

FUNDACION PARA LA EDUCACION SUPERIOR Y EL DESARROLLO



VIOLENCIA EN COLOMBIA: UNA APROXIMACIÓN ECONOMÉTRICA Y ESPACIAL PARA IDENTIFICAR LAS CAUSAS Y LAS CONSECUENCIAS

Versión Final para la Fundación Ford

FEDESARROLLO

Junio de 2004

**Violencia en Colombia: Una Aproximación Econométrica y Espacial para
Identificar las Causas y las Consecuencias**

Informe Final

Número de la Donación: 1035-0237

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Nombre de la Institución: Fedesarrollo

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Este Informe Final comprende el *Informe Narrativo Final* y las versiones finales para publicación de los artículos “*Dynamic and causes of crime in Colombia*” y “*Does Violence Reduce Investments in Education?: A Theoretical and Empirical Approach*”, productos de la investigación realizada con recursos de la Fundación Ford.

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Período cubierto por este Informe:

Parte A. 1 de Enero de 2003-31 de Diciembre de 2003.

Parte B. 1 de Enero de 2004-30 de Junio de 2004.

ABSTRACT

The origins of current violence in Colombia are diverse. During the last 40 years Colombia has faced a long-standing civil war where left-wing guerrilla groups, right-wing paramilitaries and the government are confronted. In addition, illegal drug trafficking escalated since the 1980s and, as a consequence, illegal activities and crime flourished. Lastly, the erosion of the Judicial System, provoked mainly by drug trafficking, created favorable conditions for crime development (Montenegro and Posada, 2001).

The pattern of violence in Colombia is however not homogenous across types of violence and across groups of the population. During the period spanning from 1980 to 1990 homicide rates soared reaching epidemic proportions in large cities and, after a peak in the nineties, homicide rates have fallen steadily. In stark contrast, other types of violence gained momentum in the last decade, mainly kidnapping, car theft and armed robbery. Micro evidence obtained from the Social Household Survey conducted by Fedesarrollo shows that there is an asymmetry between types of violence and households that bear the violence: lowest quintiles suffer more from homicides while highest quintiles suffer more from kidnappings and property crime.

The purpose of this research is to identify the causes of violence in Colombia and establish its economic losses. The paper "Dynamic and causes of crime in Colombia" allows the identification of the roots of violence and crime in the country. The paper "Does Violence Reduce Investments in Education?: A Theoretical and Empirical Approach" estimates the impact of violence on investments of human capital. Estimations will provide evidence on the influence of violence on education and will contribute to assess the costs of violence.

The first paper adds to previous research about causes of crime by the use of a new dataset and better set of econometric estimations. It is a "meta" study about the empirical research of crime in which several hypotheses were tested. In concrete, we found that drug crimes are highly correlated with other crimes; guerrilla activity is correlated with several crimes, including drug crimes, homicides, kidnapping and bank robbery; paramilitary activity is correlated with kidnapping and drug crimes; the legal codes respond to criminal activity, and only for few crimes (kidnapping and terrorist attacks), legal laws have some effect over the crimes; the probability of capture is an important determinant of all crimes; "poverty" only explains kidnapping; finally, presence of state is a deterrence of terrorist attacks.

The contributions of the second paper are twofold. First, the paper develops a dynamic theoretical model. Although some papers have estimated regressions to link educational outcomes and violence, no formal models have been developed yet. A theoretical model is crucial to understand the different channels through which violence affects education. Second, the paper finds violence indeed exerts a toll on education. School enrollment is less in Colombian municipalities with homicide rates above the national median. Moreover, the likelihood of school enrollment for all age groups decreases as homicide rates raises.

INTRODUCCION.

Este informe narrativo está compuesto por dos partes. En la Parte A se hace un recuento general del proyecto y los productos alcanzados entre Enero 1 de 2003 y Diciembre 31 de 2003. En la Parte B se relacionan las actividades comprendidas entre Enero 1 del 2004 y Junio 30 de 2004, las cuales fueron de presentación de los artículos en varios seminarios, incorporación de comentarios y preparación para publicación.

PARTE A. Enero 1 de 2003 – Diciembre 31 de 2003.

I. Objetivos generales

El principal objetivo de la siguiente investigación es analizar las causas de la actual violencia que enfrenta Colombia y evaluar los costos de dicha violencia para la población Colombiana.

II. Objetivos específicos

1. Complementar la base de datos recolectada por FEDESARROLLO sobre eventos violentos a nivel municipal y características de los municipios colombianos.
2. Realizar una extensa revisión bibliográfica sobre las causas de la violencia política y criminal en Colombia.
3. Escribir un artículo publicable en revistas especializadas sobre las causas de la violencia en Colombia.
4. Escribir dos artículos publicables en revistas especializadas sobre los costos económicos de la violencia en Colombia.

III. Evaluación del cumplimiento de los objetivos específicos

Para evaluar el éxito obtenido en el proyecto, se describirán los logros en cada uno de los objetivos y se analizarán las dificultades encontradas en los casos pertinentes.

Primer objetivo: Complementar base de datos.

Dada la naturaleza empírica de la investigación, era fundamental contar con una base de datos extensa que contuviera eventos violentos para cada uno de los municipios del país así como características municipales (p. ej. inversión y gasto municipal). Cuando el proyecto se inició, se contaba con una base de datos de panel bastante completa que contenía información municipal de ocurrencia de eventos violentos a nivel municipal para el periodo 1993-2000. Las variables iniciales eran:

1. Tasas de homicidios municipales y departamentales.
2. Número de robos a bancos municipales y departamentales.
3. Número de masacres municipales y departamentales.
4. Número de masacres por autor responsable (p.ej. guerrilla o paramilitares) municipales y departamentales.
5. Número de víctimas de las masacres municipales y departamentales.

6. Número de víctimas de masacres por actores responsables municipales y departamentales.
7. Número de ataques terroristas municipales y departamentales.
8. Número de ataques terroristas por tipo de ataque (p.ej. bomba) municipales y departamentales.
9. Número de ataques terroristas por tipo de infraestructura atacada (p. ej. infraestructura eléctrica) municipales y departamentales.
10. Número de ataques guerrilleros municipales y departamentales.
11. Número de ataques guerrilleros municipales por grupo guerrillero municipales y departamentales.

La base de datos iniciales se expandió con la agregación de los años 2001 y 2002 para la tasa de homicidios, con la creación de un índice de justicia penal (ver “Chapter Two” del informe final) y con la inclusión de las siguientes variables:

1. Área superficie del municipio en kilómetros cuadrados.
2. Área superficie del municipio en hectáreas.
3. Número de secuestros municipales
4. Índice de Necesidades Básicas Insatisfechas 1993, 1995 y 2000
5. Distancia a la capital del departamento.
6. Distancia a Medellín, Cali, Bogotá o Barranquilla.
7. Metros sobre el nivel del mar.
8. Índice de disponibilidad de agua por municipio.
9. Índice de erosión de suelos municipal.
10. Índice de aptitud de suelos municipal.
11. Gastos totales municipales.
12. Gastos corrientes municipales.
13. Ingresos totales municipales.
14. Ingresos corrientes municipales.
15. Transferencias de la Nación al municipio.
16. Inversiones municipales.
17. Recaudos municipales del impuesto predial.
18. Recaudos municipales del impuesto de industria y comercio.
19. Total de hogares desplazados expulsados de cada municipio.
20. Total de hogares desplazados recibidos por cada municipio.
21. Población municipal.
22. Presencia de notarias en 1995.
23. Presencia del Banco Agrario en 1995.
24. Presencia de entidades bancarias en 1995.
25. Presencia de corporaciones de ahorro y vivienda en 1995.
26. Presencia de la Iglesia Católica en 1995.
27. Presencia de iglesias no católicas en 1995.
28. Presencia de hospitales y clínicas en 1995.
29. Presencia de centros de salud en 1995.
30. Presencia de puestos de salud en 1995.
31. Presencia de oficinas de recepción de impuestos en 1995.
32. Número total de instituciones.
33. Planta educativa en la cabecera municipal.
34. Bibliotecas públicas en la cabecera municipal.

Esta base de datos, base para los estudios sobre las causas de la violencia en Colombia y sobre los costos económicos de dicha violencia, es un valioso aporte de la investigación ya que podrá ser utilizada en numerosos estudios sobre Colombia.

Segundo Objetivo: Revisión bibliográfica sobre causas de la violencia en Colombia

La violencia en Colombia ha sido materia extensa de estudio durante largos años. Sin embargo, los economistas incursionaron en este tema apenas a finales de los noventa. Con el fin de contar con una visión crítica de la violencia política y criminal en Colombia, la investigación realiza una extensa revisión bibliográfica sobre las causas de la violencia en Colombia. El objetivo de la revisión es conocer las diferentes hipótesis acerca de las causas de la violencia y llevar a cabo un análisis crítico de dichas hipótesis. El análisis estadístico posterior permite refutar o corroborar las hipótesis analizadas. La revisión bibliográfica se encuentra contenida en el artículo “Dynamics and causes of crime in Colombia” (Chapter One, Informe Final).

Tercer objetivo: Artículo sobre las causas de la violencia en Colombia

Escribir un artículo sobre las causas de la violencia en Colombia es uno de los dos objetivos principales de la investigación. El propósito final con este artículo es lograr su publicación en una revista especializada de economía. Para alcanzar tal propósito, la versión inicial del artículo fue repartida a un grupo de expertos en el tema con el fin de obtener sus comentarios. La versión revisada del artículo será presentada en un seminario el 16 de enero de 2004 en Fedesarrollo.

El artículo usa la base de datos construida en Fedesarrollo con el fin específico de hacer un “meta” estudio de las causas de crimen. Mediante varias técnicas de estimación, pudo contrastar algunas hipótesis sobre el tema. En primer lugar, el estudio encuentra una fuerte relación entre el crimen de narcotráfico y otros tipos de crimen. Tal como algunas teorías lo siguieren, recursos del narcotráfico pueden afectar el funcionamiento del aparato judicial del país. Además, la misma dinámica del narcotráfico sugiere el uso de actividades criminales para el buen funcionamiento de la actividad ilícita (por ejemplo, asesinatos). Segundo, se encuentra una fuerte relación entre actividad guerrillera y diversos crímenes como narcotráfico, homicidios, secuestros, y robo a bancos. Para el grupo FARC la correlación entre actividad guerrillera y homicidios y secuestro aumenta en el tiempo. La actividad del grupo Paramilitar esta correlacionada con los crímenes de drogas y narcotráfico.

El artículo explora sistemáticamente la relación entre el código penal y crimen. Con miras a estudiar ésta relación, se realizó un estudio exhaustivo de los códigos penales de Colombia durante los últimos 12 años. A partir de éste, se realizaron diversos índices penales, los cuales son una medida sintética de la severidad del castigo potencial por cometer el crimen. Los resultados muestran que para algunos crímenes, el índice penal induce cambios en los crímenes (narcotráfico y secuestro), pero en otros casos es inefectivo (robos). Se comprobó para casi todos los casos causalidad del crimen a la ley: aumentos en el crimen llevaron cambio en el código.

Al estimar una ecuación de determinantes de homicidio, secuestro y ataques terroristas se encontró que los determinantes varían a través de tipo de crimen y del nivel de crimen en el municipio. La variable que captura potencial beneficio del crimen fue

significativa explicando crimen solamente para aquellas ciudades donde el crimen es alto. Pobreza es uno de los determinantes de homicidios para aquellos municipios donde el crimen es bajo. Pobreza es determinante de secuestro, independientemente del municipio donde se produce. La probabilidad de captura es uno de los determinantes más importantes de crimen. Finalmente, la presencia estatal esta negativamente relacionada con ataques terroristas, no afecta el secuestro y esta relacionada negativamente con homicidios en municipios con baja tasa de crimen.

Cuarto objetivo: Dos artículos sobre los costos económicos de la violencia en Colombia

La estimación de los costos económicos de la violencia en Colombia es un tema poco explorado. Esta investigación busca contribuir a este tema, por un lado, con la estimación de los costos económicos de la violencia para los hogares colombianos y, por otro, con la identificación de los cambios de comportamiento de los hogares debido a la violencia.

La estrategia para calcular los costos económicos de la violencia en Colombia constaba de dos pasos. Primero, la investigación desarrolló un modelo teórico cuyos objetivos son entender como la violencia y el crimen afecta a los hogares y derivar una medida posible de aplicar para estimar los costos de la violencia. El modelo desarrollado se presenta en el Anexo I.

Segundo, la investigación buscaba aplicar el modelo teórico al caso específico colombiano. Para la aplicación, se contaba con la base de datos descrita anteriormente y la Encuesta de Calidad de Vida de 1997. Los resultados de la aplicación del modelo no fueron satisfactorios. Las estimaciones econométricas eran muy inestables y los parámetros estimados cambiaban fácilmente de signo y de significancia (Ver Anexo I). La poca confiabilidad de los resultados econométricos nos llevó a descartar la aplicación empírica. Esta es entonces la principal dificultad enfrentada en el proyecto.

Sin embargo, no consideramos que se deba descartar la aplicación del modelo de costos económicos de la violencia. La dificultad en las estimaciones econométricas obedecen más a la estructura de la Encuesta de Calidad de Vida de 1997 que al modelo teórico. En primera medida, dicha encuesta no fue diseñada para obtener información acerca de los costos económicos de la violencia. Por consiguiente, no contiene información detallada acerca de los gastos en medidas defensivas que realizan los hogares colombianos. Para estimar estos gastos, fue necesario calcular unas proxies que a la postre fueron imperfectas. En segunda medida, la Encuesta fue aplicada en 1997, año en el cual los hogares colombianos todavía no sentían el rigor de la violencia y, por lo tanto, las inversiones en medidas defensivas eran pequeñas.

Para estimar el modelo desarrollado en esta investigación es necesario aplicar una encuesta específicamente diseñada para este propósito o intentar aplicar el modelo con los datos de la Encuesta de Calidad de Vida de 2003. La Encuesta de Calidad de Vida de 2003 no está todavía disponible pero es posible contar con los datos en un futuro cercano.

El propósito del segundo artículo explora los cambios en comportamiento de los hogares colombianos debido a la violencia. En particular, el artículo analiza como se modifican las inversiones en capital humano en Colombia debido a la violencia (Ver

Anexo IV). El objetivo final con este artículo es lograr su publicación en una revista especializada de economía para lo cual la versión inicial del artículo fue distribuida a un grupo de expertos en el tema con el fin de obtener sus comentarios. La versión revisada del artículo será presentada en un seminario el 16 de enero de 2004 en Fedesarrollo. Asimismo, el artículo será publicado como Documento CEDE de la Universidad de los Andes para lograr una mayor difusión. Los resultados de la investigación se describen a continuación.

La violencia y el crimen pueden restringir las inversiones en capital humano. Las sociedades enfrentadas a la violencia pueden experimentar contracciones en la oferta y la demanda por educación. Las actividades delincuenciales pueden destruir la infraestructura e incrementar los costos laborales de la educación y, por consiguiente, reducir la oferta de educación. De otro lado, el ingreso de los hogares cae pues el crimen destruye los stocks de capital físico y desincentiva la inversión. Además, el bienestar de los hogares disminuye y los retornos a la educación se contraen. Como consecuencia, las inversiones en capital humano se reducen. El deterioro de los stocks de capital humano puede significar altos costos para la sociedad ya que la educación promueve el desarrollo económico y ayuda a los individuos a superar la pobreza. Recuperar los rezagos de inversión en capital humano puede tomar décadas.

La investigación tiene dos objetivos. En primera medida, el artículo desarrolla un modelo teórico que analiza la relación entre violencia y educación. La literatura económica no ha desarrollado hasta el momento un modelo teórico que permitan establecer los canales a través de los cuales la violencia afecta la educación. En segunda medida, el artículo estima el impacto de la violencia sobre la asistencia escolar utilizando una base de datos de corte transversal para Colombia. Estas estimaciones aportan evidencia del impacto de la violencia sobre la educación y contribuye a evaluar los costos de la violencia..

La investigación utiliza dos bases de datos para el análisis: la Encuesta de Calidad de 1997 (ECV-97) y los datos municipales de violencia. LA ECV-97 fue aplicada en 1997 a una muestra representativa de Colombia y de sus ocho regiones. La muestra contiene información acerca de 9,121 hogares y 38,518 individuos. El cuestionario recoge información acerca de las características socio-demográficas de cada miembro del hogar, de la asistencia educativa, del estado de salud y de los gastos del hogar. Además, contiene información acerca de la victimización de los hogares durante los últimos seis meses y de acceso del hogar a servicios públicos. La encuesta de datos municipales de violencia fue recolectada por los autores con base en información del Ministerio de Defensa, la Policía Colombiana y el Departamento Nacional de Planeación. La base de datos contiene información anual a nivel municipal para ocurrencia de eventos violentos durante el periodo 1993-2000.

Con los datos descritos anteriormente, se estimaron modelos probit de asistencia educativa para grupos de edad entre 7-11 años, 12-17 años y 17-22 años. Se realizaron dos grupos de estimaciones. El primer grupo estima la probabilidad de asistencia educativa como función de las características del individuo y del hogar. El segundo grupo incorpora, además de las características del individuo y del hogar, variables geográficas y de contexto tales como las tasas de homicidio, las transferencias de la Nación a los municipios, la planta educativa en la cabecera municipal y la distancia a la capital del departamento.

La investigación encuentra que las tasas de asistencia educativa son menores en los municipios que exhiben una tasa de homicidios superior a la mediana nacional. Más aún, la probabilidad de asistencia educativa se disminuye con incrementos en la tasa de homicidios municipal después de controlar por características individuales y del hogar. La magnitud del impacto de las tasas de homicidio es mayor que el efecto de las transferencias de la Nación a los gobiernos municipales.

PARTE B. Enero 1 de 2004 – Junio 31 de 2004.

Durante el periodo comprendido entre Enero 1 y Junio 31 de 2004 se desarrollaron tres tipos de actividades. En primer lugar, los artículos han sido presentados en varios foros sobre el tema. Segundo, las presentaciones de los dos artículos productos de la donación (“Dynamics and causes of crime in Colombia” y “Does Violence Reduce Investments in Education?: A Theoretical and Empirical Approach”) dieron lugar a varios comentarios que fueron incorporados en las versiones para publicación. Tercero, los dos artículos fueron alistados y enviados para publicación en Documentos CEDE y la revista Coyuntura Social.

El artículo “Does Violence Reduce Investments in Education?: A Theoretical and Empirical Approach” fue presentado en el Seminario de Fedesarrollo, tal como fue comentado en la primera parte de este informe narrativo. Los comentarios al artículo fueron de dos tipos. En primer lugar, se realizaron comentarios formales sobre el modelo teórico. Por ejemplo, se mencionó la idea de incluir una discusión sobre el efecto de la violencia en el precio de la educación o la posibilidad de migración debido a la violencia. En segundo lugar, se realizaron comentarios sobre la estimación del modelo, y la posibilidad de incluir otro tipo de datos de violencia calculados directamente de la Encuesta. Ambos tipos de comentarios fueron incorporados en la nueva versión del artículo. Actualmente el artículo se encuentra bajo revisión para ser publicado en Documentos Cede de la Universidad de los Andes. Se adjunta la nueva versión con este informe.

El artículo “Dynamics and causes of crime in Colombia” fue presentado en diversos seminarios y foros. Tal como se indicó en la Parte A, el artículo fue presentado en el Seminario de Fedesarrollo, en el cual se recibieron comentarios sobre interpretación de los datos. Por otra parte, el artículo fue presentado ante diversas unidades de crimen de la Fiscalía General de la República. Los comentarios de esas presentaciones sirvieron para poder analizar los datos en forma más atada a la realidad de la justicia colombiana. Asimismo, el artículo fue sometido a consideración para presentación en el seminario “Making Peace Work” del Instituto WIDER de las Naciones Unidas (<http://www.wider.unu.edu/conference/conference-2004-1/conference2004-1.htm>). El artículo fue escogido, y fue presentado el día 4 de Junio en dicha conferencia. Dicha conferencia tiene un gran impacto en países donadores de recursos, en instituciones multilaterales (Banco Mundial, por ejemplo) y en gobiernos de diversas partes del mundo. A partir de dicho foro, se realizó una nueva versión del artículo (una en inglés, la otra en español).

El artículo fue presentado para la publicación de la Coyuntura Social de Junio de 2004, y actualmente se encuentra bajo revisión. Dicha Coyuntura es un número extraordinario con motivo del cumplimiento de los 15 años de la publicación, y el artículo fue

escogido por invitación directa. Se anexa la última versión del mismo.

Anexo I: Los Costos Económicos de la Violencia en Colombia

Model 1: Defensive Expenditures and Willingness to Pay for Reducing Crime

The model assumes violence influence household's welfare and induces them to adopt preventive strategies deviating therefore budget from other goods to anti-crime investments. Divergence of expenditures to reduce likelihood of victimization impinges on household welfare because it obliges them to decrease consumption on other goods.

Households face a level of violence (V) that is determined by crime levels (C), defensive measures (D) and household characteristics (α). The victimization production function is determined by

$$V = V(C, D; \alpha).$$

Personal violence levels can decrease when households implement defensive measures such as installing anti-theft devices, hiring private guards or buying a safer home. On the other hand, violence faced by the household increases when crime levels soar. This two characteristics of the violence production function implies

$$V_D < 0 \text{ and} \\ V_C > 0..$$

Household characteristics also determine the violence production function. Criminals may target better off households or more vulnerable households (e.g. female headed households).

Households derive utility from consuming the numeraire good (x) and face disutility from violent events. The utility function is equal to

$$U(x, V)$$

where $U_x > 0$, $U_{xx} < 0$, $U_V < 0$ and $U_{vv} > 0$. Marginal utility from consuming x decreases when violence levels increase such that $U_{xv} < 0$.

The household income (I) is allocated between the numeraire good and defensive measures. If P_D defines the price of defensive measures and the price of the numeraire good is assumed to be one, the utility maximization problem is equal to

$$\begin{aligned} & \text{Max}_{x,D} U(x, V) \\ & \text{subject to } I \geq x + P_D \cdot D \\ & \text{and } V = V(C, D; \alpha) \end{aligned}$$

The first order conditions are equal to

$$U_x = \lambda \text{ and}$$

$$U_v V_D = \lambda P_D..$$

Households will invest in defensive measures up to the point where the marginal benefits from increasing personal security ($U_v V_D$) are equal to its marginal costs (λP_D).

From the first order conditions we get.

$$P_D = \frac{U_v V_D}{U_x}.$$

The marginal rate of substitution represents the marginal value of personal security, which in turn equals its marginal costs.

The economic cost to households from soaring crime is willingness to pay to avoid this increase. Willingness to pay, or compensating variation, represents the amount of income the households would be willing to give up to maintain the original utility level. To define WTP, we can use the indirect utility function

$$v(I, P_D, C; \alpha) = U(x^*, V(D^*, C; \alpha)) + \lambda [I - x^* - P_D D^*]$$

By differentiating the indirect utility function,

$$V_I dI + V_C dC = 0..$$

Willingness to pay is then equal to

$$\frac{dI}{dC} = -\frac{V_C}{V_I}.$$

From the envelope theorem, we obtain

$$(1) \quad \frac{dI}{dC} = \frac{U_v V_C}{\lambda}.$$

If we differentiate the violence production function with respect to C ,

$$\frac{dV}{dC} = V_D D_C + V_C.$$

Hence,

$$(2) \quad V_C = \frac{dV}{dC} - V_D D_C.$$

By substituting (2) in (1),

$$WTP = \frac{U_v}{\lambda} \left[\frac{dV}{dC} - V_D D_C \right]$$

The marginal loss from responding to crime is composed by

$\frac{U_v}{\lambda}$: direct disutility of crime

$\frac{dV}{dC}$: marginal increase in victimization due to crime increases.

$V_D D_C$: changes in the demand for defensive measures due to variations in crime rates times variations in victimizations due to defensive measures.

This measure, although intuitively appealing, bears two problems. First, some of its components are non-observable (e.g. disutility of crime). Second, it measures only marginal changes in crime. Therefore, we cannot use this equation to estimate non-marginal changes in crime rates, which are the most usual and are more relevant for policy purposes.

Some preliminary evidence based on ECV survey

1. Defensive expenditures and mean of defensive expenditures

- Defensive expenditures are defined as monthly expenditures for private guards.
- Near seven percent of households engage in defensive expenditures with monthly payments of \$33.812 (1997), which amounts to annual payments of \$685.707 in 2002 pesos.
- Mainly households residing in urban areas invest in defensive expenditures.

=1 si hace			
gastos			
defensivos	Freq.	Percent	Cum.
-----+-----			
0	8483	93.01	93.01
1	638	6.99	100.00
-----+-----			
Total	9121	100.00	

Mean defensive expenditures

Variable	Obs	Mean	Std. Dev.	Min	Max
-----+-----					
montgdef	638	33812.31	43468.92	500	400000

2. Defensive expenditures and mean of defensive expenditures – Urban and rural area

Rural area

=1 si hace |
gastos |

defensivos	Freq.	Percent	Cum.
0	3751	99.95	99.95
1	2	0.05	100.00
Total	3753	100.00	

Variable	Obs	Mean	Std. Dev.	Min	Max
montgdef	2	56000	67882.25	8000	104000

Urban area

=1 si hace			
gastos			
defensivos	Freq.	Percent	Cum.
0	4732	88.15	88.15
1	636	11.85	100.00
Total	5368	100.00	

Variable	Obs	Mean	Std. Dev.	Min	Max
montgdef	636	33742.54	43436	500	400000

3. Defensive expenditures and dummy for median of homicides per year

- Households engaging in defensive expenditure seem to reside in municipalities with homicide rates above the national median.

=1 si hace			
gastos			
defensivos	dumhom		
	0	1	Total
0	3422	5061	8483
	40.34	59.66	100.00
	97.05	90.46	93.01
1	104	534	638
	16.30	83.70	100.00
	2.95	9.54	6.99
Total	3526	5595	9121
	38.66	61.34	100.00
	100.00	100.00	100.00

Pearson chi2(1) = 144.5930 Pr = 0.000
 likelihood-ratio chi2(1) = 162.3432 Pr = 0.000
 Cramer's V = 0.1259
 gamma = 0.5528 ASE = 0.038
 Kendall's tau-b = 0.1259 ASE = 0.008

4. Defensive expenditures and dummy for median of homicides per year – Urban and rural areas

Rural area

=1 si hace gastos defensivos	dumhom		Total
	0	1	
0	1924	1827	3751
	51.29	48.71	100.00
	99.90	100.00	99.95
1	2	0	2
	100.00	0.00	100.00
	0.10	0.00	0.05
Total	1926	1827	3753
	51.32	48.68	100.00
	100.00	100.00	100.00

Pearson chi2(1) = 1.8982 Pr = 0.168
 likelihood-ratio chi2(1) = .
 Cramer's V = -0.0225
 gamma = -1.0000 ASE = 0.000
 Kendall's tau-b = -0.0225 ASE = 0.008

Urban area

=1 si hace gastos defensivos	dumhom		Total
	0	1	
0	1498	3234	4732
	31.66	68.34	100.00
	93.63	85.83	88.15
1	102	534	636
	16.04	83.96	100.00
	6.38	14.17	11.85
Total	1600	3768	5368
	29.81	70.19	100.00
	100.00	100.00	100.00

Pearson chi2(1) = 65.3723 Pr = 0.000
 likelihood-ratio chi2(1) = 72.5105 Pr = 0.000
 Cramer's V = 0.1104
 gamma = 0.4161 ASE = 0.047
 Kendall's tau-b = 0.1104 ASE = 0.011

5. Victimization rates for ECV Households

- Near three percent of households were victims of thefts during the last 12 months and 0.9% had a household member assassinated.

```
tab robos, missing
```

=1 if hh				
victima				
robo - 12				
meses		Freq.	Percent	Cum.
No		8872	97.28	97.28
Si		248	2.72	100.00
Total		9120	100.00	

```
. tab ases, missing
```

=1 if hh				
victima				
asesinato -				
12 meses		Freq.	Percent	Cum.
No		9041	99.13	99.13
Si		79	0.87	100.00
Total		9120	100.00	

6. Victimization rates and defensive expenditures.

- Theft victims are more likely to invest in defensive expenditures: 5.6% of households that engage in defensive expenditures were victims of theft in contrast to 2.5% of households that did not engage in defensive expenditures and were victims of theft. The causality here is difficult to discern. Did the households invest in defensive expenditures because they were facing greater victimization levels? Or, defensive expenditures are insufficient to slow crime rates in cities with high criminality rates?

a) Thefts

```
. tab robos gastdef if jefe==1, row col all
```

=1 if hh				
victima		=1 si hace gastos		
robo - 12		defensivos		
meses		No	Si	Total
No		8270	602	8872
		93.21	6.79	100.00
		97.50	94.36	97.28
Si		212	36	248
		85.48	14.52	100.00
		2.50	5.64	2.72
Total		8482	638	9120
		93.00	7.00	100.00
		100.00	100.00	100.00

```
Pearson chi2(1) = 22.1611 Pr = 0.000
likelihood-ratio chi2(1) = 17.4154 Pr = 0.000
```

Cramer's V = 0.0493
 gamma = 0.3999 ASE = 0.078
 Kendall's tau-b = 0.0493 ASE = 0.014

b) Homicides

=1 if hh			
victima	=1 si hace gastos		
asesinato	defensivos		
- 12 meses	No Si	Total	
No	8417 624	9041	
	93.10 6.90	100.00	
	99.23 97.81	99.13	
Si	65 14	79	
	82.28 17.72	100.00	
	0.77 2.19	0.87	
Total	8482 638	9120	
	93.00 7.00	100.00	
	100.00 100.00	100.00	

Pearson chi2(1) = 14.0911 Pr = 0.000
 likelihood-ratio chi2(1) = 10.2186 Pr = 0.001
 Cramer's V = 0.0393
 gamma = 0.4879 ASE = 0.113
 Kendall's tau-b = 0.0393 ASE = 0.016

7. Probit regression for victimization

a. Theft and homicide rates municipality

- The results for the victimization regression are:
 - Households less likely to be victimized: larger households and households residing in areas with high homicide rates. The last result is counterintuitive unless defensive expenditures are so effective that victimization, after controlling for household characteristics, is lower in high crime areas.
 - Households more likely to be victimized: households with older heads at a decreasing rate and with better education at a decreasing rate as well.

Probit estimates
 Log likelihood = -779.82638
 Number of obs = 6045
 LR chi2(8) = 66.95
 Prob > chi2 = 0.0000
 Pseudo R2 = 0.0412

robos	dF/dx	Std. Err.	z	P> z	x-bar	[95% C.I.]
sexojefe*	-.0062645	.0061246	-1.09	0.274	.857237	-.018268	.005739	
tamhh	-.0024204	.0010686	-2.25	0.024	4.31679	-.004515	-.000326	
edad2	-.0000267	.0000114	-2.32	0.020	2033.29	-.000049	-4.3e-06	
edad	.0028105	.0010586	2.63	0.009	43.1879	.000736	.004885	
anoseduc	.0027479	.0012759	2.13	0.033	6.15765	.000247	.005249	
anosedu2	-.0000301	.0000639	-0.47	0.638	63.4976	-.000155	.000095	
empleo*	.0170822	.0069819	1.56	0.118	.966915	.003398	.030767	

thom		-.0001048	.0000406	-2.55	0.011	67.664	-.000184	-.000025

obs. P		.0299421						
pred. P		.0257295 (at x-bar)						

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

b. Theft and total homicides at municipal level

- In this case, the effect of total homicides is positive (i.e. greater number of homicides implies a higher likelihood of victimization). It is important to understand why total homicides and homicides rates have different effects.

Probit estimates	Number of obs =	6045
	LR chi2(8)	= 73.78
	Prob > chi2	= 0.0000
Log likelihood = -776.4084	Pseudo R2	= 0.0454

robos		dF/dx	Std. Err.	z	P> z	x-bar	[95% C.I.]

sexojefe*		-.0048869	.0059374	-0.87	0.385	.857237	-.016524	.00675	
tamhh		-.0023847	.0010694	-2.22	0.027	4.31679	-.004481	-.000289	
edad2		-.0000258	.0000113	-2.26	0.024	2033.29	-.000048	-3.6e-06	
edad		.0026713	.0010514	2.52	0.012	43.1879	.000611	.004732	
anoseduc		.0017727	.0012976	1.36	0.174	6.15765	-.000771	.004316	
anosedu2		-6.40e-06	.0000641	-0.10	0.920	63.4976	-.000132	.000119	
empleo*		.0185111	.0062141	1.76	0.078	.966915	.006332	.030691	
totalhom		5.51e-06	1.44e-06	3.80	0.000	681.307	2.7e-06	8.3e-06	

obs. P		.0299421							
pred. P		.0255404 (at x-bar)							

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

8. Probit for defensive expenditures

a. Defensive expenditures and homicide rates

- Some preliminary results:
 - Households that engage in defensive expenditures with greater likelihood:
 - Older household heads at a decreasing rate;
 - Better educated household heads at a decreasing rate; and
 - Residing in municipalities with larger crime rates.

Probit estimates	Number of obs =	6045
	LR chi2(8)	= 805.76
	Prob > chi2	= 0.0000
Log likelihood = -1160.8431	Pseudo R2	= 0.2576

gastdef		dF/dx	Std. Err.	z	P> z	x-bar	[95% C.I.]

sexojefe*		.0064878	.0053151	1.15	0.250	.857237	-.00393	.016905	
tamhh		.0011381	.0011574	0.98	0.325	4.31679	-.00113	.003407	
edad2		-.0000314	.0000119	-2.64	0.008	2033.29	-.000055	-8.0e-06	
edad		.0046698	.0011415	4.11	0.000	43.1879	.002433	.006907	

anoseduc	.012467	.0014082	7.73	0.000	6.15765	.009707	.015227
anosedu2	-.0001462	.0000696	-2.01	0.045	63.4976	-.000283	-9.8e-06
empleo*	-.0170874	.0152326	-1.31	0.191	.966915	-.046943	.012768
thom	.0002607	.0000338	8.10	0.000	67.664	.000194	.000327

obs. P	.0719603
pred. P	.0332466 (at x-bar)

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

b. Defensive expenditures and total homicides

- Results are almost identical.

Probit estimates	Number of obs =	6045
	LR chi2(8) =	860.17
	Prob > chi2 =	0.0000
Log likelihood = -1133.637	Pseudo R2 =	0.2750

gastdef	dF/dx	Std. Err.	z	P> z	x-bar	[95% C.I.]
sexojefe*	.0055355	.0053186	0.99	0.322	.857237	-.004889	.01596	
tamhh	.0006709	.0011583	0.58	0.562	4.31679	-.001599	.002941	
edad2	-.0000295	.0000119	-2.48	0.013	2033.29	-.000053	-6.1e-06	
edad	.0042972	.0011325	3.80	0.000	43.1879	.002078	.006517	
anoseduc	.0100938	.0014378	6.25	0.000	6.15765	.007276	.012912	
anosedu2	-.0000932	.0000707	-1.28	0.201	63.4976	-.000232	.000045	
empleo*	-.012106	.0140972	-0.97	0.334	.966915	-.039736	.015524	
totalhom	.0000154	1.62e-06	10.92	0.000	681.307	.000012	.000019	

obs. P	.0719603
pred. P	.0326516 (at x-bar)

(*) dF/dx is for discrete change of dummy variable from 0 to 1
z and P>|z| are the test of the underlying coefficient being 0

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APPOACH**

Final Version for the Ford Foundation

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April 2004

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Empirical Approach**

Final Version for the FORD FOUNDATION

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Does Violence Reduce Investments in Education?: A Theoretical and Empirical Approach¹

Felipe Barrera

Ana Maria Ibáñez

ABSTRACT

The paper develops a dynamic theoretical model and presents empirical evidence about the relationship between violence and education. Although some papers have estimated regressions to link educational outcomes and violence, no formal models have been developed yet. A theoretical model is crucial to understand the different channels through which violence affects education. Three channels are identified. First, violence can affect directly the utility of households and, therefore, it may change the consumption of education of the house. Second, extreme violence can destroy physical capital and create uncertainty, which will lower investment and production. In the long run, destruction of physical assets and drop in investment impacts the income of households who in turn must reduce consumption and cutback investments in education. Third, violence can modify the rates of return of education, and therefore, can change the investment on education.

We find violence indeed exerts a toll on education. School enrollment is less in Colombian municipalities with homicide rates above the national median. Moreover, the likelihood of school enrollment decreases as homicide rates raises

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for all group ages. The impact of homicide rates is larger than transferences from the national government to the local government earmarked for investment in education and health.

RESUMEN

Este artículo desarrolla un modelo teórico dinámico y presenta evidencia empírica sobre la relación entre violencia y acumulación de capital humano. A pesar que existen múltiples artículos que estima la relación entre violencia y educación, no existe hasta el momento ningún modelo formal en la literatura. El modelo es esencial para identificar los canales por medio de los cuales la violencia incide en educación. El artículo identifica tres de ellos. En primer lugar, la violencia afecta directamente las decisiones de consumo de educación al afectar la utilidad de los hogares. En segundo lugar, la violencia destruye directamente los medios de producción y genera incertidumbre, lo cual reduce inversión y el ingreso de los hogares. Por ende, el consumo de educación de los mismos tiende a reducirse. Finalmente, la violencia afecta el retorno de la educación, lo cual a su vez modifica el consumo en educación.

La evidencia encontrada muestra que la violencia induce reducciones en la acumulación de educación. La matrícula educativa es menor en aquellos municipios Colombianos en los cuales la tasa de homicidios es mayor que el promedio nacional. La probabilidad de matrícula en colegios decrece a medida que la tasa de homicidios aumenta para *todos* los grupos de edades. El impacto de la tasa de homicidios es mayor que el impacto de la transferencias de educación y salud nacionales a los gobiernos locales.

JEL classification: I21, D11, H56

Key words: Theory of Education, Violence, Colombia, Empirical estimation

Does Violence Reduce Investments in Education?: A Theoretical and Empirical Approach

I. Introduction

Violence may erode investments in human capital. Societies in crime intense environments may experience contractions in supply and demand of education. Delinquent activities damage infrastructure and increase labor costs of education limiting, as a consequence, supply of education. On the other hand, the income of households falls because crime destroys stocks of physical capital and deters investment. Moreover, families well being decline and returns to education may diminish. Investments in human capital, therefore, may diminish. Deterioration of human capital stocks caused by violence may impose large losses to society. Education promotes economic growth and help individuals overcome poverty. Recouping lags in investment may take decades.

This paper seeks to address two issues. First, the paper develops a formal dynamic model to link violence and education. Although some papers have estimated regressions to link educational outcomes and violence, no formal models have been developed yet. A theoretical model is crucial to understand the different channels through which violence affects education. Second, we estimate the impact of violence on school enrollment using a cross-sectional survey of Colombia. Estimations will provide evidence on the impact of violence on education and will contribute to assess the costs of violence.

We find violence indeed exerts a toll on education. School enrollment is less in Colombian municipalities with homicide rates above the national median. Moreover, the likelihood of school enrollment decreases as homicide rates raises for all group ages. The impact of homicide rates is larger than transferences from

the national government to the local government earmarked for investment in education and health.

The paper is organized as follow. Section II reviews the human capital literature and describes some contributions of the economics literature to estimate the costs of violence. A dynamic model to understand investment in education in a violent environment is presented in Section III. Section IV describes the data used and discusses econometric results. Finally, Section V concludes.

II. Literature review

a. The influence of violence on education decisions.

When deciding investments on human capital, households compare benefits and costs to optimize their economic well-being (Becker, 1964). Benefits arise from private returns to education, mainly earnings on the labor market, and non-monetary benefits such as reductions in child mortality, improvements in birth control and a better health, among many others. On the other hand, monetary expenses and the opportunity costs from not engaging on earning activities are the main components of the costs of education.

After Becker's seminal contribution, the literature on human capital has developed prolifically. On the empirical context, three strands have emerged. The first strand examines family investments on human capital and its subsequent private returns based on earning functions and longitudinal surveys (for a detailed review see Schultz, 1988). The second strand utilizes educational production functions to identify the inputs that determine the quality of education (see Burtless, 1996; Angrist and Levy, 1999; Hanushek et al, 2001). Lastly, studies analyzing human capital in developing countries evaluate the socio-economic factors inducing school attendance (see Knaul and Parker, 1998; Ravallion and Wodon, 1998; Sosa and Marchionni, 1999).

Studies of educational achievement and school attendance have focused largely on individual and household influences. Yet lately geographical and context variables have emerged as important determinants as well (Long y Toma, 1988; Galenson, 1995; Ravallion and Woodon, 1998; Rephann, J.T, 2002). Geographical and context variables may indicate supply constraints, the costs of obtaining education as well as employment opportunities (Rephann, 2002) and, therefore, may shape human capital investments.

Violence and crime, two local-specific context variables, have been somehow ignored by the economic literature. However, a violent context can erode human capital investments by reducing households' utility, depressing private returns from education, limiting educational supply and decreasing household income. Moreover, countries facing long-standing civil wars may seriously experience deteriorations of human capital that may lead to lower economic growth and to perpetuation of poverty.

Violence can create a climate of anxiety that directly affects the utility and, therefore, the behavior of households. Crime obliges individuals to be constantly alert and adopt defensive strategies. Families living in violent areas overprotect their children and restrict their liberty to avoid victimization. Moreover, victims of crime and violence confront post-traumatic syndrome. A lower utility may oblige households to redistribute spending in order to keep utility constant. Consumption in goods that provide immediate satisfaction may increase and spending in education, which profits are not foreseeable in the near future, may diminish.

Extreme violence, such as civil wars or terrorism, can destroy physical capital and deter investment. Examples of destruction of physical capital as a consequence of armed conflicts and terrorism abound. Guerrilla groups in Colombia damage oil pipelines, Al-Qaeda crashed airplanes in the financial center of the United States and ETA in Spain uses car bombs to destroy

factories in the Vasque Region. Violence also creates uncertainty and deters investment. In the long run, destruction of physical assets and drop in investment impacts the income of households who in turn must reduce consumption. Gaviria (2000) finds in Colombia investments in education are cutback to compensate income shortages.

When violence deteriorates stocks of physical capital and human and physical capital are complements, private returns to education fall. Declines in capital stocks imply a slowdown in economic activities, a drop in demand for educated individuals and, as a result, private returns to education decrease. On the other hand, since investments in human capital diminish as a consequence of violence, the stock of educated individuals drops as well. If this drop exceeds reductions in the demand for educated individuals, returns to education increase.

Violence may also limit supply of education. Acute episodes of violence can cause destruction of physical infrastructure (e.g. schools, buses, libraries) that are crucial inputs to “produce” education. In addition, teachers may, on the one hand, elude posts in cities or towns with severe crime rates or, on the other hand, charge higher salaries to teach in violent neighborhoods (Grogger, 1997).

Despite the presumably large impact violence imposes on education, economic research on this topic is practically non-existent. A notable exception is the study by Grogger (1997) that examines violence inside school as determinants of educational outcomes and teacher salaries. On the other hand, sociologists and psychologist have analyzed the link between violence and educational outcomes in extent (see Simcha-Fagan and Schwartz, 1986; Lab and Whitehead, 1992; Bowen et al, 2002).

The economic literature has not developed yet theoretical models clarifying how violence affects households’ decision to invest on education. Moreover, empirical papers only concentrate on violence inside schools and do not examine the

effect of city and country-wise violence. In addition, these papers rely on subjective empirical measures of crime and violence. The purpose of this paper is to fill these gaps by developing a theoretical model linking investments in human capital and violence and by providing empirical evidence.

b. The costs of violence

Violence imposes social and economic costs to society. Costs of crime largely originate from reductions in economic activities, deviations of public and private funds from other purposes (e.g. education and health) to curtail violence and increments in welfare losses to households. The economic literature has concentrated mainly on estimating costs from slow down of economic activities as well as calculating public resources allotted to cut back crime.

Estimates of the costs of crime are mainly aggregated figures. Total economic losses to victims of crime, including medical costs and lost work time, during 1992 in the United States were measured in \$532 per crime and 17.6 billion for all reported crimes that year, this is equivalent to 0.3% of GDP (Klaus, 1994). Miller et al (1996) estimate losses from personal crime in the United States are \$105 billion and include from medical costs, lost earnings and public programs related to victim assistance. When pain, suffering and the reduced quality of life are incorporated, costs raise to an estimated \$450 billion annually. Londoño (1998) calculates human capital losses in Colombia originating from violence around 4% of GDP each year. Rubio (1997) approximates total household expenditures on protection and security amount to 1.4% of the Colombian GDP.

Welfare losses to households have been largely ignored despite the big burden they might be imposing. Families confront pecuniary and non-pecuniary costs from being victimized (Freeman, 1999). Victims of crime face monetary costs due to property losses, expenditures in medical and health care and legal costs associated with tort claims (Cohen et al., 1994). Non-pecuniary losses are

presumably larger and stem from three sources. First, quality of life decreases because households have to cope with the reduced sense of personal and proprietary security (Fajnzylber, 1998). Second, households must reallocate budget in order to adopt preventive strategies, like hiring private guards and installing anti-theft devices. Third, households modify their behavior in order to prevent victimization. For example, students of night schools quit for security reasons (Cuéllar, 2000), people avoid road trips and do not go out at night (Gaviria y Vélez, 2001) and households have to seek refuge in other cities or countries (Kirchhoff and Ibáñez, 2001).

Estimates of non-pecuniary losses and evidence on behavioral responses are difficult to find. Levitt (1995) calculates the cost of pain, suffering and economic loss for the average crime around \$3.000. Ibáñez and Vélez (2003) find welfare losses from forced displacement in Colombia are 25 percent of the net present value of aggregated consumption of the average household. The propensity of Colombian households to engage in anti-crime strategies is analyzed in Gaviria and Vélez (2001). Surveys applied to a representative sample of the Colombian urban population show more than 80 percent of respondents do not go out at night, 36 percent participate in neighborhood watching services, 21 percent hire private guards and 25 percent avoid road trips for fear crime.

Does crime and violence deter investment on human capital? The purpose of this paper is to provide evidence on behavioral responses to violence and crime activities. Namely, the paper seeks to address whether violence in Colombia modifies investments in education. By providing empirical evidence about behavioral responses to crime, the paper contributes to understand the economic losses of violence.

III. Education and Violence: A Simple Dynamic Model

Violence influence decisions of education investments through several channels.

The income of the family and the community fall affecting in turn the household's budget constraint; returns of education change due to violence; and violence impacts directly the well being of household. The purpose of this model² is to show some of the potential links between violence and the decision of household's education, as well as to present a formal framework in which the relationship is explicitly modeled.

3.1 The model

a. Channels between violence and educational decisions

We consider three main channels of relationship between violence and education, channels that are going to be discussed in detail below. Violence directly affects the utility of the individual ($u(.)$); it lowers the income of the parents (y^p); and it modifies the returns to education (B).

Violence directly affects the utility of individuals

We assume that violence can reduce directly the well being of individuals. In mathematical terms this is represented by the following relationship:

$$u(c_j, v_j) \text{ where } \partial u / \partial c > 0 \text{ and } \partial u / \partial v < 0 \text{ for } j = t \text{ and } t + 1 \quad (1)$$

The utility of the individual increases with consumption (c) and decreases with violence.³ One critical assumption in the model is that violence (v_t), from the standpoint of view of the family, is given. The family "receives" certain amount of violence and makes decisions based on the observed level of violence. Violence

² The model builds upon the model of Barrera (2001) by including violence as a component that affects decisions of the individuals.

³ Properties of concavity are assumed in order to reach a unique maximum.

may affect directly the utility function because it creates fear, or other “states”, that induces decreases on well being of individuals. As it is described on other papers, part of the objective of violence is to create a state of fear in order to, for instance, assure the functioning of illegal business (Gambetta (1993))

Violence affects income of parents

The effect of violence over income is explained by two mechanisms. First, violence can directly destroy physical capacity. Second, violence creates uncertainty, and therefore, will lower investment. In synthesis, these two mechanisms translates in the following mathematical expression:

$$y^p = y^p(v_t) \text{ where } \partial y^p / \partial v < 0 \quad (2)$$

The expression indicates that the income of parents depends negatively on violence. Violence can destroy directly the production activities of individuals. Terrorist attacks to towns are quite destructive of houses, shops, and infrastructure. Also, a town under the potential attack of illegal groups will see a reduction of investment, and therefore, lower production.

Violence affects returns to education

The effect of violence in the returns of education is twofold. As long as violence reduce the level of investment and the capacity of production, and assuming complementarities between deepening of physical capital and higher human capital, the returns of education diminishes with violence. However, violence may create a “stock effect” that induces increments in returns of education: if violence decreases education, let say at period t , the returns of education increase in period $t+1$. Thus, in $t+1$, investment in education increases. The net effect of violence over returns to education is therefore ambiguous:

$$B = B(\eta, v) \text{ where } \partial B / \partial v > < 0^4 \quad (3)$$

The net effect over investment in education (the increment in $t+1$ and the decline in t) can be positive or negative.

In conclusion, Equations (1) to (3) show the key main channels of the effect of violence over education. Equation (1) presents the direct effect of violence over the well being of individuals; Equation (2) presents the effects of violence over the income of parents; and Equation (3) establishes that returns to education depend on the stock effect and reductions in demand for educated individuals.

3.2 Household decision

Individuals make decisions in two periods. In the first one they decide the amount of consumption (c_t), the decision of whether to invest on education (E , $E = 0$ or $E = 1$) and the quantity of the education (q_t); the individual receives income from the parents (y^p). In the second period, the individual (inelastically) works and decides the optimal amount of consumption (c_{t+1}).

The budget constrain of the individual for period t is $y^p(v_t) = c_t + p_t * E * q_t$ (where p_t is the price of education), whereas the constrain for period $t+1$ is $B(\eta, v_{t+1}) * E * q_t = c_{t+1}$. The first one states that individual consumes and attends to school payed by the parents. The second constrains establishes that the

⁴ The variable η captures "ability", a characteristic unobservable to the researcher.

individual receives an income that is determined by the returns to education and consumes c_{t+1} .⁵

Implicitly, we assume that the provider of education is the government, and therefore, p_t reflect not the enrolment fee, but other cost associated with education (books, uniforms, etc) In general, the price of education (p_t), when it includes all the cost of education (fees, books, etc) can increase with violence. Indeed, it is more costly for Colombian government to provide education in a zone with high degree of violence. For instance, the implicit opportunity cost of teachers increases in these types of zones. Presumably, the higher cost would impact the price of providing education. We did not include this mechanism in the model because the majority of individuals in areas of high level of violence go to public, free provide schools. For this reason, prices are given to them and we will not see the effect of violence on prices translated to the household. In a complete model of demand and supply, however, this effect may be important.

The solution of the problem is by backward induction. In any path of education ($E = 0$ or $E = 1$) the individual choose optimally the consumption and the quantity of education. Given the optimal decision over these variables, the optimal E will be given by the path that yields the highest utility.

The problem of the agent when $E = 1$ is, therefore⁶,

$$\max_{c_t, c_{t+1}, q_t} [u(c_t, v_t) + \lambda_t (y^p - c_t - p_t * E * q_t)] + \beta [u(c_{t+1}, v_{t+1}) + \lambda_{t+1} (B * E * q_t - c_{t+1})]$$

⁵ Implicitly we assume perfect foresight in that individuals knows, at t , the returns of education in $t + 1$.

⁶ One assumption of the model is perfect foresight, and therefore, uncertainty is not explicitly model. However, this assumption can easily raised explicitly with a maximization of the expected function, with violence following an stochastic process.

For positive values of q and c , the solution of this dynamic problem is given by the Euler Equation

$$(\partial u(c_t, v_t) / \partial c_t) * p_t = \beta (\partial u(c_{t+1}, v_{t+1}) / \partial c_{t+1}) * B(\eta, v_{t+1}) \quad (4)$$

and the two budget constraints. The Euler Equation states that the marginal cost of education in the first period has to be equal to the marginal benefit of it at the optimum.

From this equation, the optimal demand for c and q are derived. Specifically,

$$q_t^* = q(\beta, p_t, B(\eta, v_{t+1}), y^p(v_t), v_t, v_{t+1}) \quad (5)$$

Equation (5) gives the fundamental relationship between education and violence. In fact, using the Envelope Theorem, and assuming that $v_{t+1} = f(v_t)$

$$\frac{\partial q_t^*}{\partial v_t} = \frac{\partial q}{\partial v_t} + \frac{\partial q}{\partial v_{t+1}} * \frac{\partial v_{t+1}}{\partial v_t} + \frac{\partial q}{\partial y^p} * \frac{\partial y^p}{\partial v_t} + \frac{\partial q}{\partial B} * \frac{\partial B}{\partial v_{t+1}} * \frac{\partial v_{t+1}}{\partial v_t} \quad (6)$$

The last assumption simplifies the analysis and allows us to present in one equation the total effect of violence over education. Clearly, it is possible to find separately the effect of v_t and v_{t+1} over q^* , but it implies to present the result with two equations for the two periods. Moreover, several articles present evidence about the positive correlation inter-temporal violence⁷.

⁷ For instance, Sanchez et. al. (2003) or Barrera(2004)

Equation (6) can be positive or negative. On the one hand, the first three derivatives are negative: violence decreases utility ($\partial q / \partial v_t < 0$ and $\partial q / \partial v_{t+1} < 0$) and also decreases the income of the family ($\partial y^p / \partial v < 0$). On the other, violence can have a positive or negative effect over returns. If violence induces a negative effect over returns ($\partial B / \partial v < 0$), the sign is unequivocally negative. If violence has a positive effect over returns ($\partial B / \partial v > 0$), expression (6) can be positive.

Equation (4) does not provide, however, an equilibrium since the decision of $E = 0$ is an option. When $E = 0$, the problem of the individual is

$$\max_{c_t, c_{t+1}} [u(c_t, v_t) + \lambda_t (y^p - c_t)] + \beta [u(c_{t+1}, v_{t+1}) + \lambda_{t+1} (y - c_{t+1})]$$

where y is the income that the individual perceive in period $t+1$ if he does not have any education. The solution is given by the analogous to Equation (4):

$$\partial u(c_t, v_t) / \partial c_t = \beta \partial u(c_{t+1}, v_{t+1}) / \partial c_{t+1} \quad (7)$$

In order to find whether $E = 0$ or $E = 1$, we need to compare the utility realized in both paths of decisions of education. Therefore, $E = 1$ will be an optimal solution if

$$\sum_{j=t}^{t+1} u(c_j^*, v_j) \Big|_{E=1} > \sum_{j=t}^{t+1} u(c_j^{**}, v_j) \Big|_{E=0} \quad (8)$$

The “participation” equation (8) is critical, and it comprises the second relevant relationship between education and violence. First, violence affects both sides of the inequality via lowering utility. Second, violence affects the returns of education and therefore it makes more difficult (easier) to fulfill equation (8) if the effect is negative (positive). Finally, violence lower the income of parents, which

in turn will induce a more binding budget constraint and a lower value of the left hand side of this equation.

It is important to stress several assumptions of the model. As stated above, the separation between public and private education is a critical one. In this model we assume that education is publicly provided, and therefore, individuals face “free” education. The assumption corresponds to the Colombian reality in the sense that in violence zones, public education is the norm.

Another important assumption is the lack of migration. Clearly, migration of individuals due to violence is an important phenomenon in Colombia (see Ibañez and Velez (2003)). In the model we do not incorporate this respond to violence. Clearly, this limits our results. Theoretically is possible that a family migrate from a rural area in which provision of services is limited to a city in which supply of education is higher.

IV. Empirical Estimations

4.1. The Data

The primary sources of data we used to analyze the impact of violence on education are the *Living Standards Measurement Survey* (LSMS-97) applied during 1997 in Colombia and the *Municipal Violence Data* (MVD). The LSMS-97 sample is representative of the Colombian Population and its eight regions. The sample contains information for 9,121 households and 38,518 individuals. The questionnaires that were administered to these households elicited information about socio-demographic characteristics of each household member, school attendance, health status and household spending. Information on household victimization during the last six months and access to public and social services was also collected.

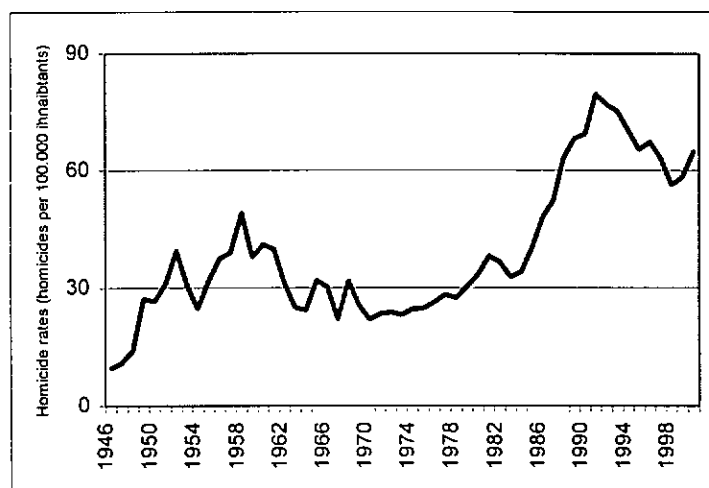
The MVD was collected by the authors based on information from the Ministry of Defense, the Colombian Police and the Department of National Planning. The MVD contains yearly information at the municipal level⁸ for occurrence of violent events during the period 1993-2000. Violent events included in the MVD are homicides rates, terrorist attacks, massacres and kidnapping.

The origins of current violence in Colombia are diverse. During the last 40 years Colombia has faced a long-standing civil war. In addition, illegal drug-trafficking soared since the 1980s and, as a consequence, illegal activities and crime flourished. Lastly, the erosion of the Judicial System, provoked mainly by drug-trafficking, created favorable conditions for crime development (Montenegro and Posada, 2001).

Violence in Colombia is widespread. While urban areas are mostly affected by crime-related activities, the civil war takes place typically in the rural areas of the country. Figure 1 shows the trend of homicides rates from 1946 to 2000. During the sixties and most of the seventies, homicide rates did not exhibit major fluctuations and in the late seventies escalated dramatically tripling by 1990. Although violence covers most of the Colombian territory, homicide rates reached epidemic proportions in large cities (Gaviria and Vélez, 2001). In contrast, massacres, armed confrontations and forced displacement are predominant violent events in rural areas. Since 1995, near four percent of the Colombian population (1'176,540 people) have fled their town to seek refuge from war.

⁸ Municipalities are the smallest administrative unit in Colombia.

Figure 1. Homicide rates in Colombia: 1960-2000



Source: Colombian National Police

What is the evolution of school enrollment in Colombia? During the period ranging from 1978 to 1995, school enrollment rates grew steadily in urban areas and registered significant gains in rural areas (see Table 1). Educational attainment increased by 2.7 years in urban areas and doubled in rural areas. As a result, the urban-rural gap narrowed significantly. Increases in school enrollment came along with less inequality (Vélez, 2002).

Table 1. School Enrollment: Urban and Rural Areas

	1978	1988	1995	1999
School enrollment – Urban areas				
Ages 7 to 11	91.8%	94.8%	96.5%	95.3%
Ages 12 to 17	76.9%	80.5%	84.4%	82.2%
Ages 18-22	31.2%	35.8%	41.0%	36.3%
School enrollment – Rural areas				
Ages 7 to 11	66.2%	85.4%	90.1%	90.5%

Ages 12 to 17	43.5%	57.2%	63.7%	66.0%
Ages 18-22	9.0%	14.6%	19.2%	20.6%

Source: World Bank (2002)

Evidence about the effect of widespread violence on school enrollment is ambiguous. Table 2 shows school enrollment rates for municipalities below and above the national median of homicides rates in 1997. When all the Colombian municipalities are included, divergences in school enrollment between violent and non-violent municipalities are not statistically significant. However, large cities exhibit two different behaviors in contrast from all Colombian municipalities and this might be driving the inconclusive results. First, violence in large cities is well above the national median. Second, investments to expand educational coverage were considerably greater in these cities. Therefore, large cities experienced unprecedented increments in homicide rates parallel to substantial expansions in access to education. If the four larger cities are dropped, school enrollments are higher in municipalities facing homicide rates below the national median. The difference is statistically significant and widens for older children and young adults.

Table 2. School Enrollment for Municipalities Below and Above the National Median of Homicide Rates

	Below the median	Above the median
School enrollment for total sample		
Ages 7-11	92.96	92.61
Ages 12-17	75.92	76.75
Ages 18-22	31.75	34.63
School enrollment for sample without four		

largest cities ¹

Ages 7-11	92.96	90.37
Ages 12-17	75.92	72.64
Ages 18-22	31.75	27.27

Source: Authors calculations based on LSMS-97 and MVD

1. The four largest cities are Bogotá, Medellín, Barranquilla and Cali

The evidence about the impact of violence on education is mixed. However, it necessary to control for other municipal conditions as well as household and individual characteristics to uncover the determinants of school enrollment. The next section estimates probit models of school enrollment to identify such determinants and clarify whether violence affects school enrollment in Colombia.

4.3. The Determinants of School Enrollment

To examine the determinants of school enrollment, two groups of probit models were estimated. The first group estimates the probability of school enrollment depending only on household and individual variables. School enrollment is estimated for children between 7 and 11 years, 12 and 18 years as well as young adults between 18 and 22 years of age. The second group of regressions includes context and geographic variables as determinants of school enrollment.

Table 3 provides estimates of the probability of school enrollment when only household and individual influences are considered. Results are consistent with findings of similar papers. Male children are less likely to enroll in school. The probability of attending school is greater for children from male headed households with better educated or wealthier parents. School enrollment is less for children with working mothers. Lastly, residing in urban regions increases the

likelihood of school attendance.

Table 4. Probability of School Enrollment – Household and Individual Characteristics

Variable	Ages 7-11		Ages 12-17		Ages 18-22	
	dF/dx	P> z	dF/dx	P> z	dF/dx	P> z
Male	-		-		-	
	0.0255	0.00	0.0304	0.00	0.0274	0.00
Male household head	-				-	
	0.0058	0.00	0.0083	0.00	0.0054	0.00
Years of schooling – More educated parent	0.0095	0.00	0.0304	0.00	0.0293	0.00
Yearly per capita aggregate consumption	0.0000	0.00	0.0000	0.00	0.0000	0.00
Working mother	-		-		-	
	0.0235	0.00	0.1481	0.00	0.1572	0.00
Urban region	0.0159	0.00	0.1190	0.00	0.1079	0.00
Pseudo R-square		0.1458		0.1367		0.1216

Source: Authors calculations based on LSMS-97

Inclusion of homicide rates and other context specific do not alter results and provides interesting insights. Violence has indeed a negative impact on school enrollment for all age groups in particular for young adults. This may imply that reductions in utility, households' income and returns from education stemming from violence outweigh increments in private returns caused by shortages in supply of educated individuals.

All other context variables have a significant influence on school enrollments. Transfers from the National Government to Local Governments⁹ are effective to increase educational coverage. In stark contrast, the size of the

⁹ These transfers are earmarked for local spending on education and health.

educational staff in the municipalities exercises a perverse incentive on school enrollment¹⁰. As educational staff increases, the likelihood of enrollment diminishes. Distance to the state capital, which may reflect availability of school supply, decrease the probability of enrollment for children between 7 and 11 years of age, increase school enrollment for children between 12 and 17 years and has no effect for young adults.

The magnitudes of the marginal effects allow us to assess the impact of homicide rates on school enrollment. A one percent increase in homicide rates drops school enrollment in greater proportions than an expansion of one percent transfers of the National Government. It is worth asking whether controlling violence may contribute equally or more to school enrollment that transfers of the National Government earmarked for education and health. This might be particularly true in countries with acute episodes of violence.

Table 5. Probability of School Enrollment – Household, Individual and Municipal Characteristics

Variable	Ages 7-11		Ages 12-17		Ages 18-22	
	dF/dx	P> z	dF/dx	P> z	dF/dx	P> z
Male	-0.0210	0.00	-0.0313	0.00	-0.0320	0.00
Male household head	0.0099	0.00	0.0079	0.00	0.0148	0.00
Years of schooling – More educated parent	0.0077	0.00	0.0320	0.00	0.0331	0.00
Yearly per capita aggregate consumption	0.0000	0.00	0.0000	0.00	0.0000	0.00
Working mother	-0.0297	0.00	-0.1638	0.00	-0.1568	0.00
Urban region	0.0220	0.00	0.1416	0.00	0.1100	0.00
Homicide rates	-0.0002	0.00	-0.0001	0.00	-0.0003	0.00
Transfers from National Government p.c	0.0000	0.00	0.0001	0.00	-0.0001	0.00

¹⁰ Recently, the law allocating public spending to education was modified. Now, education spending depends on the number of children enrolled. The previous law had perverse incentives and teachers sought assignments in municipalities with low enrollment rates.

Size of educational staff at the municipality	-0.0000	0.00	0.0000	0.00	0.0000	0.00
Distance to state capital	-0.0001	0.00	0.0000	0.00	0.0000	0.11
Pseudo R-square		0.1562		0.1482		0.1336

Source: Authors calculations based on LSMS-97

Violence in Colombia appears to erode investments in human capital. School enrollment is less frequent in municipalities with homicide rates below the national median. In addition, after controlling for individual, household and other context variables, violence influences negatively school enrollment. The costs of violence in this respect can be sizeable because deterioration of human capital is difficult to recoup in the long run.

Conclusions

Results of this paper show deterioration of human capital stocks is another economic cost of violence. As the theoretical model indicates, families reduce investments in education when confronted to violence because utility decreases, household income contracts and returns to education may shrink. But not only the “quantity” of education diminishes. Households may decide not to invest on education at all and the quality of education may also suffer due to destruction of infrastructure and a lower availability of teachers.

Estimations for Colombia reveal violence reduce investments in human capital. School enrollments in violent municipalities are small. And the likelihood of school enrollment for children between 7-11 years, 12-17 and young adults between 18-22 decreases as homicide rates increase. Violence, therefore, impinges not only monetary losses to households but modifies behavior in perverse ways. To recuperate declines in human capital investments as a result of crime may need decades.

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FUNDACION PARA LA EDUCACION SUPERIOR Y EL DESARROLLO



DYNAMICS AND CAUSES OF CRIME IN COLOMBIA

Final Version for the Ford Foundation

FELIPE BARRERA OSORIO

Fedesarrollo

Mayo de 2004

Dynamics and causes of crime in Colombia

Felipe Barrera Osorio¹

FINAL VERSION FOR THE FORD FOUNDATION

May 14, 2004

Abstract

This paper adds to previous research on the causes of crime in Colombia by using a new dataset and better econometric estimations. The paper is a “meta” study on the past empirical research on crime. Based on microeconomic foundations, it tests several hypotheses on crime in Colombia. In concrete, the first finding is that drug crimes are highly correlated with other crimes. As some theories suggest, drug activities affect the judiciary system and as a by-product, are correlated with other crimes. Also, the dynamics of drug trade suggest the use of criminal activities to enforce their own operations (e.g. homicides to enforce the law of silence). Second, guerrilla activity is correlated with several types of crimes, including drug crimes, homicides, kidnappings and bank robberies; paramilitary activity is correlated with kidnappings and drug crimes.

The article explores in a systematic way the relationship between the penal code and crime. In order to do this, an important effort is done in quantifying the legal code. The paper finds that the legal codes respond to criminal activity, but that laws have an impact on only few crime rates, such as kidnappings and terrorist attacks.

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Fourth, the paper finds that the probability of capture is an important determinant in all crimes; that “poverty” only explains kidnappings and homicide in those municipalities in which crime is low; and finally, that the presence of the State is a deterrence of terrorist attacks.

1. Introduction

The complexity of conflict and crime in Colombia is enormous. A quick review of some facts helps one to grasp the dimension of the problem. In summary, the country has been in conflict for many years and there are several groups involved in it. The objectives of the main illegal groups (the guerrilla and the paramilitaries) are diverse. The crimes rates for some types of offences are abnormally high, and for others the rates are in line with those in similar countries. These three facts all complicate the relationship between crime and conflict.

The objective of this article is to test some common and widely accepted hypotheses on the relationship between crime and conflict in the nation. The paper has four focal points. First, the article explores some of the dynamics of the “conflict”, which we define as the internal war between the guerrilla, the paramilitaries, and the military, with the civil population left in the crossfire.² Second, the article presents an analysis of the dynamic of certain crimes in the country. For instance, it explores the relationship between drug crimes and homicide. Third, the paper explores the relationship between conflict and crime. Indeed, as some of the empirical tests show, conflict is a chief determinant of certain crimes. Finally, the article analyzes the relationship between crime and the legal code. In order to do this, we constructed a “legal index” for each crime based on the national legislation on the crime during the last decade. Our contribution to the existing literature is threefold. First, we construct an improved dataset at the municipal level by

² Unfortunately this path of analysis leaves aside some of the important crimes in the country. For instance, “Family Violence” is one of the most committed crimes and, given the data at our disposal, we cannot investigate this phenomenon.

including variables not used in prior studies. Second, we estimate an equation of crime, founded on well-developed theory, using a better battery of techniques than used previously. Third, we methodically estimate several hypotheses on the causes of crime.

This work is centered on the recent period of the conflict (1990-2002). This choice of years limits the study in several ways, but it also has two main benefits. First, the rationality of the conflict is more or less homogenous during this period of time. Second, we believe that the quality of the data is better for this period of time than for prior years.

Besides this introduction, the paper has three parts. In the next section we give a short revision of the extensive literature on crime and conflict in Colombia. In general, these studies are grouped into two main categories. In one, led by historians and other social scientists, the historic view prevails, with complex, and rich descriptions of the facts and details of the conflict. In the second one, led by economists, there is an effort to measure and to test hypotheses. In this work we incorporate the two tendencies. In the description of the dynamics, we follow the historical approach, underlying the potential testable implications. In the general model, we apply rigorous economic methods. We try, however, to link both of these approaches as the rationality today is driven by the dynamics of yesterday. The third part presents the data, tests some hypotheses derived from the literature review, and estimates a general model on crime.

2. Dynamics

The literature on the dynamics of the conflict in Colombia is vast. We present some of the main ideas of an important study recently published by the UNDP, the “Informe Nacional de Desarrollo Humano 2003,” (PNUD (2003)) which gives a global recount of the conflict in Colombia. Also, we base the discussion on works by Echandia (1997, 1999) and Rubio (2002).

Several authors claim that the increment of crime in the country has several links with the conflict (for instance, Sánchez, Díaz and Formisano (2003)).³ In regions with high levels of conflict the majority of the law enforcement agents, both policemen and the army, are involved in deterring the conflict, and thus other crimes are less likely to be attended to. Moreover, the judiciary system is weak. Not only are there an important number of denounces relating to the internal war, but there also exists coercion by the illegal authors. In short, the conflict congests both the legal and enforcement systems. Finally, the guerrilla and paramilitaries are involved in drug production, which is an important source of income for the illegal groups. The presence of the drug business is correlated with several crimes (Gaviria, 2000).

Currently, the conflict in Colombia has five main authors: two important guerrilla groups, the FARC (“Fuerzas Armadas Revolucionarias de Colombia” or Revolutionary Army Force of Colombia) and the ELN (“Ejército de Liberación Nacional” or National Army of Liberation) with different beginnings; the paramilitaries, who came into existence as a response of landlords and drug producers to the guerrilla activity; the government, especially the Military Forces; and the civil society who, for the most part, is in the middle of the conflict.

The FARC started as a peasant movement in favor of land reform. During the 70’s, due to increasing inequality and lack of land reform, the movement started to grow, moving from the rural frontier to areas with large and unequal ownership of land. During the 80’s, the movement expanded to the “Llanos Orientales”, where it found a new financial source, the taxation of cocaine production. The FARC reached as well the Magdalena Medio, a region rich in cattle and gold mines that provided another two financial sources.

³ However, disagreement is common in the literature on the conflict in Colombia. For instance, two recent studies present completely opposite views of the relationship between guerrilla activity (conflict) with homicide rates. On one hand Levitt and Rubio (2002) state that “during the 90’s the empirical evidence on the link between homicide and guerrilla activity is very weak,” And on the other Sánchez, Díaz and Formisano (2003) find that “there exists a high correlation between conflict in Colombia and evolution of the homicide rate.” (own translation)

The “Bloque Sur” of the group moved to the Tolima and Huila region, with the objective of creating a corridor for drug traffic. (See Map 1)

The escalation of the conflict between the guerrillas and the government, and the zonal concentration of this guerrilla were the main characteristic during the nineties. The escalation was the response to a frontal attack by the Army to the most important guerrilla camp in 1991. Since then, the motivation of the guerrilla movement has changed dramatically through time. In the beginning, the idea of redistribution was the main motor for the movement. In the following three decades, this objective changed dramatically. Currently the objective is mainly an economic one: secure sources of income by focalizing the action and gaining control of certain critical corridors through which the guerrilla can move fast and the drugs can be trafficked.

The dynamics of the ELN are quite different. First, it started as an ideological movement for the people in the lowest part of the income distribution. Second, it started in zones where petroleum and coal were an important source of income. During the 80's, this guerrilla promoted the *de facto* local government, supporting peasant councils, within certain and determined parts of the country. During the nineties, the ELN concentrated its action to specific departments, and retreated from regions where it had tried to enter, but was prevented from doing so by the paramilitaries.

The paramilitaries began in the mid eighties as a reaction to the guerrillas. On one hand, the movement is comprised of owners of large areas of land who were taxed and kidnapped by guerrilla. On the other, the movement includes drug producers. The paramilitaries have both property resources and resources from drug business. They have been fighting, with relative success, the ELN. The relationship between the FARC and the paramilitaries changes according to the region. In areas of drug production, there has been some symbiosis in which the paramilitary drug lords produce with the security provided by the guerrilla; in other areas there have been confrontations.

In conclusion, one can say that the main driving force in the conflict in the last decade has been drug traffic (discussed by Gaviria (2000)). The conflict is based on securing financial resources and controlling strategic geographical locations, and for this reason, the geography of the conflict has change dramatically in the last decades (discussed by Echandía (1997) and Sanchez, Díaz and Formisano (2003), among others).

Gaviria (2000) tackles the problem of the relationship between drugs and crime. Since the beginning of the eighties, the homicide rate in Colombia has increased significantly, despite the fact that there have not been any significant changes in the “main” variables that explain crime. Gaviria forms the hypothesis that the chief factor that has caused the change in the crime equilibrium is the boom of drug activity in the country. He bases his hypothesis on two ideas. First, that crime, as a variable, has two equilibriums: one in which crime rates are low, the other in which crime rates are high. This last equilibrium emerges in a situation in which the rule of law is highly eroded, and different types of crimes live together reinforcing one and other, creating a high congestion in the judiciary system. The second idea of Gaviria places drug traffic as the detonator that has changed the state of the world from the low crime rate equilibrium to the high one. Gaviria presents indirect evidence that is in line with his hypothesis.

With respect to the geography of the conflict, Echandia (1997) maps the geographic change in the conflict and the implicit correlation with crime. In essence, the zones that have been affected by the conflict are strategic zones such as corridors of easy movement of troops and drugs. Also, they are zones prone to the absence of the government. According to his maps, violence is extremely high in those zones with high presence of guerrilla and paramilitaries and lack of legal forces. Velez (2003) ratifies the results using statistical data. She finds that the FARC and ELN have expanded lately towards bigger municipalities, municipalities with difficult access, and richer municipalities.

During the 90's several economists in Colombia undertook an ample agenda of estimating some hypotheses on the relationship among crime, violence and the so call “objective causes” of violence, mainly poverty and inequality. The agenda began when

more data became available. In one of the earliest studies, Montenegro and Posada (1994) regress homicide and robbery rates at the departmental level against the log of GDP per-capita, the change in the index of basic necessities, the increment of education covertures, infant mortality, the change in the urbanization index, GDP growth, and the ratio of people accused and the number of crimes committed. Their conclusions are diverse: first, poverty is not correlated with violence; second, growth is positively related with violence; and more importantly, a weak judiciary system is a determinant of crime.

In a more complete study carried out early on, Levitt and Rubio (2002) explore five hypotheses of crime in Colombia. These five hypotheses are as follows. First, drugs are one of the main determinants of crime. Second, weak judiciary system is positively correlated with crime. Third, guerrilla activity is positively correlated with crime. Fourth, poverty and income inequality are positively correlated with crime. Fifth, there is a higher propensity for violence among Colombians than for other nationalities. Among these five, Levitt and Rubio find, through indirect evidence that the first two are important in explaining crime, the third one is unclear, and the last two are without support. Again poverty does not seem to matter but the strength of the legal system and the presence of drugs do matter in determining crime rates.

The relationship between the judiciary system and crime and the unimportance of poverty is further reinforced by the findings of Sánchez and Núñez (2001). They regress homicide rates against the Gini coefficient of income inequality, presence of guerrilla, a proxy for drug traffic, and political participation, among others. Using a decomposition technique in which the differences among municipal homicide quintals is explained, they find that guerrilla presence, drug traffic and judiciary weakness are the main explanations of crime. They find as well that inequality and poverty explain a minimal part of the difference in homicide rates.

Other studies, however, have found support of poverty causing crime. Sarmiento (1999), using municipal level data, finds that the Gini coefficient of income distribution is one of the most important factors in explaining homicides. Inequality, according to the author, explains an important part of violence. This paper gives one of the most important empirical supports to the theory of “objective causes” of violence, mainly poverty and

inequality (see below for a description of objective causes). Similarly, Bourguignon, Núñez and Sanchez (2003) also find a relationship between violence and inequality. More precisely, they link violence with a specific part of the income distribution, mainly, the population below 80% of the mean income.

Sánchez, Díaz and Formisano (2003) present the most serious econometric effort to date to analyze violence in the country. They take four types of crimes (homicide, kidnappings, robbery and piracy) and regress each one against a large array of variables using a spatial technique. Again, the general conclusions are quite similar to those of Sánchez and Núñez (2001). However, they also find that the spatial component and persistence of crime are also important determinants of crime. In particular, they find that contiguous municipalities and time persistence induces an increased dynamic in crime (for each homicide, four more are created in nearby municipalities), as well as a generalized contagious effect of violence.⁴

Some empirical research has also been carried out to determine the locational choices of the guerilla. Rubio (2002) tries to explain guerrilla presence by regressing indicators of their presence in municipalities against several variables. He finds that presence of guerrilla is prone in municipalities with energy production (oil, etc), with a young population, and with a more unequal distribution of income. He does not find a statistically significant relationship between poverty and guerrilla presence. Also, against

⁴ This study poses several unanswered questions. The geographical component of the study is the contagion of crime from neighboring municipalities. The authors find that for each crime in a municipality, four other crimes occur in the neighboring municipalities. However, given the literature on the dynamics of the conflict, the spatial component observed in the conflict is quite different. The corridors, where an important amount of the conflict occurs, are well-delimited zones that leave outside parts of the country. The evidence is very clear: there is an enormous amount of dispersion in violence rates across municipalities. We expect that municipalities within a corridor (or close to a corridor) will be affected by violence. In the building of the corridor the violent agent will go from one municipality to the next one within the corridor, and during that transit, the illegal group may encounter other authors, and as result cause more crime and violence.

all conventional and empirical knowledge, he does not find a relationship between guerrilla and the production of drugs.

From the literature review, we can gather four general facts that are also the hypotheses tested in this paper. First, *the evidence on the relationship between conflict and crime is not clear*. The majority of studies do not find a relationship between poverty and violence; however, a few of them find a relationship between inequality and crime. However, probably with good data of the sixties and seventies, it would be possible to find a relationship between poverty and violence given that the guerilla groups arose as a response to fight poverty and inequality. Currently, the guerrilla and paramilitary activity in the territory is based on another rationality: they are close to financial sources, in areas without the presence of State, and in strategic corridors that may not correspond to areas with higher indices of poverty.

Second, *crime occurs in zones where the presence of the State is weak*. Fedesarrollo constructed a set of variables that allows for the direct testing of this hypothesis. Concretely, we measure the amount of municipal investment, which is a direct way to capture governmental investment.

Third, *crime is higher in richer zones*: a higher return of illicit activities will lead to higher crime rate. As argue by Bourguignon *et al.* (2003), the return of illegal activities can be modeled as an increasing function of municipal income where the crime is committed. We use several different measures of income in order to test this effect.

Finally, *crime is a decreasing function of the probability of capture*. Apparently, this is one of the most stable regularities in the empirical literature of crime in Colombia. In our analysis we test whether or not with our expanded dataset we reach the same conclusions.

3. Data, estimation and results

a. Data and four hypothesis

We use two sources of data on crime rates. First, information by the Departamento Nacional de Planeación (DNP) gives the number of homicides, massacres, total number of victims of massacres, bank robbery, kidnappings, and terrorist attacks per municipality. The data are broken down into the affiliation of the perpetrator (FARC, ELN, Paramilitary, other). Second, data from the Judiciary Police (SIJIN) reports the number of extortions, robberies, car robberies, house robberies, terrorist attacks, jail escapes, robberies of state property, and drug traffic at the departmental level.

Table 1 presents the basic crime data. We divide the presentation across three periods: between 1990 and 1993; between 1994 and 1997; and between 1998 and 2002.⁵ At the municipal level, homicides, massacres, and kidnapping are per 100,000 inhabitants. There is no clear and consistent temporal tendency. Whereas homicides and bank robberies are declining through time, massacres, kidnapping and terrorist attacks are increasing. In order to see the dispersion of crimes across municipalities, we calculate the coefficient of variance (from now on, c.v.), which is the standard error divided by the mean. Usually, if the c.v. is increasing, the population is becoming more heterogeneous, e.g. there is more dispersion of crimes across municipalities. Dispersion is decreasing for all crimes, except for massacres, at the municipal level.

⁵ This chose of periods is driven by the political timing (presidential periods), but it is somehow arbitrary.

Table 1. Crimes

	1990-2002		1990-1993		1994-1997		1998-2002	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Municipal								
Homicide	64.33	1.69	72.49	1.76	61.64	1.82	59.95	1.53
Massacre	30.49	1.37	NA	NA	23.78	1.00	34.52	1.59
Kidnapping	8.84	2.68	NA	NA	5.48	2.65	10.86	2.69
Bank robbery	0.54	16.10	0.75	21.62	0.66	19.70	0.41	12.11
City attacks	1.15	4.89	0.63	6.82	1.11	4.83	1.29	4.55
Departmental								
Terrorist	3.87	1.56	2.11	1.38	3.98	1.24	5.52	2.07
Extortion	1.85	0.98	1.87	1.05	1.63	0.94	2.06	0.96
Robbery	51.77	1.36	96.89	1.07	39.82	1.33	25.23	1.63
Stolen cars	35.51	1.10	11.72	1.62	39.54	0.94	51.33	0.80
Robbery of residency	26.17	1.42	19.59	1.50	26.17	1.65	31.44	1.15
Drug crimes	444.88	1.76	313.07	1.51	414.95	1.60	574.26	2.08
Nation. econ. patrimony	3138.82	2.17	3038.50	1.95	3237.95	2.58	3139.76	2.02

With respect to the departmental data, all the crimes, except for robberies, are increasing through time and in general the c.v. is decreasing. It is important to point out that these tendencies can be the effect of more denounces or that the authorities are becoming more effective. Clearly, these types of crime measurement are prone to measurement errors.

In conclusion, there is not a clear tendency in crime rates or levels for the period of analysis. In contrast, the country tends to be more homogeneous in the level of crime. This convergence can be towards a lower level or a higher one.

Using these data we now analyze the four main hypotheses we derived from the existing literature

1. *There is a correlation between drug of crimes and other type of crimes.*

The most simple and direct way to test this hypothesis is to analyze the correlations between different crimes. Table 2 shows the pairwise correlations between drug crimes and others crimes, as well as between homicides and other crimes. Drug crimes are statistically significantly correlated with all crimes except with car robberies. All crimes, with the exception of terrorist attacks, have a positive relationship with drug crimes. The degree of correlation has changed through time. All correlations are higher during the

first half of the period under investigation (1990-1995) than in the second period.⁶ Furthermore, the correlation with homicides also in decreased in its statistical significance. A potential explanation for these declines in the correlation between drug crimes and other crimes is that the major drug dealers (the heads of Medellin and Cali cartels) were free and in operating during the first half of the nineties. In contrast, during the second half of the decade the cartel of Medellin was dismantled and the main figures of the Cali cartel were in jail. Nonetheless, drug crime is still correlated with other types of crimes.

Table 2 Relationship between crimes: Pairwise correlation						
	Entire period		First half		Second half	
	Drug crimes	Homicide	Drug crime	Homicide	Drug crimes	Homicide
Drug crimes	1		1		1	
Homocide	0.1413*	1	0.3321*	1	0,0699	1
Terrorist attack	-0.1000*	0.2174*	-0,0994	0.2364*	-0.1173*	0.2442*
Extortion	0.1537*	0.3391*	0.2440*	0.4457*	0.1328*	0.2489*
Robbery	0,0032	0.1574*	0,0186	0.2318*	0,0656	0,0628
Car robbery	0.5587*	0.3507*	0.6978*	0.4158*	0.5407*	0.3828*
Residential rob.	0.2104*	-0.0854*	0.3139*	0,0471	0.1690*	-0.2002*
*Coefficient significant at 10 percent						

2. *Guerrilla activity causes paramilitary activity.*

A direct way to test causality between guerrilla activity and paramilitary activity is to use the Granger test of causality. In simple terms, the test explores if the past observations of a variable are important in explaining the variable that it is thought to have a causal relationship with. In order to perform the test, the variable of attacks by one violent group

⁶ Once more, the chose of periods is arbitrary. We opt to separate in this case the data between two periods and in this way, make the presentation easier.

is regressed against its own past values of attacks and the present and past values of the attacks of the other group. For example, if the past variables of paramilitaries are statistically significant in explaining the attacks by the FARC, then we can say that attacks by paramilitaries Granger causes attacks by the FARC.

Table 3 presents the results of the Granger causality tests. The first column shows the regression of attacks by paramilitaries against its own past attacks and the attacks by the FARC (and the past attacks by FARC). Lags 2 and 3 of FARC attacks are significant in explaining attacks by paramilitaries. Lag 1 of attacks by paramilitaries is significant in explaining present attacks. Running the Granger test, which is an F test, gives the value $F(4,11173)=7.44$, which supports FARC attacks causing paramilitary attacks.

The second column presents the other causality: attacks by paramilitaries causing FARC attacks. One interesting fact of the regression is the degree of persistence of FARC attacks, given by the positive and statistically significant coefficients of past attacks. The past paramilitary attacks are also statistically significant in explaining FARC attacks. As a consequence, the hypothesis of this causality is supported as well ($F(4,1173)=14.395$).

The third column shows the results for causality between paramilitaries and the ELN. In this case, none of the past attacks of ELN are statistically significant in explaining the attacks of paramilitaries. The Granger test gives a value of 0.4, which indicates that the hypothesis of causality is rejected.

The last column presents the result of causality from paramilitaries to ELN. In this case as well, the persistence of ELN activity is clear (lag attacks are statistically significant). Past attacks of the paramilitaries, however, do not explain ELN activities ($F(4,11173)=0.86107$).

In sum, there is evidence of a mutual causality between attacks of paramilitaries and the FARC. Contrary to previous research, we find that attacks of ELN and paramilitaries are

not connected, and there is no evidence of Granger causality.

Table 3. Causality among illicit groups				
	Depend. var: attack of			
Indep. var: attack of	Paramilitaries	Farc	Paramilitaries	Eln
Paramilitaries		-0,0441		0,1074
Paramilitaries(-1)	0,0780 *	1,2353 *	0,0797 *	0,1432
Paramilitaries(-2)	-0,0088	-0,2970 ***	-0,0077	-0,3765
Paramilitaries(-3)	-0,0049	0,2094	-0,0027	-0,1843
Farc	-0,0002			
Farc(-1)	0,0004	0,3890 *		
Farc(-2)	0,0010 ***	0,2812 *		
Farc(-3)	0,0031 *	0,0047		
Eln			0,0002	
Eln(-1)			-0,0001	0,4712 *
Eln(-2)			0,0004	0,0832 *
Eln(-3)			0,0000	0,1681 *
R2 adjusted	0,008	0,197	0,005	0,377
F stat	13,840	392,970	9,820	965,540
* Sign. at 99%				
** Sign. at 85%				

3. *Conflict (guerrilla and paramilitary activity) is correlated with other crimes (e.g. total homicides and drug traffic)*

As stated in the introduction, one underlying hypothesis is that the armed conflict is correlated with some types of crime. For the purposes of this analysis we model conflict as the number of municipal attacks by the three main illegal players: paramilitaries, FARC and ELN.

Table 4 presents the pairwise correlations between attacks by each armed group and different types of crime. For the entire period, the attacks by FARC and ELN are positively correlated, and statistically significant, with drug crimes, homicides, kidnappings, and bank robberies. The attacks by paramilitaries are correlated with drug

crimes and kidnappings. The Table indicates that the correlation is not stable through time. The correlation between FARC attacks and homicides and kidnappings is increasing in time.

Table 4									
Pairwise correlation: conflict and crimes									
Period:	Entire period			First half			Second half		
Attacks of:	FARC	ELN	Paramil.	FARC	ELN	Paramil.	FARC	ELN	Paramil.
Crimes:									
Drug	0.0996*	0.0558*	0.0447*	0.0955*	0.0363*	Low d.f.	0.0816*	0.0527*	0.0432*
Homicide	0.0632*	0.0336*	0.0046	0.0244*	0.0059	Low d.f.	0.1011*	0.0578*	0.0095
Massacres	-0,0679	-0,0719	0,0101	-0,1682	-0,3193	Low d.f.	-0,0659	-0,0714	0,0073
Kidnapping	0.1051*	0.1180*	0.0521*	0.0520*	0.0782*	Low d.f.	0.1035*	0.1189*	0.0509*
Bank rob.	0.2817*	0.2030*	0,0115	0.5624*	0.3199*	Low d.f.	0.2093*	0.1531*	0.0192
* Correlation significant at a 95% confidence									
Low d.f: low level of observations									

One interesting fact that appears from these correlations is the negative relationship between guerrilla attack and massacres. The relationship between paramilitaries and massacres is positive, but statistically not significant. In sum, there is a clear correlation between conflict and most measures of crime in the country. It is important to keep in mind that the sources of variation of these data are both spatial and temporal. Municipalities with higher attacks by guerrilla are the ones that observe more crimes; years with more attacks also present higher crime rates. Still, with the simple correlations the question of what causes crime is not solved.

4. *Increment in punishment by penal laws did not reduced crime.*

As the literature review shows, there is an apparent consensus that one of the major determinants of crime in the country is the strength of the legal system. To test hypothesis 4, we test for Granger Causality between the degree of punishment and the various types

of crime.⁷ In this case we run a regression of each crime against its past values and against the present and past values of the punishment index that captures the severity of punishment for that particular crime. We test if the present and past values of the index explain the current levels of the crime. In theory, if the penal law works in reducing crime then as the index increases the level of crime should decrease since higher index values indicate more severe punishment..⁸ Graphs 1 through 5 show the indices for several crimes.⁹

Each index is comprised of an array of the characteristics of punishment of the particular crime. The index includes such attributes as the length of maximum sentence, the amount of fines, and impact of aggravation or attenuation circumstances. It is based on the several Penal Codes of the country enacted during the period 1990-2002. Several intrinsic properties of the index need to be clarified. First, the punishment is higher if the value of the index is higher. Second, the absolute level of the index is not relevant. The relevant aspects are the degree and direction of change of the index through time. Third, the relative position of the index of a particular crime in comparison with other crimes is important.

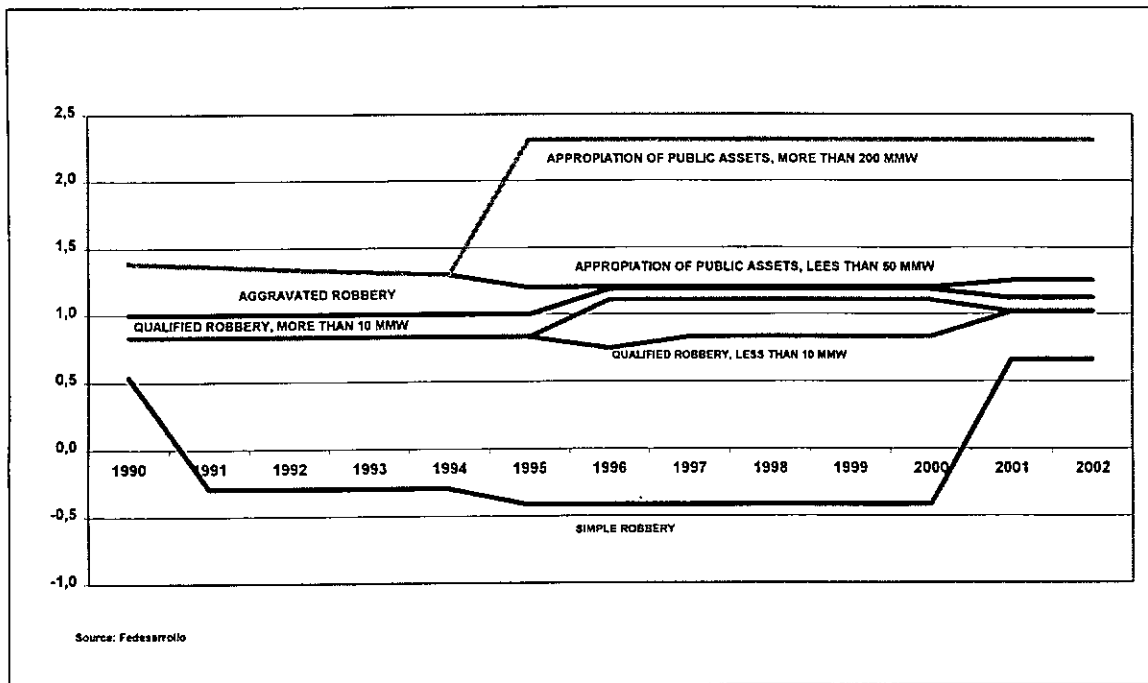
Graph 1 presents the indices for robbery and appropriation of public assets. In general terms, there was a firming up of the code for all property crimes during the nineties (with the exception of simple robbery). It is interesting to observe that appropriation of public assets receives a harder punishment than any robbery, including aggravated robbery. Finally, there are two major reforms for the punishment of these crimes during the nineties: one in 1995 and the other in 2000.

⁷ Echeverry and Partow (1998) regress a measure of probability of capture against crime. They find that the juridical system is quite ineffective: as the degree of the crime increases, the probability of conviction does not

⁸ Clearly, this method is not complete because crimes depend of other variables as well. We will estimate complete models part be of this section.

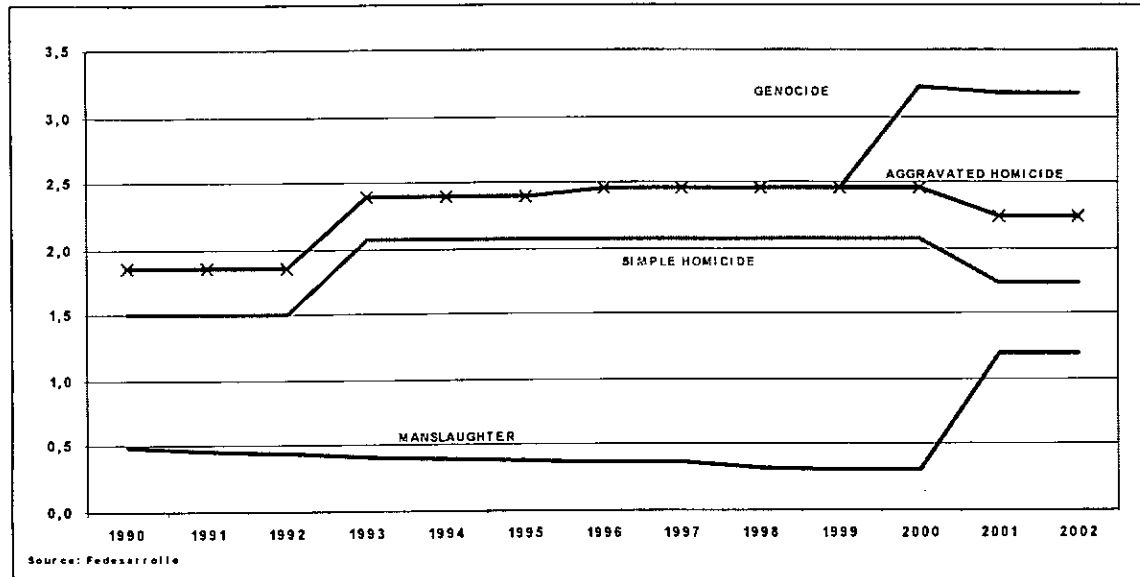
⁹ The construction of the index is presented in Barrera and Latorre (2003), and is based on Gonzalez (2003):

Graph 1. Crimes Against Property



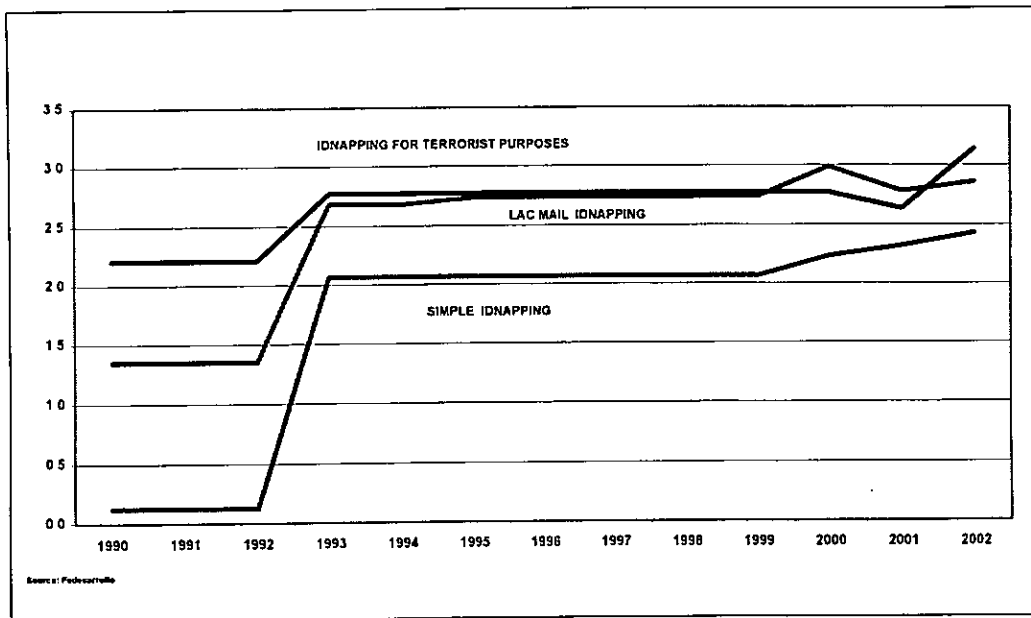
As Graph 2 shows, there is a tendency towards the greater punishment for homicide and genocide. The decline in the punishment for manslaughter is caused by a fine set in current pesos, a value that declines with inflation. There were two main reforms one in 1993 and the other in 2000.

Graph 2. Crimes Against Life and Personal Integrity



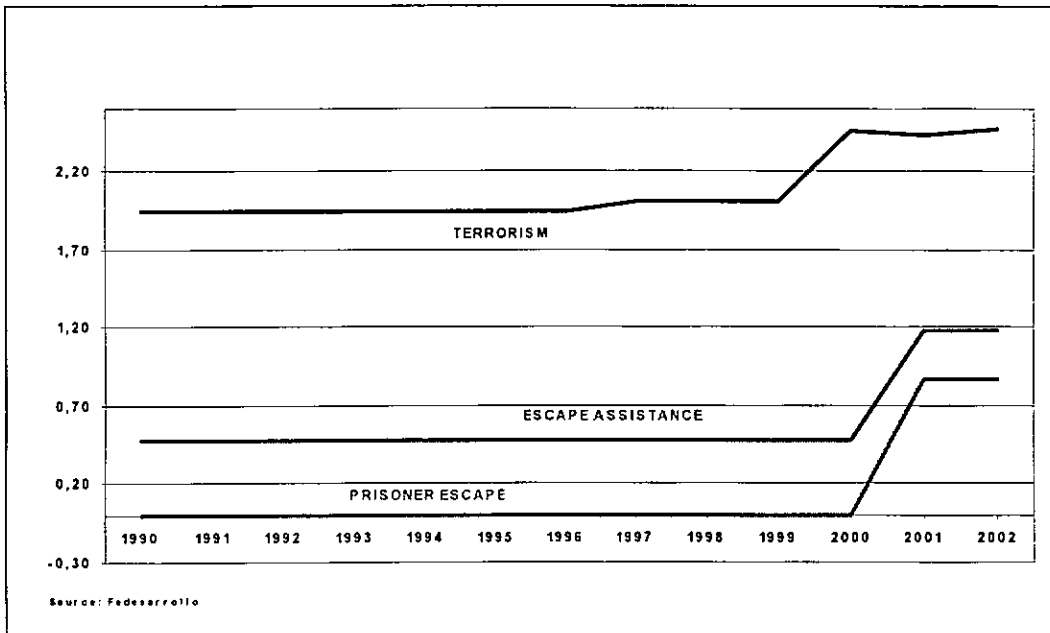
The punishment for kidnapping has gone through two major changes, both of them towards the toughening of the punishment (Graph 3). First, in 1993 the degree of punishment almost doubles with respect to the original level; second, since the 2000 the potential punishment has been increasing slightly. The tendency is the same for the three types of kidnapping – for terrorism, for blackmail or just simple kidnap.

Gra 3 Cr es A a s Perso al Freedo



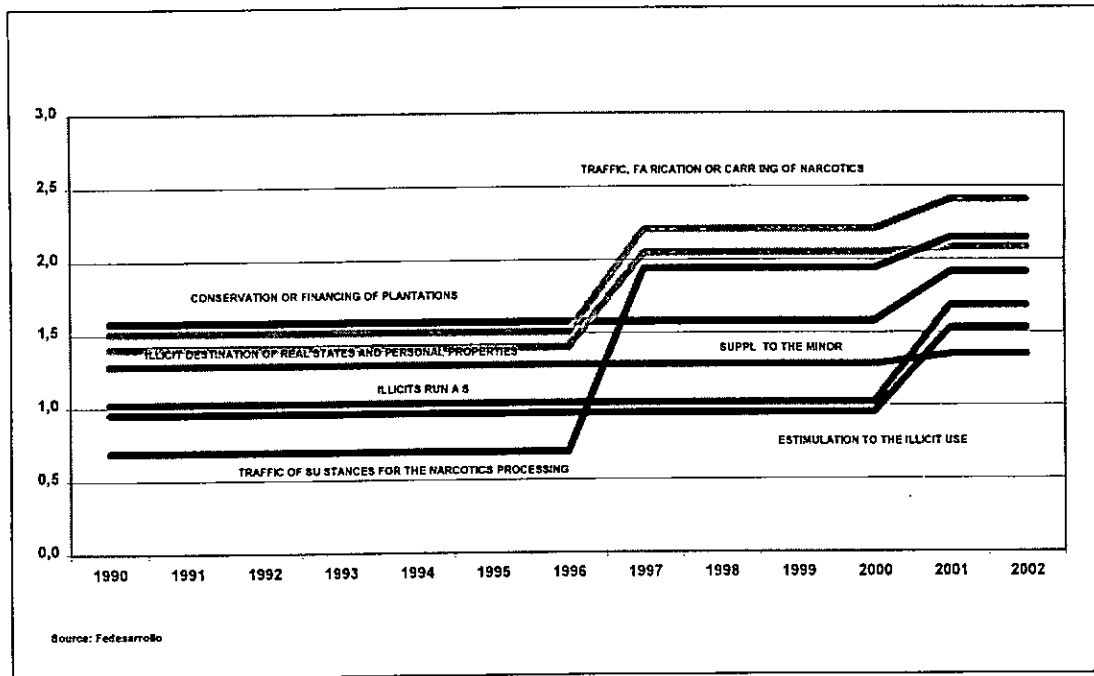
In terms of terrorism and prison escape (Graph 4), the penal code did not change until 2001, with Law 599 when crimes against public security were toughened.

Gra 4 Cr es A a s Pu l c Secur a d Pr so Esca e



Finally, punishments for drug related crimes were stable until 1997 (Graph 5). In that year the punishment increases especially crimes related with the inputs of the drug manufacturing processes. Finally, the potential punishment for all of the drug related crimes increased in 2001 with Law 599.

Graph 5. Drug Related Crimes



In order to analyze the causality we run the Granger Causality tests. Table 5a presents the regression results from these analyses. A common characteristic that emerges from the table is the persistence of crime across time. For all crimes, the coefficients on its own past values are positive and statistically significant. The only exception is homicides in which the second lag is negative

A second common characteristic is that the current value of the legal index does not affect any crime rate. Apparently for homicides, as well as for robberies, the legal code is totally ineffective, from a purely statistical viewpoint. Kidnappings are affected negatively by the past values of the legal code such that the higher the punishment was in the previous periods, the lower the kidnapping rate in the current period. The results for drugs crimes are difficult to interpret: while the first lag of the index is positive (the higher the punishment in the previous year the higher the amount of crime), the second lag is negative. Given the size of the coefficients, the effects cancel each other out and

thus effectively the degree of punishment does not impact drug crimes. Finally, for attacks (by guerrilla and paramilitaries), the past values of the legal code have some effect.

Table 5a: Regression of Crimes against Legal Codes					
Independent Variables:	Homicide	Drugs crimes	Robbery	Attacks	
Legal Code 1	1,08 *	0,74 *	0,25 *	0,47 *	0,32 *
Legal Code 2	-0,13 *	0,24 *	0,77 *	0,16 *	0,51 *
Legal Code	6,25	28,65	-59,71	21,02	2,66
Legal Code La	-76,61	-130,86 *	413,40 *	-38,72	-1,53
Legal Code La	91,58	-89,81 *	-405,59 *	-15,51	-12,77 *
Constant	-3,20	543,51 *	95,34	47,27	23,74 *
R ² adjusted	0,98	0,82	0,78	0,48	0,52
F statistic	3332	184	254	65	77
* Statistically significant at 95%					

We also test for Granger causality between crimes and legal indices. Table 5b shows the results. With respect to terrorism, we find double causality (crime “changes” the legal code, the legal code affects crime). With respect to robbery, only causality from crime to the severity of law is established. The law affects drug crimes; apparently drug crimes do not affect the severity of the law. For kidnappings, we find double causality as well, but clearly the probability of causality of the crime towards the law is stronger in a statistical sense. Finally, for homicides, only causality from the crime to the law can be established.¹⁰

¹⁰ However, as it is shown below, once we control for other covariates, the law reduces homicide.

Table 5		
Grauer Causal Effects Law and Crime		
Terror s		F stast
	La c a es cr e	12,49857 *
	Cr e c a es la	8,319349 *
Ro er		F stast
	La c a es cr e	0,667247
	Cr e c a es la	8,208441 *
Dru cr e		F stast
	La c a es cr e	3,043543 *
	Cr e c a es la	0,511039
d a		F stast
	La c a es cr e	6,485487 *
	Cr e c a es la	1226,606 *
Ho c de		F stast
	La c a es cr e	0,714841
	Cr e c a es la	2,586912 *
*: Sign (95%)		

In conclusion, for three types of crimes (terrorist attacks, kidnappings and drug crimes), the law has induced changes in the behavior of criminals. For robbery and homicide, the law is ineffective in reducing the number of these types of crimes from a purely statistical viewpoint.

A micro explanation of the behavior has two components. Robbery and homicide are “old” crimes, whereas terrorist attacks, kidnappings and (to some extent) drug crimes are “new”. New crimes induced the use of new strategies and resources from the authorities. For instance, with the large increment in kidnappings during the nineties, the Fiscalía Nacional de la República (the Office of the General Attorney) created a special unit for the fight against this type of crime. In fact, the efficiency of the code against kidnappings

can be the combination of new units and strong legislation.¹¹

b. Model estimation

Becker (1968) led the path for the economic study of violence. In essence, the importance and innovation of Becker's model lies in a new way to think about crime: crime is a rational activity, in which individuals weight the costs and the benefits of being a criminal.

Some of the most relevant conclusions of Becker's model can be synthesized in one simple equation (Becker (1968), Ehrlich (1996) and Freeman (1999)). Let $c_{i,j}$ be an indicator (0 or 1) that a person i commits crime type j ; let w_i be the wage that person i can receive in a legal activity; let $h_{i,j}$ be the (monetary) return that person i will get for crime j if the crime is successful; let p_j be the punishment (measure in monetary terms) for crime j ; let $(1 - \rho)$ be the probability of capture if the person i commits a crime (and ρ the probability of no capture); finally, let $u_i(\cdot)$ be the utility level of person i . The condition for person i to commit the crime j is as follows:

$$c_{i,j} = 1 \quad \text{if} \quad u_i(w_i) < \rho(u_i(h_{i,j})) + (1 - \rho)(u_i(p_j)) \quad (1)$$

In words, a person will commit crime j if the expected payoff is larger than the payoff from legal activity.¹²

¹¹ I am indebted to Rómulo Gonzales, ex-minister of Justice and expert on the topic for this comment.

¹² The form of the utility function captures different degrees of risk aversion. For individuals with higher risk aversion, Equation (1) is less likely to be true. Also, the utility function can capture other characteristics, like the "moral standards" of the individual.

If the payoff of illicit activities increases, the individual probability of committing a crime increases as well. Also, if the penalty or the probability of getting arrested increases, the individual probability of committing a crime decreases. Finally, if the payoff of legal activities (the opportunity cost) increases, the individual probability of committing a crime decreases.

This simple equation can have several correspondences with the problem of crime in Colombia. In the first place, the absence of the government in several places of the territory can be captured by the parameter ρ . One implication of the model is that crime is increasing with the probability of non-capture ($\partial c_j / \partial \rho_j > 0$). Another parameter related with this issue is the relationship between the degree of punishment (p_j) and crime: in theory, crime decreases as the punishment increase $\partial c_j / \partial p_j < 0$.

As argued in the previous section, the dynamics of the conflict have been changing in the last decade. Now, there is a clear incentive for the illegal groups to go where there are the sources of financing of their activities. This can be captured by the parameter \bar{h}_j . Drugs enters the equation not only through \bar{h}_j , but also via the effect their effect on ρ .

In the model, the relationship between poverty and crime is captured by the variable \bar{w} . If the returns from legal activities are low, then the crime rate can be expected to be high. Wealth measures the cumulative returns from legal activities, and therefore, the higher the poverty the higher the crime rate. The relationship between inequality and crime can be argued along the same lines. Inequality is a relative measure of the degree of poverty. Therefore, violence increases with inequality.

To get the aggregate supply function of crime from Equation (1) is quite difficult, as is the aggregation of any market. The total amount of crime j , $C_j = \sum_i c_{i,j}$, will depend on

the characteristics of the individuals and on characteristics of the society. In short,

$$C_j = f(\rho, h_{1,j}, \dots, h_{n,j}, p_j, w_1, \dots, w_n; \Omega) \quad (2)$$

where n is the total number of individuals. The variable Ω represents a series of other factor affecting crime, e.g. other institutional factors like the “moral” values of society; interactions between crime j and crime k ; or risk aversion (which will be discussed in greater detail later).

Under some assumptions, the amount of crime depends on an average return of illicit activities (\bar{h}_j) and some representative price for legal activities (\bar{w}):

$$C_j = f(\rho, \bar{h}_j, p_j, \bar{w}, \Omega) \quad (2a)$$

Empirically Equation (2a) can be estimated as:

$$C_j = \beta_0 + \beta_1 \rho + \beta_2 \bar{h}_j + \beta_3 p_j + \beta_4 \bar{w} + \beta_5 \Omega + \varepsilon \quad (3)$$

The strategy is, therefore, to estimate a specification of Equation (3). However, there are important problems in this estimation that are worth spelling out. These issues can be split in two: first, causality problems and, second, measurement errors.

The potential of double causality in Equation (3) is enormous. Consider the following example. Typically, empirical estimations take the income of the geographic region as the proxy for potential returns from crime. The theory predicts that a higher income implies a higher “potential” return from crime and therefore, more crime (e.g. a positive relationship). More crime can produce, however, lower income for several reasons: crime may lead to lower investment; crime may imply the destruction of capital; etc. Therefore, the sign of the relationship between crime and income, as a proxy of potential return from

crime, can be positive or negative.

In more formal terms, $E(\varepsilon / \rho, \bar{h}_j, p_j, \bar{w}, \Omega) \neq 0$, and therefore, estimates of $\beta_0 \dots \beta_5$ will be inconsistent. This problem permeates almost all the variables in the estimation. The probability of detention, $(1 - \rho)$, can be endogenous to crime: if crime increases, the authority can respond with more policemen in the street. Therefore, the causality can be both ways. Same reasoning applies to the severity of the punishment, p_j . As discussed above, a higher payoff of crime (\bar{h}_j) can induce more crime (as the model predicts), but more crime may induce the destruction of capital or lower investment and therefore, lower the potential payoff.

Measurement errors are also important in the empirical research of crime. If a variable is measured with error, and the error is correlated with the dependent variable, then again the estimates of the parameters of Equation (3) will be biased. If the error is not correlated with any intrinsic characteristic, estimator of Equation (3) is consistent.

With respect to this problem the literature has identified measurement errors in the dependent and in the independent variables. Apparently homicides are measure with accuracy, but other types of crimes have more problems. For instance, it is possible that information from police sources may try to inflate certain types of crimes (robbery) in order to obtain more resources. In this case, and if one of the proxies of probability of detention in Equation (3) is the size of the police force, the estimate of β_1 will be inconsistent. With respect to measurement error in the independent variables, if the error is correlated with the dependent variable the estimates will be inconsistent.

The solution for both types of problems is instrumental variables. However, finding proper instrumental variables is quite difficult. Part of the contribution of this research is to use instrumental variables techniques to get consistent estimators of Equation (3). In simple terms, a good instrumental variable is one correlated with the independent variable

that is problematic, but not related with the dependent one. For this paper, we used several instruments, each of them discussed at length when used.

We argue that Equation (3) is relevant in explaining some of the important implications from the literature of violence in the country. As described above, the drug business as a financing source determines nowadays to a large extent the dynamics of crime. As an example we can look at the stylized facts of Medellín, from where Pablo Escobar ran his drug business.

The “sicarios,” or hit men, were usually young, poor people who were part of the army of the Medellín Cartel. They killed, for money, people who were a threat for the cartel (policemen, lawyers, judges, and politicians). Usually the span of life of the typical “sicario” was very low because he / she also resulted killed in order to ensure the silence code. Does this pattern fit a model *a la* Becker? We believe that it does. First, the opportunity cost of crime, both in terms of the probability of capture and the returns from legal activities, was very small for a “sicario.” Second, the return from crime was upfront, and usually high, in relative terms. Still, one may wonder what impact had the short lifespan of those involved in the business in the individual’s decision process. The implications probably was minimal given that the span of life in the “Comunas” (the poorest neighborhoods of Medellín and the origin of the majority of the “sicarios”) was quite low. Third, the crime that induced this behavior definitely followed *a la* Becker model rationality: drugs are a well-defined example of a crime in which the criminal balances expected returns and costs.

Does the model apply to the other crimes studied in this paper? Again, our answer is a yes. One clear example is the robbery of sport utility vehicles. During the previous presidency (1998-2002), the guerrillas were given a safe haven in the jungle region of the country where drug production is rampant. The rationality for giving control of the zone to the guerrilla was to advance peace talks. During the time that the guerrilla were in control of the zone, they started to pay large amounts of money for each sport utility vehicles (SUVs) capable of managing in the jungle. Gangs of thieves started to appear

in main cities, and the robbery of cars, especially of SUVs, increased. Once the peace talks failed and the government took control of the area again the robbery of cars dropped significantly. This is an example of how thieves seized an opportunity when the payoff of the particular crime was high.

Table 6 presents basic data on the independent variables of Equation (3). With respect to the proxies of illicit income, we look at four variables: income per capita in the municipality, expenditure per capita of the municipality, transfers per capita to the municipality, and the per capita tax collected on property, industry and commerce. In essence, the assumption is that the revenues of illicit activities are increasing in these variables, as argued by Bourgnioun et al. (2003).

Table 6 Independent variables								
	1990-2002		1990-1993		1994-1997		1998-2002	
	Mea	CV	Mea	CV	Mea	CV	Mea	CV
Expenditure p.c.*	143,06	1,65	40,96	1,98	106,13	1,71	226,32	1,45
Income p.c.*	142,22	1,73	41,52	2,16	101,10	1,86	230,61	1,41
Transfers p.c.*	111,31	1,60	32,78	2,04	79,51	1,70	179,89	1,31
Prop.tax p.c.*	8,15	0,82	2,82	0,91	6,42	0,80	12,24	0,83
Indust.tax p.c.*	4,32	0,34	1,50	0,32	3,16	0,35	6,82	0,33
NBI	47,96	2,09	49,49	2,17	49,21	2,17	45,74	1,95
Criminals apprehended**	188,03	1,70	144,19	1,54	161,18	1,85	244,59	1,70
*Thousand of \$								
**Per 100.000 inha.								

The Index of Unsatisfied Basic Necessities (NBI) captures poverty, and it is a proxy for licit income. As the index increases, there are fewer opportunities for licit activities and therefore, we expect to observe a higher crime rate.

The probability of capture is measured by the number of criminals apprehended (per 100.000 inhabitants). As Table 2 shows, the number is increasing through time.

We run Equation (3) at the municipal level for three different types of crimes, homicides, kidnappings and terrorist attacks.

Homicide

Table 7 shows the regression results for the homicide rate per 100.000 inhabitants. The basic model includes municipal transfers (as proxy for potential illegal return), the index of basic unsatisfied necessities (proxy for legal return), number of criminals apprehended per 100.000 (proxy of probability of capture), the legal severity index of homicide (proxy of potential punishment), the municipal investment (proxy for governmental presence) and the level of drug activity.

Municipal transfers are a good proxy for the potential return from crime because these transfers are used by local authorities (mayors) to sign contracts, to pay the payroll, etc. In some way, they are cash money, and the guerrilla and paramilitaries pressure mayors in order to grab some of these transfers.

The index of basic unsatisfied necessities is a good proxy of legal returns because it measures poverty. A high level of the index implies more poverty and fewer legal alternatives.

The results of an OLS regression of the basic model are quite interesting. All of the signs are as expected, with the exception of the coefficient of the index of basic necessities, which is negative and significant. If the illicit return is higher, the crime activity is higher; if the probability of apprehension increases, the crime decreases; if drug activity increases, homicide crime increases; if the legal index increases, the crime decreases; finally, if the presence of the State increases, crime decreases. The explanation of the total variation of the crime by the model is, however, quite low.

If the same model is estimated using fixed effects by municipality (column two), some of the results change. In concrete, the coefficient of drug activity becomes negative. A

potential explanation for this is that drug activity is predominant in few municipalities of the country, and once we control for others characteristics of the municipality with the inclusion of fixed effects, the effect of drug activity vanishes.

Table 7

Deer as a social

Deer as a social: Deer as a social, 100,000

	Basic Model	Fixed Eff.	Fixed Eff. Homi<mean	Fixed Eff. Homi>mean	IV	IV Homi<mean	IV Homi>mean
Municipal transfers	0.016	0.024 *	0.003	0.100 *	0.010	-0.009 *	0.078 *
Index of basis necessities	-0.282 *	-0.228	0.147 *	-0.395	-0.210 *	-0.050	0.120
Criminals apprehended	-0.038 *	-0.014 ***	0.002	-0.043 *	-0.161 *	-0.023 *	-0.128 *
Drug crime	0.025 *	-0.012 *	-0.001 *	-0.004	0.064 *	0.015 *	0.036 **
Penal index hom.	-191.939 *	-90.444 *	-45.101 *	-95.481	-104.010 *	-24.770 *	-139.052
Munic.investment	-7.030E-08 *	1.37E-08	-7.61E-09	-3.18E-08	-1.47E-07 *	-3.00E-08 *	-2.62E-07
Constant	535.14 *	303.80 *	125.91 *	395.66 *	317.84 *	84.91 *	453.94 *
Number of obs.	6395	6395	4174	2254	6323	4118	2238
F statistic	49.52	11.22	7.39	3.39			
R2 adjusted	0.04	0.67	0.55	0.75	0.04	0.06	0.02
Wald statistic					113.15	68.42	20.11

The results are more interesting when we separate the municipalities to those that have high homicide rates and those that have low homicide rates. Column three presents the results for the low-homicide municipalities, and column four for those with high rates. The results are quite different for each group. For those municipalities with low homicide rates, the index of basic necessities is positive and statistically significant and the law induces changes in the behavior of the criminals. For those municipalities in which the crime rate is high, the potential amount of illicit return (captured by municipal transfers) and the number of criminals apprehended are the most important determinant of the crime.

As argued in the previous section, problems of endogeneity can be severe in the estimation of Equation (3). In order to correct for these effects, we estimate the equation using three instruments: the distance of the municipality to next main market (variable constructed by Fabio Sanchez); availability of water in the municipality; and dummy indicators for the appointment periods of district attorneys in the country. The rationality of using the first and second variable is that those variables are correlated with potential income from the illicit activities; the third one provides an instrument for changes in the legal codes and the war against drugs.

The results of the IV estimation are presented in column five. The model gives similar results as the previous ones, with the exception of the coefficient of drugs. Now, the coefficient is, as expected, positive and statistically significant. Still, the coefficient on the index of basic necessities is negative. However, when the same estimation is separated between municipalities with high and low criminal rates, the index loses significance in both regressions. Municipal transfers affect positively crimes only in municipalities with high homicide rates. Drug crimes impact positively homicide crimes in both types of municipalities. Finally, municipality investment reduces homicide crimes only in those places with low levels of homicide.

In conclusion, several main regularities emerge in the explanation of homicide rates. First, municipal transfers, as proxy for potential return of crime, explain homicides in

those municipalities with high rates of homicide. The index of basic necessities does not yield stable results. At best, it explains crime in those municipalities with low level of homicides. Number of apprehended criminals and the penal index yields stable results: in general, an increment in those two variables reduces crime rates. However, the index works “better” for municipalities with low criminal rates and apprehension of criminals in those municipalities with high criminal rates. Finally, presence of the state works in reducing crime in those places where the crime rate is low.

Kidnapping

Several differences appear between the determinants of kidnapping and of homicide. With kidnappings we use income of the municipality as proxy for illicit return of crime¹³The basic model presents all the expected signs, with the exception of the legal index. As argued before, the probability of causality between the index and the crime is from the crime to index. In other words, the law is changed, as the crime is more prevalent, and that explains the positive sign on the coefficient (Table 8). With respect to the other main difference between this regression and the analogous one for homicides, the coefficient for the index of basic unsatisfied necessities is positive and statistically significant. Once the model is run using fixed effects by municipality, the only two variables that explain the rate of kidnappings are drug crimes and the legal index.

¹³ As noted, we use several proxies for illicit returns of crime. We present the one that gives the best results. However, they are quite similar, independent of the variable.

Table 8 De er a s o d a De e de a r a l e: d a e r 100,000					
	as c Model	F ed E	IV	IV Ho ea	IV Ho ea
I co e o u c al	0,005 *	0,004	-0,007 *	-0,002 *	0,038 *
I de o a s s e c e s e s	0,090 *	0,030	0,140 *	0,005 **	0,266 *
Cr a l s a r e e d e d	-0,005 *	0,002	-0,006 *	-0,001 *	-0,007
Dru cr e	0,003 *	0,003 *	0,003 *	0,000 *	0,003 *
Pe al de d a	16,810 *	14,076 *	71,132 *	6,620 *	62,902 *
Mu c e s e	-1,11E-08 *	-6,99E-09	-9,33E-09 ***	7,84E-10	-1,54E-07
Co s a	-44,654 *	-35,801 *	-195,383 *	-16,937 *	-166,495 *
Nu e r o o s	4805	4805	4751	3654	1186
F s a s c	27,69	10,89			
R2 ad u s e d	0,03	0,1984	0,0202	0,01	0,04
a l d s a s c			155,5	63,21	50,88

As presented before, probably the results of the basic OLS model are biased due to endogeneity problems. The third column presents the IV estimation, using the same set of instruments as were used in the homicide regressions. All the variables keep the same signs, with the exception of the municipal income. However, once we split the sample into municipalities with high and low kidnapping rates, the sign on the municipal income has the expected direction for municipalities with high kidnapping rates. For the low kidnapping municipalities it is still negative. This result is analogous to the one found for homicide. Another main difference between municipalities with high and low kidnap rates is the asymmetry of the effect of criminals apprehended. It seems that greater number of apprehended criminals reduces kidnappings where kidnapping is low (contrary to the effect in the homicide case).

As in the case of homicide, we see differences of behavior between municipalities with high and low crime rates. One striking difference between homicides and kidnappings is the effect of poverty in the determinant of the crimes. While the relationship between homicide and the index of basic necessities is instable, the relationship between the index and kidnappings is stable, positive and statistically significant.

Terrorist attacks

In order to analyze the causes of terrorist attacks, we first add the attacks by paramilitaries, FARC and ELN to get an aggregate measure. Then we run the model given by Equation (3). The results are presented in Table 9.

Table 9 Descriptive statistics
Descriptive statistics

	Basic Model	IV	IV Attacks<mean	IV Attacks>mean
Property tax	1.07E-06 *	3.14E-07 *	5.65E-08 *	3.84E-07 *
Index of basic necessities	-0.004205	-0.018242 *	0.001115 *	-0.0696 *
Criminals apprehended	-0.002521 *	-0.001249 ***	-0.000341 *	0.000988
Drug crime	0.000274 *	0.000677 **	0.000128 *	-0.000821
Penal index terrorist	0.848947 *	0.206162	-0.025669	1.940723 ***
Munic.investment	-1.22E-07 *	-3.16E-08 *	1.71E-09	-3.74E-08 *
Constant	-0.187633	1.421577 *	0.138705 *	4.615077 **
Number of obs.	6416	6344	5303	1041
F statistic	949.42			
R2 adjusted	0.4701	0.3957	0.018	0.4472
Wald statistic		431.32	73.1	124.85

In this case, the proxy for illicit return is property tax. The basic model (OLS, first column) presents the same characteristics as the counterparts for homicide and kidnapping. As in the case of homicides the index of basic necessities has a negative coefficient, but it is statistical insignificant. The sign of the coefficient on property tax is positive and statistically significant. The IV estimation presents almost the same properties as the OLS. For this case, the separation between municipalities with high and low crime rates, gives three main differences. First, drug crime affect positively terrorist attacks for municipalities with low crime rates. Second, the number of criminals apprehended reduces terrorist attacks in municipalities with low crime rates. Finally, presence of the State reduces crimes for those municipalities with high crime rates.

5. Conclusion

The conclusions from the existing empirical literature are disappointing and contradictory. While some authors find that one variable is an important determinant of crime and violence, others find the contrary. For this paper we tested some of the most controversial conclusions of the literature by using a new dataset and techniques.

Our findings are the following:

1. Drug crimes are a critical determinant of all other types of crimes.
2. Guerrilla activity is correlated with drug crimes, kidnappings, homicides and bank robberies. Paramilitary activity is correlated with drug crimes and kidnappings. The correlation between FARC activity and kidnappings and homicides has been increasing in the last decade.
3. Laws are ineffective in reducing homicide rates and robberies; they are effective in reducing kidnappings, terrorist attacks and drug crimes. Causality from crime to laws (increments in crimes inducing changes in law) is apparent in homicides and robbery; double causality is detected in kidnappings and terrorist attacks.
4. Regarding the determinants of crimes, there is variation across the type of crimes and across the type of municipality.
5. The return of illicit activities is a determinant of crimes for those municipalities with high crime rates.
6. Poverty determines homicides in municipalities with low crime rates; it determines kidnappings in all type of municipalities. For terrorist attacks (guerrilla and paramilitary attacks), poverty has asymmetric results.

7. The probability of capture is a quite stable and statistically significant determinant of the three types of crimes under investigation. The higher the probability less crimes there are.
8. The presence of the State is an important and significant determinant of reducing terrorist attacks; it is not significant for kidnappings and it is significant for reducing homicide in municipalities with low levels of crime.

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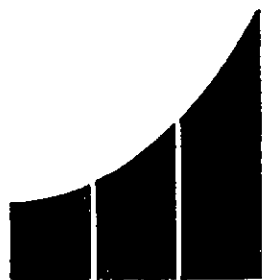
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