Panel Data Regression

Dataset Background:

The dataset is taken from An Examination of the Dynamic Behavior of Local Governments using GMM Bootstrapping Methods Journal by Dahlberg. It represents the Municipal Expenditure Data collected over a period of time. The goal is to predict the Expenditure on the basis of Revenue and Grants. Since the data contains both time-series and cross-sectional data, it is considered to be Panel Dataset.

Dataset Glimpse:

YEAR	EXPEND	REVENUE	GRANTS
1979	0.022974	0.018177	0.005443
1980	0.026631	0.020914	0.00573
1981	0.027325	0.021084	0.005665
1982	0.02887	0.023431	0.005886
1983	0.022647	0.017998	0.005591
1984	0.02156	0.017995	0.004754
1985	0.021959	0.016224	0.005491
1986	0.020889	0.015941	0.005398
1987	0.021327	0.016589	0.005135
1979	0.015662	0.014539	0.004354

Total Number of Rows: 39.

Total Number of Columns: 4.

Column Details:

- Year – the year in which the data was collected.
- Expend – the logarithm of the expenditure by the municipal corporation.
- Revenue – the logarithm of the revenue earned by the municipal corporation.
- Grants – the logarithm of the grants issued to the municipal corporation.

Main Dependent Variable: Expend.

Using SPSS Software EViews, we have analysed the data:

Descriptive Statistics:

	EXPEND	REVENUE	GRANTS
Mean	0.020188	0.015531	0.004847
Median	0.018726	0.014487	0.004781
Maximum	0.028870	0.023431	0.005886
Minimum	0.014237	0.009854	0.003974
Std. Dev.	0.004099	0.003607	0.000529
Skewness	0.664011	0.595132	0.147535
Kurtosis	2.258700	2.204175	1.890282
Jarque-Bera	3.758901	3.331357	2.142628
Probability	0.152674	0.189062	0.342558
Sum	0.787315	0.605714	0.189022
Sum Sq. Dev.	0.000638	0.000494	1.06E-05
Observations	39	39	39

Inferences:

- The variable Expend is slightly right skewed, ranging between 0.014 to 0.029.
- The variable Revenue is slightly right skewed, ranging between 0.001 to 0.023.
- The variable Grants is slightly right skewed, ranging between 0.004 to 0.006.
- There is no missing data.

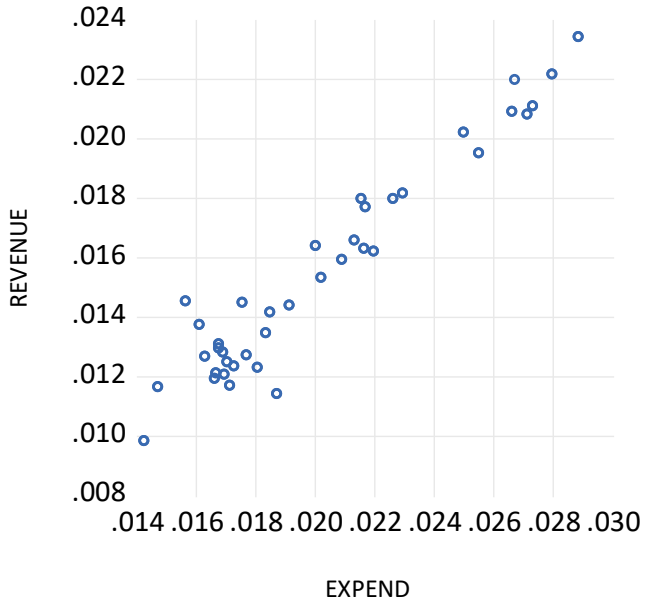
Correlation Analysis:

	EXPEND	REVENUE	GRANTS
EXPEND	1.000000	0.963747	0.821757
REVE...	0.963747	1.000000	0.787069
GRANTS	0.821757	0.787069	1.000000

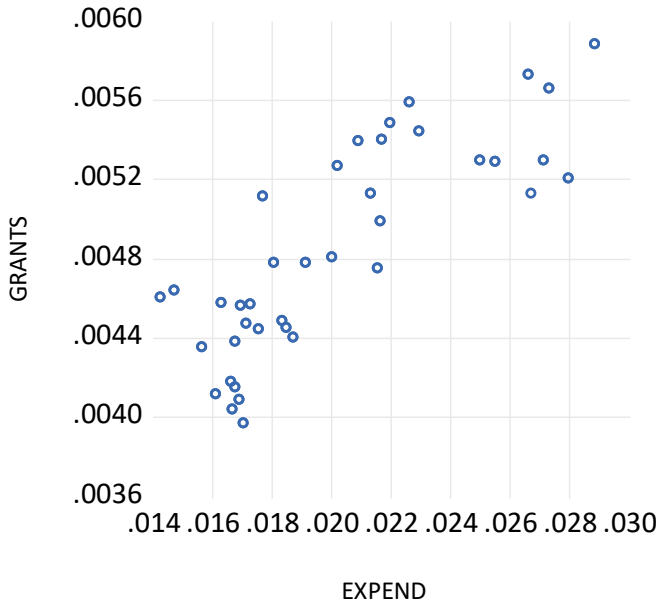
Inferences:

- The variables expend and revenue have very high degree of positive linear correlation, having correlation coefficient 0.96.
- The variables expenditure and grants have sufficient high degree of positive linear correlation, having correlation coefficient 0.82.
- The variables revenue and grants have moderate degree of positive linear correlation, having correlation coefficient 0.78.

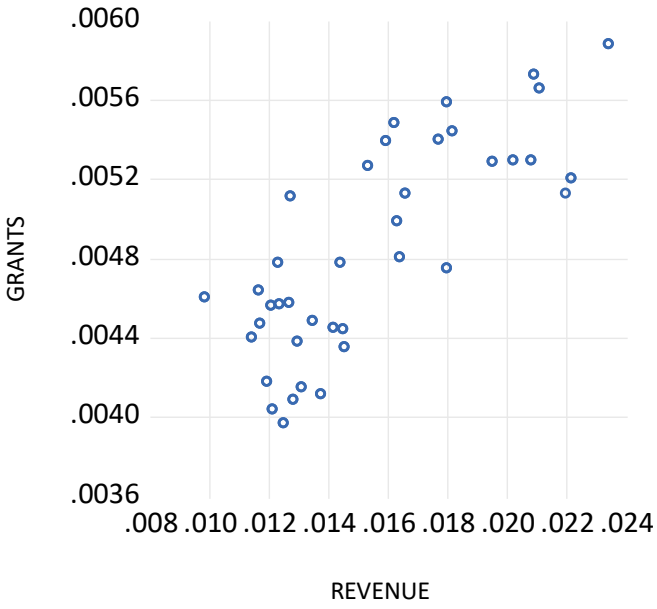
Scatter Plots:



Inference: the variables expend and revenue have very high degree of positive linear correlation.



Inference: the variables expenditure and grants have sufficient high degree of positive linear correlation.



Inference: the variables revenue and grants have moderate degree of positive linear correlation.

Regression Analysis using OLS:

Cross-sections included: 9
Total panel (unbalanced) observations: 39

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000752	0.001741	-0.432223	0.6682
REVENUE	0.946639	0.075642	12.51474	0.0000
GRANTS	1.286989	0.515587	2.496160	0.0173

R-squared	0.939311	Mean dependent var	0.020188
Adjusted R-squared	0.935940	S.D. dependent var	0.004099
S.E. of regression	0.001037	Akaike info criterion	-10.83032
Sum squared resid	3.87E-05	Schwarz criterion	-10.70235
Log likelihood	214.1912	Hannan-Quinn criter.	-10.78441
F-statistic	278.5958	Durbin-Watson stat	2.231517
Prob(F-statistic)	0.000000		

Estimate Equation:

$$\text{Expend} = -0.0008 + (0.94)(\text{Revenue}) + (1.29)(\text{Grants})$$

Inferences:

- The model has very good explanatory power, having R^2 value 0.94.
- The variables revenue and grants are statistically significant, having p-values 0.00 and 0.02.
- The intercept is not statistically significant, having p-value 0.668.

Fixed Effect Model:

Cross-sections included: 9
Total panel (unbalanced) observations: 39

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000292	0.001728	-0.168829	0.8671
REVENUE	0.951611	0.078235	12.16345	0.0000
GRANTS	1.175993	0.529612	2.220477	0.0347

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.960816	Mean dependent var	0.020188
Adjusted R-squared	0.946822	S.D. dependent var	0.004099
S.E. of regression	0.000945	Akaike info criterion	-10.85756
Sum squared resid	2.50E-05	Schwarz criterion	-10.38835
Log likelihood	222.7223	Hannan-Quinn criter.	-10.68921
F-statistic	68.65807	Durbin-Watson stat	3.463053
Prob(F-statistic)	0.000000		

Estimate Equation:

$$\text{Expend} = -0.0003 + (0.95)(\text{Revenue}) + (1.17)(\text{Grants})$$

Inferences:

- The model has very good explanatory power, having R^2 value 0.96.
- The variables revenue and grants are statistically significant, having p-values 0.000 and 0.03.
- The intercept is statistically significant, having p-value 0.87.

Random Effect Model:

Cross-sections included: 9
Total panel (unbalanced) observations: 39
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000465	0.001672	-0.278141	0.7825
REVENUE	0.950660	0.073820	12.87812	0.0000
GRANTS	1.214282	0.501532	2.421147	0.0206

Effects Specification		
	S.D.	Rho
Cross-section random	0.000540	0.2460
Idiosyncratic random	0.000945	0.7540

Weighted Statistics			
R-squared	0.948051	Mean dependent var	0.012960
Adjusted R-squared	0.945165	S.D. dependent var	0.003936
S.E. of regression	0.000924	Sum squared resid	3.07E-05
F-statistic	328.4934	Durbin-Watson stat	2.816083
Prob(F-statistic)	0.000000		

Unweighted Statistics			
R-squared	0.939263	Mean dependent var	0.020188
Sum squared resid	3.88E-05	Durbin-Watson stat	2.231562

Estimate Equation:

$$\text{Expend} = -0.00047 + (0.95)(\text{Revenue}) + (1.21)(\text{Grants})$$

Inferences:

- The model has a high explanatory power, having R^2 value 0.94.
- The variables revenue and grants are statistically significant, having p-values 0.000 and 0.02.
- The intercept is statistically insignificant, having p-value 0.78.

Hausman Test:

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.287356	2	0.8662

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
REVENUE	0.951611	0.950660	0.000671	0.9707
GRANTS	1.175993	1.214282	0.028955	0.8220

Here:

- Null Hypothesis – The random effect model is appropriate.
- Alternate Hypothesis – The fixed effect model is appropriate.

Since the chi-square statistic test with a value of 0.28 having 2 degrees of freedom has a p-value of 0.8662, we accept the null hypothesis and conclude that the random effect model is appropriate.