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The effects of crime on the Mexican economy: a vector error correction model

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Abstract

The aim of this study was to examine the extent to which crime affects the components of aggregate demand and vice versa for the case of Mexico, using quarterly data for the number of homicides and the components of aggregate demand for the period from 1990 to 2010. We estimated a Vector Error Correction Model in order to be able to distinguish the short run and long run dynamics present between crime and aggregate demand and its components. In the short run, it was found that none of the components of aggregate demand affect crime and that the only component of aggregate demand affected by crime is private consumption, which is affected negatively by an increase in the crime rate. It was also found that crime has a positive effect on GDP, government consumption and imports in the long run. On the other hand, private consumption, investment and exports have a negative effect on crime in the long run. Thus, the results obtained in this study indicate the existence of a bidirectional relationship between crime and economic activity in Mexico.

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1. Introduction

The recent years have seen a large increase in crime rates in Mexico. The Mexican government has set as a high priority to create policies and strategies to combat crime, because of the very high costs crime imposes on the Mexican society. The data show that the country experienced a sharp increase in the number of homicides during the first decade of this century. Thus, while in the first quarter of 2000 there were 2.9 homicides per 100,000 inhabitants, in the last quarter of 2010 there were 6.6 homicides per 100,000 inhabitants.

Becker (1968), a pioneer in studying this issue through an economic approach, points out how criminals, behaving as rational agents, have different options to engage in illegal activities in which they can focus their efforts to obtain greater economic returns. According to his approach, criminals consider the costs and benefits of committing a crime in their decision to become criminals.

In recent years several investigations have been carried out analyzing the relationship between crime and economic activity. Detotto and Pulina (2010) found that long-term crime has a negative effect on investment and public spending. Also, Detotto and Otranto (2010) conclude that crime often acts as a tax on the country's economy since it creates inefficiencies and uncertainty, reducing the competitiveness of enterprises and investment. Anderson (1999), states that crime creates opportunity costs for society and government. Expenditures to combat crime absorb much of government's spending, which could have been earmarked for investment and job creation. In their research, Pellegrini and Gerlagh (2004), indicate that corruption slows economic growth. Studies focusing on terrorism, such as that of Gaibulloev and Sandler (2008), conclude that terrorism has an inverse relationship with economic growth.

This paper aims to identify the impacts of crime on the Mexican economy, particularly on aggregate demand and its components. Using the methodology developed by Detotto and Pulina (2010), we estimate a Vector Error Correction Model (VECM) to analyze the short-and long-term effects of crime upon the variables used in the model. Before the estimation of the VECM model, we use the Augmented Dickey-Fuller test to determine whether or not the variables are stationary and, after this is done, we perform a Johansen cointegration test to determine if the variables are cointegrated. Also, we used the methodology proposed by Narayan and Popp (2010), to detect whether there are structural breaks in the crime series. If a structural break is detected, we include a structural break dummy variable in the VEC model.

The data used in the model were quarterly data obtained from the National Institute of Statistics and Geography (INEGI) for the period 1990-2010. The variables studied in the model are: Crime rate, GDP, private consumption spending, government spending, investment, exports and imports.

The paper is organized as follows: Section two presents a review of literature on the impact of crime on the economy; section three presents a description of the data used in the model. The fourth section develops the econometric model used in the paper, including the corresponding tests for stationarity and cointegration of the variables, as well as for the possible presence of structural breaks in the crime data. Section five presents the econometric results of the model and, finally, section six concludes.

2. Literature Review

In recent years there has been a series of studies that show a distinct causal link between crime and economic growth. Detotto and Pulina (2010), using a Vector Error Correction Model (VECM), analyzed the impact of crime on the components of GDP for Italy. The authors found that in the long run, crime has a positive effect on imports and inflation and a negative effect on investment and public spending. Habibullah and Law (2008), for the case of Malaysia, found that an increase in employment opportunities and an improvement in economic conditions decrease crime. Mahmood, Rehman and Rasheed (2009) found that there is a long-term cointegration relationship among crime, unemployment, poverty and inflation in Pakistan.

Narayan and Smyth (2004), using an Autoregressive Distributed Lag Model (ARDL) for the case of Australia, found that fraud, vehicle theft, and murder are cointegrated with male youth unemployment and average weekly earnings.

In a study for the case of Italy, Detotto and Pulina (2013) found that there is a positive relationship between the different types of crimes over time. These crimes affect directly and indirectly the rate of economic growth in the country. Peri (2004) also studies the Italian case and he finds that in the presence of organized crime, as measured by the number of homicides, economic growth is lower. Crime affects economic growth as it has a crowding-out effect on economic activity. Another example of this negative effect of crime on economic growth is given by Gaibulloev and Sandler (2008), who study the economic effects of terrorism in Asia. Using panel data, the authors find that a terrorist attack has a negative effect on growth, especially in underdeveloped countries.

3. Data

This research aims to estimate the impact of crime in Mexico's economy, particularly on aggregate demand and its components. The analysis is carried out with quarterly data, for the period 1990-2010. The variables studied in the model are: crime, GDP, private consumption spending, government consumption spending, investment, exports and imports. Following Detotto and Pulina (2010), we used the number of homicides for every 100,000 inhabitants to represent the criminality variable. Economic variables are in a per capita basis and in real terms and all the variables were transformed to their logarithms.

4. Econometric Model

Following the methodology used by Detotto and Pulina (2010), we analyze the relationship between crime and the components of aggregate demand: private consumption, government consumption, investment, exports and imports. We use a VECM model (Vector Error Correction Model) to estimate the short and long term effects of crime on each variable included in the model and vice-versa. Before estimating the VECM model, an Augmented Dickey-Fuller test is carried out in order to determine whether the variables are stationary or not. Likewise, we used the two structural break test of Narayan and Popp (2010) to detect possible structural breaks in the crime series, using this information to construct structural break dummy variables if a structural break is detected and then we include such dummy variables in the VECM model.

To carry out the ADF test, it is first necessary to determine the number of lags (p). In our model we use the SBIC criterion, as Torres-Reyna (2012) notes that this criterion is the one that works best for quarterly information for any type of sample. After the stationarity tests are carried out, we performed a Johansen test to determine whether or not the variables included in the model are cointegrated. According to Koop (2008), if the variables are cointegrated, an error correction model (VECM) can be used to understand the short-term behavior of the variables, which a simple regression cannot do.

5. Results

5.1 The VECM Model

A VECM model can be expressed as follows:

$$DY_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i Y_{t-i} + KDV_t + {}_t \qquad (1)$$

Where:

$Yt = (LH, \ldots, LIMP)$ is a vector of all endogenous variables as defined above, expressed in its first differences (D).

Π = It is the long run part of the model, which contains the cointegration coefficients β and α.

Γ= It is the matrix of short-term parameters.

DV= It contains deterministic variables, such as the constant and a trend variable.

ε_t= It is the vector of the disturbance terms, which are assumed to be uncorrelated with their lagged values nor with the variables on the right side of the equation.

5.2 Stationarity Tests

In Table 1 we can see that all variables (in levels) included in the model have a unit root, as the t-statistic is smaller (in absolute value) than the critical value. However, by differentiating each of the variables, they become stationary, as indicated by the fact that the *t* statistics calculated for all variables are greater (in absolute value) than the corresponding critical values.

5.3 Detection of possible structural breaks in the crime series

We used the Narayan and Popp (2010) methodology to investigate the possible presence of structural breaks in the number of homicides. As Table 2 shows, the Narayan and Popp (2010) test indicated that there was one slope break in the first quarter of the year 2000 and then again another one in the first quarter of the year 2006. In order to account for these structural breaks, we constructed two dummy variables and included them in the VECM model as exogenous variables.

5.4 Determination of the Optimal Number of Lags of the VECM Model

There are various methods and criteria for determining the optimal order of lags for a VECM. Table 3 shows (indicated with an asterisk) the optimal number of lags under different criteria. As can be seen, both the SBIC criteria and the HQIC criteria indicate that the optimal number of lags in the model is one. Also, as mentioned above, Torres-Reyna (2012) notes that the SBIC criterion tends to produce better results for models with quarterly series, so we decided to select a model with one lag, as indicated by the HQIC and SBCI criteria.

5.5 Cointegration Tests

Once the optimal number of lags for the model has been determined, the next step is to determine whether or not the variables are cointegrated, which is done by carrying out a Johansen test, whose results are shown in Table 4. It can be seen that the variables included in the model are cointegrated and that there is only one cointegrating relationship (Koop, 2008).

5.6 Long-Run Effects

Table 5 shows that, in the long run, all aggregate demand variables have a strongly significant effect on crime (LH). GDP (LGDP), government consumption (LG) and imports (LIM) have a positive effect on crime, while private consumption (LC), private investment (LI) and exports (LEX) have a negative effect. On the other hand, crime affects positive and significantly GDP, government consumption and imports, and negatively private consumption, investment and exports. Except for the Government Consumption variable, all the signs of the long run effects are the same than for the case of Italy obtained by Detotto and Pulina (2010). However, we found stronger long run effects for the case of Mexico for the effects of GDP and private consumption on crime, while Detotto and Pulina (2010) estimated stronger effects of investment, government consumption, exports and imports.

Regarding long run equilibrium, Table 6 shows that the ECT_{t-1} is statistically significant in five equations (D(LGDP), D(LC), D(DLI), D(LG) and D(LIM)), presenting a negative sign for D(LGDP) D(LC), D(LI) and D(LIM), which implies a convergence towards long run equilibrium.

5.7 Short-Run Effects

Short-Run effects are shown in Table 6. It is shown there that the only component of aggregate demand that is affected by crime is private consumption. Also, it can be seen in the table that there are no statistically significant effects of the components of aggregate demand upon crime. These findings contrast with the results obtained by Detotto and Pulina (2010) who found statistically significant effects of crime on GDP, government consumption and exports for the case of Italy.

Based on the results shown in Tables 5 and 6, Tables 7 and 8 compare the short and long term effects of each of the variables on crime and vice-versa. Table 7 shows the effects of aggregate demand components on crime. It can be seen that none of the components of aggregate demand affects crime in the short run but in the long run GDP, government consumption and imports have a positive effect on crime while private consumption, investment and exports have a negative effect.

Finally, Table 8 compares the effects of crime on the components of aggregate demand both in the short run as in the long run. Except for the variable private consumption, the VECM model results do not indicate the presence of significant effects of crime on economic activity in Mexico in the short run. However, in the long run, an increase in the number of crimes has a positive effect on GDP. The same direct relationship holds for government consumption and imports. On the contrary, if crime increases, the model predicts a long-term negative effect on private consumption, investment and exports.

6. Conclusions

The aim of this study was to examine the extent to which crime affects the components of aggregate demand and vice versa for the case of Mexico, using quarterly data for the number of homicides and the components of aggregate demand for the period from 1990 to 2010. We estimated a Vector Error Correction Model, as proposed by Detotto and Pulina (2010), taking into account in the model the presence of two structural breaks in the crime series, as detected by the Narayan and Popp (2010) two structural break test. The VECM model developed in the paper allowed us to distinguish the short run and long run dynamics present between crime and aggregate demand and its components.

In the short run, it was found that none of the components of aggregate demand affect crime and that the only component of aggregate demand affected by crime is private consumption, which is affected negatively by an increase in the crime rate. It was found also that crime has a positive effect on GDP, government consumption and imports in the long run. On the other hand, private consumption, investment and exports have a negative effect on crime in the long run, coinciding with the findings of Detotto and Pulina (2010) for the case of Italy.

The investigation found that there are several similarities and differences in the short and long-term effects of crime on the economy and vice versa. The effect of GDP on the crime rate is statistically significant in the long run but not in the short run. Also, an increase in private consumption, investment and exports result in a decrease in the number of crimes in the long run but have no statistically significant effect in the short run. On the other hand, while the effects of crime on the components of aggregate demand are not statistically significant in the short run (except for the case of private consumption), they are statistically significant in the long run.

The results obtained in the study indicate the existence of a bidirectional relationship between crime and economic activity in Mexico. Suggestions for further research include testing for a causality relationship between the crime rate and aggregate demand and its components. Likewise, it would be convenient to investigate the effects of the different types of crimes on the Mexican economy in order to design and adopt more efficient policies which could contribute to increase the rate of economic growth in the country.

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Table 1: Unit Root Tests

Variable	Status	ADF	Lags
LH	I(1)	1.199	1
D(LH)	I(0)	-10.832***	0
LGDP	I(1)	-2.860	2
D(LGDP)	I(0)	-6.009***	1
LC	I(1)	-2.381	2
D(LC)	I(0)	-5.956***	1
LG	I(1)	-2.405	2
D(LG)	I(0)	-9.224***	1
LI	I(1)	-3.252	2
D(LI)	I(0)	-5.400***	2
LEX	I(1)	-1.588	3
D(LEX)	I(0)	-5.903***	1
LIM	I(1)	-2.287	2
D(LIM)	I(0)	-5.493***	1

Note: D denotes the first difference operator.
Source: Own estimates.

Table 2: Results of the Narayan-Popp Unit Root Test with two structural breaks for the Number of Homicides variable

	Model Type	
	M1	M2
TB1	1998q4	2000q1
TB2	2000q1	2006q1
t- value	0.4963	-6.441

Source: Own estimates using the Gauss programming code provided by Paresh Kumar Narayan and Stephen Popp

Table 3: Determining the optimal number of lags for the VECM model

Lag	LL	LR	Df	P	FPE	AIC	HQIC	SBIC
0	846.431				0	-20.9608	-20.8653	-20.7226
1	1399.98	1107.1	64	0.000	0*	-33.1996	-32.3401*	-31.0558*
2	1460.41	120.84	64	0.000	0	-33.1102	-31.4866	-29.0607
3	1514.57	108.33	64	0.000	0	-32.8643	-30.4768	-26.9092
4	1595.77	162.39*	64	0.000	0	-33.2942*	-30.1427	-25.4336

Note: * Indicates optimal lag as selected by the criterion
Source: Own estimates.

Table 4: Johansen Test for Cointegration

Maximum Rank	Parms	LL	Eigenvalue	Trace statistic	Critical value (5%)
0	16	1329.4605	.	207.2221	170.80
1	31	1368.894	0.61334	128.3551*	136.61
2	44	1391.8273	0.42455	82.4884	104.94
3	55	1407.5216	0.31489	51.0998	77.74
4	64	1419.0272	0.24213	28.0886	54.64
5	71	1425.5792	0.14605	14.9847	34.55
6	76	1429.944	0.09983	6.2551	18.17
7	79	1432.6923	0.06408	0.7585	3.74
8	80	1433.0715	0.00910		

Source: Own estimates.

Table 5: Long-Run Elasticities

Endogenous Variables	Exogenous Variables						
	LH	LGDP	LC	LI	LG	LEX	LIMP
LH	-	44.528***	-33.315***	-8.032***	4.154***	-8.319***	8.207***
LGDP	0.022***	-	0.748***	0.180***	-0.093***	0.187***	-0.184***
LC	-0.030***	1.337***	-	-0.241***	0.125***	-0.250***	0.246***
LI	-0.125***	5.544***	-4.148***	-	0.517***	-1.036***	1.022***
LG	0.241***	-10.719***	8.020***	1.933***	-	2.003***	-1.976***
LEX	-0.120***	5.353***	-4.005***	-0.965***	0.499***	-	0.987***
LIMP	0.122***	-5.426***	4.059***	0.979***	-0.506***	1.014***	-

Note: (1) ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: own estimates.

Table 6: Short-Run Effects

Exogenous variables	Endogenous variables						
	D(LH)	D(LGDP)	D(LC)	D(LI)	D(LG)	D(LEX)	D(LIM)
D(LH)	-0.325**	0.008	0.040*	0.050	-0.045	-0.023	0.086
D(LGDP)	2.140	-0.934***	-0.695	-3.939**	1.660**	0.622	-1.457
D(LC)	-1.627	0.461**	0.303	2.427**	-1.212***	-0.269	1.047
D(LI)	-0.377	0.176**	0.136	0.661**	-0.204	-0.051	0.312
D(LG)	-0.219	0.048	0.034	-0.138	-0.253**	-0.112	-0.208
D(LEX)	-0.389	0.089	0.030	0.438	-0.222*	-0.103	0.118
D(LIM)	0.410	0.062	0.089	-0.008	0.363**	0.153	-0.013
D2000	-0.001	0.001***	0.003***	0.005***	-0.002***	0.001	0.004***
D2006	0.044	-0.010	-0.019**	-0.006	0.005	-0.007	-0.021
CointEq1	0.065	-0.028***	-0.050***	-0.119***	0.061***	-0.033	-0.107***
Constant	0.014	-0.014***	-0.024***	-0.062***	0.027***	0.007	-0.032**

Notes: (1) ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. (2) D denotes the first difference operator.
Source: Own estimates

Table 7: Effects of the Components of Aggregate Demand on Crime

	Short-Run	Long-Run
GDP	NS	+
Private Consumption	NS	-
Investment	NS	-
Government Consumption	NS	+
Exports	NS	-
Imports	NS	+

NS=Not statistically significant
Source: Own estimates

Table 8: Effects of Crime on the Components of Aggregate Demand

	Short-Run	Long-Run
GDP	NS	+
Private Consumption	+	-
Investment	NS	-
Government Consumption	NS	+
Exports	NS	-
Imports	NS	+

Note: NS denotes not statistically significant
Source: Own estimates