Does a Complex Environment Affect Police Efficiency: An Examination on Municipal Police in Mexico

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ABSTRACT
Research on police organisations argues that the external environment in which they operate have a negative effect on their performance. We tested these assumptions on a sample of 1,634 municipal police forces in Mexico, We used a conditional order-m model to examine how the environment in which police operate affects their performance. Our results indicate that not all socioeconomic, demographic and institutional factors have a negative influence on police performance.

KEYWORDS
Police efficiency; Mexico; Environmental Factors; Conditional Order-m.

1. Introduction

Mexico is experiencing one of the worst waves of violence in their recent history. To try to curb the levels of violence, budgetary allocations to the security sector in Mexico have increased by more than 61% since 2009 [20]. However, a larger security budget has not yielded improvements in the safety and security as levels of violence continue to worsen and Mexican citizens feel increasingly insecure [6]. Because crime tends to efficiency of police forces at the municipal level is critical to both improving the security situation and make better use of police's human and financial resources.

The public nature of police work, which involves constant interaction with the environment in which they operate requires further examination. The scant scholarly literature on police efficiency generally argues that socioeconomic, demographic and institutional factors explains differences in police performance [1, 19, 23]. However, the relationship between the environment and police performance does not always follow the same direction. Some studies find this relationship to be more favourable [2, 14] and, in some others, it is less favourable [3]. In other words, local characteristics may be critical improve police performance.

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This study attempts to offer some light to whether (un)favourable socioeconomic, demographic and institutional characteristics affect police performance for a sample of 1,634 municipalities in Mexico. Our findings indicate that, contrary to previous research, the relationship between police and the environment is not always negative. Thus, it is important for police organisations and managers to have a thorough understanding of the operational environment to make better use of their resources.

2. Methods

2.1. *Data and Variables*

To conduct our analyses we obtained data on municipal police organizations from the *Instituto Nacional de Geografía y Estadística* in Mexico [6]. After pre-processing the original sample[1] the final sample was comprised of 1634 municipal police forces for the year 2013-14. Table 1 presents the summary statistics of the variables employed in the analysis.

Table 1. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Inputs					
Number of Police Officers	1,634	356.38	1012.57	4	13120
Number of Police Vehicles	1,634	122.64	390.92	2	5282
Available Technology to Police	1,634	0.71	2.04	0.00070	32.15
Outputs					
Number of Crimes Prevented	1,634	1.28	10.65	1	431.58
Environmental Factors					
Average Number of Years of Education	1,634	6.70	1.49	2.03	12.09
Unemployment Rate	1,634	53.43	6.65	32.78	94
Poverty Rate	1,634	67.21	18.20	12.8	97.4
Gini Coefficient of Income Inequality	1,634	0.41	0.03	0.32	0.55
% of Youth 15 to 24 years old	1,634	13.54	1.10	9.35	19.43
Population Density	1,634	260.78	872.11	0.047	15155
Intensity of Organized Crime	1,634	0.33	0.47	0	1
Party in Government	1,634	2.15	0.60	1	3

Source: [6]

Following the scholarly literature on police efficiency, we employed the number of police officers, police vehicles, and available technology [3, 13, 21][2] as inputs in our efficiency model. We employed the total number of crimes prevented as output in our model. We generated this measure following Färe et al. (2012) [10] and the number of cases corresponding to the municipality that had the largest crimes by the number of crimes corresponding to the observed municipality.

[1] Our original sample was comprised of 2457 observations (municipal governments).

[2] The technology variable is the summation of all the technology inputs employed by the police. These include computers, laptops, phones, cell phones, tablets, and other technology available to police.

The factors comprising the conditional model to capture the environmental complexity in which police organisation operate included the average number of years of education, the unemployment rate, the poverty rate, the GINI coefficient of income inequality, the percentage of youth 15-24 years old, population density, the presence of organised crime, and the type of political party in the government (conservative, progressive or coalition). The above factors have been identified in the specialised literature as affecting the performance of police organisations [2, 9, 16].

2.2. *Methodology*

To examine the effects of exogenous factors on police performance, we employed a multiple stage analysis. In the first stage we ran an unconditional efficiency model (without the exogenous factors) using a partial frontier model (order-m) with an m value = 160[3]. In the second stage, we ran the same efficiency model conditional on the exogenous factors,which include the environmental factors in the police operational technology so that we avoided comparing units that operate in a different environment. In the final stage, we conducted non-parametric regressions with the ratio of the conditional efficiency estimates over the unconditional ones[4].This stage allowed us to examine which factor/s had the strongest effect on police efficiency. One of the advantages of the order-m methodology is that the efficiency estimates are robust to the presence of outliers because the efficiency frontier is not bounded from above at values of 1 [11]. Furthermore, this methodology is robust to the presence of outliers by using a variation of the "Free Disposal Hull"[5] method, which relaxes the convexity assumption implicit in traditional DEA models [8, 12].

3. Results

Table 2 below presents the results of both the conditional and unconditional efficiency models. The mean unconditional efficiency score was 1.018 where as the mean conditional efficiency score was 1.005. This suggests that, on average, municipal police forces could prevent about 2% of crimes if they performed at the same levels as the best performers. The results for the conditional model indicate an improvement in the average levels of police efficiency of about 1.3%.

Our findings counter previous research, which found that exogenous factors had, on average, a positive effect on police efficiency. These results, however, may conceal differences in the way in which the local external environment and the police interact. For example, research in developing regions and countries suggests that, police performance increases after controlling for exogenous factors [16]. In other words, police working in an adverse environment were penalised in the first stage and, thus, after efficiency scores after controlling for exogenous factors, leads to an improvement in

[3]Values of m should be such that the number of super-efficient (super performing municipalities) observations begins to stabilise [5]. Other research indicates that the value of m should account for 10% of the super-efficient observations [4]. Following this suggestion and our sample size, the value of m is roughly 160. Robustness checks for different values of m indicate that the chosen m is correct for our analyses.

[4]We conducted this model using DeWitte and Kortelainen's approach to conditional efficiency [7].

[5]The shape of a "Free Disposal Hull" model is stepwise instead of the convex shape of traditional DEA models.

Table 2. Efficiency Results

Unconditional Model	Count	Mean	Sd	Min	Max
Efficient-Super Efficient	82	1.021	0.038	1.000	1.342
Inefficient	1557	0.965	0.069	0.639	0.999
Conditional Model					
Efficient-Super Efficient	138	0.943	0.091	0.533	0.999
Inefficient	1496	1.011	0.016	1.000	1.147

Source: Own Analysis based on INEGI (2015).

the levels of efficiency. In contrast, research in more advanced economies suggests that socioeconomic factors tend to negatively affect police efficiency (see for example, [3]). However, this relationship had rarely been tested in the context of developing countries. In order to ascertain the direction and the magnitude of the effect of exogenous factors on police performance, we followed prior research [7] regressed the ratio of conditional efficiency over unconditional efficiency using a non-parametric regression model. The results are presented in Table 3.

Table 3. Nonparametric regression results of Environmental Factors on Efficiency

Exogenous Variable	Coefficient	Std. Error	Significance
Unemployment Rate	0.00384	(0.0002)	
Poverty Rate	0.00098	(0.00002)	***
Intensity of Organised Crime	0.00057	(0.0000)	
Population Density	-0.00001	(0.0000)	
Average Number of Years of Education	-0.00514	(0.0010)	***
% of Youth 15 to 24 years old	-0.00982	(0.0010)	***
Party in Government	-0.03026	(0.0000)	***
Gini Coefficient of Income Inequality	-0.35667	(0.1030)	***
R^2	0.518		

Source: Own Analysis based on INEGI (2015)
Notes: *** indicate statistical significance at the 0.1% level.

The effects of population density, educational attainment, the size of the youth population, the level of income inequality, and the ideology of the local government in power are negative and statistically significant. In other words, the higher the value of the exogenous factors, the the higher the impact of this variable on the levels of efficiency. Conversely, the poverty rate in the municipality is positive and statistically significant, which indicates that the higher the value of the poverty rate, the lower the impact of this variable on the levels efficiency.

The effects of the impact of the educational attainment of the population and the poverty rate differ from prior research [2, 3, 17, 18].

The positive sign of poverty on police efficiency is particularly interesting because it would indicate that police operating in poorer environments do not perform worse than police operating in more affluent context. There may be various factors that explain the positive relationship between poverty and police efficiency. First, it is likely that, since poverty is highly correlated with higher crime rates, there may be increased

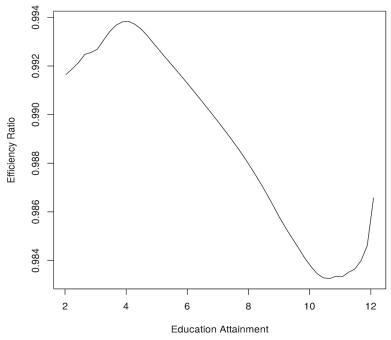

Figure 1. Education Attainment

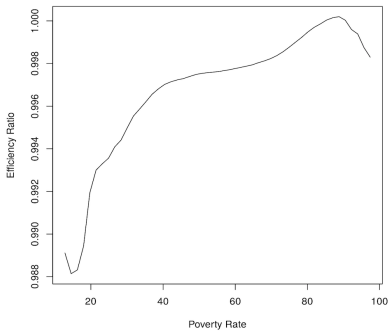

Figure 2. Poverty Rate

demand for police services and, thus, a larger output in terms of crimes prevented.

Second, although highly concentrated crimes and higher levels of poverty are generally positively correlated with each other [24], this relationship is exogenous to police activity. Therefore, it is important to control for poverty when measuring police efficiency because police activity will have an effect on the crime levels, which in turn, will be affected by poverty. However, the relationship between poverty and crime is often shaped by a complex gamut of factors related to individual and community characteristics [15, 22].

Third, the effect of poverty on police efficiency may be non-linear. Alda (2017) [2] found that the turning point of the quadratic effect of poverty occurred at high levels of poverty. Given that the mean poverty rate in Mexico is over 60% it is likely that municipalities in rural areas contribute to higher levels of police efficiency. In effect, figure 2 shows a non-linear relationship between poverty and police efficiency. A related fourth factor is that police working in poorer municipalities may have developed a 'modus operandi' that includes developing closer ties with community dwellers through foot patrols and community-oriented policing approaches, which may lead to the prevention of more crimes.

It is worth discussing is the potential interaction between the unemployment rate and poverty. Higher levels of unemployment may be correlated with higher levels of poverty and affect the direction of the sign in the regression coefficient. However, robustness tests[6] where only one of the variables is used in the analysis do not change the direction or the significance of the regression coefficient for the poverty rate variable.

The negative correlation between education and poverty is also an interesting one. Prior research suggests a positive correlation between police efficiency and higher levels of education [18]. However, our findings suggest that this relationship is non linear. Although, on average, the effect is negative, figure 1 shows a positive correlation between educational attainment at low levels of educational attainment($\leqslant$4 years of education) and at very high levels of educational attainment($\geqslant$10 years of education). This result suggest

[6]Not reported here due to space limitations.

4. Conclusions

This study has shed light on the effect of exogenous factors on police efficiency for a sample of 1,634 municipalities in Mexico. Our results suggest a counter intuitive effect of socioeoconomic factors like poverty, unemployment, and education. Perhaps the most surprising effect is that of the poverty rate where poorer municipalities appear to have higher levels of police efficiency. Our findings suggest that working in an adverse environment does not necessarily translate into lower efficiency. There complex relationship between poverty, crime, individual characteristics and local characteristics may explain the effect between poverty and police efficiency. However, it is also possible that police forces in those municipalities have devised operational strategies that are contributing to improve their performance. Stated differently, the way in which the police are organised locally can make a notable difference in how they use their resources and how it impacts their performance in preventing crime. Thus, although the environment invariably influences police efficiency, the way in which police are organised at the municipal level will mitigate the impact that the exogenous factors have on their performance.

There are limitations in this study that are worth noting. First, it was not possible to control for all the potential exogenous factors that can affect police efficiency due to lack of consistent data. The factors employed in this study are those identified in the police research literature; but there may be other factors that are specific to the Mexican policing context that would be important to explore further. Second, we used an output measure that approximates the total number of crimes prevented. However, given the heterogeneity regarding the types of crimes committed and their magnitude, it would likely influence both the unconditional and conditional efficiency estimates.

Finally, in addition to external factors, internal organisational factors also affect police efficiency and alternative models examining police efficiency should consider including internal organisational factors.

References

[1] Erik Alda. How are police doing in combating crime?: An efficiency analysis of the national police in honduras, 2013.

[2] Erik Alda. *The Impact of Exogenous Factors on Police Efficiency: An Empirical Study of Municipal Police Forces in México*. PhD thesis, American University, Washington, D.C., 2017.

[3] Carlos Pestana Barros. The city and the police force: analysing relative efficiency in city police precincts with data envelopment analysis. *International Journal of Police Science & Management*, 9(2):164–182, 2007.

[4] Andrea Bonaccorsi and Léopold Daraio, Cinzia & Simar. Advanced indicators of productivity of universitiesan application of robust nonparametric methods to italian data. *Scientometrics*, 66(2):389–410, 2006.

[5] Cinzia Daraio and Lopold Simar. *Advanced robust and nonparametric methods in efficiency analysis: Methodology and applications*, volume 4. Springer Science & Business Media, 2007.

[6] Instituto Nacional de Estadstica y Geografa (INEGI). Censos de gobierno, 2015.

[7] Mika De Witte, Kristof & Kortelainen. What explains the performance of students in a heterogeneous environment? conditional efficiency estimation with continuous and discrete environmental variables. *Applied Economics*, 45(17):2401–2412, 2013.

[8] D Deprins and L Simar. Measuring labor inefficiency in post offices. the performance of public enterprises: Concepts and measurements, m. marchand, p. pestieau and h. tulkens (eds.), 243-267. *North-Holland, Amsterdam. Farrell, MJ (l957). The measurement of production efficiency. Journal of the Royal Statistical Society A*, 120:253–281, 1984.

[9] A. Dez-Ticio and M. J. Mancebn. The efficiency of the spanish police service: an application of the multiactivity dea model. *Applied Economics*, 34(3):351–362, 2002.

[10] Rolf Färe and Shawna Grosskopf. *Intertemporal production frontiers: with dynamic DEA*. Springer Science & Business Media, 2012.

[11] Stefan Felder and Harald Tauchmann. Federal state differentials in the efficiency of health production in germany: an artifact of spatial dependence? *The European Journal of Health Economics*, 14(1):21–39, 2013.

[12] Stefan Felder and Harald Tauchmann. Federal state differentials in the efficiency of health production in germany: an artifact of spatial dependence? *The European Journal of Health Economics*, 14(1):21–39, 2013.

[13] Isabel-María García-Sánchez, Luis Rodríguez-Domínguez, and Javier Parra-Domínguez. Yearly evolution of police efficiency in spain and explanatory factors. *Central European Journal of Operations Research*, 21(1):31–62, 2013. Cent Eur J Oper Res.

[14] Jeffrey W. Goltz. *Police organizational performance in the state of Florida: confirmatory analysis of the relationship of the environment and design structure to performance*. PhD thesis, University of Central Florida Orlando, Florida, 2006.

[15] Tim Hope. *Crime victimisation and inequality in risk society*. Routledge, 2013.

[16] Alejandro Izquierdo and Carola Pessino. Mejor gasto para mejores vidas: Cómo américa latina y el caribe puede hacer más con menos. Technical report, 2018.

[17] Javier Parra Domínguez. Nuevas tendencias en el estudio de la eficiencia policial. el índice de situación policial. 2013.

[18] Sánchez Isabel María García Parra-Domínguez, Javier and Luis Rodríguez Domínguez. Relationship between police efficiency and crime rate: a worldwide approach. *European Journal of Law and Economics*, 39(1):203–223, 2015.

[19] Shinn Sun. Measuring the relative efficiency of police precincts using data envelopment analysis. *Socio-Economic Planning Sciences*, 36(1):51–71, 2002.

[20] Dalia Toledo. Descifrando el gasto público en seguridad. Report, Instituto Ethos, 2016.

[21] Sinan Ülkemen and Sebahattin Gültekin. Measuring the relative efficiency of city police departments in turkey by using data envelopment analysis. *Journal of Police Studies*, 12:126–144, 2010.

[22] Avelardo Valdez, Charles D Kaplan, and Russell L Curtis Jr. Aggressive crime, alcohol and drug use, and concentrated poverty in 24 us urban areas. *The American journal of drug and alcohol abuse*, 33(4):595–603, 2007.

[23] Arvind Verma and Srinagesh Gavirneni. Measuring police efficiency in india: an application of data envelopment analysis. *Policing: An international journal of police strategies & management*, 29(1):125–145, 2006.

[24] CS Webster and Sarah Kingston. Anti-poverty strategies for the uk: poverty and crime review. 2014.