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Abstract

In countries with high levels of inequality, progress in education has often been placed high in the list of policy proposals designed to change the unequal state of affairs. This study uses Brazilian annual data to chart the trends in wage inequality and a decomposition procedure to ascertain how wage distribution was affected by advances in education that doubled the median schooling level of prime-age men during the sample period. The results show that while falling returns to education were an equalizing factor across the wage distribution, changes in the educational composition of the work force exerted a disequalizing influence that was strongest at the top of the distribution. The net result was a fall in wage dispersion that was not as dramatic as might have been hoped.

KEYWORDS: economic inequality, wage dispersion, education, Brazil, returns to education, educational composition of the work force

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EDUCATION AND CHANGES IN BRAZILIAN WAGE INEQUALITY, 1976–2001

ORLANDO J. SOTOMAYOR*

In countries with high levels of inequality, progress in education has often been placed high in the list of policy proposals designed to change the unequal state of affairs. This study uses Brazilian annual data to chart the trends in wage inequality and a decomposition procedure to ascertain how wage distribution was affected by advances in education that doubled the median schooling level of prime-age men during the sample period. The results show that while falling returns to education were an equalizing factor across the wage distribution, changes in the educational composition of the work force exerted a disequalizing influence that was strongest at the top of the distribution. The net result was a fall in wage dispersion that was not as dramatic as might have been hoped.

Brazil's inequality in the distribution of earnings is among the highest in the world. The country's ratio of earnings at the 90th and 10th percentiles of 7.8 in 2001 far outstrips the corresponding numbers for the Netherlands (2.4), Germany (2.5), the United Kingdom (3.1), and even the United States (5.7). Past trends have not been encouraging, as dispersion increased over the 1960s, 1970s, and 1980s. However, there is reason to hope that two developments may have reversed the trend in recent years. First, following a series of economic crises that marked the 1980s, structural reforms implemented in the mid-1990s brought forth a period of relative macroeconomic stability.[1] Second, and more important, the past quarter-century has witnessed great advances in education, which include a doubling of the median level of schooling among prime-age men.

In this study, I first use annual household survey data to identify trends in the distribution of wages from 1976 to 2001, and then implement a decomposition methodology to analyze the role played by human capital advances in these trends. Thus, the study not only contributes to our understanding of wage dispersion in the world's fifth most populous country, but also sheds light on the relationship between education and changes in wage inequality, an issue that cannot be settled on theoretical grounds. On the one hand, a

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Copies of the computer programs used to generate the results presented in the paper are available from the author at the Department of Economics, University of Puerto Rico, Mayagüez, Puerto Rico 00681–9262.

[1]See Edwards (1995) for an in-depth description of the nature of the crises and the elements of economic reforms implemented in Latin America.

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rising supply of educated workers lowers returns to schooling and brings down inequality through compression effects; on the other, the same increase in education influences dispersion through composition effects that may raise or lower inequality. Did the impressive educational gains occurring during the last quarter of the twentieth century make a troubling situation even worse, or did they serve to reduce inequality? If the latter, have these changes been large enough to warrant a vision of education as the great equalizer? These are among the questions addressed in this study.

The Survey

Research on changes in distribution in Brazil goes back to Fishlow's (1972) study of inequality in the 1960s. Using information from the country's decennial censuses, Fishlow found that disparities among the economically active population had risen sharply in the context of high rates of economic growth. These results were taken as evidence not only of a possible conflict between economic growth and equality, but also of the deleterious effects of development and labor market policies implemented by the military regime at that time.

The rising trend in inequality continued in the 1970s, although a distinction has to be made between the first half of that decade, during which inequality increased, and the second, when it declined (Bonelli and Ramos 1995:358). Fishlow, Fiszbein, and Ramos (1993:17–18) hypothesized that the decline in wage concentration in the latter years stemmed from a fall in returns to education, which they attributed to an upward trend in the business cycle.

In contrast to the 1960s and 1970s, when all groups enjoyed improvements in mean income levels—albeit the improvements were significantly greater for those at the higher end—the 1980s produced only a modest increase concentrated at the top of the distribution. Inequality rose markedly, although not as strongly as it did during the 1960s. To explain these changes, Fishlow, Fiszbein, and Ramos (1993:17–18) pointed to an increase in returns to education associated with a stagnating economy. Bonelli and Ramos (1995:359), whose study had the advantage of analyzing data from a longer time period, concluded that the short-term positive relationship between growth and equality during the economic upturn of 1976–81 and the downturn of 1981–83 became blurred during the latter half of the 1980s. Growth was then accompanied by a higher level of inequality and increasing inflation. How inflation affects inequality was a question taken up by Hoffmann (1995:290–93), who found evidence of a positive relationship, and also confirmed the rise in dispersion over the 1980s and the acceleration of that tendency during the second half of the decade.

A number of these studies found that education was a major determinant of variation in wages. Fishlow's (1972) and Langoni's (1973) seminal decomposition results associating education with up to 50% of all wage dispersion were largely confirmed in subsequent studies using human capital models by authors such as Senna (1976), Castello Branco (1979), and Velloso (1979). Research by Reis and Barros (1991), going a step further, found significant regional disparities in wage-earning profiles. In terms of the contribution of education to changes in inequality, Lam and Levison (1992) established that the rise in earnings concentration over the period 1982–85 took place despite an equalizing distribution of schooling and a decline in returns to education. These trends were overridden by a rise in other sources of wage variation.

In sum, apart from a brief respite during the second half of the 1970s, it can be stated that inequality rose during the 1960s, 1970s, and 1980s. Although education seems to be of central importance among the variables affecting inequality, it does not necessarily provide an explanation of the trends in wage dispersion. While schooling has become more equally distributed, other factors also seem to be playing a role. The 1990s are a particularly suitable period for studying one such possible influence—inflation. The low-inflation conditions produced by the 1994 *Real* Plan allow for an analysis of the relationship between price

stability and wage distribution.[2] Furthermore, the reasonably stable macroeconomic framework that characterized the second half of the decade facilitates the examination of the long-run relationship between education and inequality—a question of considerable importance in view of the fact that education is the main policy proposal (Barros, Henriques, and Mendonça 2002) for reducing the country's extreme inequality.

Data

The data used in this study are drawn from the 1976–2001 National Household Surveys (PNADs), which have been carried out annually by the Brazilian Institute of Geography and Statistics (IBGE) since 1976, with interruptions in 1980, 1991, 1994, and 2000, when no compilations were performed.[3] The sample design is restricted to wage earners, in contrast to all of the aforementioned studies, which in addition incorporated employers and the self-employed—individuals whose wages reflect a mixture of returns to labor and physical capital. Furthermore, in order to make interpretation of results as straightforward as possible, a reasonably strong labor market attachment is included as a sample requirement. Therefore, the analysis is restricted to prime-age (25–54-year-old) male wage earners working at least 35 hours per week, excluding agricultural workers (whose compensation is very difficult to measure accurately). The resulting samples average close to 30,000 observations.

Wages are defined as monthly earnings over weekly hours times four and are deflated using the National Consumer Price Index (INPC), collected since 1979, and the General Price Index for Internal Consumption (IGP-DI) for the period 1976–79. Conversions are carried out according to the month when the particular survey took place, with a base month of August 1994. All statistics are computed using the weights provided by the surveys for producing representative samples of individuals.

Trends in Distribution

The macroeconomic conditions underlying the trends in wage distribution varied markedly over the period under analysis. The years 1976–80 can be categorized as a period of strong growth with moderate inflation by Brazilian standards, in view of the fact that the real gross national product increased by an average of 7.2% while inflation stood at an annual average of 53% (Table 1). The economy contracted by 6.3% during the 1981–83 recessionary period but recovered between 1984 and 1989, while inflation accelerated and reached annual rates of 323.4% in 1987, 819% in 1988, and 1349.3% in 1989. Price stabilization programs carried out in the early 1990s adversely affected the gross national product and employment and had a limited impact on inflation, which reached 1910.6% per year in 1993. Long-term price stability was attained only after the implementation of the *Real* Plan in 1994, when inflation declined to an annual average of 7.7% between 1995 and 2001. The economy grew at an average real rate of 4.2% between 1994 and 1997, but then stagnated in 1998 and 1999 as a result of restrictive monetary policies designed to stem capital outflows

[2]The *Real* Plan was an anti-inflation program based on a pledge of fiscal restraint and the creation of a new currency named the *real*, whose exchange rate became the *de facto* anchor of the program, implemented in 1994. The currency's value was supported by high interest rates, which were also required for financing an expanding fiscal deficit that resulted from difficulties in producing the promised public spending cuts. Soaring interest rates designed to stem capital outflows in the advent of the 1997 Asian and 1998 Russian crises became unsustainable in the context of a deep recession, and the currency was left to float in 1999. Thus, the *Real* Plan came to an end, but price stability endured through inflation-targeting practices.

[3]The PNAD began in 1967 but underwent a series of changes in content and geographical coverage over the next nine years; by 1976 it had assumed a format that remained reasonably constant thereafter. However, it should be noted that a minor enlargement of geographical scope occurred when the rural areas of the Brazilian Midwest were incorporated into the survey beginning in 1979. These areas account for some 1% of the country's population.

Table 1. Macroeconomic Indicators and Value of the Minimum Wage.

Year	*Monthly Inflation (%)*	*Annual Inflation (%)*	*Rate of Unemployment (%)*	*Growth in GDP (%)*	*Minimum Wage (R$94)*
1976	3.4	41.9	*	10.2	109
1977	2.7	33.8	*	4.9	113
1978	2.9	37.2	*	4.9	112
1979	4.8	64.7	*	6.8	112
1980	5.5	87.4	*	9.3	113
1981	5.6	82.3	*	–4.3	111
1982	6.0	87.7	5.8	0.8	113
1983	8.7	154.7	6.9	–2.9	105
1984	9.8	182.6	7.4	5.4	94
1985	10.2	203.2	5.5	7.8	94
1986	1.4	38.4	3.7	7.5	104
1987	14.2	323.4	3.8	3.5	82
1988	21.5	819.0	3.9	–0.1	86
1989	31.3	1,349.3	3.3	3.2	85
1990	14.5	901.3	4.3	–4.3	62
1991	15.6	375.5	4.7	1.0	71
1992	23.4	891.9	5.8	–0.5	64
1993	30.7	1,910.6	5.3	4.9	72
1994	24.2	628.4	5.4	5.9	70
1995	1.6	20.2	4.5	4.2	77
1996	0.6	7.5	5.6	2.8	77
1997	0.3	3.5	5.7	3.7	80
1998	0.3	1.6	7.7	0.2	83
1999	0.7	7.7	7.6	0.8	82
2000	0.3	4.6	7.3	4.4	86
2001	0.8	8.6	6.3	1.4	95

Source: 1976–79 inflation rates are based on the General Price Index (IGP-DI) found in Conjuntura Econômica of the Fundação Getúlio Vargas, and 1979–2001 inflation rates are based on the National Price Index (INPC) found in the Anuario Estatístico of the Instituto Brasileiro de Geografia e Estatística (IBGE). Nominal minimum wages come from the Folha de São Paulo; up to 1983, they correspond to the highest of the prevailing regional minimum wages. GDP growth rates are found in Conjuntura Econômica, and (*) unemployment rates are drawn from the Monthly Employment Survey (PME) carried out since 1982 by the IBGE. The values for the minimum wage, unemployment, and monthly inflation rates are the median values for the year.

in the aftermath of the Asian and Russian crises. Unemployment, already high by Brazilian standards, rose to levels previously experienced only during the deep recessionary period of the early 1980s.

The data on trends in absolute wages by decile provided in Table 2 underscore four periods of significant change. The first was 1982–84, when the median wage fell by 18% in the context of a contracting economy and rising inflation. Wages recuperated from 1984 to 1989, while unemployment declined and inflation soared. Short-lived price stabilization plans put in place in the early 1990s had a negative effect on wages, which rebounded only after the implementation of the *Real* Plan in 1994. During the second half of the 1990s, wages at the first six deciles reached a sustained maximum, while those at the top three deciles stabilized at levels below the peaks attained in 1989. However, lackluster growth rates in 1998, 1999, and 2001 took a toll on wages, which have been declining since 1998.

As Figure 1 shows, relative wage differentials fell during the late 1970s, increased between 1981 and 1985, and rose further between 1987 and 1989, so that by the end of the 1980s the 80-20 decile ratio had risen

Table 2. Trends in Absolute Wage Levels by Decile.

Decile	*1982*	*1984*	*1989*	*1993*	*1995*	*1998*	*2001*
1st	1.04	0.80	0.89	0.85	1.07	1.08	1.05
2nd	1.07	0.83	0.97	0.86	1.19	1.18	1.09
3rd	1.03	0.82	0.98	0.87	1.10	1.13	1.04
4th	1.05	0.85	1.04	0.89	1.15	1.16	1.03
5th	1.04	0.85	1.07	0.88	1.14	1.13	0.99
6th	1.06	0.87	1.09	0.88	1.16	1.11	1.00
7th	1.01	0.84	1.13	0.86	1.10	1.07	0.92
8th	1.07	0.88	1.17	0.90	1.15	1.08	0.94
9th	1.03	0.83	1.14	0.81	1.03	0.98	0.87

Source: Author's calculations from selected PNAD files.
Note: The table traces the trend in absolute wages at the corresponding decile indexed to its value in 1976.

by an impressive 25%—a trend consistent with what was occurring in much of Latin America (Psacharopoulos et al. 1995).[4] Only during the 1990s did inequality decline for an extended period, with the 80-20 ratio falling by 29% between 1989 and 2001. The patterns shown by other measures of wage dispersion, such as the 80-50 and 50-20 decile ratios, demonstrate that relative wage changes were somewhat stronger at the bottom than at the top of the distribution. For example, while the 80-50 ratio rose by 10% during the 1980s and fell by 14% during the 1990s, the 50-20 ratio rose by 14% and fell by 17%. On the whole, between 1976 and 2001 the 80-20 ratio fell by 14%, the 80-50 by 6%, and the 50-20 by 9%.[5] However, despite the long-term decline, it should be noted that wage differentials are still far higher than those prevalent in developed economies. Brazil's 90-10 ratio of 8.3 in 2001 greatly surpassed the corresponding ratios for The Netherlands (2.4), Germany (2.5), the United Kingdom (3.1), and even the United States (5.7). Similarly, Brazil's 80-20 ratio of 3.8 compared very unfavorably with The Netherlands' 1.4, Germany's 1.8, the United Kingdom's 2.1, and the United States' 3.0.[6]

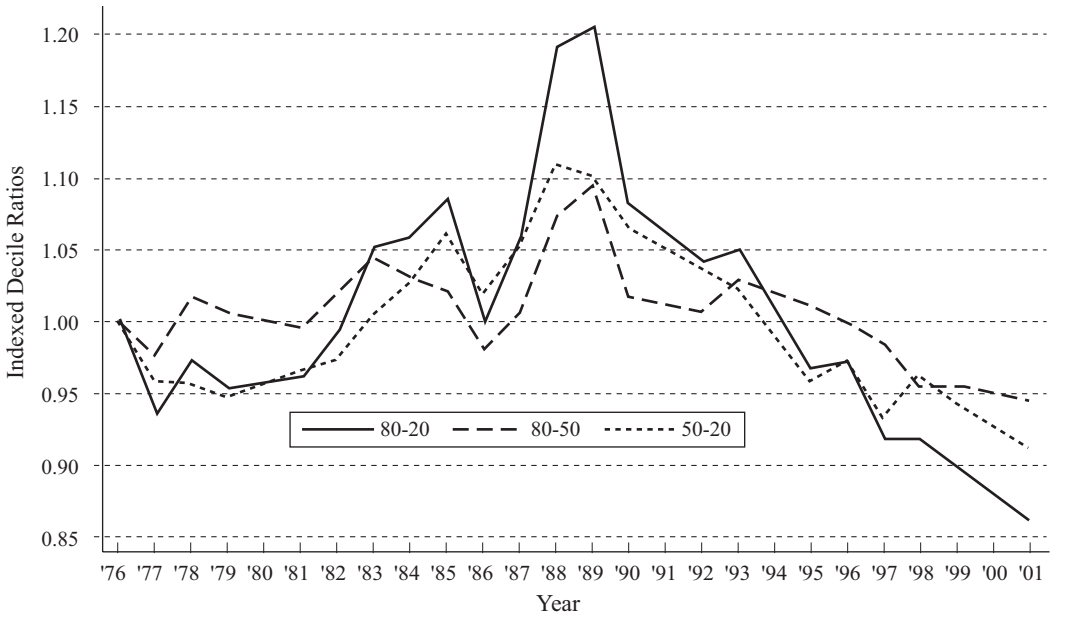
To what extent were these sharp fluctuations in wage dispersion—occurring particularly during the late 1980s and early 1990s—due to real inflationary effects, and to what extent were they due to measurement problems? A first measurement problem stems from the fact that differences in payment frequencies become important during periods of high inflation. Adopting the assumption that all wages are paid at the end of the month causes an underestimation of the real wages of those who receive half of their wages on the fifteenth of the month or a quarter of their wages each week. Second, high inflation also increases

[4]The strong but ephemeral decline in inequality evident in 1986 coincided with the implementation of the Cruzado Plan. The policies associated with that plan included a monetary reform, a prize freeze, a deindexation of the economy, and wage increases to appease labor. Inflation reappeared shortly thereafter as a result of sharply increasing consumption expenditures and the government's failure to rein in fiscal spending.

[5]The inequality pattern followed by the 80-20 ratio is similar to that demonstrated by other measures of dispersion such as the Gini coefficient (see Appendix A).

[6]The developed economies' percentile ratios are found in Gottschalk and Smeeding (1997:643). These were, however, constructed from earnings, not wages, and do not exclude agricultural workers. If the same is done for Brazil, the 2001 90-10 and 80-20 ratios are 7.8 and 4.0, respectively. Also, European and American statistics are based on distributions from the mid-1980s to the early 1990s.

Figure 1. Wage Inequality by Percentile Ratio Measure.

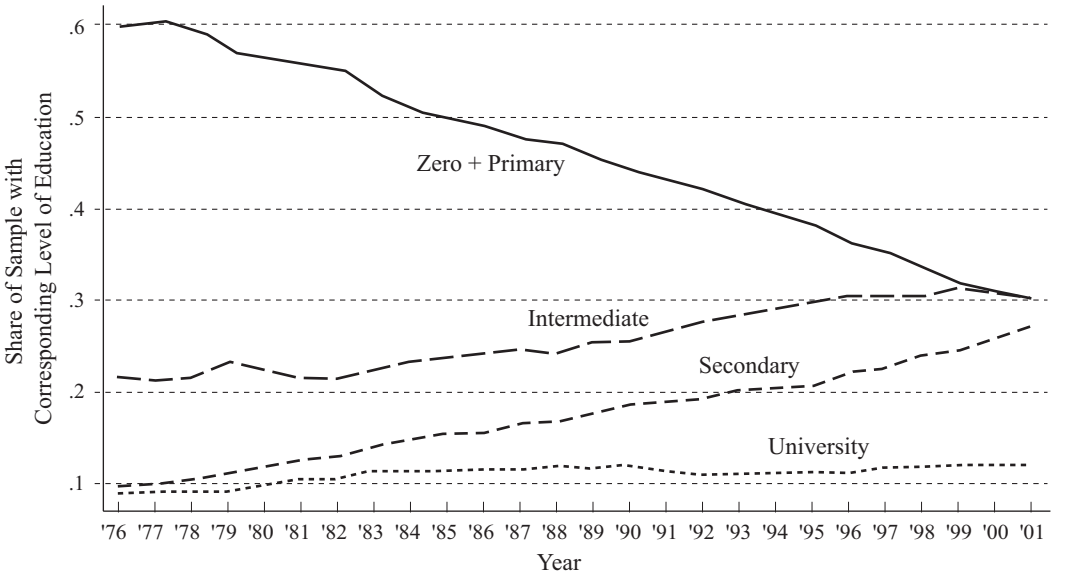


Source: Author's calculations from 1976-2001 PNAD files.
Note: The graph depicts the trends in the ratios of wages at the 80th, 50th, and 20th percentiles.

the importance of the timing of indexation. Monthly wage–related questions that are put to workers with equal real annual wages may elicit different responses if some individuals get their wages indexed one month, while others receive their adjustment during the following month. Third, answers to survey questions pertaining to wages may yield less accurate data due either to respondents' increasing difficulty in keeping up with wage information or to their confusion regarding the questions' reference periods.

While it is extremely difficult to ascertain how much of the measured changes in dispersion were due to respondent error, a notion of the importance of the first two problems mentioned above can be gained through the use of a monthly employment survey (PME) conducted by the Brazilian Institute of Geography and Statistics (IBGE) in the main metropolitan areas of the country. The surveys contain information on payment frequency as well as on wages over a four-month period. On the former question, individuals are asked whether wages are received monthly, biweekly, or weekly. On the latter question, respondents are contacted in each of four consecutive months, allowing the construction of up to a four-month panel. This information source is then used to examine the period 1987–89, when inequality and inflation rose more than at any other time in the years studied. Specifically, the surveys of September and October of 1987 and 1989 are used to calculate inequality levels among male wage earners using three wage definitions: (i) September wages, with no account taken of payment timing differences, (ii) September wages indexed according to payment timing, and (iii) the sum of September and October wages indexed according to payment timing. The results indicate

Figure 2. Levels of Education.



Source: Author's calculations from 1976-2001 PNAD files.

Note: Primary school is defined by 1-4 years of schooling, intermediate school by 5-8 years, secondary by 9-11 years, and university by at least 12 years of schooling.

that the calculation of real wages with the use of payment frequency information reduces the Gini coefficient's assessment of inequality by only 0.26% in 1987 and 0.90% in 1989.[7] Using a two-month sum of real wages reduces estimates by a further 4% in 1987 as well as in 1989. Thus, adjustments have a very limited impact on inequality trend estimates. In all three cases the 1987–89 increase in the Gini coefficient is on the order of 8%. These figures suggest that payment and indexation timing effects are not responsible for the positive relationship between inflation and inequality detected in this study.

Other measurement issues, such as top-coded or miscoded wages at the upper end of the distribution, do not seem to be behind the estimated trends. Only four observations are top-coded in one single dataset (they are more common among the self-employed). Miscoding seems to be an obvious problem only in the 1976 survey, where eleven unusually high incomes appear at the very top of the distribution and have been excluded from the analysis.[8]

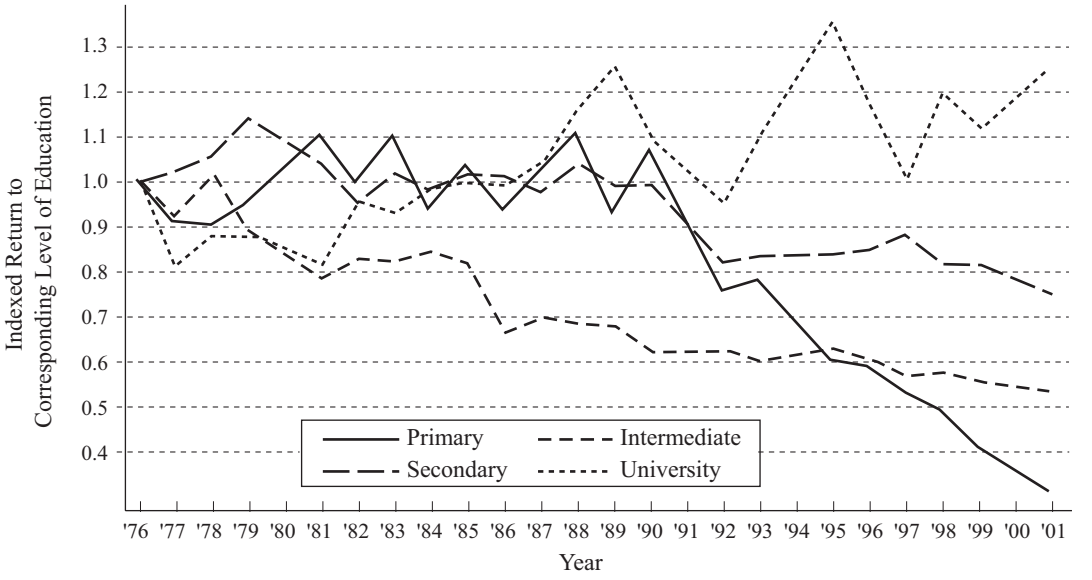
Trends in Schooling, Returns to Skill, and Residual Inequality

A breakout of the wage series into trends in worker characteristics and the returns to those characteristics reveals considerable

[7]Neri (1995:502) found that deflating wages according to the time they are received had little effect on the measurement of real wages, a result of the fact that over 80% of all employees receive their payments on a monthly basis.

[8]These incomes are up to six times as large as those of the preceding observations and are highly suspect because they accrued to electricians, cooks, construction workers, bus drivers, and mechanics.

Figure 3. Returns to Education.



Source: Author's calculations from 1976-2001 PNAD files.

Note: Returns to schooling are estimated using an earnings equation that includes an 8-variable education step function, a linear term within education categories, a quartic in potential experience, an interaction of experience with 4 education categories, plus binary variables for head of household, industrial sector, region, and urban area residence. See Appendix B for further details.

changes in the educational composition of the work force. Figure 2 shows an increase in the proportion of wage earners with secondary or intermediate education and a concurrent decline in the proportion of workers with primary or no education.[9] Moreover, this trend accelerated over time. While the share of workers with intermediate education increased by 4 percentage points during the 1980s, it increased by 5.8 percentage points during the 1990s. In the 1980s the share of workers with secondary education rose by 5 percentage points, and in the 1990s it rose another 6 points. At the same time, the proportion of workers with primary education fell by 7.3 percentage points during the 1980s and by 10 points during the 1990s. No marked change is found among the college-educated, whose share in the working population increased only modestly during the 25-year period under study.[10]

In general, the trend in the returns to education (see Appendix B) shown in Figure 3 is in accord with the changes in the educational composition of the working population. Returns to middle and lower levels of education declined considerably

[9]The old Brazilian schooling classifications were primary (1–4 years of education), intermediate (5–8 years), secondary (9–11 years), and college. The new schooling classifications are first cycle (1–8 years of education), second cycle (9–11 years), and college. This study, like most studies of education in Brazil, uses the older and richer definitions.

[10]See Birdsall, Bruns, and Sabot (1996) for a comparison of schooling trends in Brazil and Asia that documents even greater progress in the latter region.

Figure 4. Returns to Experience.

Source: Author's calculations from 1976-2001 PNAD files.

Note: Returns to experience, evaluated at 15, 20, and 25 years of experience, are estimated through the use of an earnings equation that includes an 8-variable education step function, a linear term within education categories, a quartic in potential experience, an interaction of experience with 4 education categories, plus binary variables for head of household, industrial sector, region, and urban area residence. See Appendix B for further details.

over the period under consideration. For example, returns to intermediate education declined steadily, from a premium of 81% in 1976, to 54% in 1989, to 43% in 2001. Returns to primary and secondary education remained fairly constant in the 1980s, but began to fall during the 1990s. Between 1989 and 2001 the premium to secondary education decreased from 71% to 54%. Similarly, the return to primary school tumbled from 54% in 1989 to 18% in 2001. In contrast to these trends, it can be noted that the return to a college education moved from 116% in 1976 to 146% in 2001.[11] As a point of reference, Brazilian school premia greatly exceed those in developed economies such as the United States, for which Gottschalk (1997:30–32) found a 53% wage differential between college and high school graduates. With regard to the other component of human capital, experience, no long-term trend is found. The return to experience rose and declined, converging to an annual return in the 1–2% range (Figure 4).

Finally, estimates of residual dispersion found in Figure 5 attest to the fact that while residual inequality decreased during the latter part of the 1970s, it began to rise during the 1981–83 recession and became more pronounced during the mega-inflationary 1987–89 period. This is demonstrated by the 80-20 decile ratio of the error term of the wage

[11]Using samples of metropolitan workers, Fernandes and Menezes (2000) also found falling returns to education at all schooling levels with the exception of college.

Figure 5. Residual Inequality.

Source: Author's calculations from 1976-2001 PNAD files.

Note: Shown are decile ratios of residuals of a regression of log wage rates on an 8-variable education step function, a linear term within education categories, a quartic in potential experience, an interaction of experience with 4 education categories, plus binary variables for head of household, industrial sector, region, and urban area residence.

regression (see Appendix B), which decreased by 7% from 1976 to 1979, increased by 7% from 1979 to 1987, and rose further by 13% from 1987 to 1989. Price stabilization plans appear to have reduced the measure of dispersion, which declined by 7% from 1989 to 1993 and by an additional 12% from 1993 to 2001.

At this point I seek to isolate the effects of these changing phenomena on the trends in wage inequality. I am specifically interested in the extent to which the changes in inequality were related to a changing skill profile of the working population, to changes in returns to skill, and to changes in unobservables. Such an exercise may not only allow for an understanding of the direct contributors to the trends in wage distribution, but also provide clues to possible connections with other less obvious sources of influence.

Methodology

Juhn, Murphy, and Pierce (1993:426–29) suggested a simple methodology for decomposing wage distribution trends into contributions related to temporal changes in worker skill levels, returns to skill, and levels of and returns to unobserved traits. The usual wage equation is assumed, with wages being a function of observed worker characteristics X, returns to those characteristics β, and a term u representing unobserved traits and their returns. U is expressed as two components, one corresponding to a cumulative distribution function of the wage equation residuals, and the other to an individual's percentile in the

residual distribution. That is, if $F_t^{-1}(\cdot|X_{it})$ is defined as year t's inverse cumulative residual distribution for workers with characteristics X_{it}, and θ_{it} is defined as individual i's percentile in the residual distribution, $F_t^{-1}(\theta_{it}|X_{it})$ will produce u_{it}. The wage-generating equation can hence be expressed in the following manner:

$$(1) \qquad Y_{it} = X_{it}\beta_t + F_t^{-1}(\theta_{it}|X_{it}) = X_{it}\beta_t + u_{it}.$$

Adding and subtracting both $X_{it}\bar{\beta}$ and the inverse of the average cumulative residual distribution $\bar{F}^{-1}(\theta_{it}|X_{it})$ produces

$$(2) \qquad Y_{it} = X_{it}\bar{\beta} + X_{it}(\beta_t - \bar{\beta}) + \bar{F}^{-1}(\theta_{it}|X_{it}) + [F_t^{-1}(\theta_{it}|X_{it}) - \bar{F}^{-1}(\theta_{it}|X_{it})].$$

This equation suggests that wage distributions evolve in response to three factors. The first term in the equation captures the effect on wages of changes in worker characteristics such as education and experience, holding the returns to those characteristics fixed; the second term captures the effect of changes in returns to these characteristics; and the last term reflects trends in residual dispersion.

Assessing the relative importance of each of these sources of change requires estimating wage distributions holding constant skill levels, returns to skills, and residual dispersion at progressive steps. To achieve this, the following practical procedure can be followed. First, define Y_{it}^1 (equation 3) as the wage distribution in which returns to skill and residual dispersion are held constant. In the construction of Y_{it}^1 for each of the years under study, year t characteristics are evaluated not at year t returns to those characteristics, but instead at a mean level of returns $\bar{\beta}$ over all time periods. In addition, residual variance is held constant by calculating an average cumulative residual distribution where, once again, the average is over all time periods. Each person i in year t is then assigned a residual computed using his ranking in year t's residual distribution (θ_{it}) and the inverse of the average cumulative residual distribution $\bar{F}^{-1}(\cdot|X_{it})$. Since both returns and residuals are held constant, differences in inequality in Y_{it}^1 between any two given years can be interpreted as produced by changes in observed skill levels.

$$(3) \qquad Y_{it}^1 = X_{it}\bar{\beta} + \bar{F}^{-1}(\theta_{it}|X_{it})$$

$$(4) \qquad Y_{it}^2 = X_{it}\beta_t + \bar{F}^{-1}(\theta_{it}|X_{it})$$

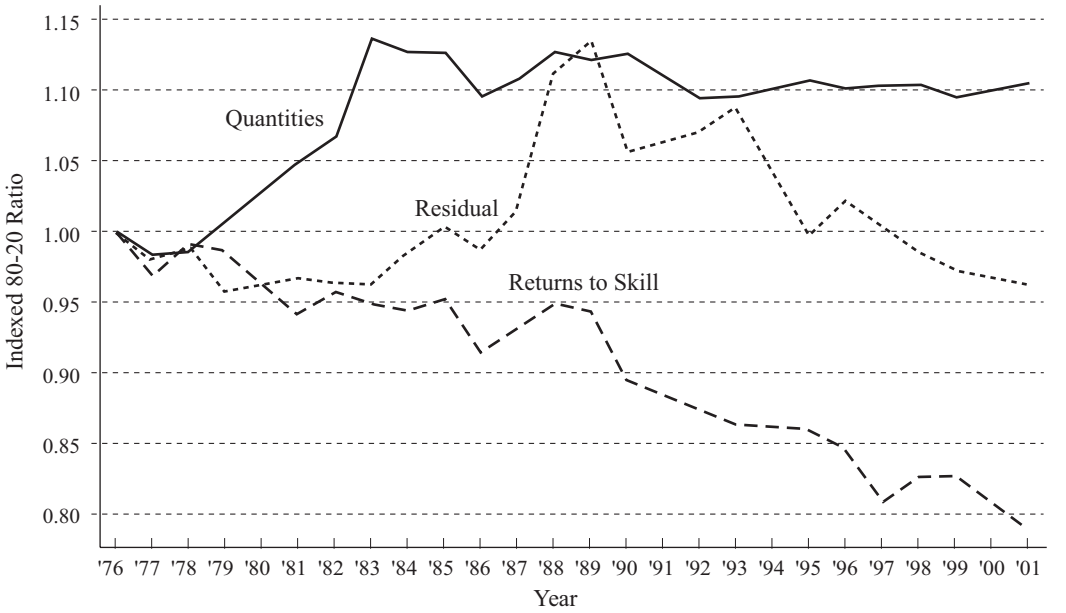
$$(5) \qquad Y_{it}^3 = X_{it}\beta_t + F_t^{-1}(\theta_{it}|X_{it}) = Y_{it} = X_{it}\beta + u_{it}$$

Second, define Y_{it}^2 (equation 4) as the wage distribution that holds constant residual dispersion, constructed for each year t using year t characteristics, year t returns to those characteristics, and a residual term computed as in the case of Y_{it}^1. Given that residual variation is held constant, any difference in inequality in Y_{it}^2 beyond that already related to observed skill level changes can be attributed to a changing structure of returns to skill for observables. Finally, define Y_{it}^3 (equation 5) as the wage distribution that allows variation in returns, characteristics, and residual variation. In the construction of Y_{it}^3, year t returns are evaluated using year t characteristics, and residuals are constructed using year t's inverse cumulative residual distribution and year t's residual ranking. Thus, Y_{it}^3 coincides with the actual wage distributions. Any difference in inequality in Y_{it}^3 not already related to changes in observed skill levels or returns to skill can be attributed to changes in residual dispersion.

Empirical Analysis

The methodology is used to construct counterfactuals illustrating how inequality would have behaved if only observable attributes, returns to those attributes, and residual dispersion had changed over time, where inequality is defined by the 80-20 decile ratio as well as by the 80-50 and 50-20 ratios in order to ascertain how dispersion behaved above and below the median. Also, to focus on the role of human capital, log wage regressions are estimated using only the education and experience variables detailed in Appendix B. Although returns to skill are generally lower when the sectoral and spatial controls are used as in Section 4, the trends remain largely unaffected.

Figure 6. Trends in the 80-20 Ratio That Would Have Occurred If Only Characteristics, Returns to Skill, and Residual Variation Had Changed.



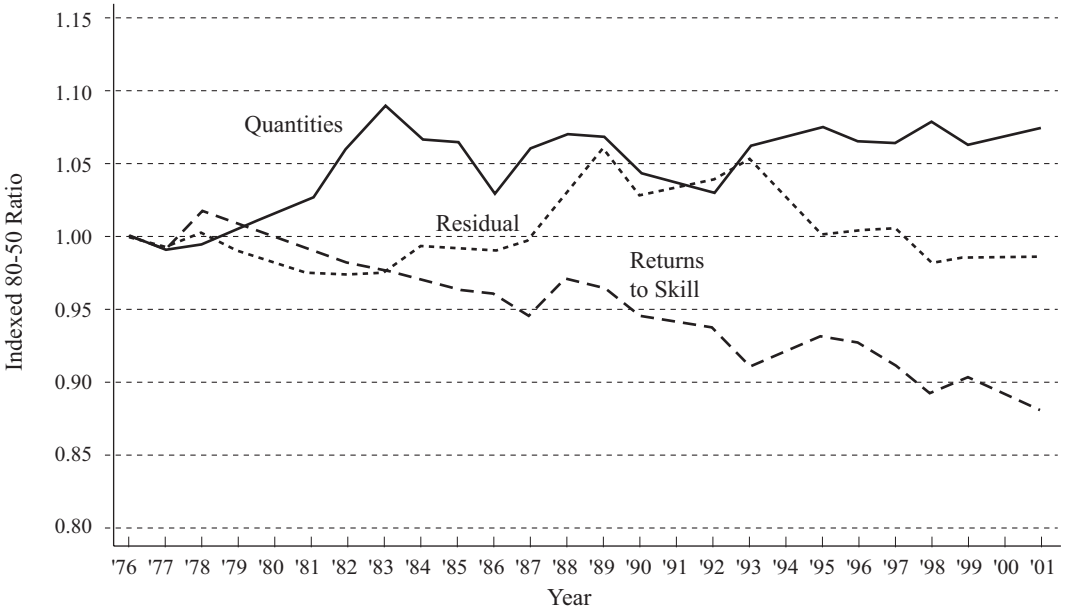
Source: Author's calculations from 1976-2001 PNAD files.

Note: This figure depicts the trend that the 80-20 ratio would have followed if only observable characteristics, returns to skill, and residual variation had changed over the 1976-2001 period. Each line represents the corresponding counterfactual indexed to its level in 1976.

Figure 6 shows that changes in returns to skill exerted an equalizing influence throughout the study period, and that this dynamic strengthened during the 1990s. Had wage inequality been affected solely by changes in returns to skill, the 80-20 ratio would have declined in 1989 to a level equivalent to 95% of its 1976 value and would have further declined by 2001 to 79% of that value. In addition, Figures 7 and 8 show that declining returns to skill reduced inequality at both ends of the distribution even in the face of a rising premium to a college degree, a phenomenon explained by the very small percentage of the sample that was affected by the latter—5.6% to 8.8% depending on the year—and by the fact that returns to all levels of schooling besides a college degree show marked declines.

In contrast, inequality trends attributable to changes in residual dispersion play a prominent role only during the 1987–93 period, when the economy bordered on hyperinflation. *Ceteris paribus,* changes in residual variation would have produced a 12% increase in the 80-20 ratio between 1987 and 1989 and another spike in 1993 when inflationary levels reached their peak. Following the advent of price stability in 1994, the influence of residual dispersion receded, so that by 2001 inequality at the top and the bottom of the wage distribution would have changed by only 1% and 3% with respect to its level in 1976. Thus, unlike in other countries, such as the United States, in Brazil there seems to be no evidence of a long-term increase in inequality driven by consistently rising residual dispersion, often

Figure 7. Trends in the 80-50 Ratio That Would Have Occurred If Only Characteristics, Returns to Skill, and Residual Variation Had Changed.



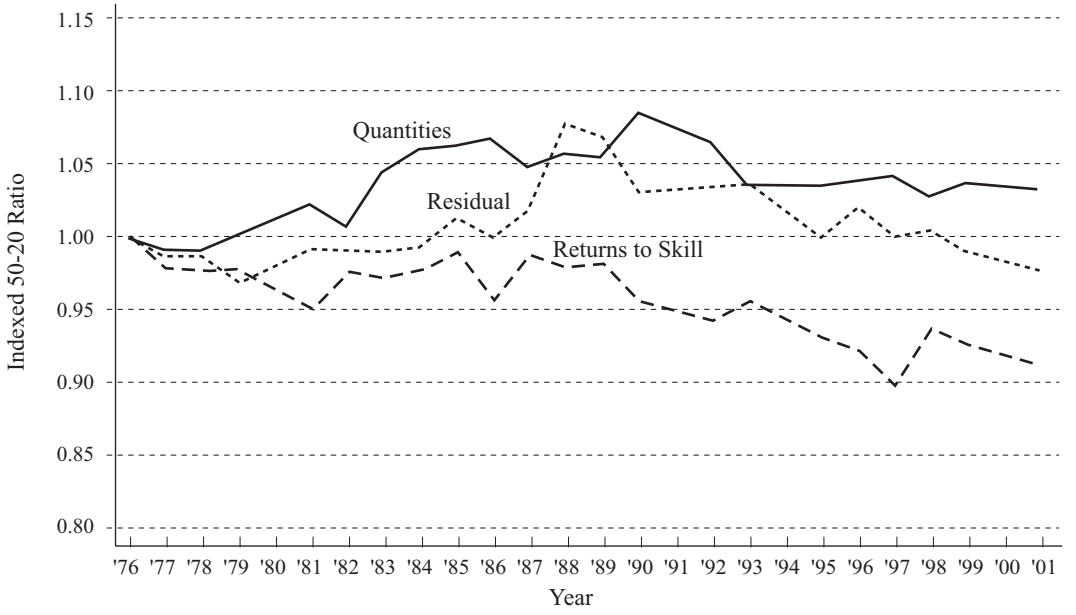
Source: Author's calculations from 1976-2001 PNAD files.

Note: This figure depicts the trend that the 80-50 ratio would have followed if only observable characteristics, returns to skill, and residual variation had changed over the 1976-2001 period. Each line represents the corresponding counterfactual indexed to its level in 1976.

tagged to an increasing valuation of unobservable attributes.

Finally, changes in the skill profile of the population exerted a disequalizing effect on distribution that nevertheless diminished slightly over time. Had these changes been the only thing affecting inequality, the 80-20 decile ratio would have increased by 12% between 1976 and 1989 but then would have fallen between 1989 and 2001 to a level 10% above its initial value. Figures 7 and 8 show that the decline in the disequalizing effects of characteristics was driven by changes occurring at the bottom of the distribution, where the 50-20 ratio rose by up to 8% but declined thereafter to a level 3% above its starting level. In contrast, at the top of the distribution changes in the education and experience profile of the work force were exerting an increasingly disequalizing influence. These differences are likely related to the two channels by which composition effects shape wage distribution. On the one hand, all else equal, growth in the size of population subgroups with high levels of within-group dispersion raises overall inequality. On the other hand, growth in the size of populations with subgroup mean wages closer to the global mean drives down overall inequality, *ceteris paribus*. In Brazil, within-group dispersion generally increases with the level of education, but the subgroup to global mean gap closes up to the 7th to the 10th year of education, depending on the year. As can be inferred from Figures 7–8, this second source of change seems to be gaining force at the bottom of the distribu-

Figure 8. Trends in the 50-20 Ratio That Would Have Occurred If Only Characteristics, Returns to Skill, and Residual Variation Had Changed.



Source: Author's calculations from 1976-2001 PNAD files.

Note: This figure depicts the trend that the 50-20 ratio would have followed if only observable characteristics, their returns to skill, and residual variation had changed over the 1976-2001 period. Each line represents the corresponding counterfactual indexed to its level in 1976.

tion, whereas at the top the sources of change are producing net disequalizing effects.

The information contained in Figures 6–8 and Table 3 sheds light on the factors driving the short- and long-run trends in wage inequality. The steadily climbing levels of inequality evident during the 1980s can be attributed to the disequalizing composition effects of an educational expansion, but also, and more importantly, to sharply increasing residual dispersion in the context of mounting rates of inflation. If only residual dispersion had changed over the 1981–89 period, the 80-20 ratio would have increased by 18% (Table 3), which represents 72% of the actual change that occurred during the period. The disequalizing skill composition effects diminished slightly during the 1990s, residual dispersion receded with the advent of price stability, and the equalizing effects of falling returns to skill gained force during the 1990s to produce an even stronger fall in inequality during that decade.

As for the perhaps more important matter of the reasons behind the long-term fall in wage inequality in a country where wages at the 90th percentile have averaged a level 10 times that found at the 10th percentile, falling returns to skill stand out as the predominant force, especially if the spike in residual variation is interpreted as a temporary phenomenon related to a very unstable macroeconomic environment. Between 1976 and 2001 skill composition changes would have produced a 10% increase in the 80-20 ratio, but changes in

Table 3. Observed Trends in the 80-20, 80-50, and 50-20 Ratios and Trends They Would Have Followed if Only Characteristics, Returns to Skill, and Residual Variation Had Changed over the 1976–2001 Period.

	80-20 ratio				*80-50 ratio*				*50-20 ratio*			
Year	*Char's*	*Ret's*	*R.V.*	*Obs.*	*Char's*	*Ret's*	*R.V.*	*Obs.*	*Char's*	*Ret's*	*R.V.*	*Obs.*
1976	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1977	0.98	0.97	0.98	0.94	0.99	0.99	0.99	0.97	0.99	0.98	0.99	0.96
1978	0.99	0.99	0.99	0.97	1.00	1.02	1.00	1.02	0.99	0.98	0.99	0.96
1979	1.01	0.99	0.96	0.95	1.01	1.01	0.99	1.00	1.00	0.98	0.97	0.95
1981	1.05	0.94	0.97	0.96	1.03	0.99	0.98	1.00	1.02	0.95	0.99	0.97
1982	1.07	0.96	0.97	0.99	1.06	0.98	0.97	1.02	1.01	0.98	0.99	0.97
1983	1.14	0.95	0.96	1.05	1.09	0.98	0.98	1.04	1.04	0.97	0.99	1.01
1984	1.13	0.95	0.99	1.06	1.07	0.97	0.99	1.03	1.06	0.97	0.99	1.03
1985	1.13	0.95	1.00	1.08	1.07	0.96	0.99	1.02	1.06	0.99	1.01	1.07
1986	1.10	0.92	0.99	1.00	1.03	0.96	0.99	0.98	1.07	0.95	1.00	1.02
1987	1.11	0.93	1.02	1.06	1.06	0.95	1.00	1.00	1.05	0.99	1.02	1.05
1988	1.13	0.95	1.11	1.19	1.07	0.97	1.03	1.07	1.06	0.98	1.08	1.11
1989	1.12	0.95	1.14	1.20	1.07	0.97	1.06	1.09	1.05	0.98	1.07	1.10
1990	1.13	0.90	1.06	1.08	1.04	0.95	1.03	1.01	1.08	0.95	1.03	1.07
1992	1.09	0.88	1.07	1.04	1.03	0.94	1.04	1.00	1.06	0.94	1.03	1.04
1993	1.10	0.86	1.09	1.05	1.06	0.91	1.05	1.03	1.03	0.95	1.03	1.02
1995	1.11	0.86	1.00	0.97	1.08	0.93	1.00	1.01	1.03	0.93	1.00	0.96
1996	1.10	0.85	1.02	0.97	1.07	0.93	1.01	1.00	1.04	0.92	1.02	0.97
1997	1.10	0.81	1.00	0.92	1.06	0.91	1.01	0.98	1.04	0.89	1.00	0.93
1998	1.10	0.83	0.99	0.92	1.08	0.89	0.98	0.95	1.03	0.93	1.00	0.96
1999	1.10	0.83	0.97	0.90	1.06	0.90	0.99	0.95	1.03	0.92	0.99	0.94
2001	1.10	0.79	0.97	0.86	1.08	0.88	0.99	0.94	1.03	0.91	0.97	0.91

Source: Author's calculations from 1976–2001 PNAD files.

Note: The table presents the coordinates of Figures 6–8, with each column representing the corresponding counterfactual indexed to its value in 1976. *Char's* refers to quantities or individual characteristics, *Ret's* to the returns to those characteristics, and *R.V.* to residual variation. The sum of the changes of the three counterfactuals is the observed (Obs.) change. For example, between 1976 and 2001 the changes in the three components referring to the 80-20 ratio (10%, –21%, –3%) add up to the actual change in that measure (–14%).

returns to skill would have driven down dispersion by 21%.[12] Differences at the top and bottom ends of the distribution largely pertain to differences in the degree to which composition effects influenced inequality, where they would have driven an 8% increase at the top but only a 3% increase at the bottom. Using as a reference other periods that are more comparable in terms of macroeconomic cycle does not change the qualitative nature of the results. Between 1982 and 1999, both recessionary years with similar GDP growth and unemployment rates, changing characteristics would have produced a 3% increase in the 80-20 ratio; changing returns to skill, a 14% decrease; and residual variation, a 1% increase. As a point of comparison, Juhn, Murphy, and Pierce (1993:430) found that all three sources of change contributed to rising levels of inequality in the United

[12]These types of numbers can be obtained from Table 3 for any period of interest. In the case of the change in the 80-20 wage ratio involving the years 1976 and 2001, the table shows that changing characteristics would have increased the 80-20 ratio by 10%, falling returns to characteristics would have reduced the ratio by 21%, and declining dispersion would have reduced the ratio by 3%. These percentages add up to the actual –14% change in the 80-20 ratio occurring between 1976 and 2001. To conserve space, coordinates are rounded to two significant digits, producing counterfactual components that may not add up exactly to the observed changes in inequality.

States, with increased residual dispersion accounting for the bulk of the changes at both ends of the distribution.[13]

Conclusion

Wage inequality among prime-age full-time Brazilian men fell during the late 1970s, rose by 25% during the 1980s, and fell once more during the 1990s, with the net result being a 14% decline in the 80-20 percentile ratio between 1976 and 2001. Behind the sharp increase in dispersion occurring over the 1980s were disequalizing composition effects associated with an educational expansion, but far more important was rising residual dispersion in the context of mounting rates of inflation. The disequalizing skill composition effects diminished during the 1990s, residual dispersion receded with the advent of price stability, and the equalizing effects of falling returns to skill gained force during the 1990s to produce an even stronger fall in inequality during that decade.

In terms of the perhaps more important question of the long-term fall in dispersion in a country where individuals at the ninth decile have averaged a wage 10 times that found at the first decile, falling returns to skill are squarely at the center of the positive developments, especially if the spike in residual variation is interpreted as a temporary phenomenon related to a very unstable macroeconomic environment. If only returns to skill had changed, the 80-20 ratio would have declined in 1989 to a level equivalent to 95% of its 1976 value, would have further declined to 86% of its 1976 value by 1995, and to 79% of its 1976 value by 2001. Disequalizing skill composition effects concentrated at the top of the distribution were unable to override the positive effects of compression in the returns to skill, and hence the net effect of educational progress on Brazilian inequality was to reduce it. However, whether a 14% decline in the 80-20 ratio constitutes a satisfying result of an educational expansion that in a span of 25 years doubled the median schooling level of the sample is a question whose answer may lie in the eye of the beholder.

[13]The incorporation of self-employed individuals in the samples has little effect on the results. It lowers the long-term fall in the 80-20 ratio from 14% to 13%, and the resulting decomposition figures are very close to those reported in Table 3. *Ceteris paribus,* changes in observed characteristics would have raised the 80-20 ratio by 8%, while changes in returns and residual variation would have reduced it by 18% and 3%, respectively. The share of self-employed individuals has held fairly steady over time, at about one-third of the male working population aged 18 to 64.

Appendix A
Measures of Wage Inequality: Percentile Ratios and the Gini Coefficient

	Decile Comparison						
Year	*80-20*	*80-50*	*50-20*	*90-10*	*90-50*	*50-10*	*Gini*
1976	4.37	2.24	1.95	10.00	4.00	2.50	539
1977	4.09	2.18	1.87	9.04	3.84	2.35	522
1978	4.25	2.28	1.87	9.79	4.02	2.44	535
1979	4.16	2.25	1.85	9.70	3.97	2.45	526
1981	4.20	2.23	1.89	10.09	3.87	2.61	517
1982	4.33	2.28	1.90	9.89	3.95	2.51	515
1983	4.58	2.34	1.96	10.34	3.93	2.63	524
1984	4.63	2.31	2.01	10.45	3.92	2.66	523
1985	4.74	2.28	2.08	10.50	3.75	2.80	529
1986	4.36	2.19	1.99	10.00	3.71	2.69	504
1987	4.62	2.25	2.05	11.02	3.75	2.94	525
1988	5.20	2.40	2.17	12.39	4.15	2.98	558
1989	5.26	2.45	2.15	12.80	4.28	2.99	557
1990	4.72	2.27	2.08	12.32	3.75	3.29	522
1992	4.55	2.25	2.02	9.19	3.60	2.55	510
1993	4.58	2.30	1.99	9.54	3.68	2.59	539
1995	4.22	2.26	1.87	9.60	3.61	2.66	514
1996	4.24	2.23	1.90	9.43	3.43	2.75	499
1997	4.00	2.20	1.82	9.53	3.58	2.67	502
1998	4.00	2.13	1.88	9.10	3.47	2.63	507
1999	3.92	2.13	1.84	8.78	3.47	2.53	498
2001	3.75	2.11	1.78	8.33	3.52	2.37	499

Source: Author's calculations from 1976–2001 PNAD files.

Note: Inequality is measured through the use of the Gini coefficient multiplied by 1000 and by the ratio of wages at the corresponding percentiles.

Appendix B

The Estimation of Returns to Skill

Returns to human capital are calculated by regressing the natural logarithm of the hourly wage on an education step function, a linear term within education categories, a quartic in potential experience, an interaction between experience and four education categories (primary, intermediate, secondary, and college education), and binary variables for head of household, industrial sector, region, and urban area residence. The education step function is composed of binary variables for the following levels of education: incomplete elementary school (1–3 years of education), completed elementary school (4 years), incomplete intermediate school (5–7 years), completed intermediate school (8 years), incomplete high school (9–10 years), completed high school (11 years), incomplete college (12–14 years), college degree (15–18 years). Region binary variables refer to the standard subdivision of the country into the North, Northeast, South, Southeast, and Midwest, while industrial sector binary variables include light and heavy industry, construction, commerce, transportation and communication, services, the social sector (for example, teaching, medical services), and public administration.

Specifically, the return to primary school is defined as the difference in wages between workers with 4 years of education and workers with no schooling; the return to intermediate school as the wage differential between workers with 8 years of education and workers with 4 years; the return to secondary education as the differential between workers who completed secondary school and those who completed intermediate school; and the return to a college education as the wage differential between workers with a college degree and workers who completed secondary education. Returns to experience are evaluated at 15, 20, and 25 years, where potential labor market experience is set as age minus education minus 7—the age at which formal education begins in Brazil. In order to control for changes in the education and experience profile of the population, returns to skill are calculated using the fixed-weight aggregation scheme of Katz and Murphy (1992).

REFERENCES

Barros, Ricardo, Ricardo Henriques, and Rosane Mendonça. 2002. "Pelo fim das décadas perdidas: Educação e desenvolvimento sustentado no Brasil" ("Toward the End of the Lost Decades: Education and Sustainable Development in Brazil"). Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada Discussion Paper No. 857.

Birdsall, Nancy, Barbara Bruns, and Richard Sabot. 1996. "Education in Brazil: Playing a Bad Hand Badly." In Nancy Birdsall and Richard Sabot, eds., *Opportunity Foregone: Education in Brazil.* Washington, D.C.: Inter–American Development Bank, pp. 7–47.

Bonelli, Regis, and Lauro Ramos. 1995. "Distribuição de renda no Brasil: Avaliação das tendências de longo prazo e mudanças na desigualdade desde meados dos anos 70" ("Income Distribution in Brazil: Appraisal of Long Run Trends and Changes in Inequality since the Mid-1970s"). *Revista Brasileira de Economia,* Vol. 49, No. 2 (April–June), pp. 353–73.

Castello Branco, Roberto. 1979. *Crescimento acelerado e mercado de trabalho: A experiência brasileira* (*Rapid Growth and the Labor Market: The Brazilian Experience*). Rio de Janeiro: Fundação Getúlio Vargas Press.

Edwards, Sebastian. 1995. *Crisis and Reform in Latin America: From Despair to Hope.* Oxford: Oxford University Press for the World Bank.

Fernandes, Reynaldo, and Naércio Menezes. 2000. "A evolução da desigualdade no Brasil metropolitano entre 1983 e 1997" ("The Evolution of Inequality in Metropolitan Brazil between 1983 and 1997"). *Estudos Econômicos,* Vol. 30, No. 4 (October–December), pp. 549–69.

Fishlow, Albert. 1972. "Brazilian Size Distribution of Income." *American Economic Review,* Vol. 62, No. 2 (May), pp. 391–402.

Fishlow, Albert, Ariel Fiszbein, and Lauro Ramos. 1993. "Distribuição de renda no Brasil e na Argentina: Uma análise comparativa" ("Income Distribution in Brazil and Argentina: A Comparative Analysis"). *Pesquisa e Planejamento Econômico,* Vol. 23, No. 1 (April), pp. 1–31.

Gottschalk, Peter. 1997. "Inequality, Income Growth, and Mobility: The Basic Facts." *Journal of Economic Perspectives,* Vol. 11, No. 2 (Spring), pp. 21–40.

Gottschalk, Peter, and Timothy Smeeding. 1997. "Cross-National Comparisons of Earnings and Income Inequality." *Journal of Economic Literature,* Vol. 35, No. 2 (June), pp. 633–87.

Hoffmann, Rodolfo. 1995. "Desigualdade e pobreza no Brasil no período 1979–90" ("Inequality and Poverty in Brazil during the 1979–90 Period"). *Revista Brasileira de Economia,* Vol. 49, No. 2 (April–June), pp. 277–94.

Juhn, Chinhui, Kevin Murphy, and Brooks Pierce. 1993. "Wage Inequality and the Rise in the Returns to Skill." *Journal of Political Economy,* Vol. 101, No. 3 (June), pp. 410–42.

Katz, Lawrence, and Kevin Murphy. 1992. "Changes in Relative Wages, 1963–1987: Supply and Demand Factors." *Quarterly Journal of Economics,* Vol. 107, No. 1 (February), pp. 35–78.

Lam, David, and Deborah Levison. 1992. "Declining Inequality in Schooling in Brazil and Its Effects on Inequality in Earnings." *Journal of Development Economics,* Vol. 37, No. 1/2 (November), pp. 199–225.

Langoni, Carlos. 1973. *Distribuição de renda e desenvolvimento econômico do Brasil* (*Income Distribution and Economic Development in Brazil*). Rio de Janeiro: Expressão e Cultura.

Neri, Marcelo. 1995. "Sobre a mensuração dos salários reais em alta inflação" ("On the Measurement of Real Wages during Periods of High Inflation"). *Pesquisa e Planejamento Econômico,* Vol. 25, No. 3 (December), pp. 497–525.

Psacharopoulos, George, Samuel Morley, Ariel Fiszbein, Haeduck Lee, and William Wood. 1995. "Poverty and Income Inequality in Latin America during the 1980s." *Review of Income and Wealth,* Vol. 41, No. 3 (September), pp. 245–64.

Reis, José, and Ricardo Barros. 1991. "Wage Inequality and the Distribution of Education." *Journal of Development Economics,* Vol. 36, No. 1 (July), pp. 117–43.

Senna, José. 1976. "Escolaridade, experiência no trabalho e salários no Brasil" ("Schooling, Work Experience, and Wages in Brazil"). *Revista Brasileira de Economia,* Vol. 30, No. 2 (April–June), pp. 163–93.

Velloso, Jacques. 1979. "Educação e desigualdade da renda urbana no Brasil, 1960/80" ("Education and Urban Income Inequality in Brazil, 1960/80"). *Pesquisa e Planejamento Econômico,* Vol. 9, No. 3 (December), pp. 661–718.