Sensitivity Analysis Of Independent Variables On Traffic Crash Prediction Models By Using Stata

Deo Chimba
Graduate Research Assistant
Department of Civil and Environmental Engineering
Florida State University

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Purpose of the study

- To evaluate roadway and operational factors influencing crash frequency on six-lane divided roadways in Florida
- Factors considered Include
    - Roadway segment length
    - Number of Vehicles (AADT)
    - Access Density
    - Median Width
    - Shoulder Width
    - Surface Width
    - Percentage of Trucks

Roadway geometrics

Roadway geometrics

Properties of Crash (Accident)

- Random in nature
- Are count data
- Are always non-negative

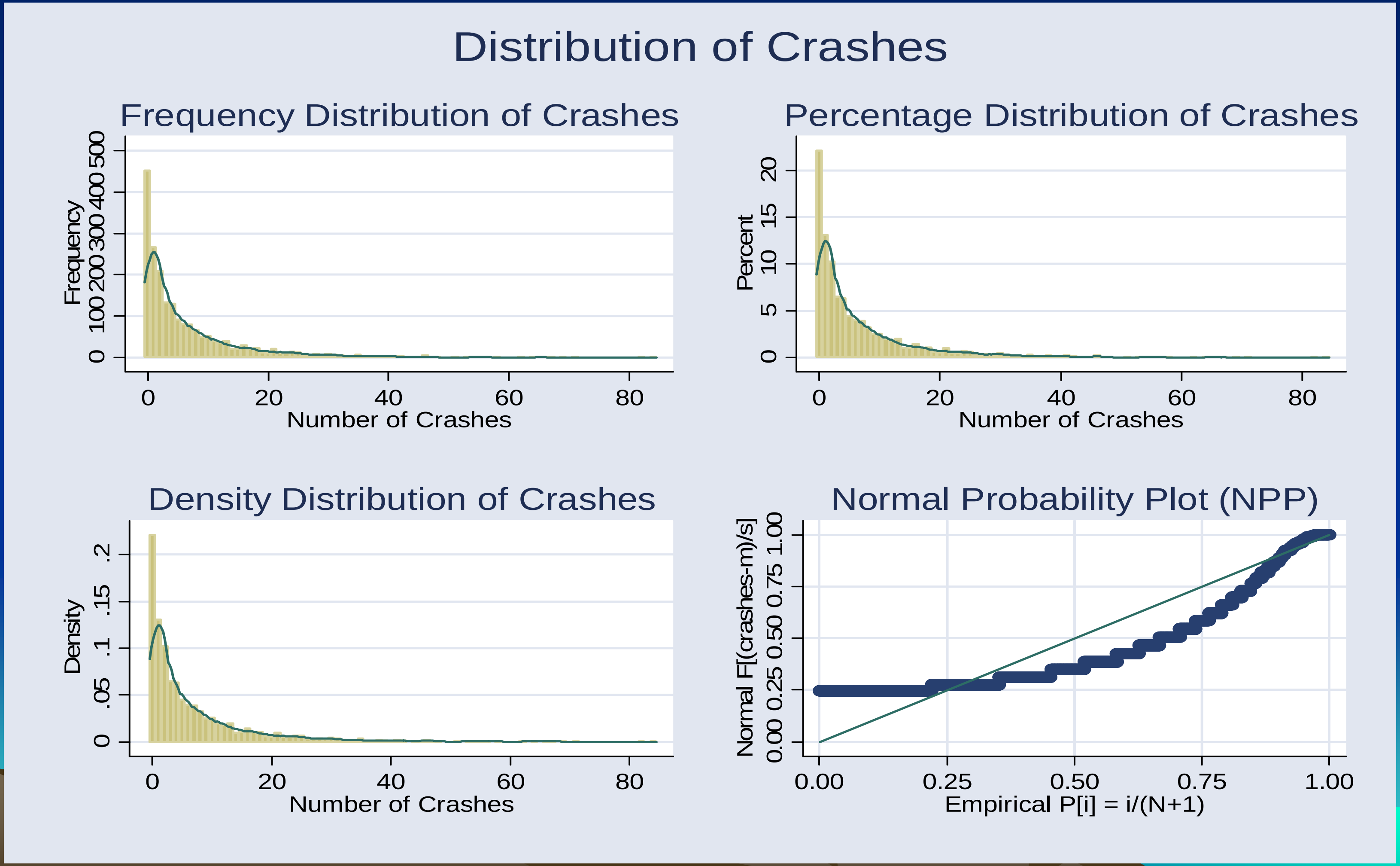
Appropriate Distribution

- Poisson Distribution
  - Assume Mean is equal to Variance

- Negative Binomial
  - Takes care of overdispersed data
  - Assume Mean is not equal to variance

Crash Distribution Plots

- Commands "*histogram crashes*" , "*pnorm crashes*" and "*graph combine*"



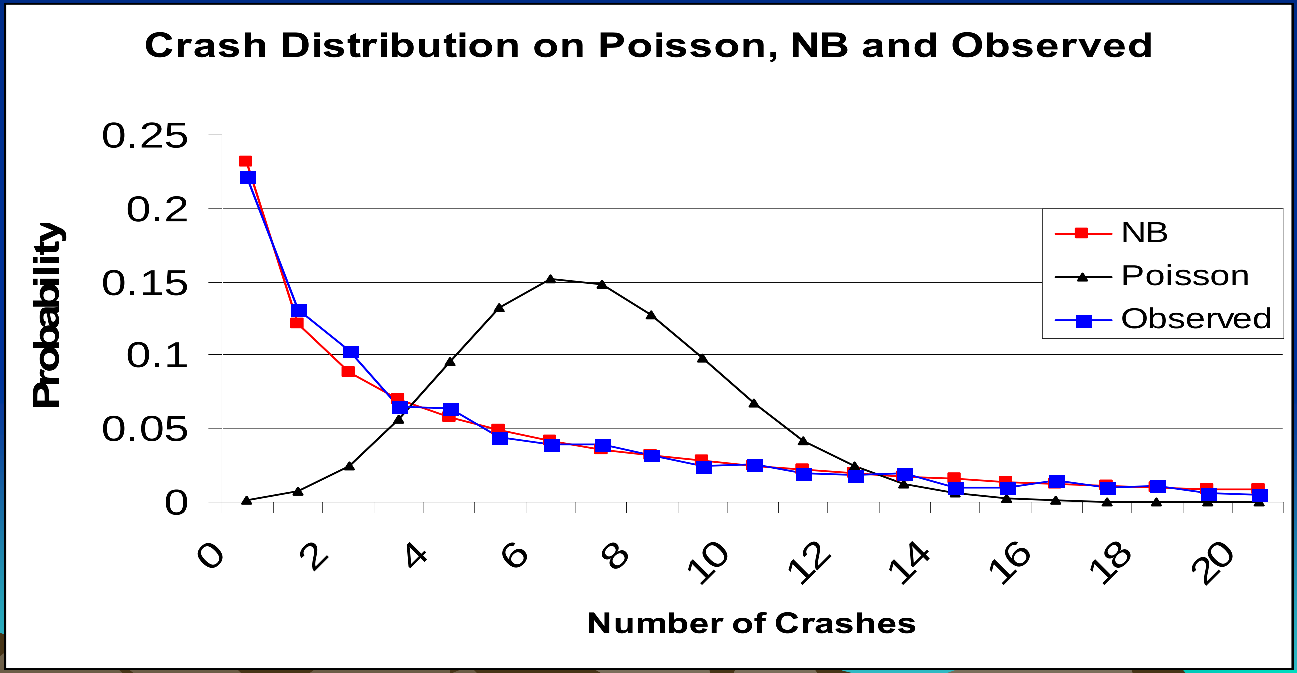
Choice Between Poisson and negative Binomial

- Equality of mean and variance
  - Command *“summarize crashes, detail”*

	Percentiles	Crashes		
25%	1	0	Observations	2038
50%	3		Mean	7
75%	9	69	Std. Dev	10
90%	18	71	Variance	100
95%	27	82	Skewness	2.86
99%	47	84	Kurtosis	14.19

Choice Between Poisson and negative Binomial Cont’

- Overdispersion test
  - Command *“nbvargr crashes”*
  - Overdispersion Factor=1.760794 , NB Favored



Test of alpha

- Negative Binomial takes $Var(y_i)=\mu_i+\alpha\mu_i^2$.

If $\alpha=0$, then Poisson is appropriate, otherwise NB

- Command *"nbreg"*
- Alpha=1.061775
- Likelihood-ratio test of alpha=0 gave χ^2= 7441.14 with a p-value =0.000.
- Hence α is significantly greater than 0, NB Favored

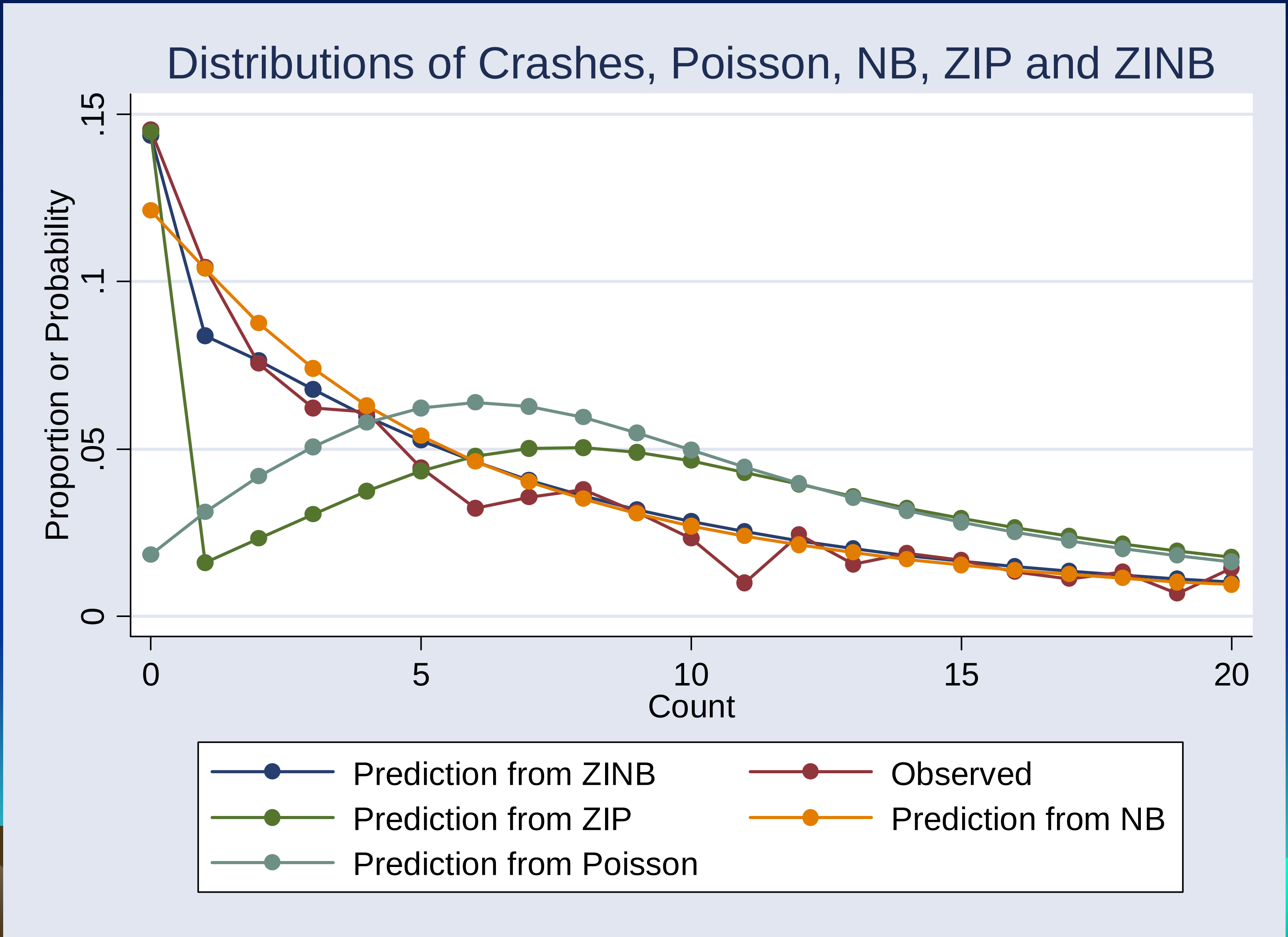
Vuong's Test

- Takes care of excess zeroes in the data
- Zero Inflated Negative Binomial (ZINB) and Zero Inflated Poisson (ZIP)

- Command *"zinb crashes length .. surwidth, inflate(length … surwidth) vuong "*

- Vuong test of ZINB vs Negative Binomial(NB), *Z = 1.54, P-value =0.06,* favoring *Negative Binomial*

Comparison of Distributions



Model

- *Command “nbreg crashes length accdens avgtfact medwidth sectadt sldwidth surwidth”*

					Number of Obs	=2038	
					LR chi2(7)	=804.57	
Negative binomial regression					Prob >chi2	=0	
Log likelihood=-5571.5611					PseudoR2	=0.0673	
crashes	Coef.	IRR	Std. Err.	z	P>|z|	[95% Conf.Interval]	
length	2.39931	11.0156	0.110069	21.8	0.000	2.183577	2.615038
accdens	0.00868	1.00872	0.002407	3.61	0.000	0.003966	0.0134
medwidth	-0.0074	0.992584	0.003058	-2.43	0.015	-0.01344	-0.00145
sldwidth	-0.0601	0.94165	0.013189	-4.56	0.000	-0.08598	-0.03428
surwidth	-0.067	0.93516	0.014891	-4.5	0.000	-0.09622	-0.03785
sectadt	2.4E-05	1.00002	1.76E-06	13.46	0.000	2.03E-05	2.72E-05
avgtfact	0.03838	1.03913	0.010137	3.79	0.000	0.018517	0.058252
_cons	2.24622		0.525809	4.27	0.000	1.215654	3.276787
Ln(alpha)	0.05994		0.040936			-0.02029	0.140175
alpha	1.06178		0.043464			0.979915	1.150475
Likelihood-ratio test of Alpha=0: chibar2(01)=7441.14						Prob>=chibar2 = 0.000	

Model Fitness Parameters

- Command *“fitstat”*

Measures of Fit for nbreg of crashes	
Log-Lik Intercept Only=-5969.901	Log-Lik Full Model=-5566.98
Deviance=11133.95	LR(7):805.852
	Prob > LR:0
McFadden's R2=0.067	McFadden's Adj R2=0.066
Maximum Likelihood R2:0.327	Cragg & Uhler's R2=0.328
AIC:5.475	AIC*n=11151.95
BIC=-4317.855	BIC'=-752.517

Finding from the model

- The longer the section length, the higher the crash rate
- The more the number of vehicle, the higher the likelihood of crash
- The higher the access density, the higher the crash rate
- The higher the percentage trucks the higher the probability of crash
- The wider the lane the lower the crash rate
- The wider the median, the lower the crash rate
- The wider the shoulder, the lower the crash rate

Sensitivity Analysis

- **Unit and standard deviation change in independent variables**
- **Marginal Effect**
- **Discrete change of the variable**

Unit and standard deviation change in independent variables

- *Command "listcoef, percent help"*

nbreg (N=2038): Percentage Change in Expected Count								
Observed SD: 9.9653801								
crashes	b	z	P>|z|	IRR &%		Std Deviation		SDofX
				e^b (irr)	%	e^bStdX	%StdX	
length	2.39931	21.798	0	11.0155	1001.6	1.8659	86.6	0.26
accdens	0.00868	3.608	0	1.0087	0.9	1.1181	11.8	12.8585
avgtfact	0.03838	3.787	0	1.0391	3.9	1.1077	10.8	2.6656
medwidth	-0.0074	-2.435	0.015	0.9926	-0.7	0.9351	-6.5	9.0195
sectadt	0.00002	13.463	0	1	0	1.4489	44.9 1	5619.36
sldwidth	-0.0601	-4.559	0	0.9416	-5.8	0.8818	-11.8	2.0927
surwidth	-0.067	-4.502	0	0.9352	-6.5	0.873	-12.7	2.0257
ln alpha	0.05994	1.464						

Marginal Effect

- Command *“mfx compute”*

<table>
<tr><td colspan="8">Marginal effects after nbreg
y = predicted number of events (predict) = 5.071057</td></tr>
<tr><th>Variable</th><th>dy/dx</th><th>Std. Err</th><th>z</th><th>P>|z|</th><th colspan="2">[95% Conf.Interval]</th><th>Mean(X)</th></tr>
<tr><td>length</td><td>12.167</td><td>0.11007</td><td>21.8</td><td>0.00</td><td>2.18358</td><td>2.61504</td><td>0.255773</td></tr>
<tr><td>accdens</td><td>0.04403</td><td>0.00241</td><td>3.61</td><td>0.00</td><td>0.00397</td><td>0.0134</td><td>13.5819</td></tr>
<tr><td>medwidth</td><td>-0.0377</td><td>0.00306</td><td>-2.43</td><td>0.015</td><td>-0.0134</td><td>-0.0015</td><td>20.7655</td></tr>
<tr><td>sldwidth</td><td>-0.3049</td><td>0.01319</td><td>-4.56</td><td>0.00</td><td>-0.086</td><td>-0.0343</td><td>2.89426</td></tr>
<tr><td>surwidth</td><td>-0.3399</td><td>0.01489</td><td>-4.5</td><td>0.00</td><td>-0.0962</td><td>-0.0379</td><td>34.7964</td></tr>
<tr><td>sectadt</td><td>1.20E-04</td><td>1.8E-06</td><td>13.46</td><td>0.00</td><td>2.1E-05</td><td>2.7E-05</td><td>47726</td></tr>
<tr><td>avgtfact</td><td>0.19465</td><td>0.01014</td><td>3.79</td><td>0.00</td><td>0.01852</td><td>0.05825</td><td>4.52513</td></tr>
</table>

Discrete change of the variable

- Command *"prchange, help"*

nbreg: Changes in Predicted Rate for crashes							
	min->max	0->1	-+1/2	-+sd/2	MargEfct		
length	275.3679	27.4951	15.3028	3.2146	12.167		
accdens	12.5078	0.0393	0.044	0.5665	0.044		
avgtfact	4.5498	0.1668	0.1947	0.5191	0.1947		
medwidth	-2.1829	-0.0439	-0.0377	-0.3405	-0.0377		
sectadt	14.6026	0	0.0001	1.8913	0.0001		
sldwidth	-2.7497	-0.3522	-0.3049	-0.6385	-0.3049		
surwidth	-4.2578	-3.3876	-0.34	-0.6891	-0.3399		
exp(xb):	5.0711						
	length	accdens	avgtfact	medwidth	sectadt	sldwidth	surwidth
x=	0.255773	13.5819	4.52513	20.7655	47726	2.89426	34.7964
sd(x)=	0.259974	12.8585	2.66564	90.01953	15619.4	2.09272	2.02567

Conclusion

- By using Various tests from Stata, Negative Binomial has been found to be appropriate distribution for our crash data
- Effect of the independent variables has been found and their significances
- Sensitivity analysis of how the change in the measure of the roadway geometrics can change the crash frequency

END

Thank you all

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