Universidad del Rosario

Facultad de Economía

STATISTICAL INFERENCE FOR TESTING GINI COEFFICIENTS: AN APPLICATION FOR COLOMBIA

Luis Fernando Gamboa

Andrés García

Jesús Otero

SERIE DOCUMENTOS DE TRABAJO

No. 65

Junio 2009

Statistical inference for testing Gini coefficients: An application for Colombia*

Luis Fernando Gamboa†
Facultad de Economía
Universidad del Rosario
Bogotá, Colombia

Andrés García‡
Facultad de Economía
Universidad del Rosario
Bogotá, Colombia

Jesús Otero§
Facultad de Economía
Universidad del Rosario
Bogotá, Colombia

June 2009

Abstract

This paper uses Colombian household survey data collected over the period 1984-2005 to estimate Gini coefficients along with their corresponding standard errors. We find a statistically significant increase in wage income inequality following the adoption of the liberalisation measures of the early 1990s, and mixed evidence during the recovery years that followed the economic recession of the late 1990s. We also find that in several cases the observed differences in the Gini coefficients across cities have not been statistically significant.

JEL Classification: C12; D31; I32.
Keywords: Inequality, Gini coefficient, bootstrap, Colombia.

*We would like to thank Russell Davidson, Luis Eduardo Fajardo, Ana Maria Iregui and Jeremy Smith for useful comments and suggestions. The usual disclaimer applies.

†E-mail: lfgamboa@urosario.edu.co
‡E-mail: andres.garcia66@urosario.edu.co
§E-mail: jotero@urosario.edu.co (corresponding author)

1 Introduction

Measuring the evolution of income distributions over time and/or across regions, and assessing the effect of policy measures on income concentration are topics of research that have historically received a great deal of attention. To address these topics, authors typically provide comparisons based on the ranking of estimated Gini coefficients, without acknowledging the fact that, being a sample statistic, these coefficients have associated sampling distributions. For example, Baer and Maloney (1997) review the impact on income distribution of the market-oriented policy reforms instituted in Latin America during the 1980s. They observe that in the case of Chile, the Gini coefficient fell from 0.49 to 0.47 under the socialist experiment of the Allende government, and then increased to 0.52 during the military dictatorship regime. Then, during 1990-1993, a period of transition back to democracy, the Gini coefficient was 0.51. On the other hand, a comparison of the variation in the Gini coefficient in Mexico during 1986-1992, a period of economic adjustments and liberalisation measures, reflects an increase from 0.43 to 0.48. As another illustration, Cunningham and Jacobsen (2008) use household survey data from Bolivia, Brazil, Guatemala and Guyana, to construct earnings inequality measures by gender and by racial/ethnic origin. They find that for Bolivia the Gini coefficients for white and non-white men (women) are 0.51 (0.54) and 0.53 (0.60), respectively. The question that arises is whether these observed differences in Gini coefficients are statistically significant.

During the last decade or so, a number of authors have considered different methodologies to estimate the standard error of the Gini coefficient; see Zheng and Cushing (2001), Giles (2004, 2006), Ogwang (2000, 2004, 2006) and Modarres and Gastwirth (2006). However, in a recent paper Davidson (2009) points out that the estimators available in the literature are either mathematically complex to calculate or quite unreliable. For example, Davidson (2009) shows that the jackknife estimator of the variance is not a consistent estimator of the asymptotic variance of the Gini coefficient, and therefore does not give reliable inference. Davidson (2009) presents a procedure to compute an asymptotically correct standard error for the Gini coefficient based on a relatively simple expression. The work by Davidson has at least three main contributions. First, it provides a bias-corrected estimator of the Gini coefficient. Second, it derives an approximation for the standard error of the Gini coefficient in which it is expressed as a sum of independent and identically distributed (*iid*) random variables. Third, it illustrates how bootstrap methods can be used to yield reliable inference about the Gini coefficient.

This paper uses Colombian household survey data over the period 1984-2005 to estimate the Gini coefficient for the main seven urban areas, as well as for the country as a whole. Rankings of Gini coefficients based on income distributions for Colombia have been undertaken by Berry and Urrutia (1976), Vélez (1995), Ocampo, Sánchez and Tovar (2000) and Birchenall (2001, 2007), among others. In sharp contrast to this literature, in this paper we estimate standard errors on these Gini coefficients enabling us to test for statistical variation across urban areas and over time. The chosen sample period is interesting because the Colombian government instituted a series of major liberalising reforms in the early 1990s, although this was followed by the deepest recession experienced by the country in the last century, and the subsequent years of recovery.

The paper is organised as follows. Section 2 briefly describes the methodology used for the estimation of the Gini coefficient and its corresponding standard error. Section 3 describes the data set used in the paper and summarises the main results. Section 4 offers concluding remarks.

2 Methodology

The standard approach to measuring income inequality is the Gini coefficient, which provides an absolute measure of the extent of inequality. The Gini coefficient ranges from 0, when all individuals have exactly the same income, to 1, when only one individual has the totality of income and everyone else has nothing at all.[1] The Gini coefficient based on a sample of data is an estimator of the true parameter with an associated standard error.

The Gini coefficient is defined as twice the area between the equidistribution line (i.e. the 45^o-line) and the Lorenz (1905) curve. Recently Davidson (2009) expressed the Gini coefficient as:

$$\hat{G} = \frac{2}{\widehat{\mu} n^2} \sum_{i=1}^{n} y_{(i)} \left(i - \frac{1}{2} \right) - 1, \tag{1}$$

where $y_{(i)}$, $i = 1, 2, .., n$, is the series of order statistics of the income variable y (that is, the original series sorted in increasing order), and $\widehat{\mu}$ is the estimated mean of y. Davidson (2009) finds an approximate expression for the bias of $\hat{G}$, from which he subsequently derives the following bias-corrected estimator of the Gini coefficient, denoted $\tilde{G}$, which is given by:

$$\tilde{G} = \frac{n}{(n-1)} \hat{G}. \tag{2}$$

While the estimator (2) is still biased, its bias is of order smaller than n^{-1}. Equation (2) can be used to obtain an estimate of the standard error of $\tilde{G}$. Using:

$$\tilde{Z}_i = -(\tilde{G} + 1) y_{(i)} + 2(w_i - v_i), \tag{3}$$

where $w_i = (2i - 1)\, y_{(i)} / (2n)$ and $v_i = n^{-1} \sum_{j=1}^{i} y_{(j)}$, the standard error of the bias-corrected Gini coefficient is denoted as:

$$\text{SE}\left(\tilde{G}\right) = \sqrt{\frac{1}{(n\widehat{\mu})^2} \sum_{i=1}^{n} (\tilde{Z}_i - \bar{Z})^2}. \tag{4}$$

Davidson (2009) shows, via simulation experiments, that the asymptotic distribution of the Gini coefficient is reliable even for sample sizes of around 100 observations. However, in case the underlying income distribution follows a lognormal

[1] This range of variation also applies to other inequality measures such as the indices of Atkinson and Theil.

distribution with a large variance, or when the distribution has heavy tails, reliable inference can be obtained by applying the bootstrap method. In particular, Davidson (2009) suggests implementing the bootstrap method as follows. First, let

$$\tau \equiv \frac{(\tilde{G} - G_0)}{\text{SE}\left(\tilde{G}\right)}, \tag{5}$$

be the test statistic required to test the null hypothesis that the bias-corrected Gini coefficient is equal to G_0. Then, one generates $b = 1, ..., B$ bootstrap samples of size n by resampling with replacement from the observed income data (which is also of size n). For bootstrap sample b, one computes a bootstrap statistic τ_b^* as in (5), but with G_0 replaced by $\tilde{G}$, that is the value of the statistic computed from the observed sample. This is required so that the hypothesis tested should be true of the bootstrap data-generating process. To calculate an interval at nominal confidence level $(1 - \alpha)$, one estimates the $\alpha/2$ and $1-\alpha/2$ quantiles of the empirical distribution of the bootstrap statistics τ_b^*.

3 Data and main results

To study the distribution of income in Colombia, we use data from the nationwide household surveys periodically undertaken by the Departamento Administrativo Nacional de Estadística (DANE). Our period of analysis, which runs from 1984 to 2005, is characterised by the implementation of two different surveys, namely the Encuesta Nacional de Hogares – ENH (National Household Survey) and the Encuesta Continua de Hogares – ECH (Continuous Household Survey). The former was applied quarterly from 1979 to 2000, and up to 1983 included the four main cities: Bogotá, Medellín, Cali and Barranquilla. In 1984 three more cities were added to the ENH: Bucaramanga, Manizales and Pasto. In 2001, the ENH was superseded by the ECH, which is a monthly survey of 13 cities: the original 7 plus Ibagué, Montería, Cartagena, Pereira, Villavicencio and Cúcuta.[2]

[2]The ECH also introduced changes in the phrasing of questions aimed at measuring labour market indicators, such us the concept of unemployment, unpaid workers, etc.

The dataset used in the analysis consists of the hourly wage per worker (in constant prices of 2005) during the period 1984-2005, which is used as a proxy for wage income. The data for each year in the period 1984-2005 was obtained by aggregating the surveys of that year. We use the seven main cities which are available throughout the sample period: Bogotá (Bog), Medellín (Med), Cali (Cal), Barranquilla (Bar), Bucaramanga (Buc), Manizales (Man) and Pasto (Pas), which account for more than seventy percent of the country's total urban population.

For the purposes of our estimations, individuals who do not report either wage income or having worked during the previous week are excluded from the analysis.[3] The evolution of the average hourly wage rate during the sample period, both for each city and for the country, is presented in Table 1.[4] The total number of observations ranges from 41,008 in 2003 to 76,946 in 1984. In turn, the median hourly wage in the seven cities varies between $1,596 in 1992 and $2,127 in 2005 (less than US$1). On average, Bogotá, which is the capital of the country as well as the most populated city, exhibits the highest median wage per hour during the sample period, whereas the city with the lowest median wage per hour is Pasto.

Appendix 1 reports our estimates of the bias-corrected Gini coefficients for the main seven cities as well as for the country, during the period 1984-2005. The appendix also contains our estimates of the standard errors of the bias-corrected Gini coefficients. The estimated standard errors are used to calculate confidence intervals at the 95% level, for which we use the corresponding quantiles of the standard normal distribution, and those that were obtained after the implementation of the bootstrap method, using 9,999 bootstrap replications.[5] At this point it is also worth mentioning that the application of the jackknife method results is much larger estimates of the variance of the bias-corrected Gini coefficients; indeed, when using

[3]It is worth mentioning that the methodological differences in the two surveys highlighted above, do not affect the wage income measure used in the paper; see Arango, García and Posada (2006) for a comparison of the methodological differences between the two surveys.

[4]All the calculations were performed in the econometrics software Rats 6.1 and Stata SE 10.2.

[5]This is the number of bootstrap replications recommended by Davidson and MacKinnon (1999) if calculating the bootstrap statistics τ_b^* is computationally inexpensive.

the data for all seven cities the estimated jackknife variance is almost 1.8 times the estimated asymptotic variance derived by the formula given in Davidson (2009).[6]

Table 2 reports the number of times the bias-corrected Gini coefficients between the pairs of cities are statistically the same over the sample period 1984-2005. For example, when looking at the cities of Bucaramanga and Barranquilla in 11 out of the 21 possible cases the coefficients between these two cities do not appear to be statistically different. As can be seen from the table, there are only three pairs of cities, namely Bogotá vs. Medellín, Medellín vs. Pasto and Bucaramanga vs. Pasto, for which the estimated coefficients always appear to be statistically different throughout the sample period.

Table 3 compares the evolution of the Gini coefficients for each city and for the country, with respect to three different base years: 1984, 1990 and 1999. The first base year is chosen simply because it is the beginning of our sample period. The second base year allows us to compare with respect to the year when the government introduced a series of structural policy measures aimed at liberalising Colombian trade and foreign exchange transactions, which were also accompanied by legislation to free the labour market while granting greater protection to union rights. The third base year allows us to provide a comparison with respect to the lowest point of the most serious recession recorded during the last century.

Let us consider first the results when using 1984 as base year. The cities of Barranquilla, Medellín and Manizales exhibit a downward trend in their Gini coefficients during the 1980s and early 1990s, which is subsequently reversed starting in the mid 1990s. In the case of Pasto, wage income distributions appear not to have changed with respect to the level observed in 1984. In the cases of Bogotá and the aggregate of the seven cities, the corresponding Gini coefficients appear to have moved upwards. Using 1990 as base year, we find that most of the Gini coefficients exhibit an increase, suggesting that the liberalising policy reforms of the early 1990s

[6] In the case of the city of Pasto, the estimated jackknife variance is almost 3 times the estimated asymptotic variance. Jackknife estimates of the standard errors are not reported here for brevity, but are available from the authors upon request.

led to a worsening distribution of income. Lastly, when looking at the period that followed the deepest recession of the last century, evidence is somewhat mixed. The years of recovery do not appear to have had an effect on wage income distribution in 21 out of the 48 comparisons provided, whereas in 18 cases there is a statistically significant fall in the Gini coefficients.

Overall, when assessing variations in the distributions of wage income with respect to 1990 and 1999, the picture that emerges is not particularly optimistic, in the sense that most of the observed variations in the Gini coefficients are in the positive direction (reflecting a worsening in inequality); it appears that the best-case scenario is that which reflects no statistically significant variation at all.

4 Concluding remarks

This paper analyses the evolution of the Gini coefficient in Colombia across cities, over a period of more than two decades. In order to provide valid inference on the observed variations of the estimated Gini coefficients, we implement the Davidson (2009) methodology to compute an asymptotically correct standard error. The estimated standard errors were used to perform hypotheses tests on wage income distribution equality across cities and over time. Focusing first on the cross section dimension, we find that there have been several years in which the observed differences in the Gini coefficients at the city level do not turn out to be statistically different from zero. This highlights the importance of taking into account the coefficient estimated standard errors when performing comparisons. Turning to the time series dimension, we compare the corresponding Gini coefficients for each city with the values observed in 1984, 1990 and 1999, and find that in most cases inequality has worsened.

References

Arango, L., A. García, and C. Posada (2006). La metodología de la encuesta continua de hogares y el empalme de la series del mercado laboral urbano de Colombia. Borradores de Economía No 410, Banco de la República.

Baer, W. and W. Maloney (1997). Neoliberalism and income distribution in Latin America. *World Development 25*, 311–327.

Berry, A. and M. Urrutia (1976). *Income Distribution in Colombia*. New Haven: Yale University Press.

Birchenall, J. (2001). Income distribution, human capital and economic growth in Colombia. *Journal of Development Economics 66*, 271–287.

Birchenall, J. (2007). Income distribution and macroeconomics in Colombia. *Journal of Income Distribution 16*, 6–24.

Cunningham , W., J. P. Jacobsen (2008). Earnings inequality within and across gender, racial, and ethnic groups in four Latin American countries. Policy Research Working Paper Series 4591. The World Bank.

Davidson, R. (2009). Reliable inference for the Gini index. *Journal of Econometrics*, *Journal of Econometrics 150*, 30–40.

Davidson, R. and J. G. MacKinnon (1999). *Econometric Theory and Methods*. Oxford: Oxford University Press.

ECLAC (2006). Social panorama of Latin America. Retrieved on May 12, 2009 from http://www.eclac.org/publicaciones/.

ECLAC (2007). Social panorama of Latin America. Retrieved on May 12, 2009 from http://www.eclac.org/publicaciones/.

ECLAC (2008). Social panorama of Latin America. Retrieved on May 12, 2009 from http://www.eclac.org/publicaciones/.

Giles, D. (2004). Calculating a standard error for the Gini coefficient: Some further results. *Oxford Bulletin of Economics and Statistics 66*, 425–433.

Giles, D. (2006). A cautionary note on estimating the standard error of the Gini index of inequality: Comment. *Oxford Bulletin of Economics and Statistics 68*, 395–396.

Lorenz, M. (1905). Methods of measuring the concentration of wealth. *Publications of the American Statistical Association 9*, 209–219.

Modarres, R. and J. Gastwirth (2006). A cautionary note on estimating the standard error of the Gini index of inequality. *Oxford Bulletin of Economics and Statistics 68*, 385–390.

Ocampo, J. A., F. Sánchez, and C. E. Tovar (2000). The labour market and income distribution in Colombia in the 1990s. *CEPAL Review 72*, 53–77.

Ogwang, T. (2000). A convenient method of computing the Gini index and its standard error. *Oxford Bulletin of Economics and Statistics 62*, 123–129.

Ogwang, T. (2004). Calculating a standard error for the Gini coefficient: Some further results: Reply. *Oxford Bulletin of Economics and Statistics 66*, 435–437.

Ogwang, T. (2006). A cautionary note on estimating the standard error of the Gini index of inequality: Comment. *Oxford Bulletin of Economics and Statistics 68*, 391–393.

Pyatt, G. (1976). On the interpretation and disaggregation of Gini coefficients. *Economic Journal 86*, 243–255.

Sen, A. (1973). *On Economic Inequality*. Oxford: Clarendon Press.

Urrutia, M. (1994). Colombia. In J. Williamson (Ed.), *The Political Economy of Policy Reform*, pp. 285–315. Washington, DC: Institute for International Economics.

Vélez, C. E. (1995). *Gasto Social Y Desigualdad*. Bogotá: Departamento Nacional de Planeación. Editorial Tercer Mundo Editores.

World Bank (2005). *World Development Report 2006: Equity and Development*. New York NY: Oxford University Press.

Zheng, B. and B. J. Cushing (2001). Statistical inference for testing inequality indices with dependent samples. *Journal of Econometrics 101*, 315–335.

Table 1. Total number of observations, median hourly wage and standard deviation (in constant prices of 2005)

Year	Total			Bog		Bar		Buc		Cal		Med		Man		Pas	
	Obs	Median	SD	Median	SD	Median	SD	Median	SD	Median	SD	Median	SD	Median	SD	Median	SD
1984	76946	1,879	3,433	1,987	3,412	1,879	3,973	1,786	2,654	1,892	3,226	1,803	3,595	1,769	2,739	1,531	3,123
1985	56130	1,726	4,005	1,841	3,821	1,782	3,283	1,582	2,599	1,656	5,350	1,711	4,554	1,584	2,696	1,461	2,261
1986	59469	1,730	4,096	1,922	4,211	1,719	3,250	1,685	2,219	1,709	2,891	1,685	5,562	1,688	2,369	1,538	2,300
1987	62414	1,733	3,041	1,836	3,473	1,682	2,380	1,653	2,118	1,803	4,041	1,703	2,306	1,653	2,854	1,545	2,561
1988	65153	1,655	2,927	1,758	3,915	1,551	1,998	1,589	2,366	1,698	2,803	1,630	2,249	1,601	2,339	1,494	2,210
1989	66147	1,677	3,955	1,786	5,845	1,651	2,365	1,576	3,770	1,732	2,953	1,629	2,586	1,651	2,263	1,500	2,383
1990	58152	1,673	2,855	1,765	3,752	1,669	2,435	1,586	2,251	1,681	2,984	1,669	2,144	1,603	1,912	1,488	2,330
1991	57804	1,617	3,514	1,754	4,475	1,596	2,096	1,527	2,186	1,694	5,156	1,596	2,485	1,579	2,071	1,444	2,223
1992	59808	1,596	4,303	1,689	4,052	1,576	8,469	1,527	2,039	1,673	2,999	1,576	2,392	1,527	2,804	1,369	2,058
1993	60134	1,637	7,570	1,683	10,564	1,611	4,797	1,567	2,627	1,763	10,432	1,632	5,711	1,535	2,370	1,578	2,367
1994	67203	1,747	6,973	1,901	8,983	1,638	8,934	1,642	3,702	1,881	4,080	1,638	6,237	1,584	3,276	1,526	2,484
1995	61442	1,702	4,590	1,916	6,669	1,672	2,950	1,631	2,604	1,865	5,367	1,672	2,788	1,523	2,245	1,424	2,535
1996	61691	1,716	4,707	1,974	5,417	1,816	3,049	1,647	3,202	1,685	2,943	1,590	6,221	1,634	3,520	1,569	4,420
1997	57145	1,748	5,065	2,297	9,379	1,838	3,364	1,660	3,127	1,623	4,496	1,657	4,688	1,585	3,490	1,628	3,206
1998	54104	1,761	4,626	2,136	7,358	1,872	3,458	1,682	4,339	1,716	4,203	1,668	4,179	1,682	3,403	1,564	3,104
1999	46287	1,720	4,137	1,956	5,725	1,729	3,133	1,652	2,790	1,718	4,611	1,663	3,174	1,771	4,261	1,597	4,029
2000	44660	1,619	5,874	1,802	9,846	1,677	4,067	1,572	7,371	1,615	3,577	1,577	4,470	1,677	4,469	1,509	3,293
2001	42339	2,051	4,576	2,122	6,964	2,191	3,852	1,964	3,710	2,068	4,119	2,034	4,299	2,089	4,250	1,942	3,511
2002	41573	2,073	6,797	2,221	15,047	2,210	3,492	2,008	3,059	2,095	4,473	2,057	3,672	2,027	3,339	2,045	3,783
2003	41008	2,018	4,110	2,149	5,255	2,014	4,072	1,961	3,142	2,020	3,764	2,048	4,686	2,048	3,524	1,975	3,555
2004	42069	2,069	5,476	2,185	6,842	2,069	3,124	2,036	3,211	2,081	4,535	2,086	4,871	2,057	8,637	2,048	3,137
2005	48062	2,127	4,493	2,319	6,655	2,235	3,866	1,986	3,803	2,145	4,529	2,134	4,010	2,098	3,260	2,000	3,573

Source: Authors calculations based on household survey data.

Table 2. Number of times the Gini coefficients are equal (1984 - 2005)

City	Bar	Bog	Cal	Med	Man	Pas
Buc	11	1	12	14	10	0
Bar		3	9	11	7	2
Bog			4	0	2	8
Cal				6	16	3
Med					7	0
Man						3

Note: The tests of hypotheses reported in Tables 2 and 3 are at the 5% level.

Table 3. Statistically significant variations in Gini coefficients

Year	Total	Buc	Bar	Bog	Cal	Med	Man	Pas
				Base year 1984				
1985	↑	-	-	↑	-	-	-	-
1986	-	-	-	↑	-	-	↓	-
1987	↓	-	↓	-	-	↓	↓	-
1988	↓	-	↓	↑	-	↓	↓	-
1989	-	-	-	↑	-	↓	↓	-
1990	↓	-	↓	↑	-	↓	↓	-
1991	↑	-	↓	↑	-	↓	↓	-
1992	↑	-	-	↑	↑	-	↓	-
1993	↑	-	-	↑	↑	↑	↓	-
1994	↑	-	↑	↑	↑	↑	-	-
1995	↑	-	-	↑	↑	-	↓	-
1996	↑	↑	↑	↑	-	↑	-	-
1997	↑	↑	↑	↑	↑	↑	-	-
1998	↑	↑	↑	↑	↑	↑	↑	-
1999	↑	↑	↑	↑	↑	↑	↑	-
2000	↑	↑	↑	↑	↑	↑	↑	↑
2001	↑	↑	↑	↑	↑	↑	-	↑
2002	↑	-	↑	↑	↑	↑	-	↑
2003	↑	↑	-	↑	↑	↑	-	-
2004	↑	↑	-	↑	↑	↑	-	-
2005	↑	↑	-	↑	↑	↑	↓	-
				Base year 1990				
1991	↑	-	↑	↑	-	-	-	-
1992	↑	-	↑	↑	↑	↑	↑	-
1993	↑	-	↑	↑	↑	↑	↑	-
1994	↑	-	↑	↑	↑	↑	↑	-
1995	↑	-	↑	↑	↑	↑	↑	-
1996	↑	↑	↑	↑	-	↑	↑	-
1997	↑	↑	↑	↑	↑	↑	↑	-
1998	↑	↑	↑	↑	↑	↑	↑	↑
1999	↑	↑	↑	↑	↑	↑	↑	↑
2000	↑	↑	↑	↑	↑	↑	↑	↑
2001	↑	↑	↑	↑	↑	↑	↑	↑
2002	↑	-	↑	↑	↑	↑	↑	↑
2003	↑	↑	↑	↑	↑	↑	↑	↑
2004	↑	↑	↑	↑	↑	↑	↑	-
2005	↑	↑	↑	↑	↑	↑	↑	-
				Base year 1999				
2000	↑	↑	↑	↑	-	↑	-	-
2001	-	↑	↓	-	↓	-	-	-
2002	-	-	↓	-	↓	-	↓	-
2003	↓	-	↓	-	↓	↑	↓	-
2004	↓	-	↓	-	↓	↑	-	↓
2005	↓	↑	↓	-	↓	↓	↓	-

Appendix 1. Estimates, standard errors and confidence intervals of the Gini coefficient

Year	Total						Bogotá					
			Confidence interval based on:						Confidence interval based on:			
	Gini	(s.e.)	$N(0,1)$		Bootstrap		Gini	(s.e.)	$N(0,1)$		Bootstrap	
			Lower	Upper	lower	upper			lower	upper	lower	upper
1984	0.405	0.0021	0.401	0.409	0.401	0.409	0.413	0.0028	0.407	0.418	0.408	0.419
1985	0.420	0.0032	0.414	0.426	0.416	0.425	0.429	0.0043	0.420	0.437	0.423	0.435
1986	0.406	0.0033	0.399	0.412	0.401	0.411	0.428	0.0048	0.419	0.437	0.422	0.434
1987	0.389	0.0024	0.385	0.394	0.386	0.392	0.416	0.0039	0.408	0.424	0.412	0.420
1988	0.396	0.0022	0.391	0.400	0.393	0.399	0.432	0.0045	0.424	0.441	0.426	0.439
1989	0.398	0.0032	0.391	0.404	0.393	0.403	0.430	0.0075	0.415	0.445	0.420	0.444
1990	0.395	0.0022	0.391	0.400	0.393	0.397	0.434	0.0044	0.425	0.443	0.431	0.437
1991	0.412	0.0028	0.406	0.418	0.409	0.415	0.462	0.0051	0.452	0.472	0.459	0.466
1992	0.419	0.0037	0.412	0.426	0.414	0.424	0.453	0.0046	0.444	0.462	0.450	0.456
1993	0.456	0.0057	0.445	0.467	0.447	0.467	0.513	0.0117	0.490	0.536	0.498	0.530
1994	0.465	0.0046	0.456	0.473	0.457	0.473	0.513	0.0079	0.497	0.529	0.500	0.529
1995	0.434	0.0033	0.428	0.441	0.431	0.438	0.478	0.0071	0.464	0.492	0.470	0.486
1996	0.442	0.0033	0.436	0.449	0.439	0.446	0.466	0.0063	0.454	0.478	0.461	0.470
1997	0.458	0.0034	0.451	0.465	0.455	0.461	0.517	0.0109	0.496	0.539	0.508	0.526
1998	0.466	0.0029	0.460	0.471	0.464	0.468	0.514	0.0080	0.498	0.529	0.508	0.519
1999	0.462	0.0027	0.456	0.467	0.460	0.463	0.503	0.0067	0.490	0.516	0.500	0.506
2000	0.486	0.0043	0.478	0.495	0.483	0.489	0.538	0.0133	0.512	0.564	0.528	0.548
2001	0.458	0.0026	0.453	0.463	0.456	0.459	0.505	0.0083	0.488	0.521	0.500	0.508
2002	0.457	0.0048	0.447	0.466	0.453	0.460	0.530	0.0190	0.492	0.567	0.511	0.547
2003	0.449	0.0025	0.444	0.454	0.448	0.450	0.490	0.0061	0.478	0.502	0.488	0.491
2004	0.450	0.0037	0.443	0.458	0.448	0.453	0.511	0.0076	0.496	0.526	0.508	0.514
2005	0.442	0.0025	0.437	0.447	0.440	0.443	0.502	0.0065	0.489	0.515	0.499	0.505

Appendix 1 (continued). Estimates, standard errors and confidence intervals of the Gini coefficient

Year	Barranquilla						Bucaramanga					
			Confidence interval based on:						Confidence interval based on:			
	Gini	(s.e.)	$N(0,1)$		Bootstrap		Gini	(s.e.)	$N(0,1)$		Bootstrap	
			Lower	Upper	lower	upper			lower	upper	lower	upper
1984	0.396	0.0087	0.379	0.413	0.382	0.422	0.387	0.0075	0.372	0.402	0.375	0.406
1985	0.408	0.0076	0.393	0.423	0.400	0.416	0.400	0.0076	0.385	0.414	0.386	0.417
1986	0.411	0.0070	0.397	0.424	0.403	0.419	0.379	0.0060	0.367	0.390	0.367	0.391
1987	0.363	0.0062	0.350	0.375	0.357	0.369	0.376	0.0053	0.365	0.386	0.366	0.387
1988	0.355	0.0053	0.345	0.366	0.351	0.359	0.396	0.0055	0.385	0.407	0.386	0.407
1989	0.377	0.0053	0.367	0.388	0.368	0.389	0.406	0.0104	0.386	0.426	0.391	0.444
1990	0.352	0.0061	0.340	0.364	0.343	0.362	0.389	0.0054	0.378	0.399	0.381	0.397
1991	0.369	0.0044	0.360	0.377	0.364	0.374	0.388	0.0052	0.378	0.398	0.380	0.396
1992	0.412	0.0221	0.369	0.455	0.381	0.554	0.376	0.0050	0.366	0.386	0.370	0.382
1993	0.414	0.0112	0.392	0.436	0.395	0.444	0.396	0.0063	0.384	0.409	0.385	0.411
1994	0.478	0.0163	0.446	0.510	0.451	0.524	0.395	0.0094	0.377	0.414	0.381	0.423
1995	0.414	0.0055	0.403	0.425	0.410	0.418	0.393	0.0058	0.381	0.404	0.388	0.398
1996	0.418	0.0050	0.409	0.428	0.415	0.422	0.426	0.0064	0.413	0.438	0.414	0.440
1997	0.426	0.0056	0.415	0.437	0.421	0.430	0.432	0.0058	0.420	0.443	0.424	0.439
1998	0.434	0.0053	0.424	0.445	0.430	0.438	0.445	0.0089	0.428	0.463	0.433	0.458
1999	0.436	0.0048	0.427	0.446	0.434	0.439	0.409	0.0064	0.397	0.422	0.405	0.414
2000	0.468	0.0071	0.454	0.482	0.464	0.473	0.464	0.0194	0.426	0.502	0.439	0.496
2001	0.420	0.0054	0.409	0.430	0.417	0.423	0.449	0.0060	0.438	0.461	0.444	0.454
2002	0.416	0.0051	0.406	0.426	0.413	0.418	0.403	0.0062	0.391	0.415	0.399	0.408
2003	0.411	0.0083	0.395	0.428	0.406	0.416	0.426	0.0056	0.415	0.437	0.421	0.430
2004	0.379	0.0064	0.366	0.391	0.376	0.381	0.418	0.0060	0.406	0.430	0.413	0.422
2005	0.383	0.0077	0.368	0.398	0.378	0.388	0.444	0.0061	0.432	0.455	0.437	0.449

Appendix 1 (continued). Estimates, standard errors and confidence intervals of the Gini coefficient

Year	Cali						Medellín					
			Confidence interval based on:						Confidence interval based on:			
	Gini	(s.e.)	$N(0,1)$		Bootstrap		Gini	(s.e.)	$N(0,1)$		Bootstrap	
			Lower	Upper	lower	upper			lower	upper	lower	upper
1984	0.402	0.0051	0.392	0.412	0.400	0.404	0.375	0.0056	0.364	0.386	0.371	0.379
1985	0.424	0.0125	0.400	0.449	0.416	0.431	0.393	0.0088	0.376	0.411	0.386	0.399
1986	0.392	0.0056	0.381	0.403	0.390	0.394	0.367	0.0113	0.345	0.389	0.356	0.377
1987	0.409	0.0078	0.394	0.424	0.405	0.412	0.322	0.0044	0.314	0.331	0.320	0.324
1988	0.395	0.0052	0.385	0.406	0.394	0.397	0.336	0.0038	0.329	0.344	0.335	0.338
1989	0.398	0.0053	0.388	0.409	0.397	0.400	0.328	0.0052	0.318	0.338	0.325	0.331
1990	0.397	0.0061	0.385	0.409	0.395	0.399	0.341	0.0039	0.333	0.349	0.340	0.342
1991	0.418	0.0116	0.395	0.440	0.410	0.423	0.349	0.0049	0.339	0.358	0.347	0.351
1992	0.418	0.0055	0.408	0.429	0.417	0.420	0.372	0.0042	0.364	0.380	0.370	0.373
1993	0.475	0.0186	0.439	0.512	0.456	0.494	0.414	0.0104	0.394	0.434	0.404	0.423
1994	0.425	0.0072	0.411	0.439	0.422	0.428	0.421	0.0106	0.401	0.442	0.411	0.431
1995	0.431	0.0106	0.410	0.452	0.425	0.437	0.378	0.0048	0.369	0.388	0.376	0.380
1996	0.408	0.0060	0.396	0.420	0.407	0.410	0.430	0.0100	0.410	0.450	0.420	0.439
1997	0.441	0.0096	0.423	0.460	0.437	0.445	0.426	0.0074	0.412	0.441	0.422	0.431
1998	0.451	0.0077	0.436	0.466	0.448	0.454	0.437	0.0067	0.423	0.450	0.434	0.440
1999	0.476	0.0079	0.461	0.492	0.473	0.479	0.416	0.0053	0.405	0.426	0.414	0.417
2000	0.456	0.0068	0.443	0.470	0.455	0.458	0.466	0.0075	0.452	0.481	0.463	0.469
2001	0.449	0.0065	0.437	0.462	0.448	0.451	0.418	0.0067	0.405	0.432	0.416	0.421
2002	0.453	0.0072	0.439	0.467	0.451	0.455	0.413	0.0056	0.402	0.424	0.412	0.415
2003	0.429	0.0068	0.416	0.443	0.428	0.431	0.448	0.0064	0.435	0.461	0.445	0.450
2004	0.446	0.0078	0.430	0.461	0.443	0.448	0.434	0.0067	0.421	0.447	0.431	0.437
2005	0.449	0.0065	0.437	0.462	0.447	0.452	0.398	0.0053	0.387	0.408	0.395	0.400

Appendix 1 (continued). Estimates, standard errors and confidence intervals of the Gini coefficient

Year	Manizales						Pasto					
			Confidence interval based on:						Confidence interval based on:			
	Gini	(s.e.)	$N(0,1)$		Bootstrap		Gini	(s.e.)	$N(0,1)$		Bootstrap	
			Lower	Upper	lower	upper			lower	upper	lower	upper
1984	0.436	0.0076	0.421	0.451	0.435	0.437	0.464	0.0096	0.446	0.483	0.463	0.466
1985	0.437	0.0092	0.419	0.455	0.436	0.438	0.455	0.0058	0.444	0.466	0.454	0.456
1986	0.403	0.0079	0.388	0.419	0.402	0.404	0.445	0.0069	0.432	0.459	0.445	0.446
1987	0.404	0.0110	0.382	0.425	0.402	0.405	0.454	0.0078	0.438	0.469	0.453	0.454
1988	0.401	0.0072	0.387	0.415	0.400	0.402	0.447	0.0060	0.435	0.459	0.446	0.447
1989	0.393	0.0065	0.381	0.406	0.393	0.394	0.449	0.0069	0.435	0.462	0.448	0.450
1990	0.374	0.0055	0.363	0.385	0.374	0.375	0.459	0.0062	0.447	0.472	0.459	0.460
1991	0.379	0.0066	0.366	0.392	0.378	0.379	0.453	0.0070	0.439	0.466	0.452	0.453
1992	0.407	0.0097	0.388	0.426	0.405	0.408	0.449	0.0063	0.437	0.462	0.449	0.450
1993	0.406	0.0070	0.393	0.420	0.406	0.407	0.443	0.0062	0.431	0.455	0.442	0.444
1994	0.427	0.0104	0.406	0.447	0.424	0.429	0.451	0.0060	0.439	0.463	0.450	0.451
1995	0.409	0.0057	0.398	0.420	0.408	0.409	0.458	0.0064	0.445	0.470	0.457	0.459
1996	0.446	0.0076	0.431	0.460	0.443	0.447	0.475	0.0109	0.454	0.496	0.472	0.477
1997	0.451	0.0064	0.438	0.463	0.449	0.453	0.469	0.0061	0.457	0.481	0.468	0.470
1998	0.456	0.0055	0.445	0.467	0.455	0.457	0.481	0.0052	0.471	0.491	0.480	0.482
1999	0.466	0.0075	0.451	0.480	0.463	0.468	0.488	0.0085	0.471	0.504	0.485	0.489
2000	0.469	0.0091	0.451	0.486	0.465	0.471	0.504	0.0057	0.493	0.515	0.503	0.505
2001	0.454	0.0065	0.442	0.467	0.452	0.456	0.489	0.0047	0.480	0.499	0.489	0.490
2002	0.441	0.0049	0.432	0.451	0.440	0.442	0.488	0.0047	0.479	0.498	0.488	0.489
2003	0.433	0.0056	0.422	0.444	0.431	0.434	0.478	0.0054	0.467	0.488	0.477	0.479
2004	0.454	0.0173	0.420	0.488	0.440	0.465	0.456	0.0049	0.446	0.465	0.455	0.456
2005	0.407	0.0054	0.397	0.418	0.406	0.409	0.473	0.0059	0.461	0.484	0.472	0.473