INCOME DISTRIBUTION, HUMAN CAPITAL AND ECONOMIC GROWTH IN COLOMBIA †

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Abstract

The increasing demand for knowledge about the effects of economic policy in Colombia motivates us to present this welfare-relevant research. This paper analyzes the relation between the distribution of human capital and economic growth in Colombia based on a heterogeneous overlapping generations model in an imperfect capital market. The analysis demonstrates the inter-play between individual aspects of inequality (parental conditioning) and the aggregate incentives of education, as the cause of the recent increase in inequality in Colombia. In periods of slow technological progress the dominant factor is the local environment; inequality declines but becomes more persistent. In periods of high technological progress, the importance of local conditions declines; this enhances mobility, increases short term inequality and generates poles in the distribution of income through the presence of wage inequality. As time goes by, this wage inequality eliminates the non-ergodic distribution for the higher incentives in human capital accumulation and determines a convergence (and improvement) in the distribution of income. Colombian income distribution has followed this path during the last two decades: in the second half of the 1970s human capital accumulation reduced the dispersion of income distribution, and led to a period of stagnation between 1983 and 1990, when mobility declined. After the structural reforms (a skill-bias technological change) the wage differential for skilled workers increased inequality by a polarization in the bi-modal distribution of income. This phenomenon generates an incentive to further accumulate human capital and through this to a lower status society, while increasing short term inequality (and mobility). Other related topics include some dynamic aspects of income and educational mobility in Colombia.

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I. Introduction

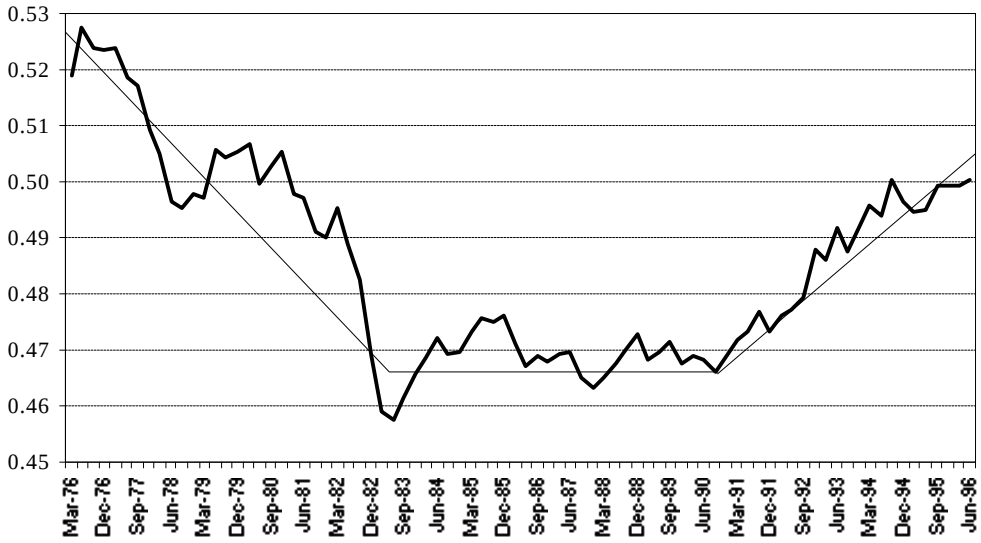
The increasing interest in the effects that private and social decisions have on the welfare of agents, has led us to reconsider the problem of income distribution, especially because in Colombia, as well as in the majority of Latin American economies, a recent and accelerated process of structural reforms based on trade liberalization has begun[1]. Simultaneously, the traditional indicators of income distribution point to a sharp decay in income distribution, making it advisable question the positive relation between the trade liberalization process and the decay in income distribution, on which there is still no consensus (not even regarding the transmission channels).

On one hand, Sarmiento (1995) surveys the results that point to a negative effect of the "apertura" process (of the new model in general) in income distribution, while Lora and Steiner (1994), using a computable general equilibrium model CGE, find trade liberalization of little significance and tend to attribute the worsening of income distribution to exogenous factors like the fall in the price of coffee and the revaluation of the peso.

At the Latin American level, Londoño and Székely (1997) find evidence that physical capital accumulation has a positive effect on income distribution; they also confirm the link between the level of human capital and improvement in income distribution. According to them, an increase in income equality in the region is limited by the inequitable distribution of physical assets. Following the work of Birdsall and Londoño (1997), higher initial wealth inequality matters for economic growth. As we will show later, this dependence on initial conditions roughly corresponds to the notion of ergodicity in economic development. Because this seems highly relevant for the Colombian economy, we need a model enabling us to study transitional characteristics in the context of non-ergodic economic growth like that of Durlauf (1993).

[1] The most important facts of the process of reforms have to do with trade liberalization, labor reforms and the new role of the state. For example, from February 1990 to August 1991, non-tariff barriers were eliminated, and tariffs sharply cut, from an average of 43.7 to 14.3%. These reforms are analyzed in Ocampo, Perez and Tovar (1997).

Figure 1. Per Capita Household Gini's Coefficient (4 Periods Moving Average)



Source: Núñez and Jiménez (1997)

Figure 1 presents a smooth version of the traditional Gini´s coefficient. The analysis of "episodes[2]" clearly shows a huge reduction of inequality during the second half of the 1970s, followed by stagnation after 1983, when the Colombian economy experienced major macroeconomic imbalances: an increasing fiscal and current account deficit, a crisis of the domestic financial system, and a cyclical downturn in the business cycle, all of which caused a decline in the role of government as a producer of human capital (Ocampo, Perez and Tovar (1997) deals with those aspects). After the structural reforms of the 1990s, the Gini's coefficient shows the increasing trend we referred in the last paragraph.

Previous papers, and in general the majority of research on the Colombian case, concentrate only on the static characteristics of income distribution, neglecting a great number of dynamic implications. The aim of this paper is to fill in some blank spaces by applying a more dynamic analysis, especially because an important part of the change in distribution can be the result of temporary phenomena that will have no long-run effects on the status of society, or because the deterioration in the situation is a necessary initial phase in the improvement process of income distribution. In fact, mobility and persistence are fundamental aspects of income distribution that have been ignored up to now by the Colombian empirical literature, due to data limitations; when dynamic aspects are

[2] As Atkinson (1997) suggests, it is misleading to talk of "trends" (the Kuznets curve, for example) when describing the contemporary evolution of income distribution.

considered, the worsening of income distribution attributed to the trade liberalization process must be seen from a different perspective, since higher income mobility associated with structural reforms assures improvements in income distribution and efficiency, and also provides better economic incentives. In Friedman's words (1962, Pgs 171-172):

> "A major problem in interpreting evidence on the distribution of income is the need to distinguish two basically different kinds of inequality; temporary, short-run differences in income, and differences in long-run income status. Consider two societies that have the same distribution of annual income. In one there is great mobility and change so that the position of particular families in the income hierarchy varies widely from year to year. In other, there is great rigidity so that each family stays in the same position year after year. Clearly, in any meaningful sense, the second would be the more unequal society. The one kind of inequality is sign of dynamic change, social mobility, equality of opportunity; the other of a status society. The confusion behind these two kinds of inequality is particularly important, precisely because competitive free-enterprise capitalism tends to substitute the one for the other. Non-capitalist societies tend to have wider inequality than capitalist, even as measured by annual income; in addition, inequality in them tends to be permanent, whereas capitalism undermines status and introduces social mobility."

We believe the relevant question of the consequences of structural reforms on income distribution rests on the mobility and temporary character of the structural adjustments effects. The analytical role of mobility in processes of structural change can be established from the perspective of political economy, an example being Fernández and Rodrik (1991), who find a bias towards the status quo based on the heterogeneity that information agents have about the benefits brought by the reforms. In this model, agents have the possibility of moving between two sectors, facing a well known cost, when the expected profit of being in the other sector is greater than such mobilization cost. This is a first link between the presence of higher mobility in the economy during structural reforms. Despite the high potential of such models to make income distribution endogenous, we have decided to follow the general approach of Galor and Zeira (1993) concerning the long-run effect of human capital: we assume an education cost that has to be financed by wealth-poor households through an imperfect capital market in which the interest rate of loans is higher than the rate from deposits, which negatively affects the growth process of the economy based on human capital accumulation. We intend to generalize the model to take into account the role of differences in wages and labor under a more dynamic situation through a human capital production function between generations in the presence of

threshold externalities. In this way we allow the solution of the model to behave as a stochastic variable which could be estimated empirically.

This paper is based on two observations (analyzed by Galor and Tsiddon (1997b)) widely supported by empirical evidence: the association between the human capital stock of parents and children (local environment), and the positive externality that higher human capital produces on the economy's growth rate (global environment[3]). A simple way of analyzing the impact that parental human capital (head of household) has on the children's school attendance is considered through the inclusion of this variable in a regression of the determinants of school attendance, as shown in Sánchez and Núñez (1995):

Table 1. Inter-generational Educational Mobility

Schooling	Father's education effect
Primary	0.0467
Secondary	0.1121
Higher Education	0.1168

Source: Sánchez and Núñez (1995)

We can see that the effect of the father's education becomes more important when we analyze the children's chances at higher education; the more educated the father, the higher the probability of higher education the children will have. On the other hand, it is necessary to consider the role of increasing urban wage inequality, consistent with Robbins' (1996) analyses; nevertheless, these facts, which must figure in the explanation of recent income inequality in Colombia, are only additions to the events we want to explain, and do not constitute an explanation.

The theoretical framework developed in the second section shows the interaction between the family environment (local) and the global environment (the driving force of wage inequality) as a determinant of the evolution of the distribution of human capital, income distribution and economic growth. During periods where the local externality is the dominant factor (in the Colombian case between 1982 and 1988), income distribution improves and is less polarized; while, after periods where the dominant factor is the global externality, income distribution displays a polarization pattern (after 1988) with high mobility, and afterwards shows a convergence pattern[4] (as in 1976 to 1982). This static point

[3] From the theoretical point of view, the new economic growth theory has rescued these aspects through "learning by doing" mechanisms. Worldwide, Mankiw, Romer and Weil (1988) show evidence that supports the importance of human capital in economic growth, in the Colombian case the papers of Posada (1995) and Cárdenas (1995) can be consulted.

[4] For this convergence to occur, an initial deterioration of the distribution is necessary. For example, Londoño (1993) finds that during industrialization after the second war, Colombia faced an increase

is briefly analyzed in the third section using non-parametric tools that emphasize the estimation of income distribution in many periods, and also using polarization indices developed by Esteban and Ray (1994). In addition we present some simple causality tests with income distribution and economic growth variables to analyze the role of polarization and inequality in the short term.

We must emphasize two important dynamic implications (developed by Galor and Tsiddon (1997b)): initial conditions determine the evolution of the distribution of human capital among dynasties, creating a tendency to inequality in the distribution of human capital; however, interactions between dynasties, and their impact on the productive structure, can lead to a qualitative transformation of the dynamics of a system with multiple equilibria to one with a single globally stable equilibrium. Income distribution is transformed into a state variable that evolves dynamically. From the empirical point of view, these two implications are condensed in the determination of mobility between different generations (overlapped) coexisting in every time period, as a status measure, and the mobility of distribution as a whole through time[5]. As the model suggests, low inequality among different families in the same generation is consistent with highly stable rankings of families in different generations, and an unstable ranking is consistent with sizable inequality in the same generation. We want to check those aspects with mobility indices as shown in Shorrocks (1978) and Geweke, Marshall and Zarkin (1986) in the fourth section. Finally we present some concluding remarks in section five.

II. A Simple Analytical Framework

The first analytical exercises on income distribution were based on the characteristics of individuals in purely microeconomic terms; a good example is the human capital model of Becker (1975) that allows the analysis of connections between individual productive ability and wages. Nevertheless, in the last few years economic theory has evolved to provide complementary forms of analyzing the properties of heterogeneous populations, allowing group effects and interaction between individuals to be considered, which we will refer to as “global externality” later on. Among recently included aspects we find the intertemporal modeling of preferences, the effects of interactions between agents and a higher level of aggregation that allows for the dynamics of distribution. The model we

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in the demand for skilled workers which made wage differences more acute. This fact initially concentrated income distribution until the supply of skilled labor increased through higher education, which in time did improve income distribution. From our point of view, the recent evolution of income distribution has some similarities with this case.

[5] This aspect has not been analyzed in Colombia due to the lack of information from surveys with longitudinal data. To solve this, we propose a method based on the estimate of the transition probabilities between the different classes of distribution.

will describe follows some previously mentioned methodological aspects based on Galor and Zeira (1993), Galor and Tsiddon (1997a), Galor and Tsiddon (1997b) and Torvik (1993). The economy behaves as a small country with given prices, and with a linearly homogeneous production function for goods using skilled labor $Y_s = F(hL_s, K_s)$ where h represents the human capital stock, L employment and K capital stock. There is still another sector of goods that are not intensive in human capital, with a production function $Y_u = F(L_u, K_u)$ that does not consider the role of the human capital stock.

The Local Environment

The model assumes a continuum of overlapping generations that live two periods with constant population (they leave one child). Each agent has a unit endowment of time that is rented to firms to receive a wage income in the second period and an bequest coming from the previous generation which reports capital earnings; these two terms compose the income (wealth) of each agent. Agents are born unskilled, but they decide whether to remain unskilled or to acquire skills that increase their future earnings. We define the impact the father's human capital stock has on the child as "local externality", in the same context that Benabou (1996) and Galor and Tsiddon (1997b) did.

In the second period the agent receives the income generated by his (her) work and the earnings of his bequest of the previous period, and makes a decision on how much to consume and how much to bequeath to the son that has been born unskilled and must face the same decision his father and/or mother made. Without education the agent (i) behaves as an unskilled worker and receives the following income:

$$y(i)_{u,t} = w + (1 + r)\, k(i)_t \qquad [1]$$

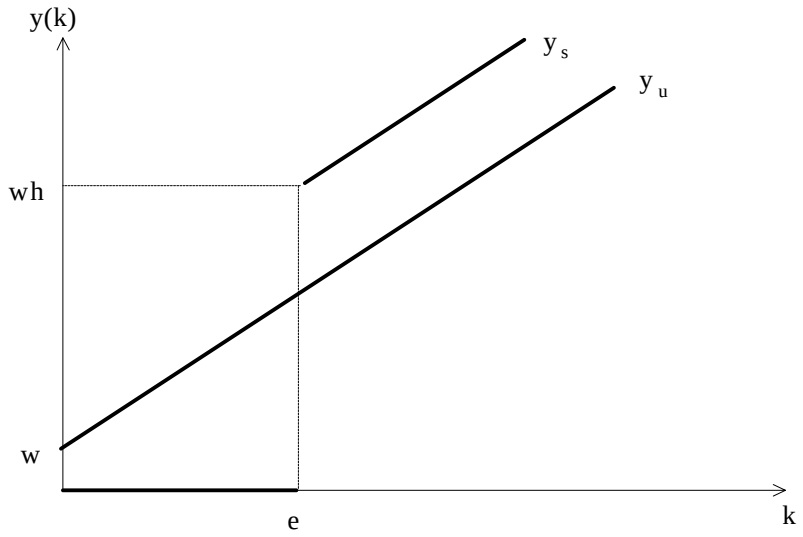
If he decides to invest in education he must face a fixed cost (e) in the initial period, but will receive a higher wage represented by a labor premium[6] (h) obtained from the higher productivity.

$$y(i)_{s,t} = wh_t + (1 + r)[k(i)_t - e] \qquad [2]$$

The graphical representation of these incomes is:

[6] Torvik (1993) sees the premium as each individual's ability. In a different context it can be thought of as the possibility of obtaining higher incomes from education, or property rights.

Figure 2. Sectoral Income



An individual decides to acquire education when the expected income of doing so is higher that the one earned without education; but there are two separate cases, in the first, we assume that the bequest is enough to cover the cost of education (e) in such a way that the agent is a net lender. In this case we need the right side of [2] to be higher than the right side of [1] with an interest rate r:

$$h > 1 + \frac{(1 + r)\, e}{w} = 1 + (1 + r)\, b \qquad [3]$$

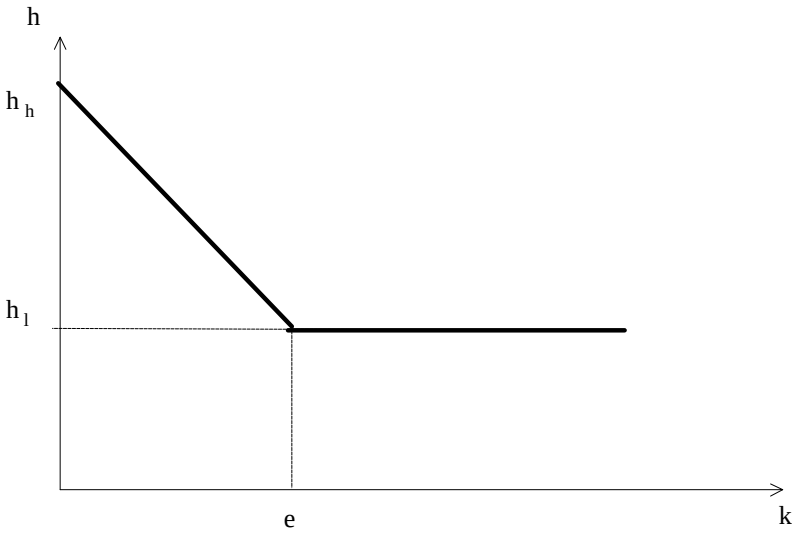
where the equality comes from assuming that the cost of education are a proportion (b) of the wage. If the agent obtains loans to finance his education, the previous condition must include a higher interest rate r*>r, and [3] then becomes:

$$h > 1 - \frac{k(i)[r^* - r]}{w} + \frac{(1 + r^*)\, e}{w} = 1 - \frac{k(i)[r^* - r]}{w} + (1 + r^*)\, b \qquad [4]$$

At this point it is clear that the education decision depends on two elements: the received bequest, and the education premium. If the bequest is high enough (i. e. at least covers the cost of education) the agent will always choose to be educated; in this case only the education premium determines the education decision. If the premium is above the threshold given in [3], that is $h_1 = 1 + (1 + r)b$, he will always invest in education. Now, when the agent acquires loans, the premium ceases to be the only determinant of the education decision. If we assume the superior threshold of the wage premium coming from

[4], $h_h = 1 + (1 + r^*)b$, the right side of the equation is negative and represents a profit high enough to trigger the decision to get educated independently of the bequest level; but if the premium is at an intermediate level, there is a trade-off between the bequest and the wage premium, as the following figure shows:

Figure 3. Bequest and Educational Trade-Off



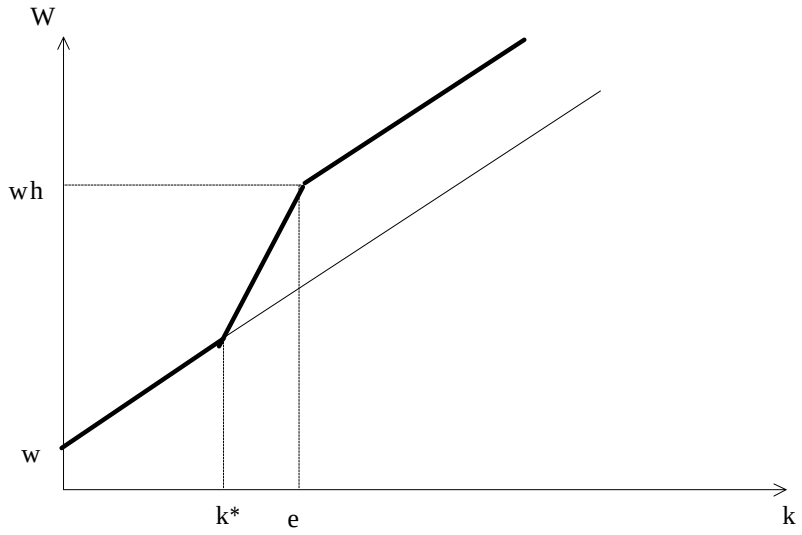
So that for an agent to become indifferent to being educated or not, the lower premium must be compensated by higher inherited wealth. The slope of the curve expresses the relation between the interest rates, if the financial market were perfect the wage premium would be the sole determinant of the decision to acquire education, and therefore will not depend on the initial capital. This fact clearly represents a non-optimal allocation of education, because -to ensure the optimality criterion- it will be necessary for education to depend only on future incentives[7]. Counting the possibility of contracting debts, the agent may become skilled, closing the existing gap in Figure 2. When the agent contracts debts to finance his education, his wealth is:

$$wh_t + (1 + r^*)[k_t - e] \qquad [5]$$

If we add this equation to the budget constraint of the agent, we have a greater opportunity set,

[7] The general discussion is found in Torvik (1993) for a different context, but it can be assimilated to this model.

Figure 4. Opportunity Set



where the new line starting at [wh,e] has a higher slope coming from higher resource costs. The agent's wealth is represented by the following function:

$$W_t = \begin{cases} w + (1+r)k_t & k_t < k^* \\ wh_t + (1+r^*)[k_t - e] & k^* \le k_t < e \\ wh_t + (1+r)[k_t - e] & e \le k_t \end{cases} \qquad [6]$$

Now, more formally, we can represent the problem of the second period of the agent through the following maximization:

$$\begin{aligned} &\underset{\{c_t, k_{t+1}\}}{\text{Max}} \; U(c_t, k_{t+1}) \\ &\text{s.a. } c_t + k_{t+1} = W_t \end{aligned} \qquad [7]$$

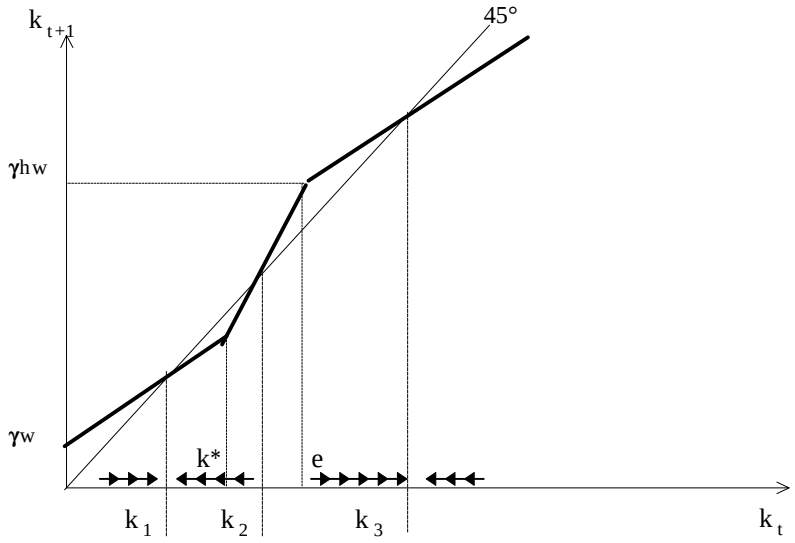
where wealth is given by equation [6] and comes from the decision to be educated in the first period (showing the dependence[8] on r*). Under usual conditions the solution is an interior point. If we assume a Cobb-Douglas function, the agent will assign his wealth in fixed proportions that depend on the parameter γ of the function:

[8] The imperfection of the financial market is not only shown by the possibility set slope but also in the effect on the k* point.

$$c_t = (1-\gamma)W_t(k_t; r, r^*, h)$$
$$k_{t+1} = \gamma\, W_t(k_t; r, r^*, h) \qquad [8]$$

Under such a utility function, the dynamic of each generation is a re-scaled representation of Figure 4:

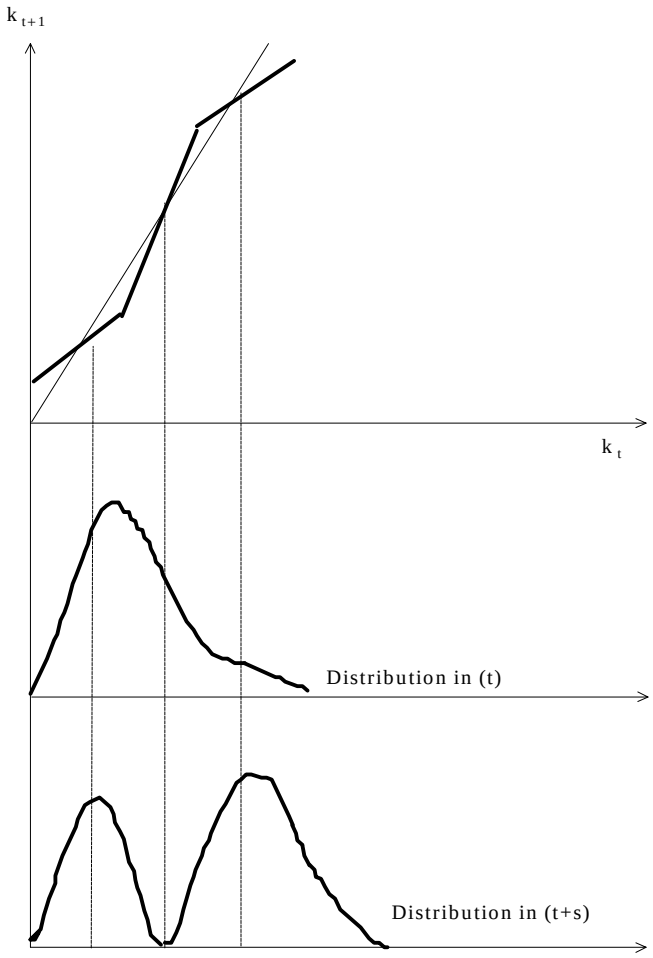
Figure 5. Capital Dynamics



Dynamics are very interesting since there are three equilibrium points and two of them are stable. Agents begin in an initial condition which is less than k*, work as unskilled workers, as do their descendants in all future generations. The level of capital to which they converge is k_1. Agents that begin in an initial condition greater than k* may or may not reach higher income levels depending on the critical point k_2; those who begin with capital smaller than this can obtain access to education, but from there on generations must remain as unskilled workers and their capital converges at k_1. Those who begin with higher bequests converge at a higher wealth level k_3 and all of their descendants can invest in education. The results of the model are pessimistic, income distribution tends to be non-ergodic[9] and to polarize into two modes, one for the rich and another for the poor, staying the same way generation after generation. Graphically, we have the formation of the two poles along time:

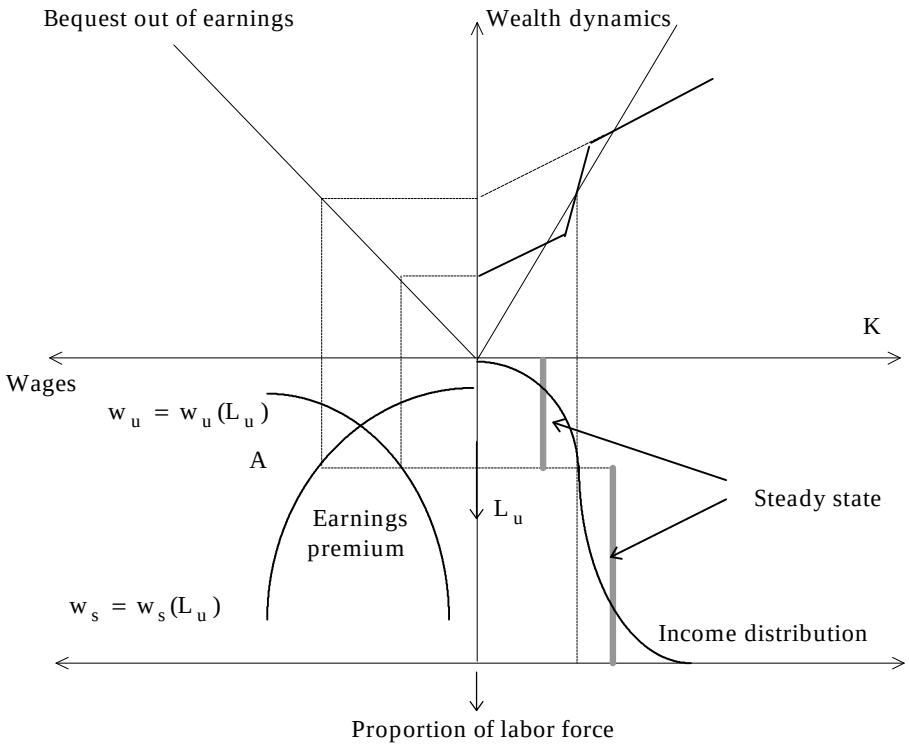
[9] This non-ergodicidity allows us to establish short-run links between income distribution and economic growth based on the mobility of agents and the polarization of distribution.

Figure 6. Income Evolution



If we wish to establish a link between the analytical framework and the processes of structural change, we might conclude that the structural reforms cause a rise in the relative demand for skilled labor and an increase in the premium for skilled workers. The estimates of labor demand in manufacturing by Cárdenas and Gutiérrez (1996) and Ramírez (1995) confirm our hypothesis. Certainly, the precise contribution of trade liberalization has been debated, and other links associated with trade liberalization have been proposed, notably that technical change has been biased towards skilled labor after the introduction of automation and information technology (those aspects are part of the global environment, discussed later). However, trade and technical change interact. This process leads to a decay in income distribution, and particularly to polarization. We can complete the local story in a four-quadrant diagram inspired by Atkinson (1997).

Figure 7. Labor Market Equilibrium, Wealth and Income Distribution in the Local Environment



The left-hand side is familiar for our preceding model, but the right hand side is not. It represents the wages for skilled and unskilled labor as functions of the proportion of unskilled workers. These functions are derived from profit-maximizing conditions of firms. Under skill-biased technological progress, the relative demand for skilled labor would create further distance between the curves in the bottom left hand quadrant (to point A, for example). Because the unskilled are subject to the bequest constraint, poor people remain poor and would become trapped (polarized). We could think, as an analytical input, that the process of structural reforms leads to a polarization of income distribution, and therefore to systematic deterioration; nonetheless, we must consider the role of (h) in the determination of the decision to be educated because, as we mentioned, there is a trade-off between these variables.

The Global Environment

To analyze the economy's growth we must know total population distribution. The population is distributed into two groups, skilled and unskilled workers, depending on the characteristics of the economy and the educational premium. Figure 4 shows that in period (t) the number of unskilled workers is in the interval [0,k*], and the skilled ones register from k* onwards:

$$L_t = L_{u,t} + L_{s,t}$$

$$L_t = \int_{[0,k^*]} f_u(t,x)dx + \int_{[k^*,\infty]} f_s(t,x)dx \qquad [9]$$

Despite the assumption of constant population, the densities of the two groups depend on time since there are agents that move between groups and for whom it is optimal to be educated or to converge into poverty traps. Similarly, we can calculate the income distribution for every time period as:

$$Y_t = \int_{[0,k^*]} g_u(t,z)dz + \int_{[k^*,\infty]} g_s(t,z)dz \qquad [10]$$

where g is the density of each group of agents. To ensure sustained growth in the economy beyond wealth-dependent growth, specifically multiple asymptotically stable steady states, we have decided to make the growth rate of human capital endogenous and to make it depend, first, on a fraction ϕ of the proportion of skilled workers, similar to that used by Lucas (1993), and, second, on the effect of the complementarity of total physical capital[10], but with a threshold externality in physical capital as in Azariadis and Drazen (1990), and Galor and Tsiddon (1997a):

$$h_t = \begin{cases} \left\{L_{s,t}\right\}^{\phi}\left\{K_t\right\}^{1-\phi} = \left\{\int f_s(t,x)dx\right\}^{\phi}\left\{K_t\right\}^{1-\phi} & \text{for } K_t \geq \overline{K} \\ h_{t-1} \quad \text{Otherwise} \end{cases} \qquad [11]$$

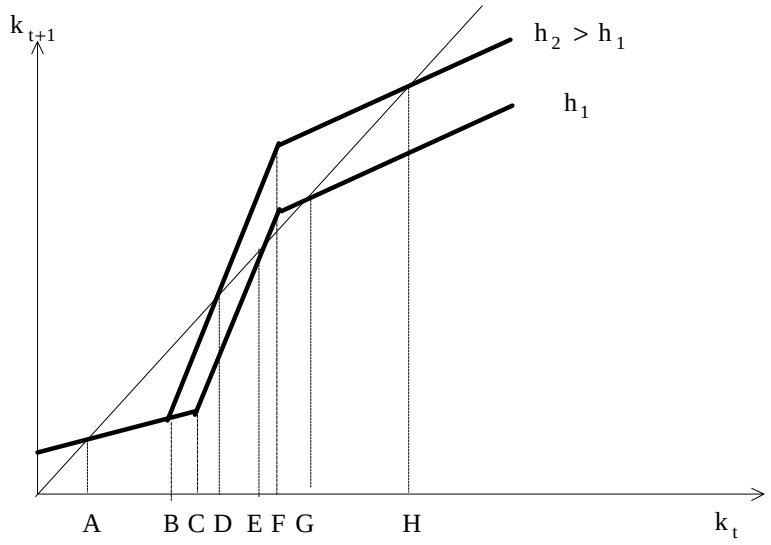
The key idea is that human capital is constant except for a threshold region, beyond which it is rapidly increasing, leading to a wide wage differential (as the Colombian case). We can think of that interval as a hurdle area where physical capital achieves a critical mass that sustains the process of economic development. Equation [11] reveals the connection between mobilization and aggregate dynamic decisions, while equation [10] expresses the static composition of income distribution, despite the fact that the density function depends on time. Traditionally, the Colombian empirical literature has based the analysis of income

[10] The main technical consequences of this function can be found in Galor and Tsiddon (1996a). Additional explanations can be associated with "idea gaps and object gaps" and the impossibility of excluding physical capital in the human accumulation process, as Paul Romer and Robert Lucas suggest.

distribution on static considerations similar to those in equation [10] and has not considered the link implied by equation [11], particularly between the functions[11] f and g.

Now, under this scheme the growth rate of the human capital stock could be sufficiently high to ensure that the non-ergodic pattern of growth can be reverted and, as time goes by, an improvement in income distribution can be reached similar to the one presented during the second half of 1970s in Colombia. To see the effect this variable has on agents' decisions regarding education, we have analyzed for two different levels of (h) in the following figure:

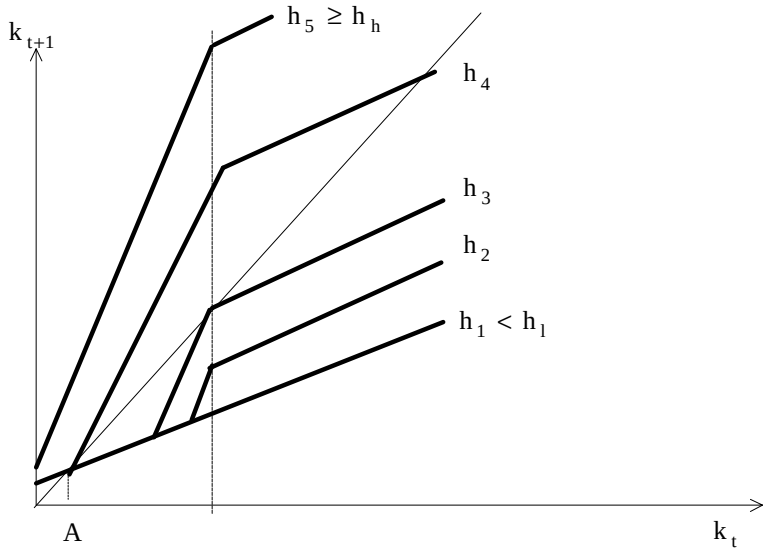
Figure 8. Human Capital and Income Dynamics



It is interesting to note that the incentives inherent in higher human capital provoke a substantial change in capital accumulation and education decisions. For low human capital levels h_1, the education decision will be taken insofar as capital is higher than C, while for higher human capital levels h_2, less initial capital will be needed B (<C) because, as mentioned previously, there is a trade-off between these two variables. Figure 8 shows two stable equilibria for low incentives A and G, and for high incentives A and H. Agents in A will not get educated and will all have the same income, while in G and H they will get educated. For skilled workers income and bequests will be higher, the higher the incentive. If we generalize this for higher human capital stocks we have:

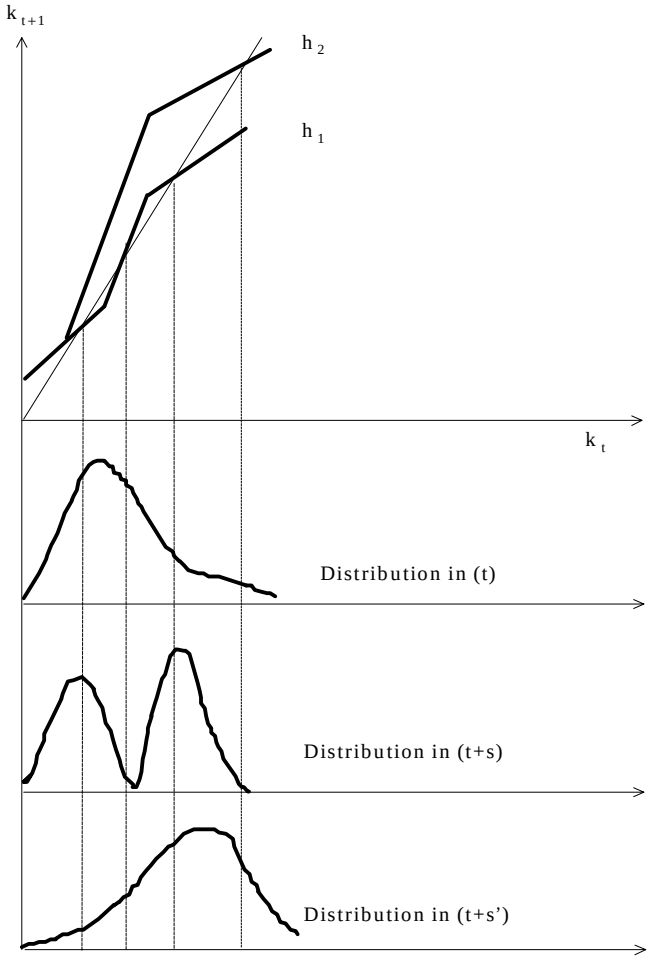
[11] Through static measures, dynamic implications can be obtained following the methodology used by Shorrocks (1978b): "inequality reduction over time", as Aaberge et. al (1994) do. Nevertheless, this type of analysis has not been developed in Colombia either; we leave its use open for future projects.

Figure 9. Human Capital and Income Dynamics



When the human capital stock is less than the inferior level h_l of Figure 3, as in the case of h_1, there is no incentive to be educated, and later on generations will reach a capital level (A). For a stock h_2, despite the fact that some members decide to study, in the long run generations converge at the same steady state observed previously, because the incentive is not sufficiently high to maintain bequests that ensure education for all generations; the economy then falls into a poverty trap. In case three, agents with sufficient initial endowment chose to study, in the steady state. Case four presents a situation in which the incentive to be educated leads to a steady state where the entire population decides to be educated, despite the fact that such was not their parent's decision in the initial period. In case five, human capital is so great that the decision does not depend on their initial wealth level.

Figure 10. Income Evolution



We find that the initial human capital level is not the only determinant of the economy's development, as affirmed by Londoño and Birdsall (1997); in fact, we believe that human capital composition is the key element. In this scenario, the long-run distribution of human capital loses its dependence on initial conditions and overcomes the effect of the local externality. In summary, in (and after) periods of major technological progress, the relative importance of parental-environmental conditions (the cause of persistent inequality) diminishes, and mobility and inequality rise because there is an increasing demand for skilled workers. This technological effect increases wage inequality in favor of high-skilled workers, stimulating further human capital accumulation based on technological conditions (this takes a generation).

In development stages where the local externality ceases to be the dominant factor, we observe a polarization in income distribution; whereas, after periods where the aggregate effect dominates there is convergence. The present model, as does that of Galor

and Tsiddon (1997b), suggests a trade-off between equality and persistence in the long run, with short-term inequality preceding periods of prosperity and less persistence in society. An unequal distribution of human capital is necessary to increase average human capital in the economy and output during early stages of development. Inequality can induce more educated agents to deteriorate distribution, but at the same time to eliminate less educated agents through technical progress and the global externality. A corollary of the previous point is that economies promoting more income equality can be stuck in poverty traps with low levels of income, without reaching prosperity.

III. The Shape of the Income Distribution

If we wish to understand the implications of the previous model, we must divide the analysis into two different aspects with regard to the behavior of income distribution. Although it is true that certain changes alter static aspects of distribution, we must also consider specific aspects of the evolution in time of such distribution. Our analysis of the evolution of income distribution centers on two main points:

(i) Static aspects, like the change in **shape** of the distribution, which in turn depends on:

a- Income **level** and changes in the distribution as a whole
b- **Income inequality** and changes in the **spread** of inequality[12]
c- Grouping and polarization patterns at several points along the income scale[13]

(ii) The distributional dynamic inside income distribution: How a fraction of the distribution **mobilizes** in time to pass from being unskilled to skilled, for example.

A basic conclusion of our model is that the first (or any single) moment of the distribution is not sufficient to capture the impact of distribution on aggregate income, as in the case of models of representative agents[14], so that the use of particular coefficients is not adequate for our purpose. What we need is a computational calculation which, based on the ideas derived from the previous model, helps us to understand the shape of the entire

[12] Those are the main aspects of Colombian analyses about income distribution; they are based on Gini's and inequality decomposition measures as Theil indices.
[13] An axiomatic treatment of this topic can be found in Esteban and Ray (1994) with many illustrative examples.
[14] It is important to note that the use of particular coefficients on income distribution can lead to erroneous perceptions when used with comparative purposes, as Atkinson (1970) pointed out. Moreover, an index focuses only in one specific feature, for example, the inequality indices are designed to pick up changes in dispersion but not trends in income levels or income clumping.

income distribution. The mechanism that we will use is called **Stochastic Kernel** and is derived from the equations of the model. The kernel is a particular case of density functions that allows us to understand the population's concentration of income along the income scale[15]. In doing so it captures the essential characteristics of the distributional shape. A simple way of illustrating the possible results is by assuming that the density of income in the distribution can be understood graphically through the following representation, taken from Cowell, Jenkins and Litchfield (1994) and Quah (1996):

Figure 11. Income Shape

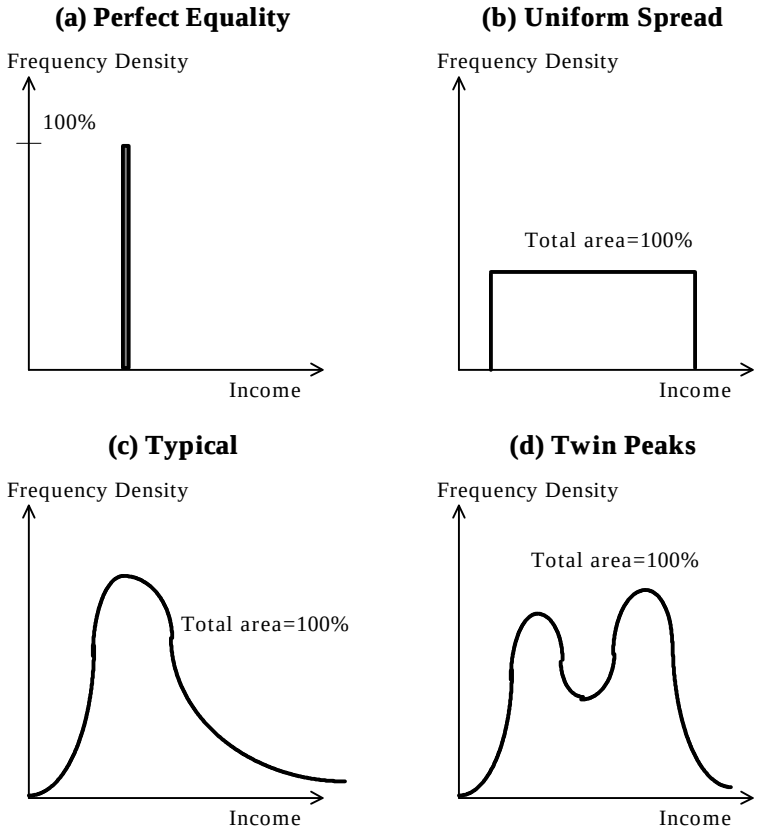


Figure (a) represents a perfect distribution in which every income is concentrated in a particular value. Figure (b) a uniform spread between the rich and the poor, generating a significant inequality. Figure (c) presents an income distribution between the last two, that we call typical, similar to those presented in Figures 6 and 10. Finally, we show in panel (d) the result of a deterioration in distribution due to the polarization of income, where the high and low income groups are grouped, with the result that the medium income groups

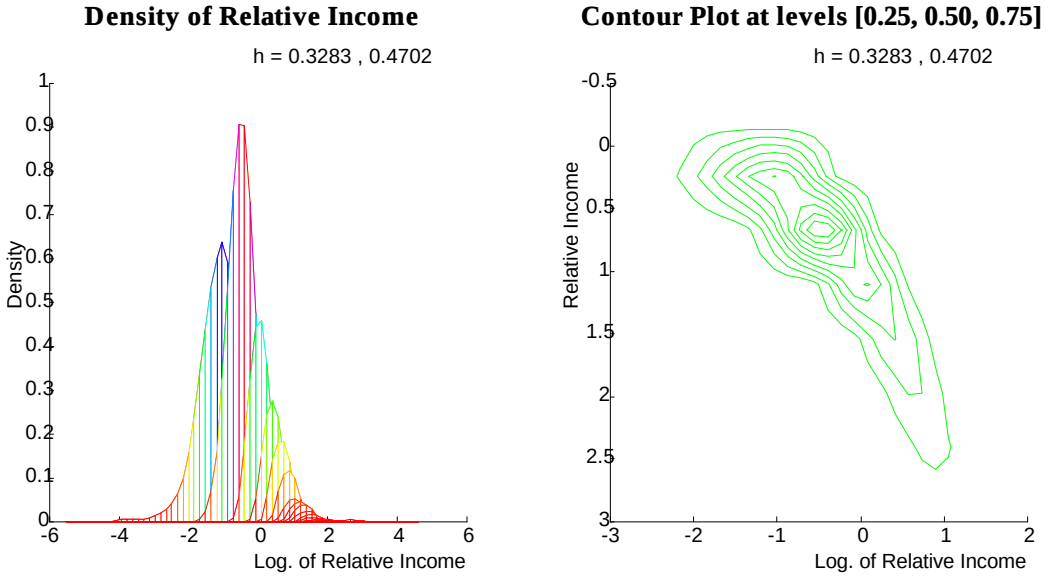
[15] A traditional concept associated with the kernel function is the histogram. The histogram is a crude description of density because its apparent shape can be altered by the choice of the length of the intervals.

disappear, as pointed out in the previous model. The area under the density function between two income levels is the proportion of the population with incomes within that income range; so that the total area enclosed in the function equals one (100% of the population). Formally, we can define the kernel as a function K where:

$$\int_{[0,\infty]} K(v)dv = 1 \qquad [12]$$

The idea underlying this procedure can be clarified by sliding a viewing window over the data, and then making an estimation of the density which depends on the number of observations chancing to fall within the window as it slides along the income scale. In the following graph we present the result of adjusting income distribution in the years 1976, 1983, 1990 and 1996, as turning points in the Gini´s behavior under this probability function:

Figure 12a. Densities and Contour Plot (Sept. 1976)[16]



[16] Variable h at the top of every graph bears no relation to our preceding concept of human capital; it refers to the band-width in the estimation (analogous to the bin-width of an histogram).

Figure 12b. Densities and Contour Plot (Sept. 1983)

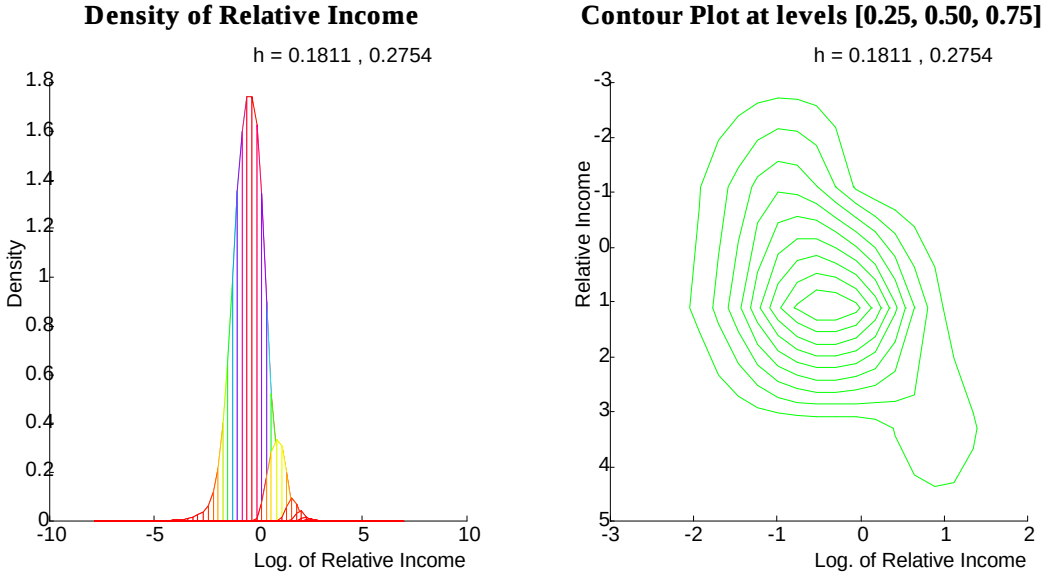


Figure 12c. Densities and Contour Plot (Sept. 1990)

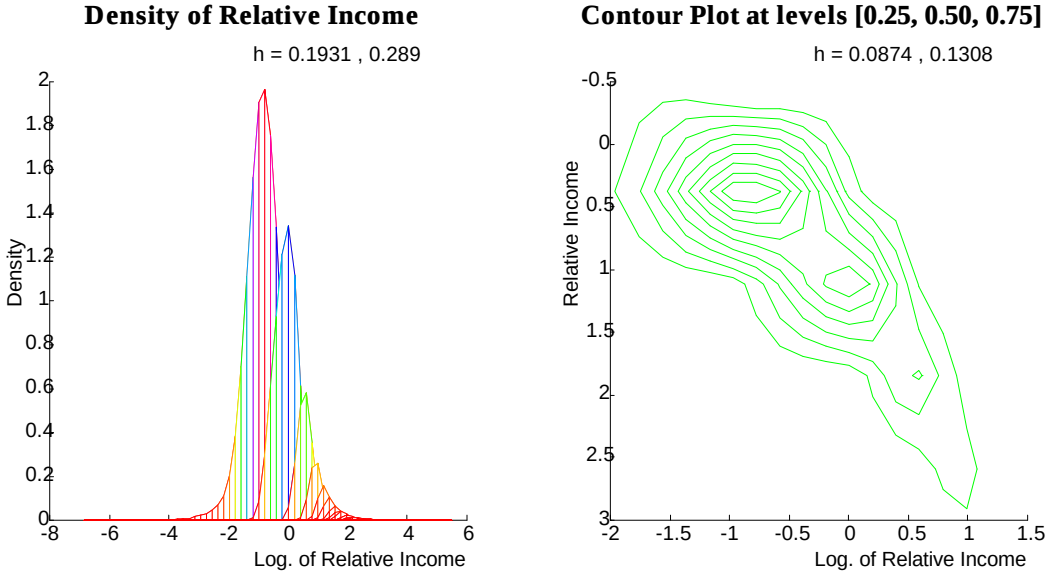
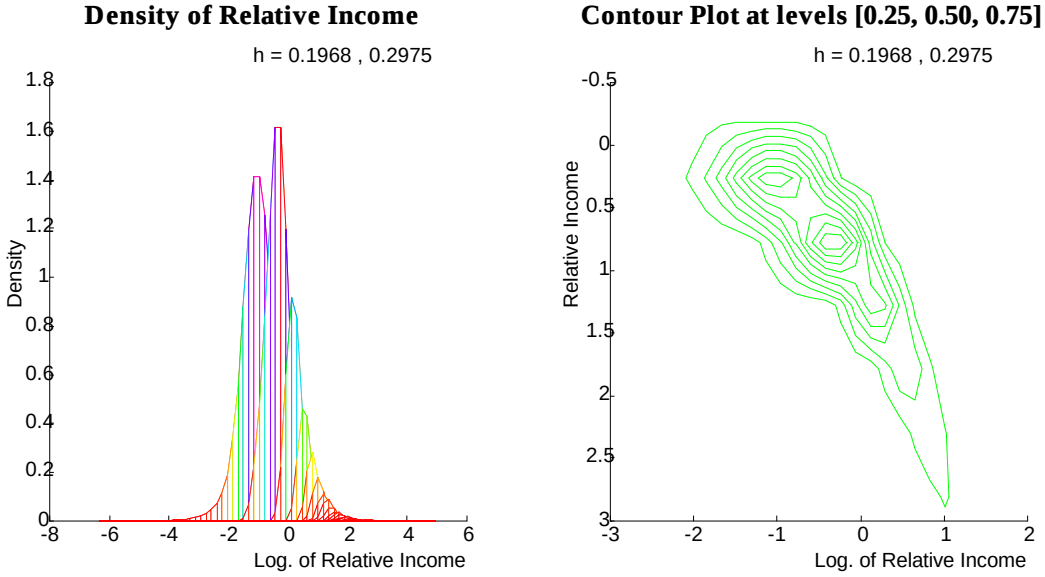


Figure 12d. Densities and Contour Plot (Sept. 1996)



The stochastic kernels are estimated using the Epanechnikov window[17] to analyze the joint density of relative income (relative to income average) and its logarithmic transformation at date t, choosing window width (h) according to a normal scale, as suggested in Beardah and Baxter (1994). The contour plots on the right side of the figures are obtained by projecting onto the horizontal plane the kernel of the relative income and the log-relative income. The contour levels were chosen to be 0.25, 0.50 and 0.75, to be informative of some structure on the left side figures. 0 on the horizontal axis indicates an income equal to the population average, because our logarithmic scale, and negative numbers represent incomes above the income average. Symmetrically, positive numbers represent incomes below the income average.

Looking across two decades, we see in 1976 an almost unimodal distribution, at a little under 0. The Gini's coefficient in this period was 0.52, consistent with an increasing dispersion around the unique modal income[18]. By 1983, the September survey shows the lowest Gini's coefficient in the preceding 20 years, around 0.45. This improvement in equality comes from a reduced dispersion along the income scale (as the contour plots

[17] For the statistical properties expounded in Beardah and Baxter (1994), and Silverman (1986), we take K to be the Epanechnikov kernel function, defined as:

$$K(v) = \begin{cases} 3\left(1 - v^2/5\right)\Big/4\sqrt{5} & \text{, if } |v| < \sqrt{5}\,; \\ 0 & \text{otherwise} \end{cases}$$

[18] We cannot conclude the absence of polarization, but it seems clear that the clustering does not occur in two modes.

suggest) consistent with rich-poor transfers and the near-0 mode in logs. When we look at the distribution for the 1990s, the bi-modality property surfaces, and in 1996 this (increasing) aspect clearly identifies the most recent income distribution. This picture give us an important clue to understanding the nature of the change in overall income distribution in Colombia in the period of the structural reform. Our plots suggest, in accordance with our theoretical framework, that the income distribution results from mixing two (or more) separate underlying income distributions, in turn arising from wage inequality generated from a skill-biased technological change (the Apertura). Thus, the effect of structural transformation during this decade is a polarization of incomes into two groups: low-income levels (close to half of relative income), and middle-income level (almost equal to relative income). Our findings are similar to those of Cowell, Jenkins and Litchfield (1994).

Clearly, income distribution in Colombia during the structural reform does not have the standard unimodal shape; instead, it has a bi-modal character and different income clumping patterns. These changes have generated lively discussion in the United States regarding the disappearing middle class, and regarding economic growth in terms of twin peaks[19] and "convergence clubs". In any case, it seems worth noting that these measurement tools challenge our thinking about how we assess income distributions and major economic reforms (various clumping patterns are consistent with the same degree of inequality, for example).

Another important aspect that we would like to consider more explicitly, in light of our previous finding, is the possibility of clustering around a greater number of modes;. The knowledge of the degree of polarization and stratification can be more telling (in terms of our preceding model, this is clear) than any measure of inequality. To study the clustering of income distribution in Colombia, we follow Esteban and Ray (1994)[20]. What we wish to capture is the effective asymmetric opposition (antagonism) that a group of incomes feels towards another one (high degree of heterogeneity across groups), but considering the possibility of some kind of identification (high degree of homogeneity within each group). Our polarization measure P is of the form[21]:

$$P = N\sum_{i=1}^{n}\sum_{j=1}^{n}\pi_i^{1+\alpha}\pi_j \left| y_i - y_j \right| \qquad [13]$$

[19] This topic is discussed in Birchenall and Murcia (1997).

[20] Those skeptical about the differences between inequality and polarization measures can consult Jenkins (1996) and Wolfson (1994) for a detailed discussion and different measurement methodologies.

[21] It is important to note that this measure is concerned with behavior around various income poles, and not only with a bi-modality; for this reason a greater similitude with Gini is possible.

where π_i are the population frequencies in every class, N is used for population normalization (zero degree homogeneity) according to $N = [\sum_{i=1}^{n} \pi_i]^{-(2+\alpha)}$, y is the logarithm of household income, and α represents the opposition effect that must be restricted to belong to [1,1.6) as Esteban and Ray proves.

Figure 13. Annual Per Capita Household Polarization Index (α=1.5) and Gini's Coefficient

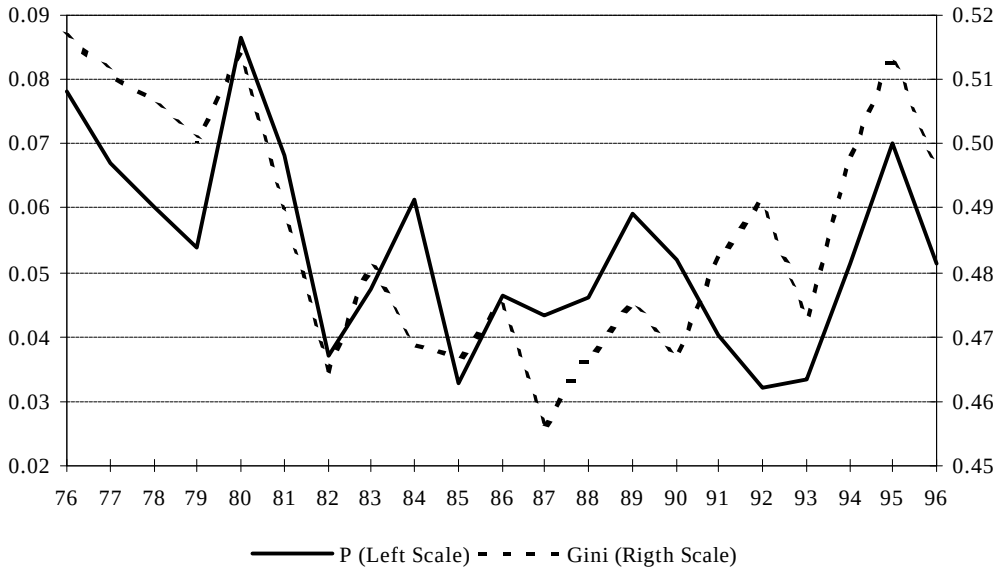
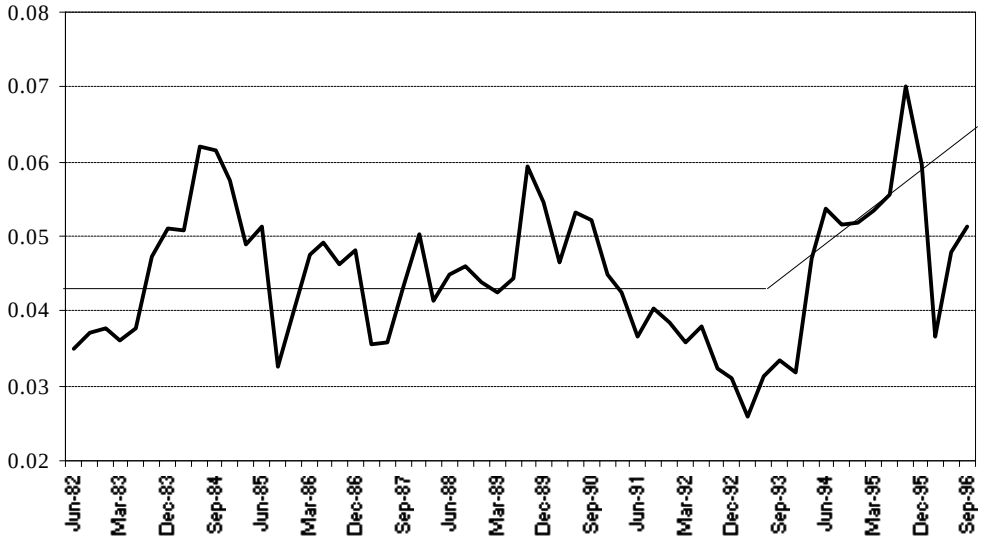


Figure 13 plots the Gini and the polarization index for every September; this index fluctuates and there are periods when the two indices behave in similar ways, but also periods of little co-movement, as in the late 1980s and the early 1990s. Over the entire sample, the polarization index correlates positively (0.51) with Gini, sharing the same episodes, as expected. Figure 14 plots the polarization index for quarterly data from 1982-I. It is of course difficult to locate the precise moment for the increase in polarization, but it may be indicative to observe that after 1993 there was an episode of increase. This evidence, albeit certainly not conclusive, is consistent with our view that polarization provides an explanation of the current situation in Colombian income distribution.

Figure 14. Quarterly Per capita Household Polarization Index (α=1.5)



Turning to more dynamic aspects, Table 5 provides Granger-causality tests. This table gives a compact description of tests of exclusion restriction in four-variable VARs in Gini, polarization index, fixed investment growth and aggregate income growth[22]. Results are presented for four and eight lags; in each cell entry there is a pair of numbers giving marginal significance levels for excluding the right-hand bloc from the named left-hand variable. The first number is the marginal significance level in the 4-lag VAR and the second in the 8-lag VAR. The results suggest that the polarization of income is the variable most strongly and dynamically correlated with income inequality and GDP growth.

Table 5. Exclusion Restriction (Granger-causality) Tests. Marginal Significance Levels[23]

	Right hand side bloc			
Left-hand-side Variable	**Gini**	**P(α=1.5)**	**Inv. Growth**	**GDP Growth**
Gini's Coefficient	(0.000 / 0.000)	(0.316 / 0.086)	(0.126 / 0.096)	(0.077 / 0.166)
P(α=1.5)	(0.003 / 0.082)	(0.000 / 0.000)	(0.702 / 0.664)	(0.699 / 0.517)
Fixed Investment Growth	(0.005 / 0.134)	(0.250 / 0.446)	(0.000 / 0.002)	(0.119 / 0.281)
GDP Growth	(0.060 / 0.201)	(0.004 / 0.019)	(0.298 / 0.082)	(0.000 / 0.002)

Source: Author's calculations.

[22] Quarterly information originated in DNP-Umacro.

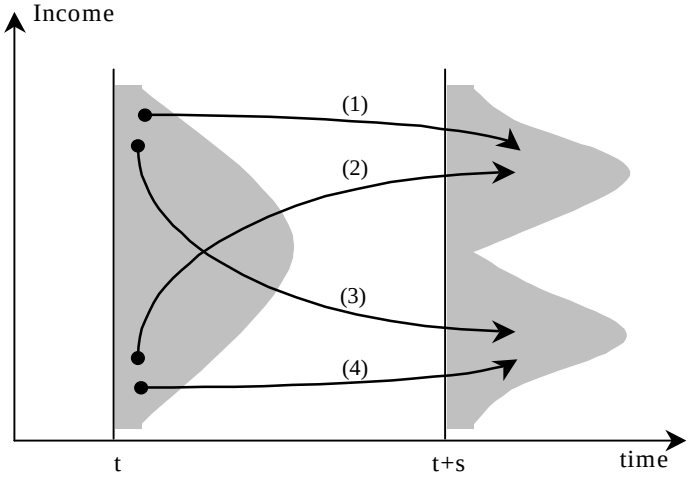
[23] All VARs include seasonal dummies and were estimated using quarterly data form 1977-I through 1996-IV. χ-square statistic (marginal significance levels) in parentheses.

Roughly speaking, polarization Granger-causes inequality (and vice versa), and GDP growth in long term; the marginal significance level for excluding the polarization measure in the equation for GDP growth is between 0.4% and 2%, and is the smallest of the table's off-diagonal entries. In longer-lag systems, the polarization measure appears to help predict the Gini's inequality coefficient; however, this relation is unstable and disappears once we consider shorter-lag systems. The opposite direction is present in the relation between the Gini's coefficient and GDP growth: in the short term there is a strong relation, while in longer systems there is none. To conclude, the relation between inequality (measured as Gini's) and polarization is dynamically mutual, and in the long run seems to be bi-directional. The effect of fixed investment growth is stable and significant in the long run in the economy's growth rate and in income inequality; however, it seems to have little effect on polarization. The most relevant point is that the polarization effect contains important predictive information for aggregate growth in the short and the long run, as we expected from our theoretical framework.

IV. An Introduction to the Dynamics of the Distribution

The most important and innovative points to be analyzed are the dynamic aspects of income distribution. Figures 6 and 10 allow us to interpret how the distribution **mobilizes**, because we included in our analysis both time and changes in the previous descriptive properties for densities, when we looked at income distribution in two time periods, t and t+s, as Figure 12 shows. Figure 15 illustrates this phenomenon in a simple way, showing how agents move between groups in a **distributional dynamic** sense.

Figure 15. Twin Peaks Dynamics



In the previous figure we see how a fraction of the distribution moves in time[24]. Arrows (1) and (4) point to the presence of persistence phenomena (the poor remain poor and the rich get richer) at the extremes of the distribution, while intermediate arrows, (2) and (3) show the mobility of the middle sector[25]. We consider two different aspects of mobility, because low inequality among different families in the same generation is consistent with highly stable rankings of families in different generations, and an unstable ranking is consistent with sizable inequality in the same generation. Thus, our main task is to describe the behavior of income mobility in addition to inter-generational education mobility in the long-run.

Income Mobility

We have previously analyzed the evolution of income distribution in Colombia from a comparative static point of view, based on the shape of the distribution; however, this method can turn out to be a second-best representation of the evolution of income distribution, because it overlooks the point of view of mobilizations of individuals between groups (from the first quintile to the second, from unskilled to skilled, from urban to rural, from poor to rich,...). About this aspect we can affirm that a society is more mobile if the period within which a person attempts to leave his original income class (quintile) is shorter. To perform this analysis we concentrate on determining the probability of transition between states in every possible class of income level. Due to the type of information reported in the household surveys, the classification of individuals regarding their possible state would require a division of the space of the variables in (n) discrete regions q (quintiles), to count the transitions of entering and exiting each one of these categories or classes, finally building a matrix M of the form:

$$M_{ij}(t) = \frac{\#\left\{Y_{t+s} \in q_j(t+s)\right\}}{\#\left\{Y_t \in q_i(t)\right\}} \quad i, j = 1,2,\ldots,n \qquad [14]$$

This means that the transition probability can be defined as:

$$\text{Prob}(Y_{t+s} \in q_j \mid Y_t \in q_i) = M_{ij}(t) = M_{ij} \qquad [15]$$

where s is the difference in time between observations and M is a Markov's chain describing the agents' movements between the different classes (or quintiles). The second equality

[24] Quah (1996) shows in a convincing way that this distribution occurs in the economies of the world, rich economies have converged in "clubs" that have led them to be richer, while poor ones have for their part become poorer.

[25] The direction of these arrows depends on the initial conditions, as we saw before; that is, whether they begin at interval [0,k*] or from [k*,∞].

comes from the assumption of stationary probabilities of transition, or time homogeneity. In general, each element in matrix M will be the probability of transition between two classes, for example, of belonging to the first quintile in the period t+s given that in t he belonged to the second quintile. In general matrix M has the following form:

$$M(t) = \begin{bmatrix} M_{11} & \cdots & M_{1n} \\ \vdots & \ddots & \vdots \\ M_{n1} & \cdots & M_{nn} \end{bmatrix} \qquad [16]$$

Some transition probability requirements are: the probabilities of transition between two classes must be positive, less than one, and the sum of each row must be one:

$$\begin{aligned} 0 \leq M_{ij} \leq 1 \\ \sum_{j=1}^{n} M_{ij} = 1, \quad \forall i \end{aligned} \qquad [17]$$

If we consider $p_i(t)$ as the proportion of income in class (i) in t, and assume $\overline{p}(t) = [p_1(t), p_2(t), \ldots, p_n(t)]$ as the total system, then the evolution of those variables has the form:

$$p_j(t+s) = \sum_{j=1}^{n} \left\{ p_i(t)\, M_{ij}(t) \right\} \qquad [18]$$

$$\overline{p}(t+s) = \overline{p}(t)\, M(t) \qquad [19]$$

The main problem in building the mobilization possibilities between classes is that, as opposed to panel data, Household Surveys in Colombia present only the frequency distributions of the number of individuals in each class, but do not provide information on each agent. In fact, individuals in the sample change and we have access only to the proportion in each group for every period. To compensate for this gap in the Colombian information, we have estimated econometrically the possibilities of transition between states the agents in the economy face, so that every probability reflects the behavior of unobservable individuals. The estimation procedure is based on Lee, Judge and Zellner (1970)[26]. One main result is the estimation of probabilities of transition between income

[26] Due to the nature of the data, the estimation must include a heteroskedasticity correction in a restricted estimator. The procedure is based on a GLS estimator with an iterative procedure of quadratic primal-dual programming.

distribution quintiles between 1976 and 1995, using information on the annual shares (to September). The result is[27]:

Table 6. Nineteen Year Mobility (1976-1995)[28]

		1995 Quintiles					
		[0.2]	**[0.4]**	**[0.6]**	**[0.8]**	**[1.0]**	**Total**
1976 Quintiles	**[0.2]**	0.372	0.238	0.153	0.145	0.092	1.000
	[0.4]	0.214	0.376	0.214	0.109	0.087	1.000
	[0.6]	0.073	0.195	0.337	0.235	0.160	1.000
	[0.8]	0.009	0.097	0.232	0.356	0.307	1.000
	[1.0]	0.000	0.000	0.022	0.144	0.834	1.000

Source: Author's estimates based on Lee, Judge and Zellner (1970).

For example, the probability of a person in quintile five in 1976 to become a part of quintile one in 1995 is zero. From those who started in the highest quintile in 1976, 90.2 percent found themselves in the two highest quintiles in 1996; this degree of persistence in the high scale is completely consistent with our theoretical finding (that poor people mobilize to high income levels). Therefore, of those who did exit the bottom quintile, most of them did not make much progress (they had no possibility of doing so) with the largest group staying in the same quintile. The richest remain so, with a probability of 0.90; and the poorest remain poor, with a probability of 0.60. It is interesting to note that the interior diagonal is greater than the off-diagonal entries; this means that middle-income families are likely to remain where they are in the distribution, also facing almost equal probabilities of rising or falling[29].

From the construction of these transition probabilities we get different mobility indices that can capture the dynamic aspects of income distribution in particular values; the indices are taken from Geweke, Marshall and Zarkin (1986) and Shorrocks (1978). Because these measures are probably less known that the measures of inequality, they require further discussion. The basis of the analysis is the relation established by the diagonal of the matrix as a persistence measure, since it indicates the probability of remaining in the same state through time. These measures can be interpreted as the difference between the

[27] We have employed a macro bayesian transition probability estimator based on different priori distributions. One exercise was to consider the US transitions matrix of Gottschalk (1997) for 17-year mobility, and an egalitarian prior. The results are similar at the extremes of the distribution. The general discussion of this procedure can be found in Lee, Judge y Zellner (1970).

[28] The classes are arrayed in increasing order, the upper left-hand portion shows transitions from poor to poor, and the lower right-hand transitions from rich to rich.

[29] Because the transition matrix is fractile, we know that there is an ergodic distribution uniform to the quantiles.

observed matrix and the limit matrix of Markov's process[30]. This limit matrix has all rows equal and an invariant distribution that represents a state of equal opportunities, because the probabilities of transition are the same and do not depend on the initial state[31]. The measures tell us how close the present position of income distribution is with respect to perfect equality. Indices are based on the decomposition of the matrix in its eigenvalues (λ):

Table 7. Income Mobility Indices

Index	
μ_T	$\frac{n - \text{Trace}(M)}{n-1} = \frac{n - \sum_j \lambda_j}{n-1}$
μ_A	$\frac{n - \sum_j \lvert\lambda_j\rvert}{n-1}$
μ_L	$1 - \lvert\lambda_2\rvert$
μ_D	$1 - \left\lvert \prod_j \lambda_j \right\rvert^{\frac{1}{n-1}}$

Source: Geweke, Marshall and Zarkin (1986) and Shorrocks (1978)

The description of index μ_T is based on the trace of the transition matrix, equal to the sum of the eigenvalues. When the trace is equal to one, all of the eigenvalues (except for the first one) are equal to zero, and μ_T is equal to 1, showing the existence of equal or less persistent opportunities. When the transition matrix is the identity matrix, the index is zero, showing the presence of perfect persistence. If the eigenvalues are all positive and real, the previous index is equal to the second measure; but this is not generally the case. This measure μ_A captures the convergence speed. The third measure is based on the second largest eigenvalue modulus. Due to the structure of the transition matrix, the greatest modulus is always one, and the second determines aspects of asymptotic convergence; if this second eigenvalue is zero, the index represents the possibility of higher mobility. When the second eigenvalue is one, we are facing an identity matrix of perfect immobility. The last index expresses the possibility that all the eigenvalues are one, as in the case of perfect immobility, and also the possibility of at least two equal eigenvalues, as in the case of

[30] Stationary ergodicity in the Markov process is equivalent to the convergence of Cesàro averages of the transition probability to a unique invariant measure. If the distribution posses ergodicity, the equilibrium distribution (all rows of M are identical) can be found by iterating the equation [19].

[31] In a more formal way, we can say that they are uniformly distributed in an ergodic limit.

perfect mobility. In general, if μ equals zero M is the identity matrix and there is no mobility. If μ equals one, there is perfect mobility. As an example, the indices for the last Markovian matrix are:

Table 8. Intra-distribution Mobility: US-Colombia

	US (1974-1991)	Colombia (1976-1995)	Equal Opportunities
μ_T	0.7587	0.6813	1.000
μ_A	0.7587	0.6813	1.000
μ_L	0.4779	0.2822	1.000
μ_D	0.1796	0.2286	1.000

Source: Author's calculations based on Table 6 and Gottschalk (1997).

The main result from the last table is the presence of high persistence in Colombian income distribution, especially at higher levels. But we cannot regard these results as conclusive, because low inequality among different families in the same generation is consistent with highly stable rankings of families in different generations, and a unstable ranking is consistent with sizable inequality in the same generation. The role of long-run educational mobility is the topic of the next section.

Long-run Educational Mobility

As the model suggests, the local (family) externality has a strong effect on the skill accumulation of every generation; at this level, we constructed an experience index based on age, educational level and initial age of schooling for every son. The index is:

$$\text{Experience} = \text{Age-Years of Schooling-6 Years} \qquad [20]$$

When the index is very high, we expect that the individual will cease to accumulate human capital[32]. This strategy is similar to Rustichini, Ichino and Checchi (1997) but with different objectives. We define a four-year limit (three- and five-year limits are almost identical). With this restriction, our transition probability matrix can use the equation [14] in every survey because we have educational information for every household head, and for every son. Thus, for September of 1976 and 1996, the transition matrix takes the following form:

[32] This restriction is equal to the one used in Sánchez and Núñez (1996). The index of experience is frequently found in the literature of income distribution.

Table 9a. Inter-generational Educational Mobility (Sept. 1976)

		Son's Educational Level			
		Primary	**Secondary**	**Higher**	**Total**
Father's Educational Level	**Primary (0-5)**	0.690	0.290	0.020	1.000
	Secondary (6-11)	0.331	0.606	0.063	1.000
	Higher (12+)	0.080	0.673	0.247	1.000

Source: Author's calculations.

Table 9b. Inter-generational Educational Mobility (Sept. 1996)

		Son's Educational Level			
		Primary	**Secondary**	**Higher**	**Total**
Father's Educational Level	**Primary (0-5)**	0.504	0.427	0.069	1.000
	Secondary (6-11)	0.232	0.645	0.123	1.000
	Higher (12+)	0.091	0.356	0.552	1.000

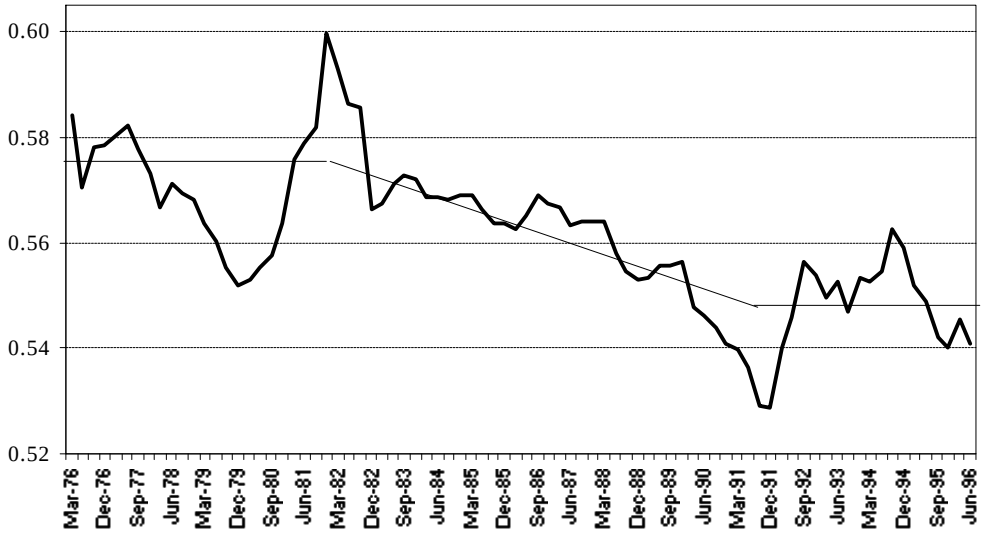
Source: Author's calculations.

The interpretation is similar to Table 6, the diagonal shows the phenomenon of persistence in education. In 1976, persistence at the lowest educational level for every generation was 69%, while in 1993 it dropped to 50%. At the other extreme, persistence at the highest educational level increased during the most recent years, and if we observe the entire data set, it suggests that persistence at the highest level is the cause of the recent higher mobility. In Table 9 we found a high significant level of persistence at the top of the income distribution, and our present findings confirm this aspect. Mobility in highly educated people is clear enough, but we also found a high relation of persistence between highly-skilled people or high-income classes. This persistence is not a bad thing. To the contrary, it suggests a structural transformation toward a less stratified society, but this transition carries a short (middle) term increase in inequality, as we did indeed expect from our theoretical findings.

Dynamically, we can analyze the evolution of mobility using the latest indices for every household survey. Figures 16 plots two of these:

Figure 16a. Inter-generational Mobility. μ_T Index (4 Periods Moving Average)

Figure 16b. Inter-generational mobility. μ_L Index (4 Periods Moving Average)



In this last figure we observe the same episodes regarding income distribution discussed in the present document. These periods are highly relevant to our analytical proposals on the recent evolution of income distribution. Despite it being too early to state conclusive results, it seems that the stagnation of income distribution during the 1980s was accompanied by a reduction in mobility, or equivalently by the increasing importance of local conditions in the evolution of human capital accumulation. During the 90s, the process of declining mobilization stopped, consistent with the increasing importance of the conditions of global externality, as our preceding theoretical model suggests. In Figure 16a we observe the declining trend in mobility since 1976 (a high-status society); as of 1992, the persistence stopped.

To sum up, in periods of slow technological progress the dominant factor is the local environment, inequality declines but becomes more persistent. However, in periods of major technological progress, the importance of local conditions declines, enhances mobility, increases short term inequality and generates poles in the distribution of income.

Table 10. Exclusion Restriction (Granger-causality) tests. Marginal Significance Levels

Left-hand-side Variable	Right hand side bloc		
	Gini	**P(α=1.5)**	μ_L
Gini's Coefficient	(0.000)	(0.698)	(0.069)
P(α=1.5)	(0.006)	(0.000)	(0.127)
μ_L	(0.295)	(0.005)	(0.001)

Source: Author's calculations.

Merely as a dynamic exercise, in table 10 we present the Granger-causality test in an 8-lag VAR. The results suggest that inter-generational mobility is the main cause of polarization and inequality in income distribution. The properties of the results depend to a considerable extent on the assumption of non-ergodic income distribution, because this property allows us to analyze the short-term dynamics and not only the long-term aspects.

V. Conclusions and Extensions

This paper has provided a framework for analyzing the recent increase in income inequality in Colombia. It has applied new tools for modeling evolving income distribution dynamically, using polarization measures and mobility indices. Section 2 presents a simple model providing a general equilibrium framework describing income distribution dynamics in an explicit model that accounts for wage inequality, mobility and polarization; phenomena of high importance in recent episodes. More interesting is the fact that this

simple deterministic overlapping model makes us see polarization at early stages of development as a result of slow technological progress; later, we also see a convergence pattern based on high incentives for human capital accumulation. In the Colombian case, we can interpret "Apertura" as a skill-biased technological change which increases wage inequality and induces polarization, and also leads to high mobility, with conditions which are less dependent on the local environment.

We endeavored to minimize the distance between the theoretical analysis of Section 2 and the empirical analysis of subsequent sections. The empirical methods differ from those commonly found in income inequality studies; they are designed to cover aspects of polarization, clumping and mobility. The main finding explains the polarization pattern of recent years, based on kernel density estimations. This tool has been applied extensively in different kinds of analyses, as in Quah (1996), and Cowell, Jenkins and Litchfield (1994). Further evidence on the importance of polarization is provided by the index of Esteban and Ray (1994). Even though this measure analyzes many possibilities of polarization, its evolution suggests an important aspect, forgotten in the Colombian literature. The substantive empirical findings at this stage show interesting dynamic properties, the mobility indices are not trivially constant and they are strongly related to economic growth, as the polarization pattern indicates.

Despite the previous model, there are other parts of the puzzle that we have omitted, and clearly we need to devise additional explanations based on capital income. Clearly, the data we used presents a bias toward labor income, and for that reason we certainly have ignored some effects of physical capital accumulation. The implications of these variables are far from clear; we believe that these income streams may be subject to the intervention of financial institutions such as pension funds and social security. Other topics we have ignored are the role of educational systems and government policies. In addition, we can think of a tax policy with increasingly redistributive effects with taxes on the highly skilled, and subsidies for the less skilled. It seems to us that this field remains to be explored.

VI. References

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