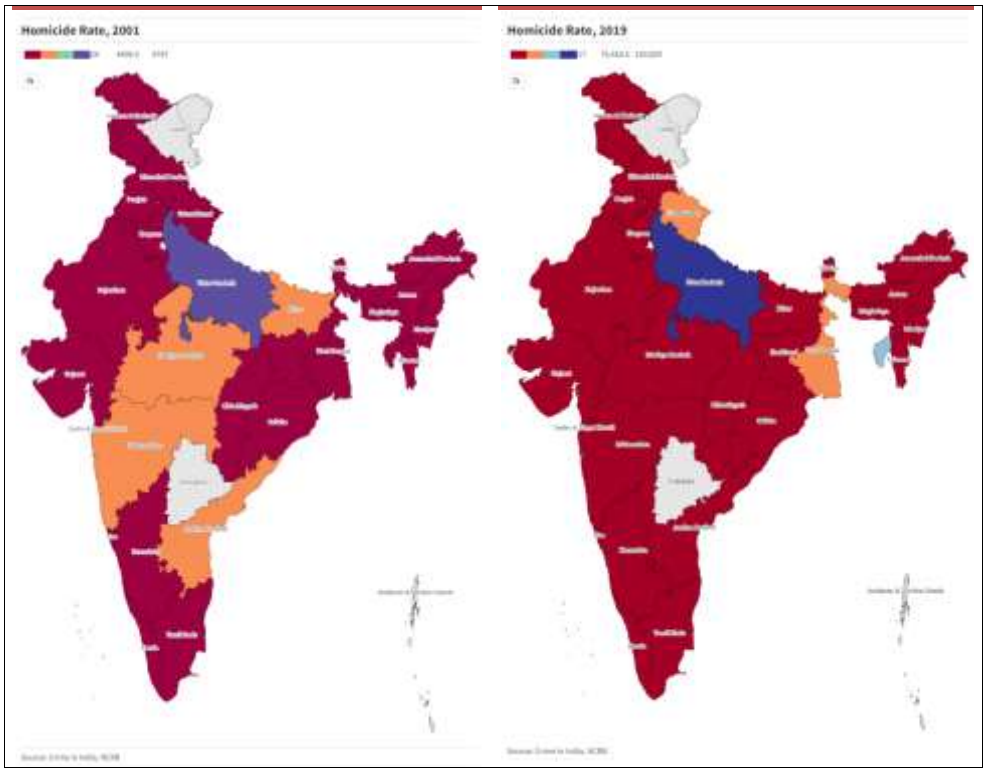
Data sources

For our empirical study, the data was collected from 2003 to 2019 pertaining to the state level. It includes 28 states and 4 Union Territories (30 observations). The data for three Union Territories that is Lakshadweep, Dadar, and Nagar Haveli, and Daman and Diu were not available for the study, hence they were not considered in the result. In the data set, there were a few missing observations for which we used interpolation. We took data till 2019, because of the COVID-19 pandemic.

The following table (Table: 1) lists the variables for which the data was collected for this study. It also denotes their nature along with the authentic source.

Table 1: The variables for which the data was collected for this study. It also denotes their nature along with the authentic source.

Variables	Nature of variables	Source of data
Homicide rate	Number of murders committed per lakh population	CRIME IN INDIA, NCRB
SGDP Per Capita	SGDP Per capita, current prices (US Dollar per capita)	RBI Handbook of Statistics
Education Expenditure	Public Expenditure on Education as a Percentage of Gross Domestic Production (GDP) in India	Ministry of Human Resource Development, Govt. of India. (ON3039) & Past Issues.



If we compare the above two maps, we see that in the year 2001, the Homicide rate was the maximum in Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, and Bihar. In 2019, the homicide rate has fallen in most states, but for some, it has risen too, like West Bengal, Uttarakhand, and Tripura.

Methodology

Our analysis starts with basic descriptive statistics of data. To draw a relationship between crime and economic growth we start with the dynamic panel estimation where the predicted variable is per capita state GDP and predictor variables are homicide rate and educational expenditure through random and fixed effects panel regression estimation. But to reduce or to wipe away the problem of endogeneity we use three lags of dependent variable as our predictor variable. The value of GDP will also be related to its lag because the investment decisions made in previous years will give a return in forthcoming years. So this model will also use SGDP's lag as the predictor variable which makes our model dynamic. Using the lag of SGDP will improve the value of both R2 (within and between) in this model because of the increase in the explanatory power of the model. To redress the problem of heteroscedasticity we use robust regression. We start by considering the following simple panel production function model with crime effects in per capita terms which is opted from the Surender (2013) [10] study as follows:

$$Yit = Aitexp(\beta Cit)$$

Where Y stands for the per capita SGDP and A and C measure the total factor productivity and crime rates (in logarithmic terms) in a year. By taking logs on both sides this can be represented as the autoregressive distributive lag model (ARDL).

$$Yit = ait + b1yi,t-1 + b2yi,t-2 +\ldots\ldots + bpyi,t-p + d1Ci,t-1 + d2Ci,t-2 + \ldots\ldots + dpCi,t-p + ui + eit$$

To establish the relation between crime and economic growth we'll use fixed and random effect panel regression. To check the validity of with which regression (fixed or random) we should continue, we will be using the Hausman test where under the null we will be checking there is no correlation between the individual characteristics and predictor variable. If the null is rejected we accept the fixed effect. To remove the effect of individual characteristics on the explanatory variable, we will be using the triple time lag of the homicide rate.

Fixed effect panel regression

The concept presented here suggests that states possess distinct attributes that could impact the outcome or predictor variable. As these individual characteristics are non-random and can influence the outcome or predictor variable, it is essential to account for them. By doing so, we ensure that the impact of the predictor variable remains unaffected by individual characteristics. In the context of fixed effects, there is an assumption of correlation between a state's error term and predictor variables. It's important to note that the fixed effect of one entity is not correlated with the fixed effect of another entity.

The entity fixed effects regression model is

$$Yit = ai + bXit + ui + eit$$

i = 1...n; t = 1....T

Where:

Yit: outcome variable (for entity i at time t)
ui: within entity error term
eit: overall error term
ai: unknown intercept for each entity
Xit: vector of the predictor variable

The entity fixed effects regression model is

$Yit = \alpha i + \beta Xit + ui + eit$

Random effect panel regression

The justification for employing the random effects model is its departure from the fixed effects model. In this approach, the variability across entities is presumed to be random and unrelated to the predictor or independent variables incorporated into the model. Random effects posit that the error term of an entity is uncorrelated with the predictors, enabling time-invariant variables to serve as explanatory factors. However, in the random effects model, it is necessary to identify and specify individual characteristics that could impact the predictor variables. A challenge arises when certain variables are unavailable, potentially introducing omitted variable bias into the model.

Descriptive Statistics-

The table below explains the descriptive statistics of the state GDP, education expenditure, and homicide rate variables that affected India's SGDP from 2005 to 2019. Within this period, the average value of the SGDP is 68.6 thousand across India, going to as high as 313 thousand. In contrast, for the homicide rate, the average value is 1186.4, with a maximum value of 7231. Education Expenditures have been increasing yearly due to the economic growth led by various reforms, with a mean of 12 lakhs.

```
. xtsum sgdp homiciderate educationexpenditure

Variable              |      Mean   Std. dev.       Min        Max |   Observations
----------------------+--------------------------------------------+--------------
sgdp          overall |  68655.67   51898.89      7588     313973 |    N =      420
              between |             36225.54  18901.13   198308.1 |    n =       28
              within  |             37749.87  -48808.4   184320.6 |    T =       15
                      |                                          |
homici~e      overall |  1186.436   1295.357         7       7231 |    N =      420
              between |             1281.939  15.33333     5647.8 |    n =       28
              within  |             299.1533 -655.3643   2769.636 |    T =       15
                      |                                          |
educat~e      overall |   1274238    1633585         0   1.26e+07 |    N =      420
              between |             989564.4    69024.2    4081743 |    n =       28
              within  |              1312281  -2763752   1.06e+07 |    T =       15
```

Our analysis was carried out in the STATA17 software package for estimating our panel regression on our dependent variable SGDP on the independent variables, i.e., homicide rate and education expenditure.

Results-

Fixed and random effect model

Given that individual characteristics are non-random and can impact the outcome variables, it is imperative to manage and control them. This ensures that the predictors' effects remain uninfluenced by these fixed characteristics. In the fixed effects model, it is posited that a correlation exists between the error term and predictor variables. Notably, the fixed effects of one state cannot be correlated with those of another.

On the other hand, random effects operate under the assumption that the state's error term is uncorrelated with the independent variable, permitting time-invariant variables to function as explanatory factors. In the realm of random effects, it becomes necessary to identify and specify the individual characteristics that may or may not impact the independent variables. However, a potential drawback arises when certain variables are unavailable, potentially introducing bias through omitted variables into the model.

Fixed Effect

```
Fixed-effects (within) regression               Number of obs     =         420
Group variable: st                              Number of groups  =          28

R-squared:                                      Obs per group:
     Within  = 0.1736                                         min =          15
     Between = 0.0625                                         avg =        15.0
     Overall = 0.0726                                         max =          15

                                                F(2,390)          =       40.97
corr(u_i, Xb) = -0.6313                         Prob > F          =      0.0000

------------------------------------------------------------------------------
        sgdp | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
homiciderate |  -36.18624   5.969946    -6.06   0.000    -47.92354   -24.44894
educationexp~e|  .0069981   .0013609     5.14   0.000     .0043224    .0096738
       _cons |   102671.1   7865.043    13.05   0.000     87207.91    118134.3
-------------+----------------------------------------------------------------
     sigma_u |  47656.974
     sigma_e |  35569.659
         rho |  .64223363   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(27, 390) = 14.46                     Prob > F = 0.0000
```

Random Effect

```
Random-effects GLS regression                   Number of obs     =         420
Group variable: st                              Number of groups  =          28

R-squared:                                      Obs per group:
     Within  = 0.1625                                         min =          15
     Between = 0.0773                                         avg =        15.0
     Overall = 0.1008                                         max =          15

                                                Wald chi2(2)      =       73.50
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =      0.0000

------------------------------------------------------------------------------
        sgdp | Coefficient  Std. err.      z    P>|z|     [95% conf. interval]
-------------+----------------------------------------------------------------
homiciderate |  -21.97624   3.960168    -5.55   0.000    -29.73803   -14.21445
educationexp~e|  .0082477   .0013146     6.27   0.000     .0056711    .0108242
       _cons |   84219.59   8431.123     9.99   0.000     67694.89    100744.3
-------------+----------------------------------------------------------------
     sigma_u |  34119.738
     sigma_e |  35569.659
         rho |  .47920353   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

If the Prob>chi2 number is < 0.05, our model is good. The F-test shows whether all the coefficients in the model are jointly different than zero. Two-tailed p-values test the hypothesis that each coefficient differs from 0 (according to its t-value). A value lower than 0.05 will reject the null and conclude that our independent variable has a significant effect on the outcome variable (95% significance). In both fixed and random effect models, the effect of homicide rate on SGDP is negative and significant. When there is a change in homicide rate by one unit, SGDP falls by 37 units. Similarly, the education expenditure positively impacts the SGDP, which is also significant. A unit increase in education expenditure increases the SGDP by 0.007 units. There could be other factors that could impact India's SGDP.

Hausman test

The Hausman test tests whether the individual characteristics are correlated with the independent variable or not (Greene, 2008, chapter 9). The null hypothesis is that they are not (random effects).

	Coefficients (b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) Std. err.
homiciderate	-36.18624	-21.97624	-14.21	4.467362
educatione~e	.0069981	.0082477	-.0012496	.0003521

b = Consistent under H0 and Ha; obtained from **xtreg**.
B = Inconsistent under Ha, efficient under H0; obtained from **xtreg**.

Test of H0: Difference in coefficients not systematic

chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 10.12
Prob > chi2 = 0.0015
(V_b-V_B is not positive definite)

The Prob>chi2 is less than 0.05, so we use the fixed effect model.

Robustness Check

We are doing the robustness check; that is, we are trying to control for heteroskedasticity. If we see the result of our fixed and random effect models (above), they are very/almost similar to the robust model. So, there is no heteroskedasticity in our model. In our robust model, our results are also significant.

Fixed Effect Robust

```
. xtreg sgdp homiciderate educationexpenditure, fe robust

Fixed-effects (within) regression               Number of obs     =        420
Group variable: st                              Number of groups  =         28

R-squared:                                      Obs per group:
     Within  = 0.1736                                         min =         15
     Between = 0.0625                                         avg =       15.0
     Overall = 0.0726                                         max =         15

                                                F(2,27)           =      61.88
corr(u_i, Xb) = -0.6313                         Prob > F          =     0.0000

                                    (Std. err. adjusted for 28 clusters in st)
```

sgdp	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
homiciderate	-36.18624	6.656993	-5.44	0.000	-49.84526	-22.52722
educationexpenditure	.0069981	.0014214	4.92	0.000	.0040817	.0099145
_cons	102671.1	9047.518	11.35	0.000	84107.12	121235.1
sigma_u	47656.974					
sigma_e	35569.659					
rho	.64223363	(fraction of variance due to u_i)				

Random Effect Robust

```
Random-effects GLS regression                   Number of obs     =        420
Group variable: st                              Number of groups  =         28

R-squared:                                      Obs per group:
     Within  = 0.1625                                         min =         15
     Between = 0.0773                                         avg =       15.0
     Overall = 0.1008                                         max =         15

                                                Wald chi2(2)      =     151.49
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000

                                    (Std. err. adjusted for 28 clusters in st)
```

sgdp	Coefficient	Robust std. err.	z	P>|z|	[95% conf.	interval]
homiciderate	-21.97624	2.671297	-8.23	0.000	-27.21189	-16.7406
educationexpenditure	.0082477	.0011417	7.22	0.000	.0060099	.0104854
_cons	84219.59	9473.753	8.89	0.000	65651.38	102787.8
sigma_u	34119.738					
sigma_e	35569.659					
rho	.47920353	(fraction of variance due to u_i)				

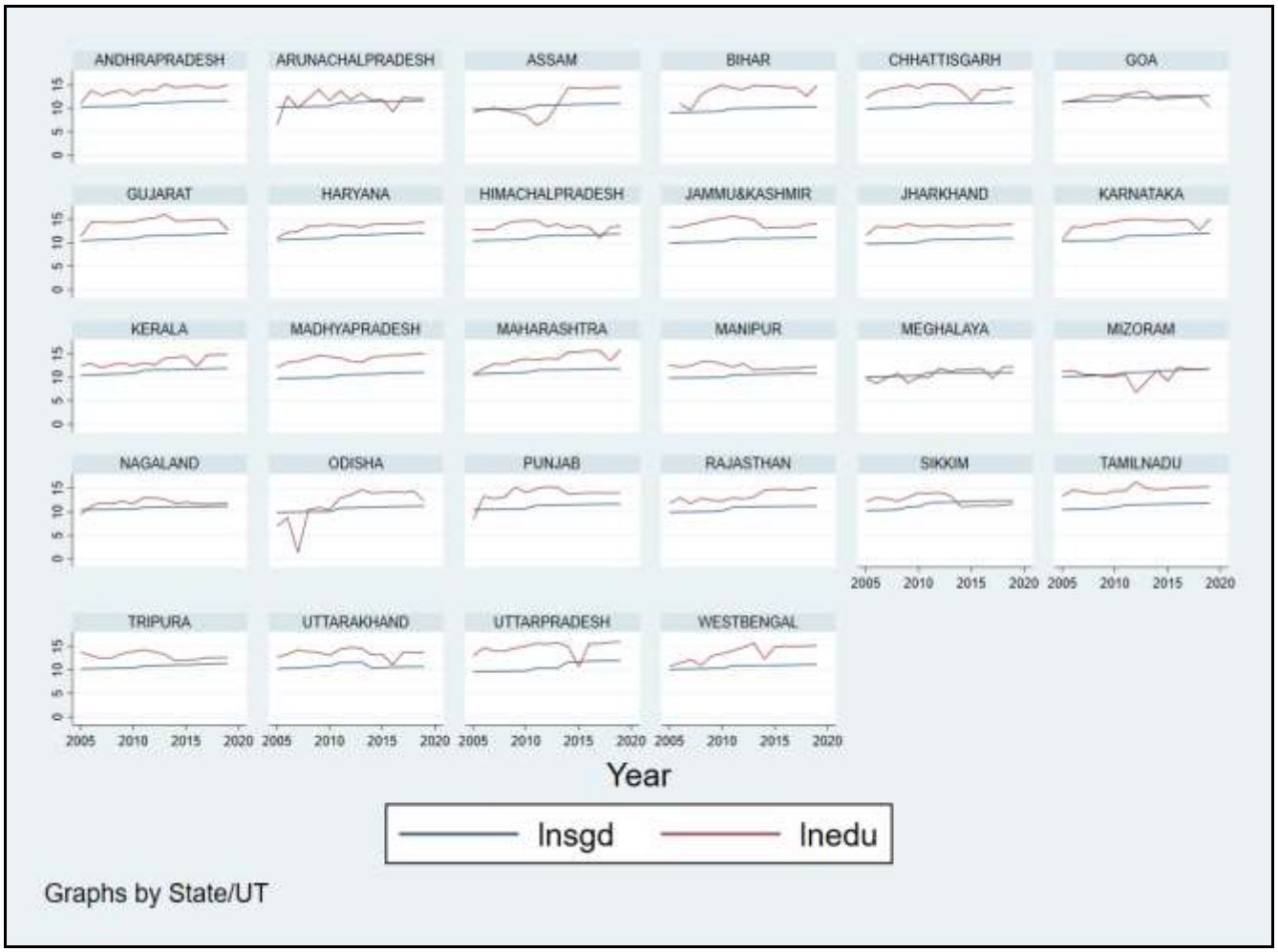
Also, we tried to capture the dynamic panel modeling. Here, the variable disc is the first difference of SGDP. We can see that by 0.93 units, the current year's SGDP impacts the following year's SGDP, which is positive and significant.

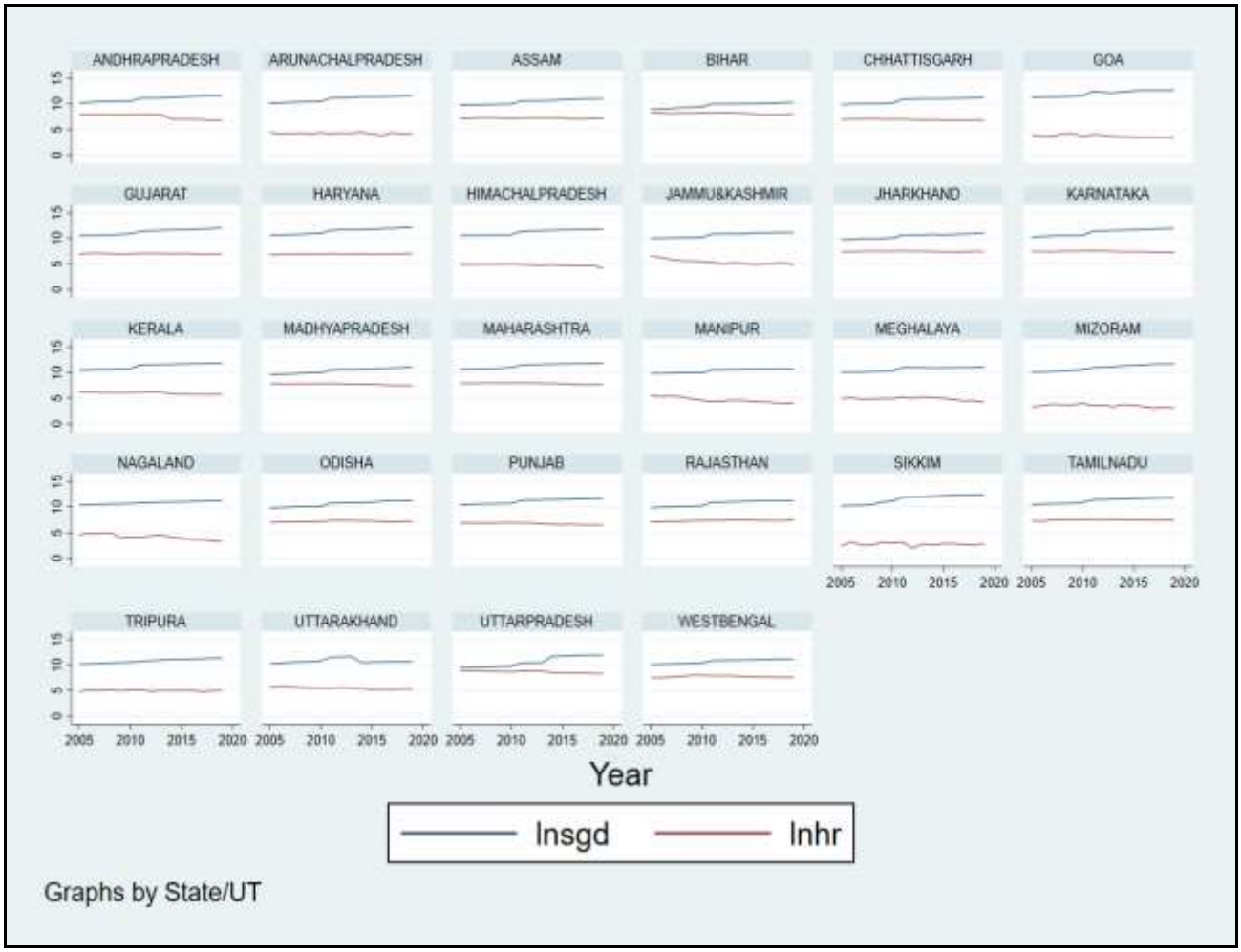
```
Random-effects GLS regression                   Number of obs     =        392
Group variable: st                              Number of groups  =         28

R-squared:                                      Obs per group:
     Within  = 0.1584                                         min =         14
     Between = 0.2933                                         avg =       14.0
     Overall = 0.2071                                         max =         14

                                                Wald chi2(3)      =      91.49
corr(u_i, X) = 0 (assumed)                      Prob > chi2       =     0.0000
```

sgdp	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
disg	.9305571	.1565549	5.94	0.000	.6237151	1.237399
homiciderate	-14.05635	2.28519	-6.15	0.000	-18.53524	-9.577458
educationexpenditure	.0082177	.0014749	5.57	0.000	.0053269	.0111085
_cons	71445.97	4064.483	17.58	0.000	63479.73	79412.21
sigma_u	8067.4087					
sigma_e	33958.165					
rho	.05342386	(fraction of variance due to u_i)				

Appendix: (GRAPHS)

With the graph below, we can see the trend line of SGDP, homicide rate, and education expenditure, state-wise.





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