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# The relationship between development, investments, insecurity and social conditions in Colombia: a dynamic approach

Alexander Cotte Poveda

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**Abstract** In this paper, we investigate the relationship between economic development, investments, savings, insecurity and social conditions in Colombian departments. Using a dynamic heterogeneous panel analysis, we study the effects of insecurity and social conditions on economic development through an estimation of panel data cointegration techniques. The models applied in this study suggest a long-term relationship among economic development, investments, savings, social conditions and insecurity. Investments, savings and human development index have a positive and significant coefficient, which indicates that these variables produce incentives for economic development, whereas GINI and homicides have a negative relationship, demonstrating that these variables undermine economic development. All findings are important in the design of strategies and policies that strengthen income distribution equality, a key factor that determines growth and development through adequate government expenditures that encourage savings and investment decisions with the aim to improve welfare and the standard of living.

**Keywords** Social conditions · Economic development · Dynamic of the long run · Saving · Investments

**JEL Classification** O10 · C23 · E20 · I30 · E20 · B50

## 1 Introduction

The literature has indicated that a policy that encourages saving and investment is central to achieving sustained economic development. The savings rate indicates the potential growth of production, and the relationship between savings, investment and economic growth and

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A. Cotte Poveda (✉)  
Department of Economics, University of Göttingen, Platz der Göttinger Sieben 3,  
37073 Göttingen, Germany  
e-mail: alexcotte@yahoo.com

A. Cotte Poveda  
Faculty of Accounting and Administration, University of La Salle, Cra. 2 No. 10–70, Bogotá, Colombia

development has been demonstrated in the growth model developed by Kalecki (1954), Kaldor (1954), Sen (1961), Kaldor and Mirrlees (1962).

In economic theory, several authors have studied the long-term relationship between economic development and savings and investments. Kalecki (1954) described the long-term relationship from the standpoint of developmental factors such as innovation, capital accumulation and long-term investments that energise the cycle and maintain the long-term trend towards achieving increased profits and production, which generate higher economic growth and development. Kaldor (1954) analysed the link between long-term trends and cycles and found that increases in production induce higher capital accumulation from the additional rate of savings and investments, generating longer periods of economic growth and development. Sen (1961) evaluated the optimum savings rate and demonstrated that investments generate a productive capacity over a period of time and that present savings decrease actual consumption that would lead to the achievement of additional consumption in the future to maintain higher growth and development. Kaldor and Mirrlees (1962) showed the relationship between technical progress and investments and determined that a higher rate of investment encourages saving, productivity and innovation. Technical change is an important factor for increasing economic growth and development for long periods.

Moreover, the savings-investment relationship is the fundamental element in the model that was introduced by Harrod (1939) and Domar (1946) and then developed by Kalecki (1954), Hahn (1963) and Romer (1986). These economists found that asset accumulation was the cause of economic growth and development and agreed that a higher savings rate leads to higher economic growth and development because high savings leads to high investment. Hence, savings and investment are important factors to improve economic growth and development.

Sustained economic growth and development require a strong and efficient state characterised by the quality of its institutions and its economic policies. The protection of property rights, the absence of corruption in the public sector, respect for the rule of law through an independent and effective judiciary, respect for basic political and civic rights and well functioning democratic institutions are key features that generate positive effects on economic development (Hall and Jones 1999, Acemoglu and Johnson 2003, Fukuyama 2004). In terms of economic policies, a stable macroeconomic environment, generalised access to the world economy, protection of individual property rights and spending on public goods that provide a benefit to all are good for economic growth and development (Easterly 2003, Tabellini 2004). Therefore, missing or weak political institutions or economic policies can generate unstable and insufficient growth and development.

Overall, it is important for countries to achieve balanced growth and development and reduce disparities in the factors that determine growth and development across regions. State policies are fundamental in maintaining sustained growth in both gross domestic product (GDP) and GDP-per capita and for promoting social stability.

Empirical studies on the relationship between economic growth and development and savings have focused primarily on the following methods: (I) Using the Granger causality framework in developed countries, in the early stages of development, growth is principally the result of institutional change, whereas in the second stage of development, savings should generate a rapid growth (Attanasio et al. 2000; Dhakal et al. 1991). (II) Analysing the relationship between domestic savings and economic growth and development in developing countries, time series and panel data indicate that there is a long-term relationship between economic growth and development and the savings growth rate. These studies conclude that a higher savings rate leads to higher economic growth and development. In developing countries, the saving-growth-development nexus could be related to an increase in direct foreign

investment (Agrawal 2001, Anouro and Ahmad 2001, Alguacil et al. 2004). (III) Using the Granger causality test and cross-country regressions to compare developed and developing countries, it was demonstrated that there is a causal link between the economic growth rate and the savings growth rate. In developing countries, foreign investment is a key strategy because domestic saving is important for innovation. In contrast, developed countries do not need to attract foreign investment to innovate so savings are not as important for growth. Similarly, savings are directly associated with productivity growth in developing countries but not in developed countries (Mohan 2006, Aghion et al. 2009).

The effects of investment on economic growth and development are the result of the interrelation among capital accumulation, productive employment, and the absorption of technical progress (Ffrench-Davis 2009). In transitioning and developing countries, investments are a source of economic development and modernisation, income growth and employment (OCED 2002). Empirical studies have shown this relationship, e.g., Apergis et al. 2004 and Stanisic, 2008, using a panel data set for transition economies and found that investments have a significant relationship with economic growth in transitioning countries that are characterised by high levels of income and the implementation of successful programs. Using a pooled cross-sectional time series regression with panel-corrected standard errors, Kehl, 2008 concluded that to be effective, investments in developing countries must focus on a political-institutional design that includes democratic development and effective policymaking institutions that can optimise the use of direct foreign investments and promote economic growth and development.

Other factors that can determine trends in economic growth and development, such as political instability, regional conflicts and insecurity, are often cited as major obstacles for economic growth and development because these factors increase transaction costs, decrease opportunities and lower state capacity. Together, they undermine investment, which is the main path for achieving sustained growth and development (World Bank 2007, Ikejiaku 2009). Social factors, such as inequality, poverty and education, are determinants of economic growth and development. Empirical analysis using cross-country data has demonstrated that inequality tends to retard growth and development in developing countries because it reduces productivity and increases poverty (Deininger and Squire 1998, Barro 2000, Bourguignon 2003). Education is a key strategy for economic growth and development because better education leads not only to higher individual income, productivity and creativity, but education is also a necessary (although not always sufficient) precondition for long-term economic growth and development and a more equal income distribution (Ozturk 2001, IIASA 2008).

The purpose of the present paper is to use an empirical approach to investigate the interactions between investments, savings, insecurity and social conditions on economic development across regions of a developing country choosing a Colombia as a case study. Using panel data from a sample of 32 regions between 1993 and 2007, we applied a dynamic heterogeneous non-stationary model (the pooled mean group (PMG) estimator developed by Pesaran et al. 1996; 1999). This model can resolve the problems of non-stationary data, heterogeneity across panel series and dynamics. In this study, Colombian departments were selected based on their diversity in terms of size, geography, level of development, natural resource endowments, economic structure, human capital and skills and the presence of state and social structures. Using a diverse sample allowed us to analyse the trends in economic development using different approaches. For example, we examined economic factors (savings and investment), insecurity (homicides), and social factors (GINI and human development index). Empirical studies are limited in the context of developing countries affected by conflict and instability, which are associated with low levels of economic growth and development. The main contribution of this study is that economic development is analysed using an empirical

approach that takes into account factors such as investment, savings, insecurity and social conditions that are studied from social and political stability variables, which have not been studied often in the context of countries with internal conflict, such as Colombia.

Moreover, studies on economic growth and development across Colombian departments have primarily analysed the relationship between geographical variables and development, indicating that geography affects income via the productivity of the land, the availability of natural resources, the presence of tropical diseases, and agglomeration (Sanchez and Nunez 2000). Studies have also looked at the interrelationships among violence, development, economic growth, and drug production, which suggests that poverty and the lack of economic growth and development drive both violence and drug production (Holmes et al. 2002), which indicate the importance of this study as a contribution to the empirical analysis of economic growth and development across Colombian departments through a novel, dynamic, heterogeneous non-stationary model that takes into account economic, social and security factors.

The remainder of the paper is organised as follows. In Sect. 2, the hypotheses are presented. The basic model, methods and data are presented in Sect. 3. Section 4 shows the results of the empirical analysis and discusses its implications. Conclusions are drawn in Sect. 5.

## 2 Hypotheses

The following hypotheses are tested empirically to identify the interactions between economic factors, insecurity and social conditions on economic development across a sample of Colombian departments between 1993 and 2007. There is limited empirical evidence thus far regarding the connection between economic, social and security variables and economic development. The studies investigating the relationship between economic factors and development suggest that increasing savings and investments leads to increasing economic development through a more efficient allocation of resources. Therefore, low economic growth, savings and investments should generate stagnation in development and population welfare.

The effects of social variables are central to increasing economic growth and development. Therefore, a decrease in the human development index (HDI) and high levels of inequality undermine economic development. Good governance and economic growth promote development through social investments, better opportunities for the population and a higher standard of living within a more equal and inclusive society.

High levels of insecurity (measured as homicides) lead to a decrease in economic development. Regions with widespread social problems (e.g., poverty, indigence and unemployment) are characterised by a collapse in both state presence and functionality and poor economic growth and development, which, in turn, increase insecurity and violence. To increase security and reduce violence, there exist strategies linked with effective social policies, increasing welfare, successful income generation initiatives, and better income distribution measures that stimulate development and help to deal with the root causes of insecurity and violence (Biekart et al. 2005).

## 3 Methodology

### 3.1 Model and data

The model was derived from economic theory where economic activity is determined by the level of savings and investments, which are determinants of economic growth and regional

development (Kalecki 1954, Kaldor 1954, Kaldor and Mirrlees 1962). The purpose of the present paper is to use an empirical approach to investigate the interactions between investment, savings, insecurity and social conditions on economic development across Colombian departments. To investigate the long run determinants of these relationships, we used the following model:

$$GDPPC_{i,t} = \alpha_{i,0} + \beta_{i,1}INV_{i,t} + \beta_{i,2}SAV_{i,t} + \beta_{i,3}HDI_{i,t} + \beta_{i,4}GINI_{i,t} + \beta_{i,j}HR_{i,t} + u_{i,t} \quad (1)$$

where *GDPPC* is the gross domestic product per capita, *INV* are the investments measured as gross fixed capital formation, *SAV* is the saving, *HDI* is the human development index, *GINI* is an indicator of the inequality of income distribution and *HR* is an explanatory variable taken both from theory and from the empirical literature on *insecurity* and is defined as the homicide rate per 100,000 inhabitants for each Colombian department *i* in the period *t*.

### 3.2 The empirical strategy

In this study, the model is estimated using a dynamic heterogeneous panel data model in which the short and long-run causality among economic development, investments, savings and insecurity is explored using several test and panel data cointegration techniques that are explained in this section.

#### 3.2.1 Panel unit root tests

Panel unit root tests have different approaches. The augmented Dickey–Fuller test (ADF) for panel data models may be described as follows:

$$\Delta y_{it} = \rho_i y_{it-1} + \sum_{j=1}^p \delta_j \Delta y_{it-j} + x'_{it} \beta + \varepsilon_{it}, \quad (2)$$

where  $y_{it}$  is the series of interest  $i = 1, 2, \dots, N$  cross-section units over periods  $t = 1, 2, \dots, T$ ,  $x_{it}$  represents a column vector of exogenous variables, including any fixed effects or individual trends,  $\rho_i$  is the mean-reversion coefficient,  $p$  is the lag length of the autoregressive process and  $\varepsilon_{it}$  is an idiosyncratic disturbance assumed to be mutually independent. If  $|\rho_i| < 1$ ,  $y_{it}$  is said to be weakly (trend-) stationary, and if  $\rho_i = 1$ , then  $y_{it}$  presents a unit root.

The ADF model for panel data usually includes two assumptions about  $\rho_i$ . First, it assumes that the persistence parameters are common across departments so that  $\rho = \rho_i$  for all  $i$ . Under this assumption, the Breitung (2000) and Levin et al. (2002) approaches (both assessing a null hypothesis of a unit root in contrast to the alternative of no unit root) and the Hadri (2000) test (which assesses the null of no unit root in contrast to the alternative hypothesis of a unit root) can be applied. Second, it allows  $\rho_i$  to vary freely across units, allowing for individual unit root processes. This is the case for the ADF and Phillips-Perron (PP) tests suggested by Maddala and Wu (1999) and Choi (2001) and the Im-Pesaran-Shin (IPS) test suggested by Im et al. (2003). All three test the null hypothesis of a unit root in contrast to the alternative hypothesis of some individuals without unit roots. In general, the possible deterministic components employed are fixed and individual effects and individual trends.

### 3.2.2 Cointegration techniques

The application of panel data cointegration techniques to estimate the proposed model offers various advantages, such as the inclusion of the cross-sectional dimension, which generates statistical tests that are normally distributed, more powerful and do not depend on the number of regressors as in the individual time series. To test the presence of cointegration in the proposed model, the Pedroni (1999) test is assessed. The test is as follows:

$$y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1,it} + \beta_{2i} x_{2,it} + \dots + \beta_{Mi} x_{M,it} + \epsilon_{i,t} \tag{3}$$

where  $i = 1, \dots, N, t = 1, \dots, T$  and  $m = 1, \dots, M$ . Pedroni (1999) computes four within tests and three between tests. If residuals in Eq. 3 are written as an AR (1) process  $\hat{\epsilon}_{it} = \rho_i \hat{\epsilon}_{it-1} + u_{it}$ , the alternatives hypothesis for the tests are expressed in the following manner:

- For within tests, the alternative hypothesis is  $H_A : \rho_i = \rho < 1 \forall_i$
- For between tests, the alternative hypothesis is  $H_A : \rho_i < 1 \forall_i$

The seven tests are as follows:

1. Within tests (*Panel cointegration statistics*)

- Panel  $v$ -statistic: non-parametric test, variance ratio

$$T^2 N^{3/2} Z_{\hat{v}N,T} \equiv T^2 N^{3/2} \left( \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^2 \right)^{-1} \tag{4}$$

- Panel  $\rho$ -statistic: non-parametric test, Phillips-Perron  $\rho$  statistic

$$T N^{1/2} Z_{\hat{\rho}N,T-1} \equiv T N^{1/2} \left( \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^2 \right)^{-1} \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i) \tag{5}$$

- Panel  $t$ -statistic: non-parametric test, Phillips-Perron  $t$  statistic

$$Z_{tN,T} \equiv \left( \hat{\sigma}_{N,T}^2 \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^2 \right)^{-1/2} \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i) \tag{6}$$

- Panel  $t$ -statistic: parametric test, augmented Dickey–Fuller  $t$  statistic

$$Z_{tN,T}^* \equiv \left( \hat{s}_{N,T}^{*2} \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^{*2} \right)^{-1/2} \sum_{i=1}^N \sum_{t=1}^T \hat{L}_{11i}^{-2} \hat{\epsilon}_{it-1}^* \Delta \hat{\epsilon}_{it}^* \tag{7}$$

2. Between tests (*Group mean panel cointegration statistics*)

- Group  $\rho$ -statistic: non-parametric test, Phillips-Perron  $\rho$  statistic

$$T N^{-1/2} \tilde{Z}_{\hat{\rho}N,T-1} \equiv T N^{-1/2} \sum_{i=1}^N \left( \sum_{t=1}^T \hat{\epsilon}_{it-1}^2 \right)^{-1} \sum_{t=1}^T (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i) \tag{8}$$

- Group  $t$ -statistic: non-parametric test, Phillips-Perron  $t$  statistic

$$N^{-1/2} \tilde{Z}_{tN,T} \equiv N^{-1/2} \sum_{i=1}^N \left( \hat{\sigma}_i^2 \sum_{t=1}^T \hat{\epsilon}_{it-1}^2 \right)^{-\frac{1}{2}} \sum_{t=1}^T (\hat{\epsilon}_{it-1} \Delta \hat{\epsilon}_{it} - \hat{\lambda}_i) \tag{9}$$

- Group  $t$ -statistic: parametric test, augmented Dickey-Fuller  $t$  statistic

$$N^{-1/2} \tilde{Z}_{iN,T}^* \equiv N^{-1/2} \sum_{i=1}^N \left( \sum_{t=1}^T \hat{s}_i^{*2} \hat{\epsilon}_{it-1}^{*2} \right)^{-\frac{1}{2}} \sum_{t=1}^T \hat{\epsilon}_{it-1}^* \Delta \hat{\epsilon}_{it}^* \tag{10}$$

where

$$\begin{aligned} \hat{\lambda}_i &= T^{-1} \sum_{s=1}^{k_i} \left( 1 - \frac{s}{k_i + 1} \right) \sum_{t=s+1}^T \hat{\mu}_{it} \hat{\mu}_{it-s}, & \hat{s}_i^2 &= T^{-1} \sum_{t=1}^T \hat{\mu}_{it}^2 \\ \hat{\sigma}_i^2 &= \hat{s}_i^2 + 2\hat{\lambda}_i, & \hat{\sigma}_{N,T}^2 &= N^{-1} \sum_{i=1}^N \hat{L}_{11i}^{-2} \hat{\sigma}_i^{*2}, & \hat{s}_i^{*2} &= T^{-1} \sum_{t=1}^T \hat{\mu}_{it}^{*2} \\ \tilde{s}_{N,T}^{*2} &= N^{-1} \sum_{i=1}^N \hat{s}_i^{*2}, & \hat{L}_{11i}^2 &= T^{-1} \sum_{t=1}^T \hat{\eta}_{it}^2 + 2T^{-1} \sum_{s=1}^{k_i} \left( 1 - \frac{s}{k_i + 1} \right) \sum_{t=s+1}^T \hat{\eta}_{it} \hat{\eta}_{it-s} \\ \hat{\mu}_{it} &= \hat{\epsilon}_{it} - \hat{\rho}_i \hat{\epsilon}_{it-1}, & \hat{\mu}_{it}^* &= \hat{\epsilon}_{it} - \hat{\rho}_i \hat{\epsilon}_{it-1} - \sum_{s=1}^{k_i} \hat{\rho}_{ik} \Delta \hat{\epsilon}_{it-k}, \\ \hat{\eta}_{it} &= \Delta y_{it} - \sum_{m=1}^M \hat{b}_{mi} \Delta x_{mi,t} \end{aligned}$$

### 3.2.3 Pooled mean group (PMG) and mean group (MG) estimations

In this study, it was important to apply a method that would be suitable for dynamic panel data and that allows for the consideration of non-stationary variables and cointegration relationship. We used the pooled mean group estimator (PMG) suggested by Pesaran et al. (1999) to estimate dynamic heterogeneous panel models. This method restricts the long-run coefficients from differing over the cross-section but allows for the short-run coefficients and error variances to differ across groups in the cross-section. Using the PMG also obtains pooled long-run coefficients and averaged short-run dynamics as a sign of mean reversion. The PMG is generated from an autoregressive distributive lag ( $p, q, \dots, q$ ) model:

$$y_{it} = \sum_{j=1}^p \lambda_{ij} y_{it-j} + \sum_{j=0}^q \delta'_{ij} x_{it-j} + \mu_i + \epsilon_{it} \tag{11}$$

where  $X_{it} (K \times 1)$  is the vector of explanatory variables for group  $i$ ,  $\mu_i$  represents the fixed effects, the coefficients of the lagged dependent variables ( $\lambda_{ij}$ ) are scalars and ( $\delta_{ij}$ ) are  $(K \times 1)$  coefficients vectors. Eq. 11 can be re-parameterised as follows:

$$\Delta y_{it} = \emptyset_i y_{it-1} + \beta'_i x_{it} + \sum_{j=1}^{p-1} \lambda_{ij}^* \Delta y_{it-j} + \sum_{j=0}^{q-1} \delta_{ij}^* \Delta x_{it-j} + \mu_i + \epsilon_{it} \tag{12}$$

where

$$\emptyset_i = - \left( 1 - \sum_{j=1}^p \lambda_{ij} \right), \beta_i = \sum_{j=0}^q \delta'_{ij}, \lambda_{ij}^* = - \sum_{m=j+1}^p \lambda_{im} \text{ and } \delta_{ij}^* = - \sum_{m=j+1}^q \delta_{im}$$

First, it assumes that the residuals in Eq. 12 are independent and identically distributed (iid), with a mean of zero variance greater than zero and finite fourth moments. Second, the roots of Eq. 12 must be outside the unit circle. This supposition ensures that  $\theta_i < 0$ , and hence, there exists a long-run relationship between  $y_{it}$  and  $x_{it}$  defined by

$$y_{it} = - \left( \frac{\beta'_i}{\theta_i} \right) x_{it} + \eta_{it}.$$

The long-run homogeneous coefficient is equal to  $\theta = \theta_1 = - \left( \frac{\beta'_i}{\theta_i} \right)$ , which is the same across groups. The PMG uses a maximum likelihood approach to estimate both the model and a Newton–Raphson algorithm. The lag length can be determined using the Akaike information criterion.

Pesaran et al. (1999) propose a Hausman test based on the fact that an estimate of the long-run parameters in the model can be derived from the average (group mean) of the country regressions. This point is consistent with the assumption of heterogeneity. However, if the parameters are in fact homogenous, the PMG estimates could be more efficient. Thus, we can form the test statistic:

$$H = \hat{q}' [Var(\hat{q})]^{-1} \hat{q} \sim \chi^2_k \quad (13)$$

where  $\hat{q}$  is a  $(k \times 1)$  vector of the difference between the mean group and PMG estimates and  $Var(\hat{q})$  is the corresponding covariance matrix.

Under the null hypothesis that the two estimators are consistent but only one is efficient,  $Var(\hat{q})$  is assessed as the difference between the covariance matrices of the two underlying parameter vectors. If the poolability assumption is invalid, the PMG estimates are no longer consistent and it fails the test.

This analysis tested for long-run homogeneity using a joint Hausman test based on the null hypothesis of equivalence between the PMG and mean group estimator proposed by Pesaran and Smith (1995). The mean group estimator is an average of  $N$  individual estimations that allows for long-run heterogeneity. If this rejects the null, it rejects the homogeneity of the cross-section's long-run coefficients. The estimator used is a maximum likelihood estimator as suggested Pesaran et al. (1999).

### 3.2.4 Dataset

The dataset used in this study covers 32 Colombian departments from 1993 to 2007. The main data sources are the following: the National Institute of Legal Medicine, the National Policy of Colombia thought Centre of Criminalist Research (DIJIN) (Centro de Investigaciones Criminológicas, DIJIN), CERAC (Conflict Analysis Resource Center), the DNP (National Planning Department), and the DANE (Colombian Department of Statistics).

## 4 Estimation results and discussion

The results of the application of panel cointegration techniques to determine the interrelationships among economic development, investments, savings, insecurity and social conditions are described in this section.



**Table 1** Results of panel unit root tests for all variables

Test	Variable	GDP <sub>pc</sub>	Investments	Saving	HDI	GINI	Homicides
Im-Pesaran-Shin	Level	2.192 (0.985)	-2.300 <sup>b</sup> (0.010)	-0.740 (0.229)	-3.573 <sup>a</sup> (0.000)	8.927 (1.000)	-0.456 (0.324)
	1 <sup>st</sup> difference	-7.937 <sup>a</sup> (0.000)	-7.943 <sup>a</sup> (0.000)	-5.822 <sup>a</sup> (0.000)	-10.10 <sup>a</sup> (0.000)	-4.865 <sup>a</sup> (0.000)	-4.933 <sup>a</sup> (0.000)
Levin, Lin and Chu test	Level	3.176 (0.999)	-7.820 <sup>a</sup> (0.000)	-6.630 <sup>a</sup> (0.000)	-1.934 (0.026)	-5.472 <sup>a</sup> (0.000)	-2.225 <sup>b</sup> (0.013)
	1 <sup>st</sup> difference	-6.669 <sup>a</sup> (0.000)	-9.745 <sup>a</sup> (0.000)	-58.39 <sup>a</sup> (0.000)	-13.58 <sup>a</sup> (0.000)	-14.64 <sup>a</sup> (0.000)	-6.653 <sup>a</sup> (0.000)

<sup>a</sup> denotes significance at the 1% level. <sup>b</sup> denotes significance at the 5% level  
 Note In this study were also applied the following unit root tests: [Breitung \(2000\)](#), Fisher-Type test using ADF and PP-test ([Maddala and Wu \(1999\)](#) and [Choi \(2001\)](#)), which give results similar confirming that all series are *I*(1) and integrated of the same order

**Table 2** Panel data cointegration tests

Pedroni panel cointegration test	(1)	(2)	(3)
Pedroni panel cointegration test			
Panel v-statistic	-3.186 (0.999)	-2.649 (0.996)	-2.093 (0.981)
Panel rho-statistic	-1.117 (0.131)	2.847 (0.997)	4.371 (1.000)
Panel PP-statistic	-6.101 (0.000)	-3.547 (0.000)	-2.256 (0.012)
Panel ADF-statistic	-6.211 (0.000)	-3.001 (0.000)	-3.008 (0.013)
Group mean cointegration test			
Group rho-statistic	2.239 (0.987)	5.639 (1.000)	5.978 (1.000)
Group PP-statistic	-5.287 (0.000)	-2.771 (0.002)	-7.262 (0.000)
Group ADF-statistic	-2.389 (0.000)	-2.553 (0.000)	-6.165 (0.000)

#### 4.1 Results of the panel unit root test

Table 1 shows the results of the unit root tests. The statistical properties of each variable are studied using a standard method tests for panel data, namely, [Im et al. \(2003\)](#) (IPS) and [Levin et al. \(2002\)](#). These tests determine whether the series are stationary  $I(0)$  or non-stationary  $I(1)$ . Table 1 shows that each variable is non-stationary. Therefore, the variables present a unit root. This fact suggests that all series are integrated in the same order, and hence, the cointegration between the variables can be studied.

#### 4.2 Results of panel cointegration tests

Table 2 present the results of panel cointegration tests of the models selected in this study to determine the relationship among economic development, investments, savings, insecurity and social conditions in Colombian departments, using [Pedroni \(1999\)](#) tests to determine the presence of cointegration. The results show that among seven [Pedroni \(1999\)](#) tests, there is at least one that indicates a rejection of the null hypothesis of no cointegration in all 3 models (see Table 3 for a description of the variables in every model). This fact allows us to estimate the panel data cointegration relationships.

#### 4.3 Results of estimating the panel cointegration model using PMG, MG and DFE estimations

The results of dynamic heterogeneous panel models using the PMG estimator are reported in Table 3, which include the long- and short-run parameters and the Hausman test. This test strongly suggests that the assumption of long-run homogeneity using the PMG method is not rejected (high p-values on the H-tests). This implies that the estimated long-term effects on economic development, insecurity and social conditions can legitimately be treated as if they

**Table 3** Dynamic heterogeneous panel estimation results from the PMG, MG and DFE estimators

Parameter	[1]			[2]			[3]		
	PMG	MG	DFE	PMG	MG	DFE	PMG	MG	DFE
Constant	2.441 <sup>a</sup> (0.353)	4.644 <sup>a</sup> (0.795)	2.317 <sup>b</sup> (0.978)	3.021 <sup>a</sup> (0.618)	-0.8763 (4.377)	1.369 (0.852)	2.532 <sup>a</sup> (0.592)	-3.037 (8.022)	1.870 <sup>b</sup> (0.954)
Investments	0.098 <sup>a</sup> (0.012)	0.112 <sup>c</sup> (0.063)	0.045 <sup>b</sup> (0.019)	0.007 <sup>b</sup> (0.003)	0.040 (0.034)	0.039 <sup>c</sup> (0.021)	0.009 <sup>a</sup> (0.003)	0.712 (0.666)	0.035 <sup>c</sup> (0.018)
Saving	0.014 (0.023)	-0.107 (0.233)	0.080 <sup>b</sup> (0.038)	0.247 <sup>a</sup> (0.023)	0.222 (0.151)	0.207 <sup>a</sup> (0.074)	0.241 <sup>a</sup> (0.025)	-0.236 (0.393)	0.166 <sup>b</sup> (0.071)
HDI				1.499 <sup>a</sup> (0.205)	-0.869 (0.700)	0.258 (0.353)	1.469 <sup>a</sup> (0.201)	-0.342 (0.319)	0.227 (0.329)
GINI				-1.217 <sup>a</sup> (0.301)	-17.84 (16.65)	-5.961 <sup>a</sup> (2.021)	-1.093 <sup>a</sup> (0.326)	48.38 (60.87)	-4.757 <sup>a</sup> (1.821)
Homicides							-0.003 (0.007)	0.078 (0.098)	-0.146 <sup>b</sup> (0.072)
Log likelihood	704.68			783.55			815.75		
No. Obs	448	448	448	448	448	448	448	448	448
Hausman test <sup>a</sup>	0.935	0.996	-	0.270	1.000	-	0.449	1.000	-

Standard error in parentheses.

<sup>a</sup> Significant at the 1% level, <sup>b</sup> Significant at the 5% level, <sup>c</sup> Significant at the 10% level

were common across departments. Similarly, the test also suggests that between MG and DFE, the mean group is consistent and efficient, while it is inconsistent for DFE. The results of the Hausman test indicate that in all cases, the null hypothesis of homogeneity cannot be rejected, and hence, the PMG estimates are efficient. Therefore, the results are discussed based on the PMG estimates.

This empirical analysis provides evidence of a systematic relationship among economic development, insecurity and social conditions. Specifically, variables seem to be co-integrated, which suggests that there exists a long-term relationship between them. Investments, savings and HDI have a positive and significant coefficient, indicating that an increase in these variables leads to higher economic development, whereas GINI and homicides both have negative coefficients, demonstrating that higher inequality and insecurity undermine economic development.

Savings and investments both have a positive and significant coefficient, indicating a direct relationship between these variables and economic development. Therefore, savings and investments play a significant role in the process of economic development in the Colombian departments. Several researchers have demonstrated the importance of savings and investments on growth and economic development. On the one hand, when investment increases, the potential for further investment grows, which generates higher economic growth. This helps to improve the standard of living because the population has more job opportunities and greater prosperity, which translates to higher economic development. In contrast, when investment decreases, there are fewer possibilities to increase economic growth and fewer opportunities are generated for the population. This could decrease the possibilities of further savings and investments, which would increase poverty, unemployment, insecurity, and other factors that lower economic development (Robinson 1933, 1962, 1967; Kaldor 1954; Sen 1961; Kaldor and Mirrlees 1962).

HDI has a significantly positive correlation with economic development, demonstrating that a department with higher HDI also has higher economic development. These results could be explained by the fact that a department with a high level of GDP<sub>pc</sub> contains a

population that can afford a higher level of social benefits, such as education and health. Furthermore, when the population in a department is well educated and healthy, human capital and productivity will improve, increasing  $GDP_{pc}$ . These results agree with Schuller (2009), Koreleski (2007) and Vogel and Wolf (2004) in the context of European countries and Poter et al. (2007) in the context of global competitiveness. Progress in living conditions is measured as the capability to live better and richer lives with more freedom and opportunity. Both  $GDP_{pc}$  and HDI give an adequate picture of the average standard of living (Anand and Sen 2000).

The results of the GINI index show a positive and significant coefficient for economic development, which demonstrates that income equality is the key factor for improving economic development in Colombian departments. Economic development requires a high level of  $GDP_{pc}$  and a suitable income distribution. Therefore, the task of policymakers is to design policies and strategies to decrease inequality and increase both the economic development and welfare of the population, which implies high growth in income per capita and an improvement in its distribution (Barro 2000, Kwasi 2011). Similarly, other researchers have also shown that an unequal income distribution could generate social conflicts that may weaken institutions, which results in reduced consumption, investments and growth (Solimano 1999, Deininger and Olinto 2000).

Insecurity, which is indicated by the homicide rate, shows a negative coefficient for economic development, confirming the hypothesis that high levels of insecurity undermine economic development. These results agree with the literature in which it has been shown that socio-political instability, violence, social conflicts and civil wars may obstruct savings, investments and income. Together, these destabilising factors lower welfare and the standard of living in populations, which are fundamental elements for the achievement of an improved and sustained economic development. (Robinson 1979, Barro 1991, Svensson 1998, Berkman 2007). Moreover, the economic cost of violence constrains economic development by removing resources from strategic public development spending areas (education and health) to security and other activities to control crime and violence (Howard et al. 2007).

Finally, this analysis shows the importance of several variables in economic development in a country such as Colombia. Policymakers must design strategies and policies that strengthen income distribution as a key factor that determines growth and development. This can be achieved through adequate government expenditure that encourages savings and investment decisions with the aim to improve both overall welfare and the standard of living. Moreover, these strategies must integrate effective policies for controlling crime and insecurity, both factors that could undermine economic development over time.

## 5 Conclusions

This paper addresses the empirical relationship among economic development, investments, savings, social conditions and insecurity from a dynamic heterogeneous panel data perspective using Colombian departments as a case study for the period 1993–2007. The empirical analysis is performed using panel data cointegration techniques.

The main empirical findings of this study can be summarised as follows: *i.* the variables used in this study are integrated in the same order; *ii.* the models selected allow us to estimate the panel data cointegration relationships from the results of panel cointegration tests; *iii.* PMG estimates are efficient for the models selected; and *iv.* The relationship between economic development, insecurity and social conditions has long-term effects and can be treated in a similar manner across Colombian departments.

The results suggest a long-term relationship among economic development, investments, savings, social conditions and insecurity. Investment, savings and IDH have a positive and significant coefficient, indicating that an increase in these variables leads to higher economic development, whereas GINI and homicides have negative coefficients, demonstrating that higher inequality and insecurity undermine economic development.

These results suggest political strategies to improve economic development and the standard of living by generating adequate incentives that promote growth and development through higher savings and investment, lower inequality in income distribution and better security conditions.

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