Economic Growth in Colombia: a Reversal of "Fortune"?

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ECONOMIC GROWTH IN COLOMBIA: A REVERSAL OF 'FORTUNE'?

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ABSTRACT

Since 1979, Colombia's annual GDP growth has been on average two percentage points lower than what was observed between 1950 and 1980. The sources-of-growth decomposition shows that this deceleration can be accounted entirely by changes in productivity. Indeed, between 1960 and 1980 productivity gains increased output per worker by nearly 1% per year. Since 1980, productivity losses have <u>reduced</u> output per worker at about the same rate. The time series analysis suggests that the implosion of productivity was caused by the increase in criminality which diverted capital and labor to unproductive activities. In turn, the rise in crime was the result of rapid expansion in drug-trafficking activities, which erupted around 1980. Consequently, the fortunes associated with the emergence of Colombia as the world largest producer of cocaine had a significantly negative effect on growth and productivity. This explanation is supported by cross-country evidence that shows that Colombia's underperformance, especially in the 1990s, is explained by its high homicide rate.

CRECIMIENTO ECONÓMICO COLOMBIANO: ¿CAMBIO DE "SUERTE"?

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RESUMEN

Desde 1979, el crecimiento anual del PIB en Colombia ha estado en promedio dos puntos porcentuales por debajo del crecimiento observado entre 1950 y 1980. Las fuentes de descomposición del crecimiento revelan que esta desaceleración está explicada por cambios en la productividad. En efecto, entre 1960 y 1980 las ganancias en productividad aumentaron el producto por trabajador en casi un punto porcentual por año. Desde 1980, las pérdidas de productividad han <u>reducido</u> el producto por trabajador a una tasa similar. El análisis de series de tiempo sugiere que la contracción de productividad fue causada por un aumento en la criminalidad, la cual desvió el capital y la mano de obra hacia actividades improductivas. Las mayores tasas de criminalidad fueron resultado de la rápida expansión del tráfico de drogas, cuyo punto de partida se puede situar alrededor de 1980. De tal manera, la riqueza asociada con el surgimiento de Colombia como el más grande productor de cocaína tuvo un efecto negativo sobre el crecimiento y la productividad. Esta explicación se encuentra apoyada por comparaciones entre países, las cuales revelan que el bajo crecimiento de Colombia, especialmente en la década de los años noventa, se explica por sus altas tasas de homicidios.

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1. INTRODUCTION

Colombia has traditionally been regarded as a success story in terms of economic growth and stability. According to Figure 1a, this reputation is based on the macroeconomic performance between the 1930s and 1970s, which was characterized by increasing GDP growth rates combined with a reduction in volatility (measured by the standard deviation in growth rates). In fact, GDP growth rose to an annual average of 5.8% during the 1970s from 3.8% during the 1930s. The standard deviation in the growth rate fell from around 3% during the 1930s and 1940s to 1% during the 1960s (and then rose to 1.7% during the 1970s in spite of much sharper external shocks relative to previous decades).

As shown in Figure 1b, per capita GDP growth rates show similar trends. In this case, the acceleration in growth was particularly significant during the 1960s and 1970s. The economics profession, both nationally and internationally, impressed with this performance, considered Colombia as a paradigm of macroeconomic management, praising the combination of able technocrats and sound institutions as the key driving elements of this success story.

As in every other Latin American country, growth decelerated significantly during the 1980s. Figures 1a and 1b show that very clearly: average GDP growth fell to 3.4% per year, while the annual per-capita GDP growth was 1.2% (nearly two percentage points below the rate observed in the previous decade). This was, of course, Latin America's "lost decade" when GDP contractions were the norm in the region. In fact, at that time Colombia was seen as an over-performer mainly because it did not default on its debt and did not experience negative economic growth, contrary to was observed in many other Latin American countries. However, during the 1990s Colombia's economic growth decelerated even further -to an average per capita growth rate of 0.9% per year. This was a surprising result for two reasons. First, almost every other country in the region (with the exception of Paraguay) had higher growth during the 1990s relative to the 1980s. Second, Colombia adopted a package of reforms in the early 1990s with the explicit goal of accelerating growth.

This paper deals with several issues related with this reversal in economic fortune. It starts by analyzing the time series evidence in order to test for structural breaks in Colombia's postwar economic growth data. The evidence, which is robust to various specifications and methodologies, indicates that a downbreak in growth rates occurred in 1979. Furthermore, using standard growth decomposition exercises, the paper shows that the reduction in economic growth can be explained by the reduction in productivity, rather than a deceleration in the rate of accumulation of physical and human capital.

In searching for more fundamental determinants, the paper finds that the unexpected (and quantitatively large) increases in crime rates (measured by homicides and kidnappings) were the driving force behind the deceleration in growth. In turn, higher crime rates have been the result of the expansion of drug-trafficking activities, which took off during the late 1970s and early 1980s. In other words, although initially perceived as favorable to

the economy, the sudden increase in illicit exports did in fact become a curse, causing a major reversal in terms of growth performance.

This explanation differs from the more traditional views on recent growth performance in Colombia, based on the role of external shocks, fiscal management, and the consequences of a comprehensive structural reform package introduced in the early 1990s. In fact, most explanations have highlighted the role of the debt crisis in the 1980s, the growing fiscal deficit during the 1990s, and the adoption of the 'Washington Consensus' package (especially trade liberalization and central bank independence) during the 1990s. In the case of the latter, some analyses argue that the adoption of the package was the cause of low growth, while others consider that low growth has been the result of the lack of additional reforms that are necessary for the package to deliver better results[3].

This paper searches for an alternative explanation framed in the context of the recent growth literature and the cross-national evidence. After analyzing the underlying factors that explain economic growth in Colombia it concludes that the 'fortunes' generated by drug-trafficking –which exacerbated crime and violence- explain the change in economic performance in Colombia since 1980.

In other words, the paper identifies a fortuitous event that interacted with some initial conditions –high levels of inequality and poverty and the weak presence of the State in certain areas of the country- that was able to alter the growth trajectory for over two decades. In addition, the initial shock induced further changes in the institutions and policies, leading to the vicious circle of low growth and high crime. More concretely, the sudden increase in drug-trafficking set in motion a chain reaction which not only exacerbated crime and conflict (with a consequent negative impact on productivity) but possibly also had an adverse effect on the ability to conduct more prudent macroeconomic policies. The increase in government expenditures and the resulting fiscal deficit were, to some extent, the result of the conflict itself[4].

The analytical narrative is carried out at three different levels. First, using the standard sources-of-growth accounting, the paper presents new evidence on the 'proximate' determinants of growth: (a) physical capital deepening; (b) human capital accumulation; and (c) productivity growth. As is well known, this decomposition has limitations because accumulation and productivity are endogenous factors. In spite of the shortcomings, the decomposition shows that most of the 'explanation' of the reversal of growth in Colombia can be attributed to total factor productivity. However, this does not provide a structural interpretation of what caused the growth deceleration in Colombia.

Second, the paper analyzes the 'deep' or 'fundamental' determinants of growth. Recent growth studies have focused on the role of physical geography and institutions in

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[3] Ocampo (2004) argues that the sequencing and speed of structural reforms was not helpful to growth. At the other end, Edwards and Steiner (2000) underscore the lack of comprehensiveness in Colombia's reform package.
[4] Additional expenditures to preserve the rule of law (e.g. defense and justice) are one example of the links between conflict and fiscal outcomes.

determining the long–run performance of nations. This paper argues that it was an interesting interaction between these two forces that led to lower growth. Colombia has the ideal geographical location and the ecological systems for the development of the illicit drug business. In turn, these activities deteriorated institutional quality (e.g., the protection of property rights) with a negative effect on economic outcomes.

The paper is divided in five additional sections. Section 2 deals with the time series evidence and applies a simple procedure in order to identify a structural downbreak in Colombia's GDP growth since 1979. Section 3 presents the standard sources-of-growth decomposition in order to quantify the role of physical and human capital accumulation, as well as technological change in per-worker GDP growth. The evidence indicates that productivity is the key driving force behind the reduction in growth since 1979. Using time series data, Section 4 shows that the higher levels of crime and violence were the cause of the productivity implosion during the 1980s and 1990s. Section 5 looks into this issue using some cross-country regressions. Section 6 concludes.

2. GROWTH REVERSAL: TIME SERIES FACTS

The purpose of this section is to identify structural breaks in Colombia's postwar economic growth. We follow closely the empirical strategy of Berg et al. (2006) and apply the two-step procedure proposed by Bai and Perron (1998, 2003a) aimed at testing for multiple structural breaks in a single time series, when both the total number and the potential location of those breaks are unknown. In the first step, the procedure identifies all possible breaks and estimates their statistical significance using F tests. If there is evidence of at least one structural break, the procedure then selects the optimal number of breaks using information criteria, such as the Bayesian Information Criteria (BIC) or the modified Schwartz criterion (LWZ). Alternatively to information criteria, Bai and Perron (2003a) suggest to use a sequential F statistic, which tests the null hypothesis of 0 breaks against 1 break; if the null is rejected, then a new break is added and the test is performed again, testing the null of 1 break versus 2 breaks, and so on.

In empirical work, an important issue is concerned with the selection of the minimum number of years between breaks h (known as the "interstitiary period"). This decision involves a trade-off because choosing a long interstitiary period (say $h = 10$ years) means that the procedure can miss some true breaks that are less than 10 years apart. But, on the other hand, a short interstitiary period implies the use of very small subsamples with as few as $2h + 1$ observations. A shorter sample lowers the power of the test (i.e. the null hypothesis of no structural break is not rejected when it should be rejected).

We use annual GDP growth data between 1951 and 2005, so the total sample size (T) equal to 55 observations. Additionally, we impose a relatively long interstitiary period, $h = 13$, to minimize the problem of small subsamples. Thus, the maximum number of breaks allowed by the procedure, m, where $m = \text{int}\left[T / h\right] - 1$, is equal to 3.

Table 1 and Figure 2 summarize the results which robustly support the presence of a downbreak in 1979[5]. According to the estimates, GDP growth fell to 3.2% between 1980 and 2005, from 5.2% between 1951 and 1979. This is a significant alteration in growth path: while output doubled every 13 years before 1979, it has taken 22 years after then. How is that change explained? What caused such a large reduction in growth? These are the questions to which we now turn.

3. PROXIMATE CAUSES OF GROWTH: ACCUMULATION AND PRODUCTIVITY

This section closely follows the framework developed in Hall and Jones (1999) in order to estimate the contribution to growth of changes in the capital-output ratio, changes in the educational attainment of the population, and changes in productivity. Using the simplest Cobb-Douglas approach, assume that output Y_t in period t is produced according to:

$$Y_t = K_t^\alpha \left(A_t H_t\right)^{1-\alpha},$$

where K_t denotes the stock of physical capital, H_t is the amount of human capital-augmented labor used in production, and A_t is the labor-augmenting measure of productivity. Assume that each unit of labor (L_t) has been trained with E_t years of schooling. Human capital-augmented labor is given by:

$$H_t = e^{\phi(E_t)} L_t.$$

According to this specification, the function $\phi(E)$ reflects the efficiency of a unit of labor with E years of schooling relative to one with no schooling ($\phi(0) = 0$). The derivative $\phi'(E)$ measures the effect on efficiency of an additional year of schooling, which corresponds to the return to schooling estimated in a Mincerian wage regression.

Rewriting the production function in terms of output per-worker, $y \equiv Y/L$, we obtain:

$$y_t = \left(\frac{K_t}{Y_t}\right)^{\alpha/(1-\alpha)} h_t A_t,$$

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[5] The dates and number of breaks remained constant for shorter interstitiary periods. In addition, we applied the methodology presented in Ben-David and Papell (1997) who estimating an equation of the form:

$$\Delta y_t = \mu + \theta D_t + \sum_{j=1}^{k} c_j \Delta y_{t-j} + \varepsilon_t$$

Where y is the log of GDP, μ is a constant, D_t is a dummy variable that takes a unitary value if $t > T_B$, where T_B is an arbitrary break in the sample. The coefficient θ captures the effect of structural changes in economic growth. Using all the possible values for T_B we test the null hypothesis of no structural change in growth ($\theta = 0$) and compare the t-statistic of all the estimated values of θ (using $k=4$ based on the Akaike information criterion). The structural change corresponding to $T_B = 1979$ has the maximum t-statistic.

where h_t is human capital per worker. Taking logs and first-differences:

$$\Delta \ln y_t = \frac{\alpha}{1-\alpha} \Delta \ln\left(\frac{K_t}{Y_t}\right) + \Delta \phi(E_t) + \Delta \ln A_t.$$

This equation allows us to decompose growth in output per worker into changes in physical capital intensity, growth in human capital per worker (educational attainment), and growth in productivity (the residual). Note that writing the decomposition in terms of the capital-output ratio rather than the capital-labor ratio facilitates the interpretation because the former is proportional to the investment rate (along a balanced growth path)[6].

To proceed with the decomposition we use data on output (GDP), labor input (employment), average educational attainment, and physical capital for the 1950-2005 period. Figure 3 shows the average years of schooling of the urban and rural population based on the population censuses and the household surveys[7]. It is interesting to note that the educational attainment has been increasing at a stable rate since the early 1970s. Even though faster progress on this front was made between 1965 and 1973, this is not a likely factor in explaining the origin of the growth reversal.

Returns to schooling are a key input in order to construct the function $\phi(E)$. Núñez and Sánchez (2000) estimate a Mincer equation and provide this information. According to their results, which are based on the quarterly household surveys for the period 1976-1998, the rates of return to education in Colombia do not have the standard concavity that has been obtained for other countries (see Table 2). In fact, the returns to education per year of education (for individuals with 11 years of schooling) are 10 percent for men and 16 percent for women. These levels are about the same as the ones observed for individuals with five years of schooling, corresponding to primary education. Workers with completed higher education have the highest returns to education (21.5 percent). For comparison, Figure 4 includes a measure of $\phi(E)$ based on the more standard concave returns to education such as the ones obtained by Psacharopoulos (1994)[8].

The stock of capital was constructed using the perpetual inventory model on disaggregated investment data since 1925. For the year 2005, the stock of capital corresponds to the sum of all investment since 1925, net of depreciation[9]. Although the methodology underestimates the stock of capital for earlier dates, the capital stock is only used for the 1955-2005 period (due to the limitations with data on years of schooling

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[6] It is also interesting to note that GDP per worker (compared to GDP per capita) is a better measure of welfare when nonmarket production is important.

[7] The source is (*Estadísticas Históricas de Colombia,* Cuadro 7.3 (1954-1996)) and calculations from DNP-DDS for the period 1997-2005.

[8] According to this source, the rate of return (per year of education) for the first four years of education is 13.4%, for the next four years it falls to 10.1%, and to 6.8% for education beyond the 8th year. The main results of this paper do not change when these alternative returns to schooling are used.

[9] We use a 8% depreciation rate for machinery and furniture, 20% for transportation equipment, and 2% for housing and construction. The weighted average rate of depreciation is 4.9%.

prior to 1955). Thus, in practice at least 30 years of investment data are considered for each observation of the stock of capital.

Before showing the results of the decomposition it is useful to take a cursory look at the raw data. Figure 5 plots output per worker against the capital/output ratio for the period 1955-2005 (in logs). Interestingly, there seems to be a regime change in 1979. The pre-1979 period is characterized by an increase in output per worker and a decrease in the capital/output ratio, suggesting that productivity played a role in explaining the increase in output per worker. In contrast, between 1979 and 1999, increases in the capital/output ratio were proportionally larger than increases in output per worker. This can be taken as evidence that the accumulation of physical capital is not likely to be the cause of the deceleration in growth since 1979.

This is indeed what the decomposition shows. Table 3 presents the results of the decomposition exercise using the returns to education derived from Núñez and Sánchez (2000) and an estimated capital share (α) between 0.2 and 0.4 (we report the results corresponding to 0.3)[10]. The results show that annual growth in output per worker fell to 0.8% between 1980 and 2005, from 1.6% between 1955 and 1979. Figure 6 shows the estimated total factor productivity[11].

The decomposition indicates that the reduction in output growth cannot be explained by changes in physical and human capital intensity. In fact, physical capital intensity (i.e. in the capital/output ratio) was a positive source of growth between 1979 and 2005 (adding on average 0.5 percentage points to the growth rate per year). The same is true for human capital per worker, which was a steady source of growth in output per worker. Indeed, during the post-1979 this factor alone would have accounted for an annual growth in output per worker of 0.9%. This means that, between 1979 and 2005, the educational advancement of the population and the greater physical capital intensity would have resulted in a 1.4 percent growth rate in output per worker, no too different from what was observed before 1979. If anything, physical and human capital alone would have resulted in higher output growth in the post-1979 period, relative to the pre-1979 results.

This leaves the residual (i.e. productivity) as the key 'explanation' of the low growth outcomes. In terms of the accounting, productivity added 1 percentage point in output growth per year up until 1979. Between 1979 and 2005 it subtracted 0.6 percentage points in the growth of output per worker per annum. In the words, the growth deceleration appears to be a simple reflection of a major reversal in productivity growth.

The information per decades is also shown in Table 3. Output per worker grew at an annual rate of 1.3 percent in the late 1950s and the 1960s, and then accelerated to 1.9 percent during the 1970s. It then fell to 0.6 percent during the 1980s and 1.1 percent during the 1990s.

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[10] These results remain unchanged under the alternative measurement of the returns of education. The same occurs when $\alpha = 0.2$ and $\alpha = 0.4$ are used.

[11] The Bai-Perron test finds a downbreak in of TFP growth in 1974 (robust to the choice of *h*).

As mentioned, the contribution of human capital accumulation to economic growth has been relatively stable, reflecting the relatively stable progress in educational attainment (or, at least, reflecting the parsimony of the years of schooling data). There is, however, an interesting difference in the role of productivity when comparing the 1980s with the 1990s. The 1980s emerge as a period of negative productivity growth and low physical capital deepening (incidentally, the two factors often mentioned in the literature as justifying the structural reforms of the early 1990s). In contrast, during the 1990s, capital intensity increased (as a consequence of the investment boom that resulted from trade liberalization, capital inflows, and currency appreciation), while productivity growth collapsed even more during this period.

5. EXPLAINING THE GROWTH AND PRODUCTIVITY IMPLOSION

It is extremely difficult to point towards changes in the political system or in economic policies in order to explain the deceleration in economic growth since 1980. On the one hand, most legal and constitutional reforms occurred in the early 1990s, almost ten years after the decline in growth. Although the economy experienced a negative external shock during the early 1980s, mainly due to the end of the coffee boom of the late 1970s and the beginning of the debt crisis, it is hard to argue that this sole factor could explain such a long-lasting deceleration in growth. Not only coffee has become much less relevant for the economy but also it is a well-established fact that the debt crisis was not as severe for Colombia as for other highly-indebted nations. Therefore, it is necessary to look into other areas in order to find the explanation for the productivity implosion.

The emergence of Colombia as a major illicit drug producer is perhaps the most prominent aspect of the country's recent economic and political history. According to data from the United Nations (www.unodc.org) cocaine production, which was practically inexistent in 1980, grew to 90 tons in 1990 and then rose to 700 tons in 2000. The area under cultivation of illicit crops increased to nearly 140,000 hectares in 2000, from less than 20,000 in 1980. The standard argument is that coca production in Colombia substituted imports of coca paste from Bolivia and Peru. Between 1980 and 2000, Colombia became the largest cocaine producer in the world, arguably controlling 80% of the supply[12].

The expansion in drug-trafficking activities can be linked to the collapse of productivity, mainly through the effect of drug-trafficking on crime and violence. The homicide rate (homicides per 100,000 population) increased to 62 on average during the 1990s, from 41

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[12] Estimations of the proceeds from the drug trade are highly speculative. Some conservative measures (see Steiner (1997) and Rocha (2000)) put a low boundary in the US$2-3 billion per year range (around 3% of GDP). However, apart from the concerns on the quality of area and production data, the issue of which price to use is highly controversial. According to Miron (2001), in 1998 the price of the coca leave necessary to produce one gram of pure cocaine was between US$0.36-$0.57. The price of one gram of cocaine in the Colombian wholesale market was US$1.50-$2.00, and US$12.00-$18.00 in the U.S. wholesale market. The price paid by the final consumer was US$122.00. This means that the price was multiplied 73 times between Colombia and the streets of the U.S. In the case of coffee, this factor ranges between 29 and 34 times.

during the 1980s, 23 during the 1970s, and 19 during the 1960s. A similar patter can be observed fro kidnapping rates. The increase in the homicide rate, in turn, is related to the increase in the activities of insurgent and paramilitary groups.

Figures 7a and 7b plot the area under coca cultivation, as well as homicide and kidnapping rates[13]. The strong relationship between these variables has been the subject of a number of studies that argue that the extraction of rents from primary goods (such as oil and coca) has strengthened the military capacity of the insurgent groups. One example is Collier (2000), who points that:

> "… economic characteristics – dependence on primary commodity exports, low average incomes, slow growth, and large diasporas – are all significant and powerful predictors of civil war. Rebellions either have the objective of natural resource predation, or are critically dependent upon natural resource predation in order to pursue other objectives.."

In the Colombian context, the predatory behavior of the insurgent groups in their regions of influence has been documented Rangel (2000). Virtually no one, including the rebels, questions the fact that the expansion of the insurgent groups during the 1980s and 1990s –both in terms of their ability to recruit and the sophistication of their arms- was based on the extraction of rents from the growing cocaine business[14].

The relationship between drug-trafficking and overall criminality has been analyzed by Gaviria (2000). He argues that expansion of drug-trafficking activities not only had a direct impact on crime but also indirectly through the effect on the congestion of the judicial system and the consequent reduction in the probability of punishment. Also, the change in moral values and the diffusion of crime technologies had a negative effect on overall delinquency.

Social capital or social infrastructure is, arguably, the main channel linking crime and violence, on the one hand, and productivity on the other[15]. Lederman, Loayza, and Menéndez (2001) have provided empirical evidence showing a strong negative relationship between violent crime and social capital which they define as "...The set of rules, norms, obligations, reciprocity, and trust embedded in social relations, social structures, and society's institutional arrangements which enables its members to achieve their individual and community objectives..." As they point out, the relationship between social capital and crime may run in both directions. The incidence of violent crime may diminish social capital, such as trust, or may increase it, through the formation of

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[13] Data on illicit crop cultivation come from Arango et al. (2004) for the period 1976-2003 and from the Sistema Integrado de Monitoreo de Cultivos Ilícitos (SIMCI, 2006) for 2004-2005. Data on Homicide comes from Reportes de Criminalidad (Policia Nacional, DIJIN, Various Issues). Kidnappings come from statistics of the Departamento Nacional de Planeación based on Ministerio de Defensa and Fondelibertad. Population data was taken from Flórez (2000) and DANE (after 2000).

[14] In their public statements, FARC-EP (the largest rebel organization) justifies the extraction of rents as a tax levied on the small coca growers in exchange for protection.

[15] The term social infrastructure is more precise because it refers to elements that are not really factors of production.

community organizations to fight crime[16]. However, the evidence suggests that the erosion of social capital is the dominant factor.

The relationship between productivity and social capital or social infrastructure has been a recurrent theme in the recent growth literature. In an influential paper, Hall and Jones (1999) argue that the lack of social infrastructure encourages predatory behavior. Under these circumstances a fraction of the population is employed in unproductive activities, either by engaging in crime-related activities or by protecting their human and physical assets, making no contribution to output. In addition, some of the physical capital can diverted to unproductive activities. Defense equipment is perhaps the best example. This form of diversion is captured in the productivity component of the sources-of-growth accounting. Similarly, the productivity term captures the contribution of other factors of production (e.g., land) that may become unusable when it is too costly to protect them.

From a different angle, social capital, or 'trust', decreases the costs of social transactions, such as the costs of negotiations, enforcement, etc. In the words of Robison and Siles, as quoted by Loayza et al. (2001) "…transaction costs are reduced by increases in social capital because each party to the trade has his well-being linked to the well-being of his or her trading partner" (1997, 5).

In sum, there are multiple channels through which and increase in crime can cause output and productivity losses. We now turn to the evidence in favor of the argument that the expansion of drug-trafficking activities was the main factor behind the exponential increase in crime rates, and that, in turn, worsened security conditions had a negative effect on growth.

Empirical evidence

This section presents some basic evidence that supports the main hypotheses of this paper. We start by reporting the cross correlations between drug trafficking (area under cultivation), homicide rate, and productivity (all in growth rates). These correlations suggest that contemporaneous and past increases in the area under illicit crops are associated with higher crime rates, while higher homicide rates (present and past) are negatively correlated with growth in total factor productivity.

In particular, Figure 8a shows that present and past (up to six years before) changes in the area cultivated with illicit crops are positively and significantly correlated with growth in homicide rates. Figure 8b shows that the opposite is not necessarily true: past changes in the homicide rate do not seem to be significantly correlated with growth in illicit crops.

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[16] Rosenfeld, Messner, and Baumer (1999) examine the relationship between social capital and homicide in the U.S., while Moser and Holland (1997) and Moser and Shrader (1998) analyze this issue with data for Latin America and conclude that "[t]here are often higher levels of participation in community action groups in less violent areas".

Regarding the relationship between TFP and homicides, Figure 8c shows a negative (and significant) correlation between present and past changes (up to 12 years before) in the homicide rates and contemporaneous TFP growth. Again, the opposite is not true: past changes in TFP do not seem to bear any relationship with the contemporaneous crime rates (Figure 8d).

Finally, there is a negative correlation between past changes in the area under illicit crops (up to two years before) and contemporaneous changes in TFP (Figure 8e). However, past changes in TFP do not seem to be significantly correlated with current growth in illicit crops (Figure 8f).

Time series estimations

VEC and VAR models provide a more precise estimation of the causal relationship between the three variables of interest: Area under illicit crops, homicide rates and TFP. Although the three variables should ideally be included in the same model, in practice this is not possible given the limited number of observations. In fact, the variable measuring the area under illicit crops is available only since 1975, severely reducing the degrees of freedom in a model with three equations. Therefore, we estimated a VAR model for each one of the three pairs of variables, rather than including the three variables jointly. The estimated impulse-response functions are shown in Figure 9.

All models shown in this section use first differences in logs of the variables of interest, given that they are all integrated of order one, I(1), in levels (see Appendix 1). Also, the null hypothesis of cointegration between these variables can be rejected. Once stationary variables were obtained, we used the minimum number of lags -in each VAR model- that allows the errors to be normal while not exhibiting multivariate autocorrelations.

The first VAR(1) model uses first differences of the logs of area under illicit crops and TFP:

$$\begin{bmatrix} \Delta Ln(Area)_t \\ \Delta Ln(TFP)_t \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix} + \begin{bmatrix} \phi_{111} & \phi_{112} \\ \phi_{211} & \phi_{212} \end{bmatrix} \begin{bmatrix} \Delta Ln(Area)_{t-1} \\ \Delta Ln(TFP)_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

Figure 9a shows that a positive shock in the growth of the area with illicit crops is associated with a permanent reduction in the growth of TFP. Also, the null hypothesis that changes in the log of Area do not Granger cause changes in the log of TFP can be rejected (see Appendix 2). Conversely, changes in TFP are not associated with significant changes in Area, and the corresponding hypothesis that TFP growth does not cause Area growth cannot be rejected (Figure 9b).

Turning to the relation between Area and Homicides we estimate a VAR (5) of the following form:

$$\begin{bmatrix} \Delta Ln(Area)_t \\ \Delta Ln(Homicide\ Rate)_t \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix} + \begin{bmatrix} \phi_{111} & \phi_{112} \\ \phi_{211} & \phi_{212} \end{bmatrix} \begin{bmatrix} \Delta Ln(Area)_{t-1} \\ \Delta Ln(Homicide\ Rate)_{t-1} \end{bmatrix} + ...$$

$$... + \begin{bmatrix} \phi_{151} & \phi_{152} \\ \phi_{251} & \phi_{252} \end{bmatrix} \begin{bmatrix} \Delta Ln(Area)_{t-5} \\ \Delta Ln(Homicide\ Rate)_{t-5} \end{bmatrix} + \begin{bmatrix} \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix}$$

Figure 9c shows that positive shocks to changes in the log of Area cause permanent increases in changes in the log of the Homicide Rate. The corresponding Granger causality supports this interpretation (Appendix 2). Shocks to homicide rate do not seem to have an effect on Area (Figure 9d).

Finally, the relationship between Homicides and TFP is estimated with a VAR(12) of the following form:

$$\begin{bmatrix} \Delta Ln(Homicide\ Rate)_t \\ \Delta Ln(TFP)_t \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \end{bmatrix} + \begin{bmatrix} \phi_{1,1,1} & \phi_{1,1,2} \\ \phi_{2,1,1} & \phi_{2,1,2} \end{bmatrix} \begin{bmatrix} \Delta Ln(Homicide\ Rate)_{t-1} \\ \Delta Ln(TFP)_{t-1} \end{bmatrix} + ...$$

$$... + \begin{bmatrix} \phi_{1,12,1} & \phi_{1,12,2} \\ \phi_{2,12,1} & \phi_{2,12,2} \end{bmatrix} \begin{bmatrix} \Delta Ln(Homicide\ Rate)_{t-12} \\ \Delta Ln(TFP)_{t-12} \end{bmatrix} + \begin{bmatrix} \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix}$$

The results suggest that positive shocks to the change in the log of the homicide rate generate reductions in TFP growth (Figure 9e), while increases in TFP growth are associated with reductions in the growth of the Homicide Rate (Figure 9f). However, Granger causality tests indicate that causality runs from homicides to TFP, rather than the opposite (Appendix 2).

In sum, the evidence presented in this section strongly supports the view that the increase in the area under illicit crops was, to a large extent, an exogenous event which had very adverse consequences for Colombia. Challenging the conventional wisdom, which often sees drug trafficking activities as a consequence of insecurity and low growth, we argue just the opposite. Here, the increase in crime and the subsequent reduction in productivity are the result of a sudden increase in the production of illicit crops. This result has important policy implications because it suggests that a reduction in drug production can have a large economic dividend.

6. SOCIAL CONFLICT AND GROWTH: CROSS-COUNTRY EVIDENCE

The time series evidence shown in the previous section can be complemented with an analysis of the relationship between crime and growth using data from a large sample of countries. We do this in two steps. First, we look at the long-term relationship between homicides and per capita GDP for a large sample of countries. This evidence shows that countries with higher homicide rates tend to have lower incomes, even after controlling for potential endogeneity. Second, we look at a panel of countries and estimate a growth

model using data from the 1960s to 1990s. We do this with purpose of identifying the key variables that explain Colombia's growth deceleration since 1980.

Long-run relationship between crime and income

Although there is a debate on the specific mechanisms and their interaction, physical geography and institutions seem to be the two key determinants of the long–run performance of individual economies. According to the geography-driven models of growth, the prevalence of tropical conditions acts as a constraint to growth. The main reason is that technologies are ecologically-specific and that the technologies developed for the temperate zones are more productive. Also, technological innovation is an increasing returns activity, so the technological gap between tropical and temperate zones has widened (see Sachs, 2001).

Institutions have received a great deal of attention in the recent empirical growth literature. A number of papers show that property rights, appropriate regulatory structures, quality and independence of the judiciary, and bureaucratic capacity are essential pre-conditions and determinants of growth. For instance, Acemoglu, Johnson and Robinson (2001 and 2002) and Rodrik, Subramanian, and Trebbi (2002) argue that weak institutions, but not physical geography, explain variations in economic development across former colonies.[17]

Most of this literature takes as a starting point the estimation of 'benchmark' regression of the cross-country determinants of economic development of the following form:

$$\ln gdp_t = \beta_0 + \beta_1 \, \text{Institutional Quality}_t + \beta_2 \, \text{Geography}_t + \varepsilon_t$$

The dependent variable is the natural log of real GNP per capita at purchasing parity in 1995 US dollars, LGNP95, as taken from the World Bank's *World Development Indicators*.

A frequent proxy for institutions is the risk of confiscation and forced nationalization of property, EXPROP, obtained from Political Risk Services[18]. Acemoglu, Johnson, and Robinson (2001) have noted that EXPROP is likely to be endogenous because high-income countries may be better able to protect property rights than poor countries. They use a measure of mortality rates from the early 19th century in logs, LMORT, as an instrument for EXPROP, although the sample of countries is severely reduced when LMORT is used.

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[17] These variables are highly interrelated. Tropical countries have relied on extractive activities that have resulted in rent-distributive institutions (in Colonial times and now), rather than institutions that promote local industry (see Engerman and Sokoloff, 1997). The question is whether geography has a direct impact on long term growth, for reasons different than its impact on institutions.

[18] The average value for Colombia over the period 1985-1995 (obtained from Sachs and McArthur, 2001) measured on a 1 to 10 scale (higher values imply lower expropriation risk) is 7.39, compared to a sample mean of 7.02. This implies that 46 countries (out of 118) have a lower risk of confiscation than Colombia.

Infant Mortality Rates in 1995 (deaths per 1000 live births; taken from the United Nations), IMR95, has been a frequent geographically-related variable used in the estimations[19]. Of course, joint endogeneity between health indicators and income also seems plausible. McArthur and Sachs (2001) have shown that cross-country differences in health are affected by physical geography (mainly because of disease incidence in tropical ecozones). Therefore, IMR95 can be instrumented using the mean annual temperature in Celsius, MEANTEMP; the portion of land area within 100 km of the sea coast, LT100KM (both from Gallup, Sachs, and Mellinger, 1999); and the absolute value of latitude, LATABS (from La Porta et al., 1999)[20].

Equations 1 and 2 in Table 4 replicate McArthur and Sachs (2001) and reiterate the point that EXPROP and IMR95 are powerful explanatory variables. The coefficients are highly significant and the R-squared is high (0.8). In the specific case of Colombia, the regressions predict a value for per capita GNP in 1995 which is between 1% and 4% below the observed level. This implies that the level of GNP in Colombia is quite in line with the value that corresponds to a country with that level of political institutions (as measured by EXPROP), health, and geography.

However, it is clear that the risk of confiscation and forced nationalization of property does not capture the essence of Colombia's institutional problems. As argued in the previous section, the Homicide Rate is perhaps a better measure. For this reason, Equations 3 and 4 in Table 4 add the homicide rate in 1995 to the list of explanatory variables[21]. In Equation 3, the coefficient on HOMICIDES95 comes out with a negative sign but insignificantly different from zero. In Equation 4, which excludes EXPROP, the effect of HOMICIDES95 is negative and significant. Figure 10 shows the partial correlation between the log of per capita GDP in 1995 and the homicide rate (controlling for the effect of infant mortality). Clearly, there is a negative correlation between income and crime.

Interestingly, Equation 4 does poorly in predicting Colombia's GDP. In fact, based on this simplified model, the 1995 levels of criminality and infant mortality would predict, in the steady state, a level of income between 41% and 57% below the level observed in that year. In other words, Colombia's level of income is higher than what corresponds to a country with such a high level of criminality.

One possible interpretation of this result is that the quality of institutions (in this case the homicide rate) in a given time period will affect the *growth rate* of the economy during

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[19] The value for Colombia is 30, compared to a world average of 48.

[20] Colombia's average temperature is 22.5° (Celsius). The absolute degree of latitude is 0.04°, indicating that most of the territory is tropical in an ecological sense. Only 16% of the land is within 100 km from the seacoast, making Colombia one of the most landlocked countries of the world (139 out of 150 countries have a higher proportion of the territory close to the seacoast).

[21] The homicide rate comes from the U.N. Demographic Yearbooks and shows that Colombia had the highest homicide rate (80 per 100,000 inhabitants) among a group of 84 countries in 1995. In 1985 the rate was much lower (37.4 per 100,000 pop.), but even then there was only one country (out of 66) with a higher rate.

that period, and not the contemporaneous *level* of income. In other words, the correct specification should use the growth rate during a time interval as the dependent variable. This structure is more appealing for the issue at hand, given that high criminality is a relatively recent phenomenon so it may have had on growth rates, but not yet on the per capita level of income. However, the regressions in levels are of interest because they suggest that if crime is not reduced, the level of income will fall in the long run (steady state) to a level consistent with the predictions of the model.

Explaining the growth deceleration in a panel of countries

Given that our goal is to explain changes in growth rates across time periods (i.e. why Colombia's growth decelerated in the 1980s and 1990s, relative to the 1960s and 1970s) and across countries (why Colombia's growth decelerated during the 1990s, relative to the region) we should use country panel data on growth performance and its determinants.

In this section, following the work of Loayza, Fajnzylber, and Calderon (2005) we estimate the determinants of per capita GDP growth in an unbalanced panel of 65 countries where each observation corresponds to a 10-year average (for the years 1971-80, 1981-90, and 1991-99) In total, there are 175 observations. The estimated equation has the following form:

$$\Delta y_{iT} = \delta_1 \ln y_{iT_0} + \delta_2 gap_{iT_0} + \hat{\mathbf{a}}_3' X_{iT} + \mu_T + \eta_i$$

where Δy_{iT} is growth rate of output per capita in country i during decade T. The right hand side variables include the level of per capita income at the beginning of the decade, $\ln y_{iT_0}$ (to capture transitional convergence), the output gap (also at the start of the decade) based on the Baxter-King filter, gap_{iT_0}, a set of explanatory variables (X_{iT}), a decade-specific effect (μ_T), and unobserved country specific factors (η_i) which are potentially correlated with the explanatory variables.

The inclusion of the output gap as an explanatory variable controls for movements in cyclical output and, thus, differentiates between transitional convergence and cyclical reversion. The decade-specific effect controls for changes in external conditions that affect all countries alike (i.e. the debt crisis of the 1980s).

Loayza, Fajnzylber, and Calderon (2005) use two types of explanatory variables (X_{iT}).[22] The first class includes variables that measure external shocks and the quality of macro

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[22] See their book for a complete description of the variables, including data sources and a literature review of the studies that have used similar variables.

policies. These are variables that are more likely to explain changes in growth performance in one country across time:

Shocks to the terms of trade: Measured as the log difference of the terms of trade, measured in the customary way.

Lack of price stability: Measured by the average inflation rate for the corresponding country and decade.

Cyclical volatility of GDP: Measured by the standard deviation of the output gap for the corresponding country and decade.

External imbalances and the risk of balance-of-payments crises: Measured by an index of real exchange rate overvaluation.

Systemic banking crises Measured by the fraction of years that a country undergoes a systemic banking crisis in the corresponding period, as identified in Caprio and Klingebiel (1999).

The second class, and the one of interest from the viewpoint of this paper, includes the more structural variables that have been identified in the empirical cross section growth literature as powerful determinants of growth (more often across countries than across time). The variables used in their specification are:

Education: Measured as the rate of gross secondary-school enrollment.
Financial depth: Measured by the ratio of private domestic credit supplied by private financial institutions to GDP.
International trade openness: Measured by the volume of trade (real exports plus imports) over GDP, adjusted for the size (area and population) of the country, for whether it is landlocked, and for whether it is an oil exporter[23].
Government burden: Measured by the ratio of government consumption to GDP.
Public services and infrastructure: Measured by the number of main telephone lines per capita.

Governance is the final element in the list of structural variables. This is a wide area that covers aspects such as the institutional quality of government, including the respect for civil and political rights, bureaucratic efficiency, absence of corruption, enforcement of contractual agreements, and prevalence of law and order. Evidently, there are many variables related to the concept of governance, and choosing one is somewhat an arbitrary decision. Writing on the uses and abuses of these indicators, Arndt and Oman (2006)

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[23] This is a standard procedure that uses the fitted values of a regression of trade volume on those variables.

show that the most widely used are composite perceptions-based indicators. They argue that even the most carefully constructed of these indicators lack transparency and comparability over time, and suffer from selection bias.

Loayza, Fajnzylber, and Calderon (2005) use the first principal component of four indicators reported by Political Risk Services in their publication *International Country Risk Guide* (ICRG). These are the indicators on the prevalence of law and order, quality of the bureaucracy, absence of corruption, and accountability of public officials. All of them enter with almost identical weights in their first principal component.

Although the perfect governance indicator does not exist, we prefer to use the homicide rates for three reasons. First, the measure chosen by Loayza et al. (2005) does not come out significant in all of their estimations. Second, homicide rates have some variation between decades which would be useful to exploit. Third, from the discussion of the previous sections we know that the increase in homicides rates has a potentially relevant role in explaining Colombia's growth deceleration.

Data on homicides come from the United Nations World Surveys on Crime Trends and Criminal Justice Systems[24]. These surveys have been implemented every five years since 1970 in 157 countries. Crime variables include counts of recorded crime for homicide, assault, rape, robbery, theft, burglary, fraud, embezzlement, drug trafficking, drug possession, bribery, and corruption. There are also counts of suspects, persons prosecuted, persons convicted, and prison admissions by crime, gender, and adult or juvenile status[25]. The countries participating in the survey and the variables available vary by year. To maximize the number of observations we use information on average homicide rates during the decade[26]. Figure 11 shows the data, which suggests that Colombia became an outlier in this matter during the 1990s.

Panel results

Table 5 shows the results of an OLS pooled regression. Equation 1 replicates the original estimation of Loayza et al. (2005), while equation 2 uses the homicide rate instead of their measure of governance. The estimated coefficient is not only negative and significant, but also quantitatively very large: An increment of 1% in homicide rates is associated with a 0.3 percentage points reduction in per capita GDP growth. Finally, Table 6 shows the observed per capita growth rates for Colombia, the fitted values predicted by the model, and the corresponding error of the regression. Interestingly, the model predicts the deceleration of the 1990s, contrary to the original estimation in

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[24] See Burnham and Burnham (1999) for a complete description of the data.

[25] Other variables include the population of the country and largest city; budgets and salaries for police, courts, and prisons; and types of sanctions, including imprisonment, corporal punishment, deprivation of liberty, control of freedom, warning, fine, and community sentence.

[26] This gives more observations than measuring homicide rates at the beginning of the decade.

Loayza et al. (2005). This implies that the inclusion of the homicide rate is a key factor explaining why growth decelerated in the 1990s relative to the 1980s.

8. CONCLUSIONS

Colombia's GDP has been growing at an average rate of 3% per year since 1980, which represents a slowdown of 2 percentage points per year relative to the period between 1950 and 1979. This paper analyzes the possible causes of such a prolonged deceleration in growth, which has had devastating consequences on welfare.

The paper looks at this issue in three steps. First, it deals with the proximate causes of growth –the standard sources-of-growth-decomposition- and concludes that the deceleration of growth is the result of an implosion of productivity. This is interesting because it implies that both physical and human capital accumulation were not the cause of the reduction in growth. Indeed, this reduction is explained entirely by changes in productivity growth. Prior to 1980, productivity gains added 1 percentage point to the per-capita GDP growth on average per year. Since 1980, productivity losses have been subtracting a similar amount.

In the second step, the paper deals with the determinants of productivity using the time series evidence. The conclusion is that the implosion of productivity is directly related to the four-fold increase in criminality. The existing literature has already shown that the explosion of crime was the result of the rapid expansion of drug-trafficking activities and the intensification of the internal armed conflict (fueled by the rents from the drug trade). Thus, the paper argues that it is not a coincidence that the implosion of productivity, the increase in crime, the expansion of drug-trafficking, and the strengthening of the insurgent movements, occurred at the same time, starting around 1980. However, the evidence suggests the presence of causal relation from drugs to crime, and from crime to productivity. This is of interest because it supports the idea that reducing drug rents has a large economic dividend.

The third step focuses on the cross-country evidence. Countries with high homicide rates grow less and have lower per capita incomes. Moreover, Colombia's growth deceleration during the 1990s (relative to the 1980s) can be adequately explained by its high homicide rate.

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Table 1

Results of the Bai-Perron Test
(Presence of structural breaks in GDP growth)

Series: Colombia GDP growth, 1951 to 2005

Specifications			
$z_t = \{1\}$	$h = 13$	$m = 2$	$T = 55$

Tests 1/			
supF(1)	supF(2)	UDmax	WDmax
6.6666*	4.5130	6.6666*	6.6666*

SupF(1|0)	SupF(2|1)
6.6666*	2.5893

Number of breaks selected		
Sequential	BIC	LWZ
1	1	1

Parameter estimates with one break (std. errors in brackets)		
δ_1	δ_2	T_1
5.1747	3.1879	1979
(0.3532)	(0.3730)	

1/ For all tests and calculations of standard errors, a heteroskedasticity and autocorrelation consistent covariance matrix using a quadratic kernel with automatic bandwidth selection based on an AR(1) approximation is used. Residuals are pre-whitened using a VAR(1). See Bai and Perron (2003a).

* Significant at 10% level.

Source: Author's calculations.

Table 2
Returns to Education
(based on the estimation of the Mincer equation)

Years of schooling	Total	Men	Women
0-4	0.0853	0.0763	0.0830
5	0.1214	0.1029	0.1576
6-10	0.0761	0.0618	0.1021
11	0.1369	0.1018	0.1595
12-15	0.1201	0.1238	0.1127
16+	0.2158	0.2320	0.2026
Average	**0.1020**	**0.0923**	**0.1152**

Source: Nuñez and Sánchez (2000).

Table 3
Sources of Growth Decomposition

	(1)=(2)+(3)+(4)	(2)	(3)	(4)
Growth in:	per worker GDP	Capital-Output ratio	Human capital per capita	Productivity
1955-1979	1.55%	-0.25%	0.74%	1.05%
1980-2005	0.80%	0.47%	0.92%	-0.60%
1955-1959	1.31%	0.31%	0.26%	0.72%
1970-1979	1.91%	-0.34%	1.02%	1.23%
1980-1989	0.63%	0.38%	1.08%	-0.84%
1990-1999	1.13%	1.00%	0.80%	-0.68%
2000-2005	0.53%	-0.28%	0.87%	-0.06%

Source: Author's calculations.

Table 4
Institutions, crime and geography
Regression Results

REGRESSION Dependent Variable	1 LGNP95	2 LGNP95	3 LGNP95	4 LGNP95
Estimation	IV	IV	IV	IV
CONSTANT	7.67	5.24	7.74	9.99
t-stat	10.54	4.14	10.22	103.8
EXPROP	0.22	0.52	0.23	
t-stat	2.95	3.45	3.09	
IMR95	-0.02	-0.012	-0.03	-0.04
t-stat	-4.06	-2.11	-3.32	-8.75
HOMICIDES95			-0.004	-0.01
t-stat			-1.05	-2.13
GINI60-70				
t-stat				
N	118	63	49	50
Ad R-sq	0.76	0.79	0.85	0.80
Residual for Colombia	0.0439	0.011	0.41	0.57
Instruments:				
MEANTEMP	☿	☿	☿	☿
LT100KM	☿	☿	☿	☿
LATABS	☿	☿	☿	☿
LMORT		☿		

Source: Author's calculations.

Table 5
Growth determinants
Panel regressions

Dependent variable: Growth rate of GDP per capita, by decade: 1971-1999
(t-statistics are presented below the corresponding coefficient)

Category	Variable	Eq. 1	Eq. 2
Convergence Factors	Initial GDP per capita (in logs)	-0.023 (-4.290)	-0.025 (-4.780)
Cyclical Reversion	Initial Output Gap (log[Actual GDP/potential GDP])	-0.052 (-0.720)	-0.068 (-0.950)
Structural Policies and Institutions	Education (secondary enrollment, in logs)	0.014 (2.910)	0.015 (3.220)
	Financial Depth (private domestic credit/GDP, in logs)	0.001 (0.390)	0.001 (0.420)
	Trade Openness (structure adjusted trade volume/GDP, in logs)	0.010 (2.420)	0.009 (2.060)
	Government Burden (Government consumption/GDP, in logs)	-0.013 (-2.210)	-0.009 (-1.460)
	Public Infrastructure (Main telephone lines per capita, in logs)	0.012 (3.800)	0.011 (3.550)
	Governance (1st principal component of ICRG indicator)	-0.001 (-0.570)	
Stabilization Policies	Lack of Price Stability (Inflation rate, in log[100+inf. Rate])	-0.015 (-2.830)	-0.014 (-2.790)
	Cyclical Volatility (Std. Dev. Of output gap)	-0.058 (-0.410)	-0.038 (-0.290)
	Real Exchange Rate Overvaluation (in logs; index is proportional, overvaluation if > 100)	-0.011 (-2.200)	-0.013 (-2.700)
	Systemic Banking Crises (Frequency of years under crisis: 0-1)	0.000 (0.000)	0.001 (0.130)
External Conditions	Terms of Trade Shocks (Growth rate of Terms of Trade)	0.128 (2.590)	0.123 (2.550)
Criminality	Homicide Rate per 100.000 inhabitants (in logs)		**-0.003** **(-2.140)**
	Number of observations:	123	123
	R-squared	0.479	0.499

Source: Author's calculations.

Table 6

Variable of interest: Change in the growth rate of GDP per capita

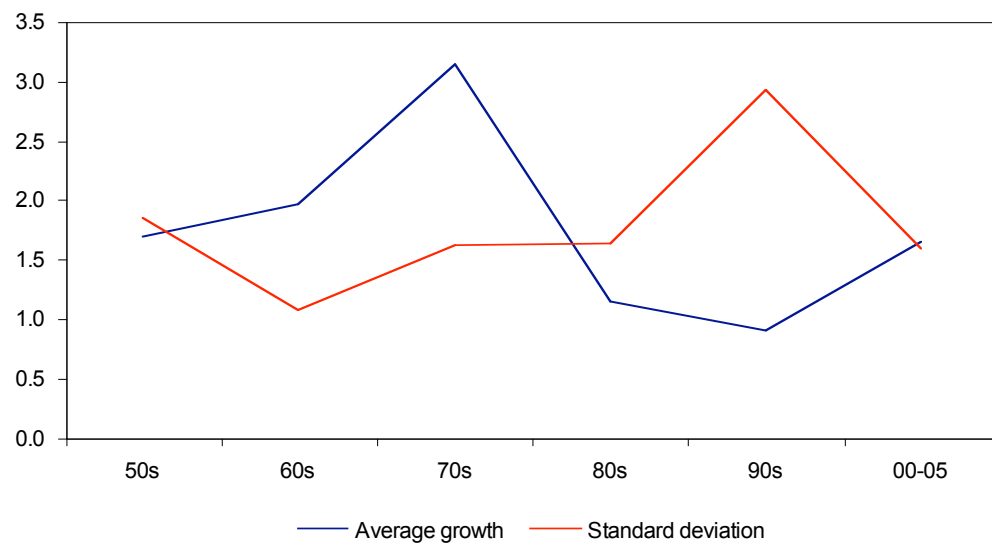| Decade	Actual change	Estimated change		Error	
		Eq. 1	Eq. 2	Eq. 1	Eq. 2
1980s vs. 1970s	-1.78%	-2.92%	-1.54%	1.14%	-0.24%
1990s vs. 1980s	-0.55%	2.11%	-0.30%	-2.66%	-0.25%

Source: Loayza et al (2002) and Author's calculations.

Figure 1a
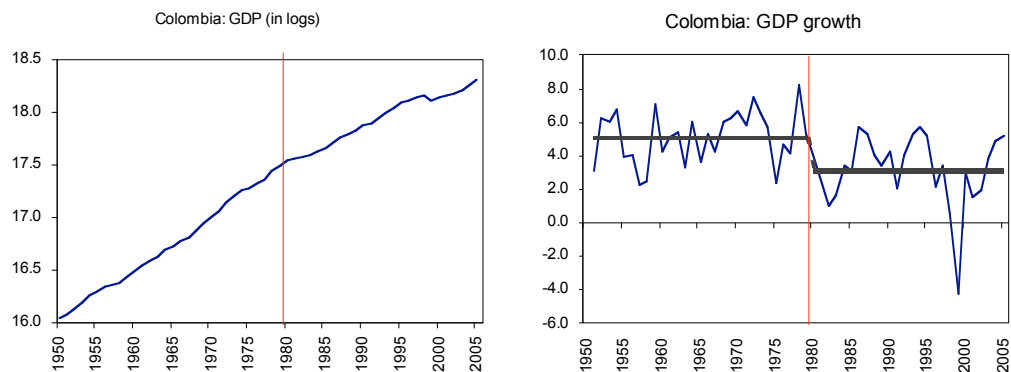
Colombia: GDP Growth
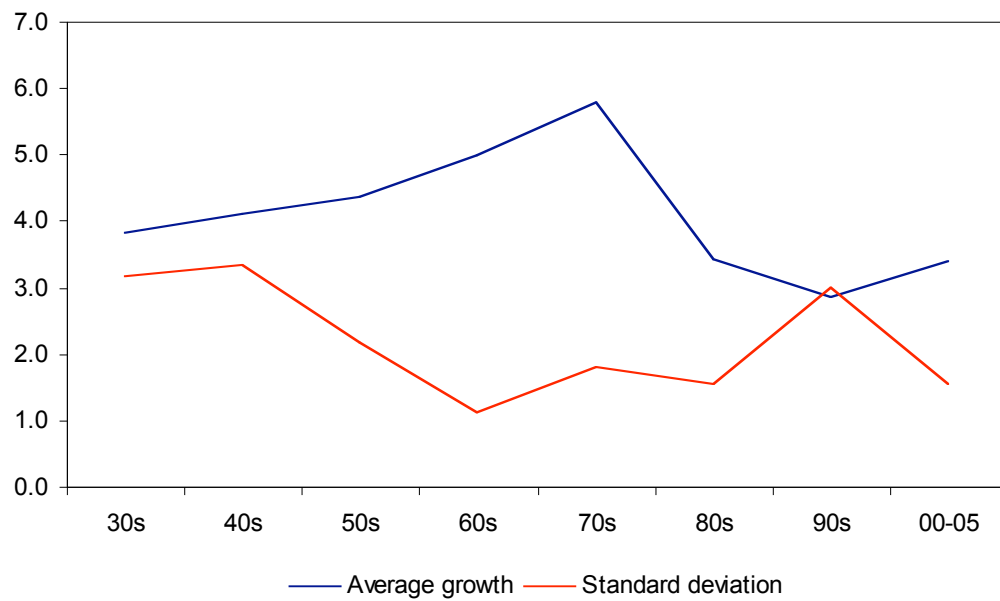
Figure 1b

Colombia: per capita GDP Growth

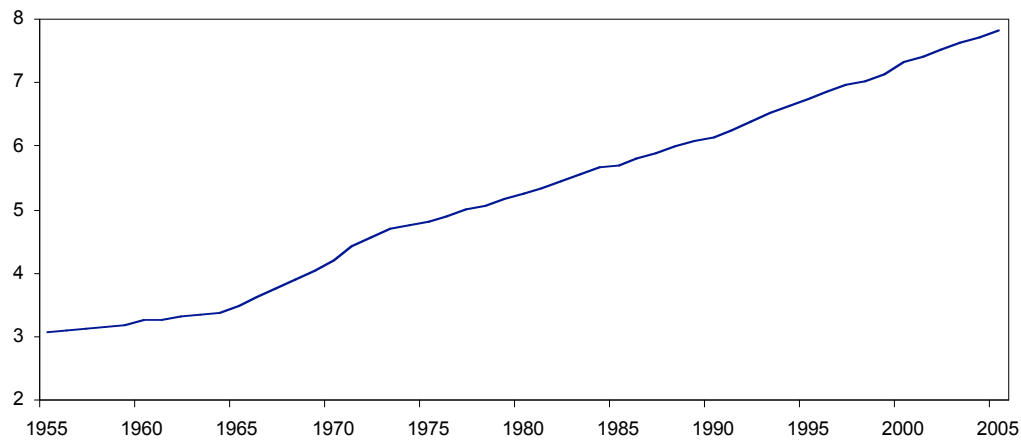Source: Author's calculations based on National Accounts data from DANE.

Figure 2
Structural Break

Colombia: GDP (in logs)

Colombia: GDP growth

Note: Minimum period between structural breaks was set to h = 13 years.

Source: Author's calculations based on National Accounts from DANE.
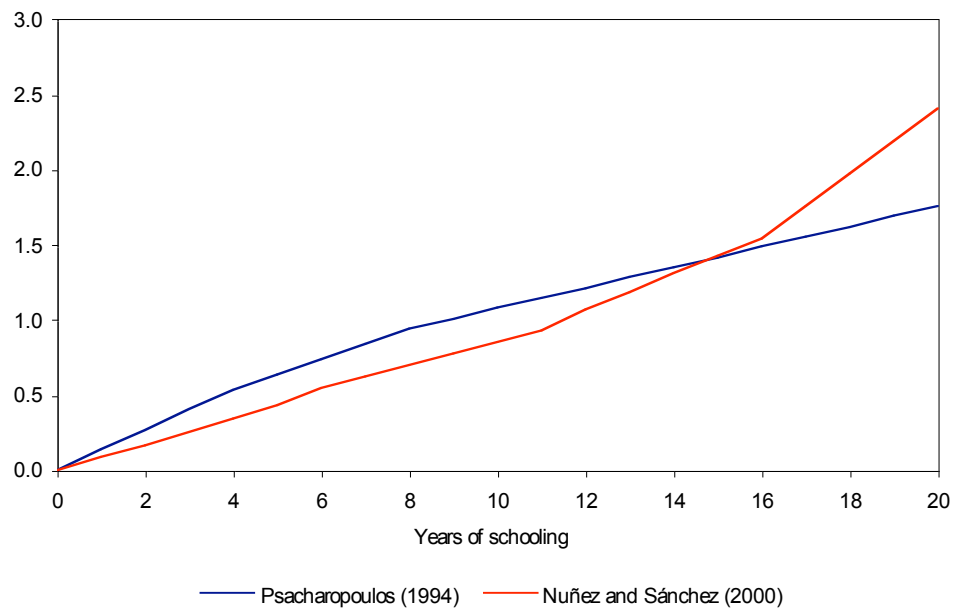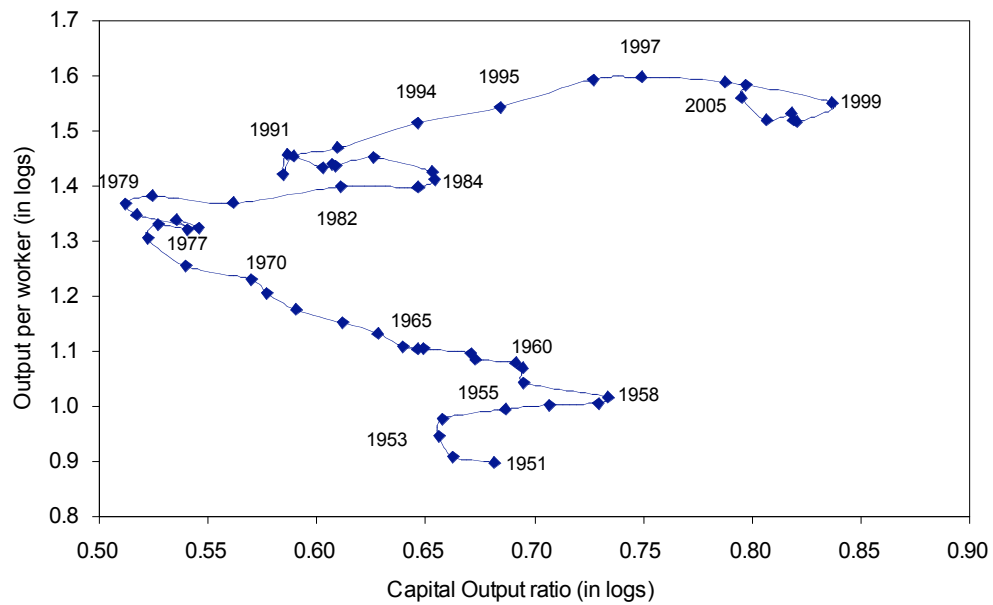
Figure 3

Average years of schooling
(Population over 15 years of age)

Source: Estadísticas históricas de Colombia, Cuadro 7.3 (1954-1996) and calculations from DNP-DDS for the period 1997-2000.
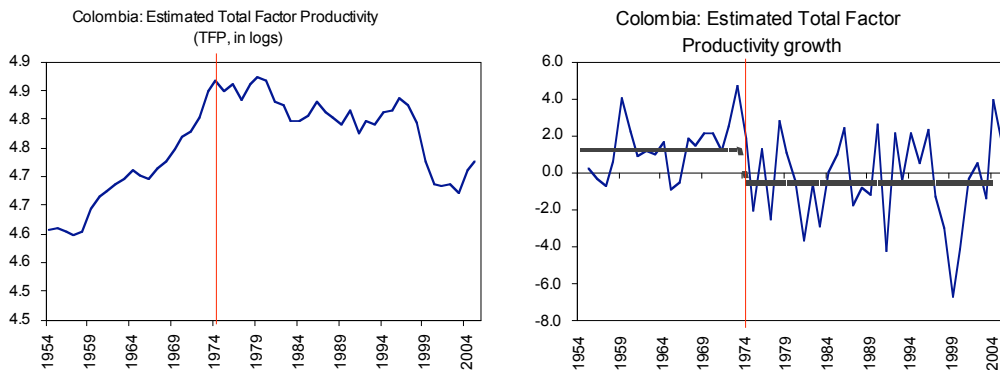
Figure 4

PHI(E)

Years of schooling

—— Psacharopoulos (1994)   —— Nuñez and Sánchez (2000)

Figure 5
Capital/Output ratio and Output per worker (in logs)

Source: Author's calculations.

Figure 6

Colombia: Estimated Total Factor Productivity (TFP, in logs)
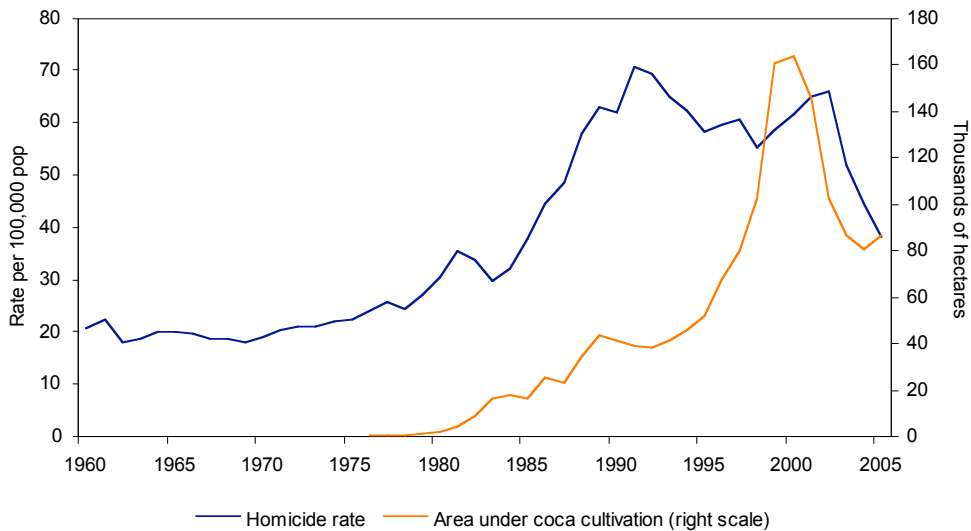
Colombia: Estimated Total Factor Productivity growth

Notes:
TFP was computed asumming an alpha equal to 0.3, minimum period between breaks was set to $h= 13$ years.
Source: Author's calculations based on National Accounts from DANE.

Figure 7a

Homicide rate vs. Area under coca cultivation

Homicide rate   Area under coca cultivation (right scale)

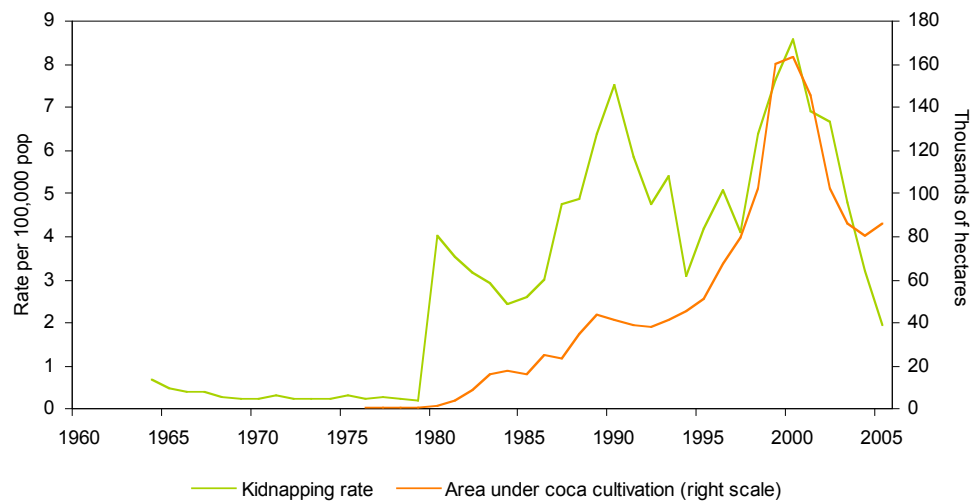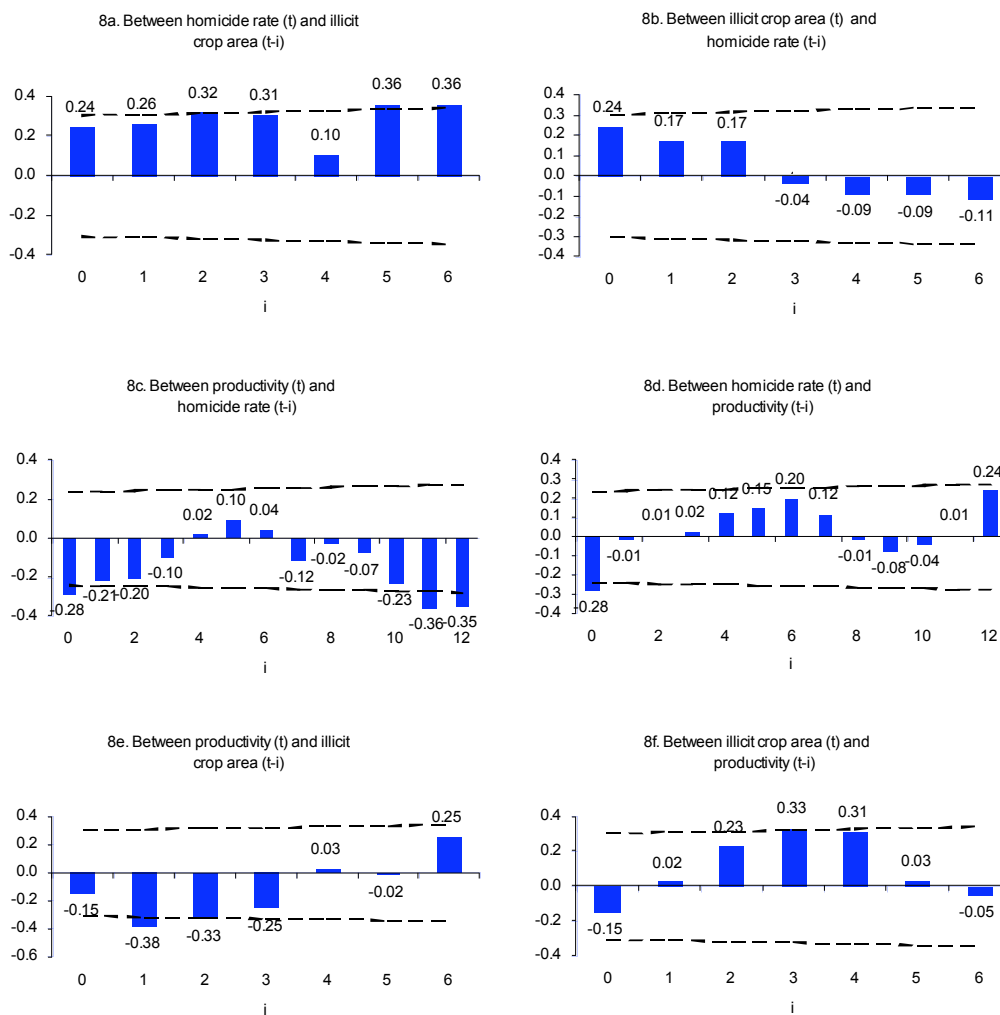Source: Policia Nacional, Ministerio de Defensa, Arango et al (2004) and SIMCI.

Figure 7b

Kidnapping rate vs. Area under coca cultivation

Source: Policia Nacional, Ministerio de Defensa, Arango et al (2004) and SIMCI.

Figure 8
Partial Correlations
All variables expressed in percentage growth

8a. Between homicide rate (t) and illicit
crop area (t-i)

8b. Between illicit crop area (t) and
homicide rate (t-i)

8c. Between productivity (t) and
homicide rate (t-i)

8d. Between homicide rate (t) and
productivity (t-i)

8e. Between productivity (t) and illicit
crop area (t-i)

8f. Between illicit crop area (t) and
productivity (t-i)

Source: Author's calculations.

Confidence Interval at 90%.

Figure 9
Impulse-response functions

9a. Response of Productivity to shocks in Cultivated
Area

9b. Response of Cultivated Area to shocks in
Productivity

9c. Response of Homicide Rate to shocks in
Cultivated Area

9d. Response of Cultivated Area to shocks in
Homicide Rate

9e. Response of Productivity to shocks in Homicide
Rate

9f. Response of Homicide Rate to shocks in
Productivity
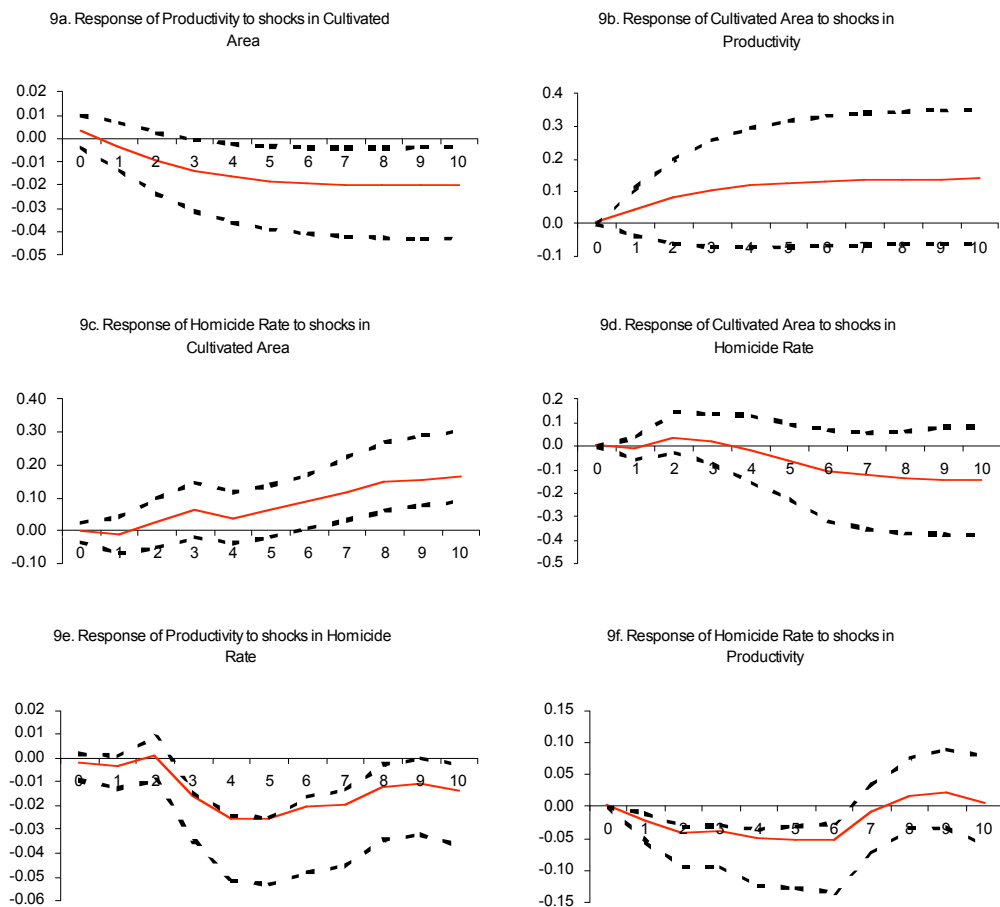
Source: Author's calculations.
Confidence Interval at 90% using 10.000 bootstrap replications.
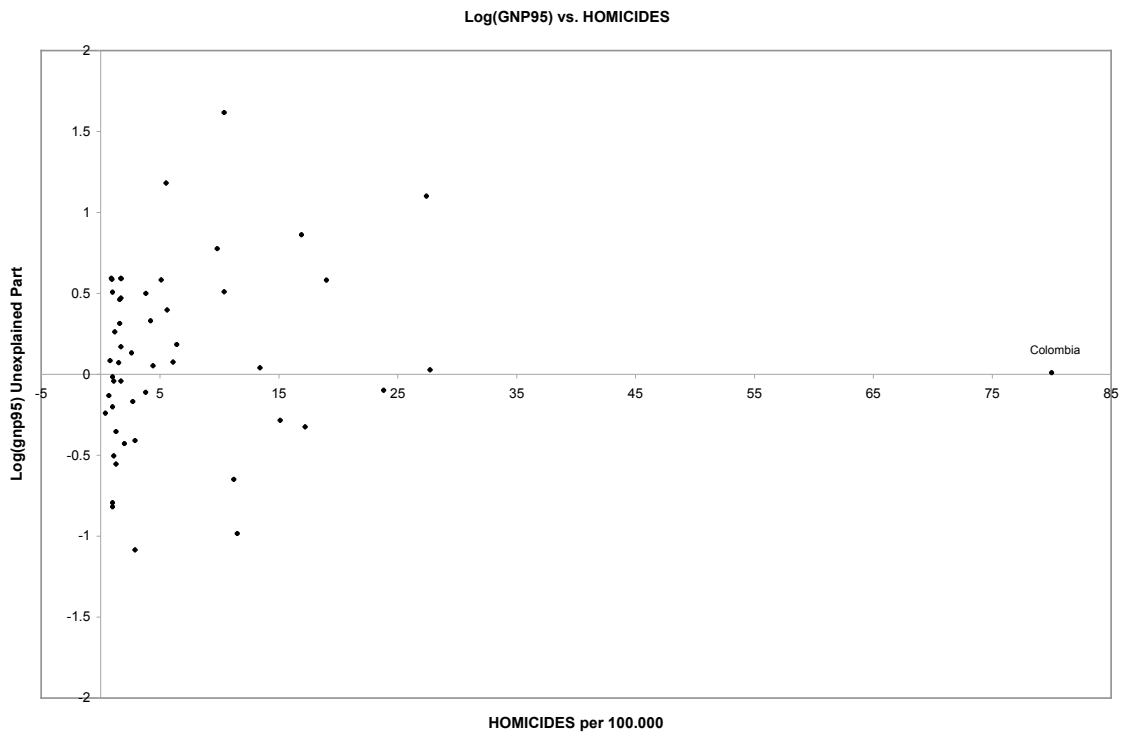Orthogonal Impulse Response Function using Cholesky decomposition.

Figure 10

Log(GNP95) vs. HOMICIDES

Colombia

Log(gnp95) Unexplained Part

HOMICIDES per 100.000

Figure 11

11a. 1970s

Homicide rate

COL

log GPD per capita 1970

11b. 1980s

Homicide rate

COL

log GPD per capita 1980

11c. 1990's

Homicide rate
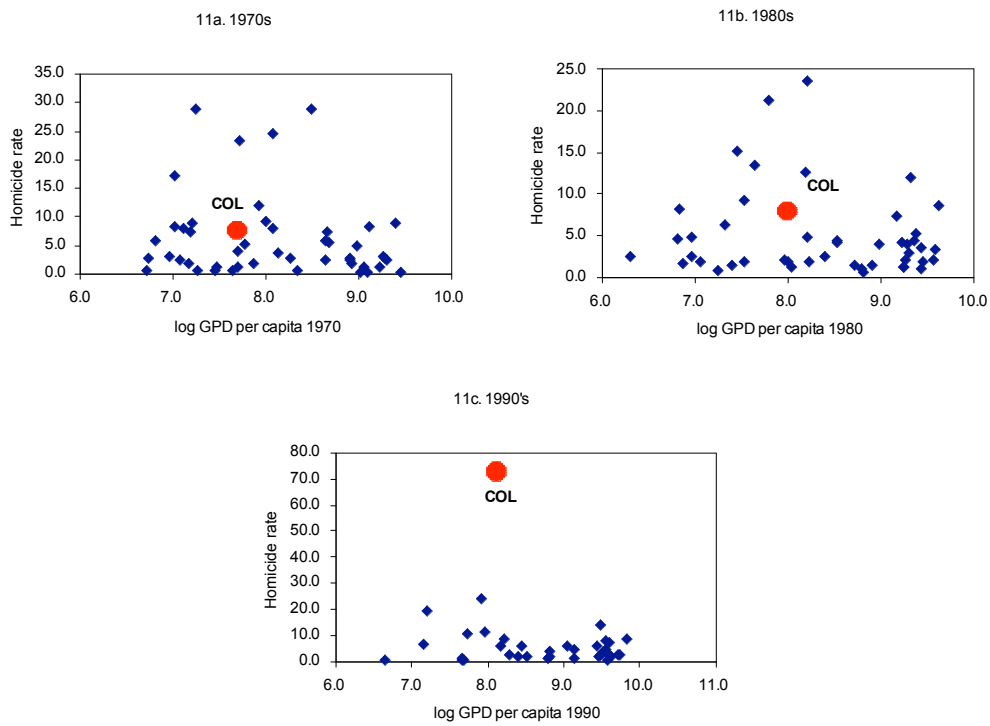
COL

log GPD per capita 1990

Source: Loayza et al (2002) and Burnham and Burnham (1999).

Appendix 1
Unit Root tests

Series	Deterministic	ADF	Critical value (5%)	Result	KPSS	Critical value (5%)	Result	Sample
log(Area)	Constant	-2.92	-2.97	I(1)	0.574	0.463	I(1)	1976-2005
log(TFP)	Constant	-2.75	-2.92	I(1)	0.351	0.463	I(0)*	1955-2005
log(Homicide Rate)	Constant	-1.23	-2.92	I(1)	0.757	0.463	I(1)	1958-2005

*I(1) at 10%.

Source: Author's calculations

Appendix 2
Granger Causality Test

Variable	Lags in VAR	Null hypothesis	Result at 5%	P value F test
Growth in Homicide Rate	5	Cultivated Area does not granger causes Homicide Rate	Reject null	0.0078
Growth in Cultivated Area		Homicide Rate does not granger causes Cultivated Area	Don't reject null	0.8820
Growth in Homicide Rate	12	Productivity does not granger causes Homicide Rate	Don't reject null	0.5207
Growth in Productivity		Homicide Rate does not granger causes Productivity	Reject null	0.0011
Growth in Cultivated Area	1	Cultivated Area does not granger causes Productivity	Reject null	0.0466
Growht in Productivity		Productivity does not granger causes Cultivated Area	Don't reject null	0.4182

Source: Author's calculations.