Income distribution and macroeconomics in Colombia

Javier A. Birchenall
University of California* [1]

This paper studies the relation between macroeconomic variables and the distribution of income in Colombia. We relate the dynamics of aggregate economic variables with the cross-section of disaggregate income to determine the transmission and propagation mechanisms of aggregate shocks. The most important finding is a strong negative effect of inflation rates on the distribution of income by education groups and productive sectors.

Keywords: income distribution, business cycles, index models
JEL Classifications: D31, O12, E32

Introduction

This paper studies the relation between macroeconomic variables and the distribution of income in Colombia. The relation between macroeconomic performance and income distribution is one of the most important aspects of stabilization policies (see, for example, Demeny and Addison, 1987). Its empirical analysis has received nonetheless very little attention among macroeconomists. Since research in macroeconomics is mostly concentrated on the duration and depth of business cycles, it almost always omits the analysis of business-cycle dispersion. Disaggregate variables are analyzed to understand the implications of modeling microeconomic units, but they are not considered as alternative valuable information.[2]

Economic models traditionally assume individual representative agents but the probabilistic evolution of income distribution under representative agent models produces well-known counter-factual results. For example, individual incomes should be perfectly correlated among themselves, and each individual's income should vary as much as anyone else's, and as much as per capita income. Models with agent heterogeneity are able to overcome the predictions of representative agent models, but they face additional empirical problems that make it difficult to disentangle the relation between aggregate variables and the distribution of income. For example, once heterogeneity is taken into account, changes in aggregate variables might just be the reflection of changes in individual decisions and not purely exogenous changes. In addition to causality issues, the effect of aggregate variables on individual income is subject to a dimensionality problem; instead of a single dependent variable associated with multiple independent variables, the distribution of income has to be considered as multiple dependent variables associated with multiple independent variables.

* *Address for correspondence*: Javier A. Birchenall, Department of Economics, 2127 North Hall, University of California, Santa Barbara CA 93106. jabirche@econ.ucsb.edu

To overcome the counter-factuality, causality and dimensionality problems, we follow the approach developed by Quah and Sargent (1993) and assume that the cross-sectional distribution of income can be described by a low-dimensional parameterization in which aggregate variables operate as a common factor (or index). As in Quah and Sargent (1993), the empirical strategy of the paper seeks to determine which common aggregate variable explains the pattern of relationships among individual income and macroeconomic shocks. The paper employs several measures of macroeconomic shocks that include Gross National Product (GNP) growth, unemployment rate, real devaluation rate, money supply growth, fixed investment growth, inflation rate, real interest rate, and real international reserves growth. All measures seem to affect income inequality to some degree, but inflation has the strongest effect. Both in the short and in the long run, higher inflation reduces sectoral and educational income for all groups in the population.

Our results, that find inflation to have adverse effects on the distribution of income, are consistent with previous studies. For example, Blinder and Esaki (1978), and Black and Blinder (1986, pp. 180-208) estimate the effect of changes in inflation and unemployment on the share of a given quintile in terms of the income distribution and the poverty rate in the United States. They find that income distribution is responsive to both variables, but the effects of inflation are seen to be much less important on distribution than on unemployment. Powers (1995) considers, as a dependent variable, the poverty rate based on goods and services consumed, rather than on income, and finds large effects of inflation in the United States. Blejer and Guerrero (1990) estimate the effect of macroeconomic variables on the income ratio between higher and lower deciles in the Philippines; they find that unemployment, inflation, and government spending worsen the income distribution while productivity gains, real exchange rate, and real interest rate improve the distribution of income.

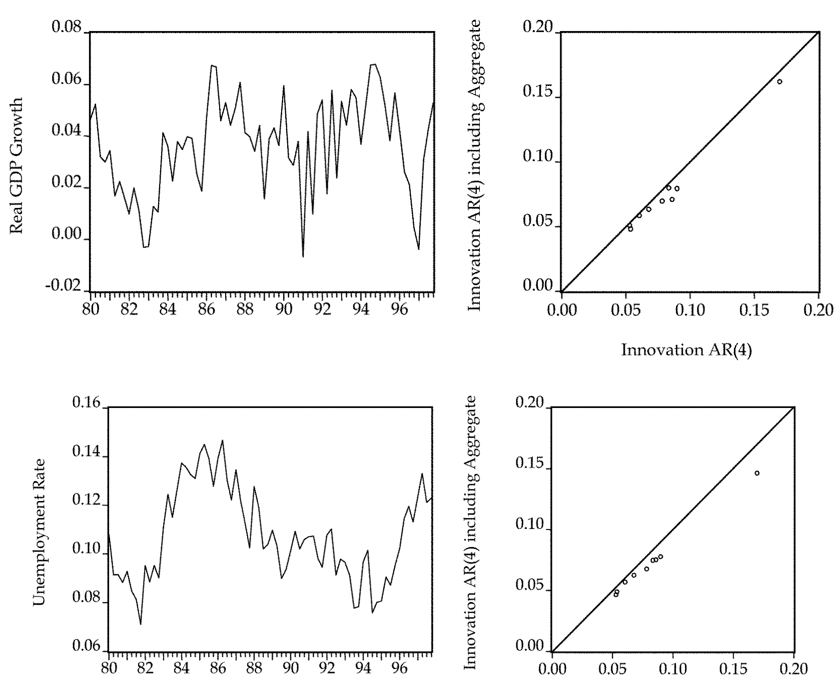
Silber and Zilberfarb (1994), and Yoshino (1993) consider alternative characterizations of the relation between inflation and income inequality based on expected and unexpected components of inflation. Silber and Zilberfarb (1994) find that a rise in inflation (and/or unemployment) increases the income share of the wealthiest 20 per cent with stronger effects for unanticipated changes in inflation. They also find, however that it/they reduce/s the income share of the lower half of Israeli households. Yoshino (1993) finds as well that both expected, and unexpected inflation are regressive in Japan, with expected inflation insignificant for the lowest income groups and unexpected inflation insignificant for the middle income group. Previous studies in Colombia also suggest that income inequality varies negatively with unemployment and inflation, (see Bernal, Cardenas, Núñez and Sánchez, 1997).

The study proceeds as follows. The next section provides a brief overview of the macroeconomic changes in Colombia between the 1980s and 1990s. A following section illustrates the problems associated with the assumption of exogenous aggregate factors in regressions that estimate the impact of aggregate variables on the distribution of income. We employ a simple model in which labor-force participation is not taken as continuous and individuals are not perfectly synchronized. In that model, aggregate variables are composed by individual variables, so they cannot be considered exogenous as commonly employed in empirical analysis. A fourth section describes our empirical strategy based on dynamic index models and the last section briefly draws the article to conclusion.

Macroeconomic change in Colombia

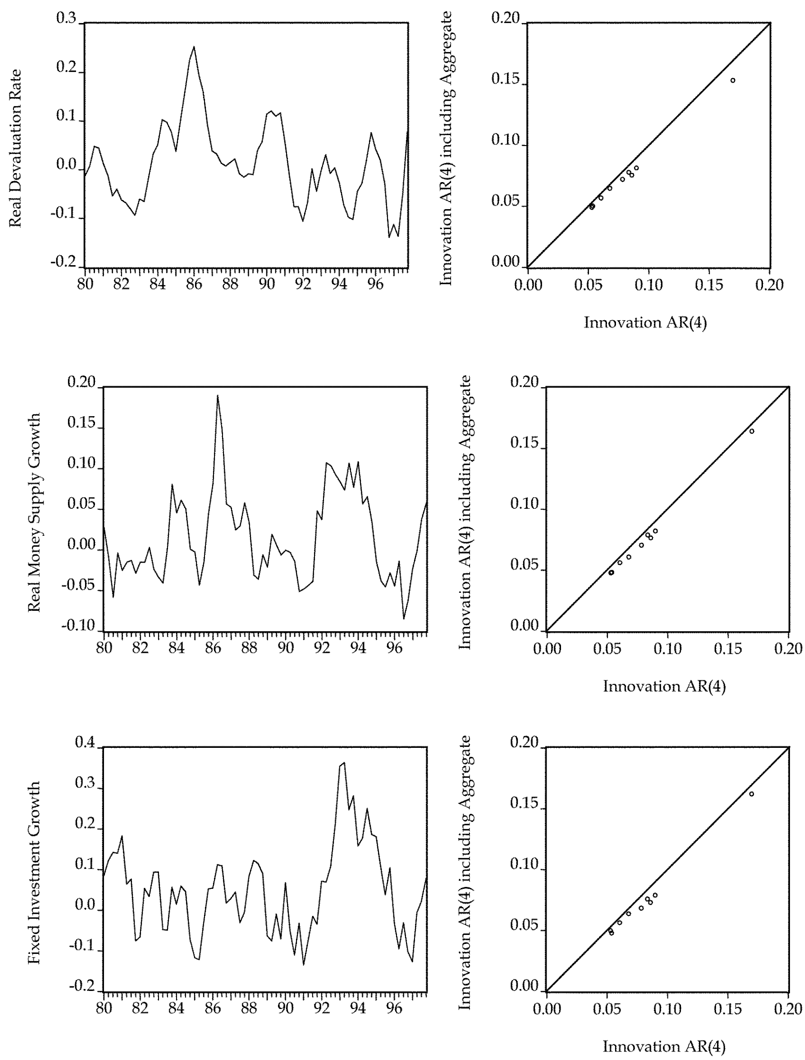
Here a brief overview is provided of the evolution of macroeconomic variables in Colombia during the 1980s and 1990s. A more detailed description of the macroeconomic performance of Colombia can be found in Lora (1994), and Ocampo, Sánchez and Tovar (2000). The aggregate variables we consider in our study are included in the left panel of Figure 1 displayed below.

Figure 1
Dynamic index models, sectoral income



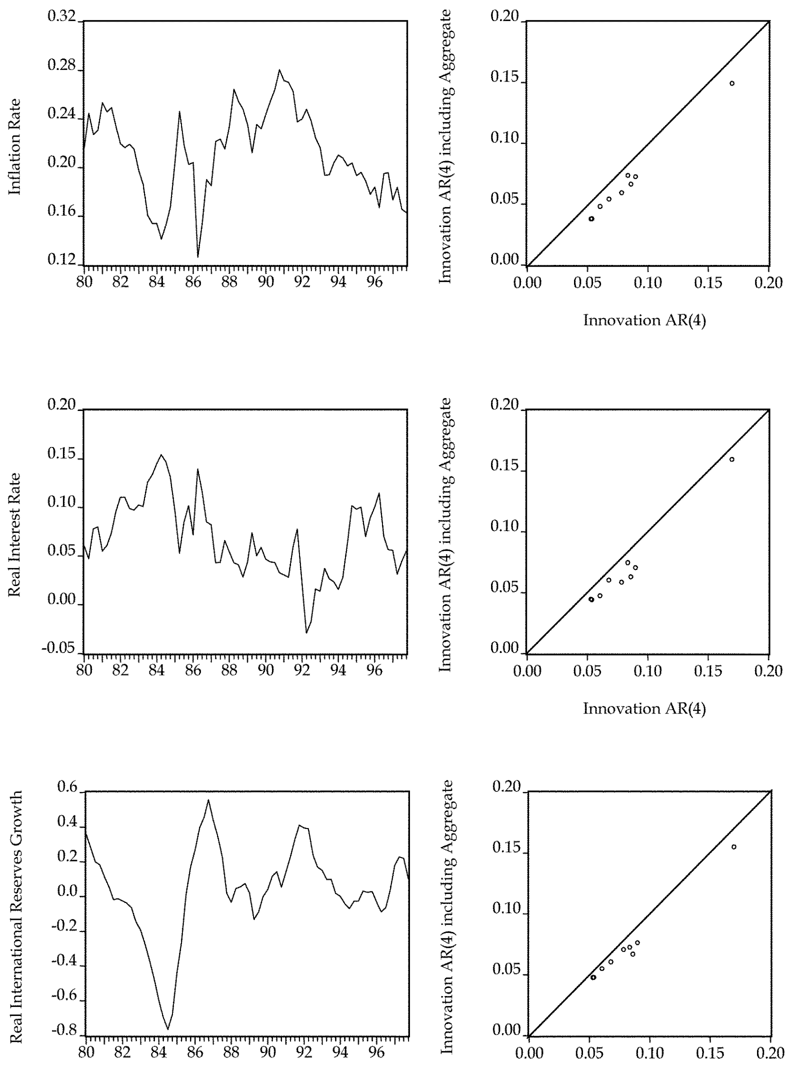
During the 1980s, Colombia's macroeconomic policies were focused on stabilization, intended to control inflation, fiscal deficits, and external imbalances. As

Figure 1
(cont.)



most Latin American economies, Colombia experienced a deep recession during the early 1980s but in contrast to the average experience of Latin America, Colombia exhibited positive income growth throughout the 1980s. As Figure 1 shows, following a Gross Domestic Product (GDP) growth decline in the early 1980s, income growth reached levels near 5 per cent. The average growth rate during the decade was 3.5 per cent. The figure also marks clearly the business cycles in Colombia. After the recovery of the mid-1980s, the country experienced a recession in the

Figure 1
(cont.)



early 1990s and a pronounced boom that lasted until the mid-1990s. The cycle patterns are also easy to identify through the changes in the unemployment rate.

Colombia's performance regarding inflation was different from most Latin American countries. In contrast to high inflation (i.e., three-digit inflation rates) in Latin America, Colombia's average inflation rate during the 1980s was 20 per cent although it did reach levels above 30 per cent in the early 1990s (Dornbusch and

Fischer, 1993). Colombia also experienced high real devaluations during the 1980s attempted to recover income growth. Although, international reserves declined markedly during the 1980s, Colombia was the only Latin American nation that did not default even once on its payments during the 1980s crisis. Performance regarding money growth, investment, and interest rates during the 1980s can be characterized by a relatively stable performance.

As Birchenall (2001) notes, along with the majority of Latin American countries, Colombia nonetheless experienced an accelerated process of structural reforms to its economy in the first years of the 1990s. The reforms produced trade liberalization, changes for labor, and a new role for the State that created, among other things, an independent Central Bank in charge of inflation exclusively. Changes in trade liberalization were based on imports liberalization and exports promotion. Associated with the reduction in tariffs for imports and higher incentives for foreign investment, Colombia experienced growth rates in fixed investment to levels above 30 per cent (see Figure 1). Growth rates for investment were almost always negative during the 1980s.

According to Lora (1994), the main purpose of the Colombian reforms in labor legislation was to eliminate a number of rigidities, such as the retroactivity of severance payments and other stability clauses. The reforms seem to have had a positive effect on the unemployment rate, although a recovery in economic activity was also observed after the reforms were implemented. The structural reforms also generated major tax reforms and the privatization of several banks that had been nationalized after the 1982 crisis. They also redefined the main functions of the Central Bank. For example, as Ocampo, Sánchez and Tovar (2000) note, a new Constitution approved in July 1991 replaced the Monetary Board by the Central Bank Direction Board. The 1991 Constitution made the new monetary authority formally independent of the government for the purposes of monetary and exchange-rate management.

A tight monetary policy was adopted in Colombia in the mid-1990s to control the inflationary pressures of the early 1990s. Monetary policy produced a series of changes to the exchange-rate band, a reduction in aggregate demand (improving the external accounts) and lower inflation. According to Ocampo, Sánchez and Tovar (2000, p. 58), however, the changes were achieved "at the cost of bringing on the worst recession in Colombian history and accelerating the deterioration of the financial system portfolio".

A simple framework

This section presents a simple model of heterogeneous agents, in which aggregate and individual variables are correlated but without any causality from macroeconomic variables to individual income. The example serves to illustrate the endogeneity issues that arise in empirical studies of income distribution and macroeconomics. The example is related to Quah (1996), and Manski (1993, section 5). It indicates that individual labor supply depends on the real wage which is in turn determined by aggregate labor demand conditions. Higher wages increase labor supply but changes in individual characteristics might also affect wages creating a reverse causality problem.

Consider a simple model to analyze aggregate-disaggregate relations mediated through market-clearing prices.[3] Let $j \in \mathbf{J}$ denote household j with standard preferences over streams of consumption $c(j)$ and leisure $1 - l(j)$ represented by $\ln[c(j)] + \alpha \ln[1 - l(j)]$, subject to a traditional budget constraint $c(j) = a(j) + wl(j) \equiv y(j)$, with $a(j)$ as non-labor income, w as the real wage, and $y(j)$ as total household income. As the outcome of utility maximization, households provide a labor supply $l(j)$ (when j participates in the labor market) defined by

$$l(j) = \frac{1}{1+\alpha} - \frac{\alpha}{1+\alpha}\frac{a(j)}{w},$$

with the reservation wage $\bar{w}(j) = \alpha a(j)$.

Consider an aggregate production function that combines labor as a fixed factor. For simplicity, let $C(w,Y)$ denote the associated cost function[4] with Y as the aggregate production or aggregate income obtained, summing over the entire collection of households' income:

$$Y = \int_{j \in \mathbf{J}} y(dj). \tag{1}$$

The equilibrium wage solves

$$\frac{1}{1+\alpha} - \frac{\alpha}{1+\alpha}\frac{1}{w}\int_{j \in \mathbf{J}:\alpha a(j) \leq w} a\,(dj) = C_w(w,Y), \tag{2}$$

in which the right-hand side represents aggregate labor demand and the left-hand side, aggregate labor supply. The existence and uniqueness of the equilibrium is granted by the assumptions on technology and preferences. The right-hand side of Equation (2) is strictly decreasing (i.e. $C_{ww}(w,Y) < 0$), and the left-hand side is strictly increasing on the wage rate. The most important conclusion from the equilibrium is a closed relation between wages and aggregate income as a result of the production side of the economy. For instance, each Y describes a unique w that satisfies Equation (2). Assume that market-clearing relation given by $w = \Omega(Y)$, and consider household income as

$$y(j) = \frac{a(j)}{1+\alpha} + \frac{\Omega(Y)}{1+\alpha}, \text{ for all } j \in \mathbf{J}. \tag{3}$$

A simple inspection of the previous equation suggests that individual behavior depends on an aggregate factor with coefficient $(1+\alpha)^{-1}$ and on individual aspects collected in the first term of Equation (3). However the intuition is misleading. Aggregate fluctuations do not *cause* the individual behavior in the term suggested by Equation (3); the individual behavior and the aggregate are *jointly determined*: neither one causes the other. In fact, as Quah (1996) shows, there is no sense in which Equation (3) describes the effect on disaggregate income of aggregate shocks. To further illustrate that point, consider the traditional exogeneity tests.

Take Equation (1) and compute the joint density for aggregate income for **J** individuals by

$$P(Y) = \int\int ... \int [f(y(1), y(2), ..., y(\mathbf{J})] \, dy(1)dy(2)...dy(\mathbf{J}),$$

where $f(y(1), y(2), ..., y(\mathbf{J}))$ is the joint density multivariate probability function. If we consider disaggregate income as independent and identically distributed variables, we can use the following transformation:

$$P(Y) = \int\int ... \int [f_y(y(1))f_y(y(2))...f_y(y(\mathbf{J}))] \, dy(1)dy(2)...dy(\mathbf{J}), \text{ or} \quad (4)$$

$$P(Y) = p(y(1))p(y(2))...p(y(\mathbf{J})) = \prod_{j=1}^{\mathbf{J}} p(y(j)).$$

where $f_y(y(j))$ and $p(y(j))$ are the marginal density and the probability function respectively. From the previous expression, we can see that strong exogeneity (Hendry, 1994) no longer holds because a joint density cannot be factorized into a conditional density and a marginal density. That is,

$$P(Y, y(j)) \neq P_{Y|y(j)}(Y, y(j))p(y(j)), \quad (5)$$

since the conditional probability implies

$$P_{Y|y(j)}(Y, y(j)) = p(y(1))...p(y(j-1))p(y(j+1))...p(y(\mathbf{J})), \quad (6)$$

while the bivariate joint distribution is

$$P(Y, y(j)) = p(y(1))...p(y(j))^2...p(y(\mathbf{J})). \quad (7)$$

The traditional notion of exogeneity cannot be applied to aggregate-disaggregate relations because probability densities of aggregate variables are not statistically independent from the individual variables. As Equation (4) shows, in an economy with a small number of individual independent agents, aggregate and disaggregate variables exhibit *mutual causality*.

The simple model described above has abstained from dynamic considerations and additional complications, such as imperfect competition and monetary factors.

Even in our simple and naive framework, the identification of causal aggregate effects on individual variables is, however, not straightforward. First we try to identify whether those aggregate effects exist and are significant in the distribution of income in Colombia. Then we employ a methodology that attempts to overcome the mutual causality problem.

Some empirical results

The data employed in this study are drawn from quarterly National Household Surveys (NHS) from 1980-I to 1997-II. The surveys were carried out by the National Department of Statistics and the National Department of Planning. The NHS collect information on general attributes of the entire population for the working-age population (individuals ages 12 or older), with quarterly information available for urban observations belonging to seven cities (Barranquilla, Bucaramanga, Bogotá, Manizales, Medellín, Cali, and Pasto). They account for 67 per cent of the urban population. Our data for disaggregate variables are based on particular groups, given the absence of longitudinal data in Colombia. We employ the NHS from Núñez and Jiménez (1998), in which truncation problems at the highest income levels are corrected. The sample consists of public- and private-sector salaried workers between 16 and 65 years old whose salary is positive. The data is based on total income for employed workers – domestic employees, the self-employed, unpaid family workers, and firm-owners are not included –, and no corrections for sample selection are performed. We also consider labor income by productive sectors and educational levels, based on the NHS (Núñez and Jiménez, 1998). The schooling categories are based on the number of years of schooling $[0, 1-5, 6-10, 11, 12-15, 16+]$ and the productive sectors are industry, energy (electricity, gas and water), construction, retail trade, transportation and communication, finance, services, others (mainly agriculture, forestry, and fishing).

Mutual causality

We first examine the causality relation between aggregate income and income inequality. We employ Granger-causality tests to evaluate the significance of the mutual-causality problem proposed in Equation (3). As we mentioned before, aggregate GDP changes can simply reflect individual decisions and indicate commonalities not related to causality.

To determine the possibility of mutual causality between aggregate and disaggregate variables we consider simple causality tests between aggregate income growth and parametric measures of the income distribution in our data. Since the household surveys are produced continuously we can construct parametric measures of the distribution, even if there is no longitudinal sample. Table 1 provides

Granger-causality tests or tests of exclusion restrictions in bivariate Vector Autoregressions (VAR(2)) comprising real GDP growth and summary statistics of the income distribution: mean, median, maximum, standard deviation, skewness, and kurtosis. Gini's coefficient and Theil index are also included to reflect the fact that the Gini puts relatively more weight on the middle of the distribution, while the Theil emphasizes the tails. Results are presented for four, six, and eight lags. Each cell entry contains a pair of numbers giving marginal significance levels for excluding the income-distribution summary statistic from the real GNP growth equation in the first entry. Significance levels for the exclusion of real GNP growth in the income-distribution measure are described in the second entry.[5]

Table 1
Exclusion restrictions (Granger causality test), marginal significance levels

	System lag length		
	4	**6**	**8**
Mean	(0.0001/0.0038)	(0.0000/0.0358)	(0.0003/0.0578)
Median	(0.0004/0.0005)	(0.0000/0.0163)	(0.0009/0.0454)
Maximum	(0.0127/0.6842)	(0.0000/0.2054)	(0.0004/0.0938)
Standard deviation	(0.0007/0.0000)	(0.0045/0.0000)	(0.0038/0.0000)
Skewness	(0.3672/0.0809)	(0.0020/0.0013)	(0.0038/0.0004)
Kurtosis	(0.3191/0.0682)	(0.0002/0.0010)	(0.0002/0.0000)
Gini's coefficient	(0.0227/0.0000)	(0.0186/0.0000)	(0.0211/0.0000)
Theil index	(0.0905/0.0000)	(0.1162/0.0000)	(0.0722/0.0001)

The results shed light on the relation between aggregate income changes and disaggregate income distribution. Aggregate income helps to predict the dynamics of almost every measure of income distribution and vice versa.[6] For example, the mean, the median, and the maximum in the income distribution have a strong predictive power for aggregate income. The marginal significance level for excluding all three variables in the equation for aggregate growth is well below 1 per cent. If all fluctuations were due to shocks that affect a fraction of agents, only one of those variables would likely have predictive power on the GNP equation. For instance, it is not only the shocks that affect the poor that matter for the dynamics of the economy but the individual income changes of the rich as well. Aggregate fluctuations also have strong predictive power for the evolution of the mean and the median of the distribution. Marginal significance levels for aggregate income in the maximum individual income are only below 10 per cent in longer-lag systems.

The standard deviation of the distribution of income also has predictive power for aggregate growth, while aggregate growth helps predict income inequality. Aggregate income has strong predictive power for skewness and kurtosis, but measures of skewness and kurtosis have no predictive power for aggregate growth in shorter-lag systems. Marginal significance levels exceed 30 per cent. Similarly, in 6-lag systems, the marginal significance for the Theil index is only 11 per cent. The Gini coefficient has some predictive power on the income equation, and income has a strong predictive power for the Theil index and the Gini coefficient.

To conclude, parametric measures of income distribution contain important predictive information for aggregate fluctuations, and aggregate income changes have important predictive information for the distribution of income. Distributional variables are dynamically correlated with aggregate income because aggregate shocks seem to affect (and are affected by) income distribution through propagation mechanisms across different portions of the cross-section distribution. The propagation channels are the main subject of the next section.

An alternative method

To analyze the relation between aggregate and disaggregate variables we consider the relation between macroeconomic variables and disaggregate income distribution series. We follow the approach developed by Quah and Sargent (1993) since we interpret Equation (3) as an observable dynamic index model with large cross sections. Quah and Sargent (1993) consider a general framework to exploit cross-sectional covariation. Their approach allows the variables to be integrated and co-integrated, to express the estimation as a state space form, and to employ a classical EM algorithm in estimation. Quah and Sargent (1993) also refrain from specifying in advance any particular pattern of permanent and common components.[7] To avoid simultaneity and persistence problems, their methodology uses only orthogonality properties to obtain the following features: (i) the cross-section dependence is described by some fixed low-dimensional parameterization, (ii) the model structure is independent of the unknown orders of integration and co-integration, and (iii) the key parameters of the model are consistently estimable even when the cross-section dimension is bigger than the number of time series observations.

We now describe the Quah and Sargent (1993) approach. Assume that every individual variable $y(j)$ is affected by: (i) a collection of R common (aggregate) factors $Y = (Y(1), Y(2), ..., Y(R))'$ (ii) a set of exogenous variables like a constant, deterministic trend, or seasonal dummies $W(j)$, and (iii) an idiosyncratic disturbance $\varepsilon(j)$ uncorrelated across individuals and aggregate factors. The general form of the model (i.e. Equation 7 in Quah and Sargent, 1993), is

$$\Phi_j(L)y(j) = \sum_{r=1}^{R} \phi_{jr}(L)Y(r) + \delta_j W(j) + \varepsilon(j), \tag{8}$$

where L is the lag operator and, Φ_j and ϕ_j are two-sided finite autoregressive polynomials in the lag operator. No individual restrictions are needed for the lag polynomials or for the sum of their coefficients; ϕ_j can give rise to transitory and permanent effects of aggregate variables. The most important restriction on the previous equation is the orthogonality condition on $\varepsilon(j)$. Assuming that $\varepsilon(j)$ is uncorrelated across individuals and aggregate factors ensures that all cross-correlation between aggregate and individual variables is mediated through the common factors $Y(r)$. The previous assumption also reduces the number of parameters to be estimated in the covariance matrix and provides consistent estimates of all parameters. Further estimation and technical details can be consulted in Quah and Sargent (1993).

Data

The graphic representation of Equation (8) has, in common with Equation (3), the fact that individual variables are decomposed into two different factors. The first one has the Y's which are common factors across all agents, and the second is given by factors specific to each agent.

Figure 1

Figure 1 explores the contribution of various aggregate observable measures of economic activity. The left panel plots the time series of the aggregate index variable. The right panel records an estimate of the index model. The index model plot corresponds to residual sample standard deviations from four-order Vector Autoregressions (VAR(4)) fitted independently across sectors, including seasonal dummies and a deterministic trend in a one-dimensional index model. The use of the standard deviations of the AR4 innovations has several implications.

First, as Quah and Sargent (1993) note, no point in the right panel of Figure 1 can lie above the 45-degree line but the distance of every point with respect to the 45-degree line describes the predictive capacity of every aggregate measure. The further below a point is from the line, the greatest its dynamic correlation with the aggregate variable. Unfortunately, the analysis has to be carried out with a very limited number of individual time series, due to data availability. Second, the structure of the index model serves to indicate which variables are correlated with income distribution measures but fail to clarify the sign of the correlation. The only aspect that the estimation measures up to this point is the predictive capacity of the aggregate factors. In that sense, the index model is a generalization of our previous causality tests.

The inclusion of multiple aggregate indices (variables) is a generalization of the previous results that we do not pursue, since we want to determine the most important channel for the diffusion of aggregate shocks. All aggregate measures provide information for the evolution of disaggregate income variables, although the strongest relations appear to be from the inflation rate and the real interest rate. Since the real interest rate discounts the inflation rate, both results suggest an important contribution of inflation for the dynamics of sectoral income. The distance between each point and the 45-degree line is larger for the inflation rate and the real interest rate. Monetary factors, the unemployment rate, and GNP growth seem to have smaller predictive capacity for the distribution of income in Colombia.

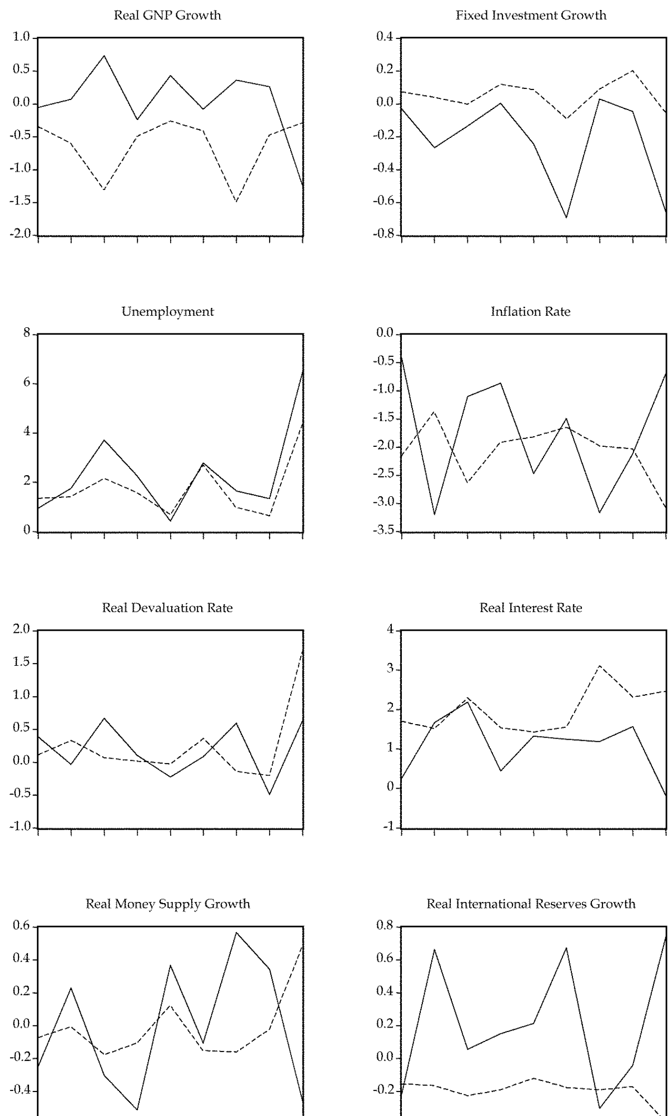
The main limitation of Quah and Sargent's non-parametric estimation method is that the index models provide information only on the "importance" of different variables on the distribution of income, so at this stage is not possible to determine whether inflation has negative or positive effects on sectoral income. To overcome this limitation, we consider long-run and short-run impulse-response functions for each aggregate variable in Figure 2.[8] Dashed lines represent short-run multipliers to aggregate shocks and continuous lines long-run responses. The horizontal axes of Figure 2 represent individual series and the vertical axes, the response of each group. As the figure shows, individual effects vary dramatically in the short as well as in the long run in response to aggregate shocks. If all sectors in the economy experienced aggregate shocks in the same fashion, the long-run and the short-run responses would be completely flat. Since the effects are different in each sector, the impulse response diagram is not constant.

Figure 2

Figure 2 suggests several effects, those due to inflation, interest, and employment rates. Since inflation is the aggregate variable with the most predictive power for the distribution of income we consider it first. Even though the magnitude of the effects is different, inflation rates have negative effects on sectoral income for all productive sectors in the short and in the long run. An increase in the inflation rate reduces sectoral income in the long run with effects larger than in the short run for about half of the sectors in the economy. Real interest rates have a positive effect in the short and long run with the long run effect smaller that the short run effect. If changes in the real interest rate reflect changes in the inflation rate, the positive effect of interest rates can simply reflect changes in inflation. If that is the case, the positive effect of interest rates provides additional evidence that inflation rates have a negative effect in the distribution of income in Colombia. Since the responses to changes in interest rates are not exact inverses to the response to inflation, the real interest rates must also have an effect on the distribution of income.

As with the interest rate, the unemployment rate has a positive effect on the distribution of income, although we do not report standard errors. Since the unemployment rate has a small predictive impact (see Figure 1), it is not clear that the coefficients are all significant. GNP growth has a short-run negative effect on sectoral income in all sectors described above but it has positive long-run effects. The cumulative long-run effect seems to be smaller in absolute value than the short-run effect. In that sense, Figure 2 suggests that aggregate economic growth increases sectoral income in the long run after some negative effects in the short run. Capital accumulation, measured by the growth rate of fixed investment, has a positive

Figure 2
Impulse functions, sectoral income

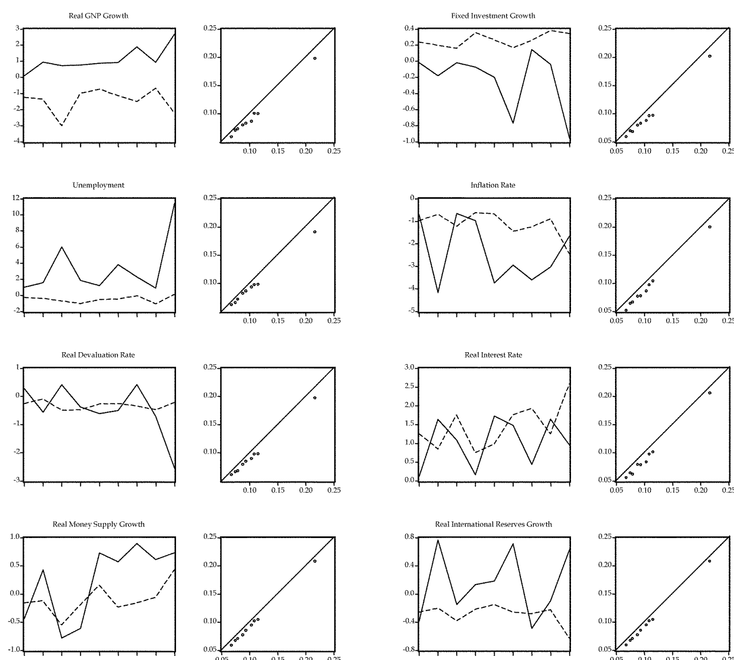


effect on the short-run sectoral income, but it has a negative effect in the long run. This pattern is the opposite to the pattern of income growth. Monetary variables, the exchange rate, and the international reserves have effects that vary considerably by sector, but they seem to be less relevant for sectoral income changes.

Figure 3

Figure 3 complements the previous description by the estimation of index models and impulse-response functions for different educational groups. Each plot describes the long-run and short-run impact of the macroeconomic shocks (left panel) and the residual sample standard deviation for the index (right panel).

Figure 3
Index models and impulse functions, educational income



The results in Figure 3 are similar to the previous findings. Inflation and the real interest rate have a predictive power on educational income. Inflation rates also have a negative effect for all education groups in the short and in the long run. In contrast to Figure 2, almost all long-run multipliers for inflation are higher in absolute value that the short-run multipliers. That seems to suggest that high inflation lowers income unambiguously with negative effects that accumulate over time. The real interest rate also has a significant predictive power for the income of different educational groups and the impact in the short and in the long run seems to be positive. Both effects are consistent with our previous discussion that highlights the connection between inflation rates and the real interest rate, so they do not deserve additional consideration. The main difference between the findings of Figures 3 and 2 is the role of GNP growth. Figure 3 suggests that GNP has more predictive power for educational income than for sectoral income. The distance between each point and the 45-degree line in Figure 3 is of a magnitude similar as the distance of the points for the inflation rate. That indicates that GNP is dynamically correlated with the distribution of income for different educational groups. As before, the impact of economic growth seems negative in the short run and positive in the long run. Monetary factors and the devaluation rate seem to be less important for understanding income distribution.

Since education is associated with higher income levels, we can determine for which income groups inflation and GNP growth have the strongest effects. From Figure 3, the long run impact of inflation rates seems to have a U shape. Inflation affects individuals with no education almost in the same amount as individuals with over 16 years of education. Still, the impact of inflation is higher for individuals with education levels between both extremes. In the short run the effects seem to be symmetric or smaller in variation than in the long run. Short-run changes in the real interest rate also seem to have stronger effects in people with more education, and in the long run the effects are more or less symmetric. Finally, GNP growth in the long run seems to favor individuals with higher educational levels. The impact of economic growth in the long run is positive for all groups, but it is smaller for individuals with low or zero education.

After inspection of the previous figures, the following results appear robust for sectoral and educational income: (i) the inflation rate has a consistent negative effect on income for all sectors and education groups in the short as well as in the long run, (ii) the real interest rate has a positive effect on income for all sectors and education groups in the short and the long run, although the effect appears related to the inflation rate, and (iii) GNP growth has a long-run positive effect on income as determined by education groups and sectors, although in the short run GNP growth has a negative impact on those income distribution measures.

Conclusion and interpretation

This article is a study of aggregate-disaggregate relations in Colombia, linking income distribution to macroeconomic variables. We constructed a simple model to show that the empirical relation between aggregate and disaggregate variables is subject to a form of mutual causation. For instance, aggregate variables might move just in response to distributional changes, and so, alternative orthogonality conditions are required to identify the impact of aggregate variables on the distribution of income. The paper departs from previous analyses by employing the dynamic index model proposed by Quah and Sargent (1993). Quah and Sargent's methodology deals with individual time series subject to a common factor or index. The index representation assumes that all cross-sectional dependence is described by a low-dimensional parametrization given by aggregate variables. As Quah and

Sargent (1993) show, the method is useful for analyzing comovements or aggregate income-distribution dynamics.

The most important result in our empirical section is the significant impact that inflation has on the distribution of income. Both in the short and in the long run, higher inflation reduces sectoral and educational income for all the groups in the population. The effects are not uniform, all impulse response diagrams show that inflation has a small effect on low and high education groups. Inflation has the most negative effect on individuals with education levels between 6-15 years.

Although we cannot specifically test each possibility, there are several potential channels through which inflation appears to increase inequality. For example, as Ferreira and Litchfield (2001) note, some channels include: economies of scale in financial transactions and limited financial-insurance opportunities for low-income people, limited access to indexed financial assets by the poor, and imperfect indexation for poorer workers. Bulir and Gulde (1995) considered the association between inflation, income distribution, and financial policies in a systematic way. They found that inflation acts as a tax on the poor and that its variability (related to inflation uncertainty) also has a strong impact on income inequality.

Regardless of the channel, inflation has a negative impact on the distribution of income in Colombia. The results are not surprising since Colombia experienced persistent moderate inflations between 1973 and 1997 and a high level of indexation and nominal rigidities,(Dornbusch and Fischer, 1993). Since 1991, when the Central Bank received its prime Constitutional mandate of preserving purchasing power, inflation has been declining from an average of 25 per cent to levels below 10 per cent. The change in inflation has broken the world's most stable moderate inflation (Dornbusch and Fischer, 1993). Besides the importance of inflation for the evolution of income inequality, the results indicate that GNP growth rate has a negative effect in the short run but a positive impact on the long run for all sectors and education groups. In summary, inflation and GNP growth seem to be the most important macroeconomic shocks for understanding income distribution in Colombia.

Notes

[1] *Acknowledgments*: I am grateful to Danny Quah for very helpful discussions on an earlier draft of this manuscript. Three anonymous referees and the editor provided many useful comments and suggestions. Francisco Lasso and Jaime Jiménez also provided their help processing the National Households Surveys. I also want to thank Francisco González, Camilo Zea, and my colleagues of the Unidad de Análisis Macroeconómico for their extensive comments and discussion. This paper was written while the author was working at the Departamento Nacional de Planeación (DNP), Bogotá, Colombia. Any opinions are those of the author and not of the DNP.

[2] One of the reasons for such neglect is the fact that asynchronized individual movements may be fully consistent with smooth aggregate behavior. A typical example is Caplin and Spulber (1987), where price rigidity due to menu costs at the firm level is consistent with complete aggregate price flexibility. Caballero (1992) presents additional examples based on asymmetric factor adjustments at the firm level.

[3] The price-mediated effect of aggregate variables on individual behavior is quite generally accepted. Manski

(1993) goes further to explain the "reflection" problem associated with inferences about the influence of aggregate behavior on individuals that comprise the economy. The reflection idea is linked to the problem of simultaneous movements of a person and her/his reflection on a mirror. Does the mirror image cause the person's movements or just reflect them?

[4] We could alternatively describe a production function, but the cost function appears more direct to establish a relation between individual and aggregate variables.

[5] All VARs include seasonal dummies and were estimated using quarterly data from 1980-I through 1997-II.

[6] We can complement Table 1 with a purely microeconomic decomposition of income evolution. Using an econometric procedure, Núñez and Sánchez (1998) find that microeconomic variables can explain nearly fifty per cent of the evolution of income inequality in 1980s and 1990s.

[7] As Quah and Sargent (1993, p. 288) note: "when the cross-sectional dimension is potentially large, standard co-integration tests cannot be used, and thus the researcher cannot condition on a particular assumed pattern of stochastic trends to analyze dynamic index structure."

[8] Short- and long-run multipliers for each income group are based on the dynamic structure of the economy. The long-run calculations follow traditional time series procedures by adding the coefficients in $\phi_j(L)$.

References

Bernal, R., M. Cardenas, J. Núñez and F. Sánchez. 1997. "Macroeconomic Performance and Inequality in Colombia: 1976-1996", *Archivos de Economia* DNP 72.

Birchenall, J. 2001. "Income Distribution, Human Capital and Economic Growth in Colombia", *Journal of Development Economics* 66:271-287.

Black, R. and A. Blinder. 1986. "Macroeconomics, Income Distribution and Poverty" in *Fighting Poverty: What Works and What Does Not*, eds S. Danziger and D. Weinberg. Cambridge, MA: Harvard University Press.

Blejer, M. and I. Guerrero. 1990. "The Impact of Macroeconomic Policies on Income Distribution: An Empirical Study of the Philippines", *Review of Economics and Statistics* 72:414-423.

Blinder, A. and H. Esaki. 1978. "Macroeconomic Activity and Income Distribution in the Postwar United States", *Review of Economics and Statistics* 60:604-609.

Bulir, A. and A.M. Gulde. 1995. "Inflation and Income Distribution - Further Evidence on Empirical Links", IMF Working Paper 95/86.

Caballero, R. 1992. "A Fallacy of Composition", *American Economic Review* 82:593-624.

Caplin, A. and D. Spulber. 1987. "Menu Costs and the Neutrality of Money", *Quarterly Journal of Economics* 102:703-725.

Demeny, L. and T. Addison. 1987. "Stabilization Policy and Income Distribution in Developing Countries", *World Development* 15:1483-1498.

Dornbusch, R. and S. Fischer. 1993. "Moderate Inflation", *World Bank Economic Review* 7:1-44.

Ferreira, F. and J. Litchfield. 2001. "Education Or Inflation? The Micro and Macroeconomics of the Brazilian Income Distribution During 1981-1995", *Cuadernos de Economia* 38:209-238.

Hendry, D. 1994. *Dynamic Econometrics*. Oxford, UK: Oxford University Press.

Krusell, P. and A. Smith. 1998. "Income and Wealth Heterogeneity in the Macroeconomy", *Journal of Political Economy* 106:867-896.

Lora, E. 1994. "Colombia: Structural Reforms and Economic Performance", CSIS Policy Papers on the Americas 5.

Manski, C. 1993. "Identification of Endogenous Social Effects: The Reflection Problem", *Review of Economic Studies* 60:531-542.

Núñez, J. and J. Jiménez. 1998. "Correciones a los Ingresos de las Encuestas de Hogares y Distribucion del Ingreso Urbano" in *La Distribucion del Ingreso en Colombia*, ed. F. Sánchez. Bogota: DNP-Tercer Mundo Editores, pp. 333-354.

Núñez, J. and F. Sánchez. 1998. "Descomposición de la Desigualdad del Ingreso Laboral Urbano: 1976-1997" in *La Distribución del Ingreso en Colombia*, ed. F. Sánchez. Bogota: DNP-Tercer Mundo Editores, pp. 297-332.

Ocampo, J., F. Sánchez and C. Tovar. 2000. "The Labour Market and Income Distribution in Colombia in the 1990s", *CEPAL Review* 72:53-77.

Persson, T. and G. Tabellini. 1994. "Is Inequality Harmful for Growth?", *American Economic Review* 84:600-621.

Powers, E.T. 1995. "Inflation, Unemployment and Poverty Revisited, Economic Review", Federal Reserve Bank of Cleveland, 3rd quarter, pp. 2-13.

Quah, D. 1996. "Aggregate and Regional Disaggregate Fluctuations", *Empirical Economics* 21:137-159.

Quah, D. and T. Sargent. 1993. "A Dynamic Index Model for Large Cross Sections" in *Business Cycles, Indicators, and Forecasting*, eds J. Stock and J. Watson. Chicago: University of Chicago Press, pp. 285-306.

Silber, J. and B. Zilberfarb. 1994. "The Effect of Anticipated and Unanticipated Inflation on Income Distribution: The Israeli Case", *Journal of Income Distribution* 4:41-49.

Yoshino, O. 1993. "Size Distribution of Workers' Household Income and Macroeconomic Activities in Japan: 1963-88", *Review of Income and Wealth* 39:387-402.