THE EFFECTS OF LABOR FORCE AGING AND FEMALE PARTICIPATION GROWTH ON THE INCOME INEQUALITY

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Several studies have pointed that the rapid transformations in the composition of a population have serious economic consequences. Part of the literature that analyzes the economical consequences of population growth has attempted to investigate the effects of labor force age structure on the income inequality distribution. Three main reasons motivating the investigation of the demographic changes and income inequality in Brazil follow. First, it has one of the worst and more persistent unequal income distribution worldwide. Second, since the late 1960's, Brazil has been experiencing one of the most impressive fertility decline among the developing countries and, as a consequence, it has been facing an accelerated aging process. Lastly, over the past several decades, the Brazilian labor market has been facing significant increase in female's labor force participation. Considering that females' mean incomes are lower than those earned by their male counterparts, and that income inequality tends to be smaller among women, some sort of effect resulting from this crescent female's labor force participation is expected to occur over the inequality.

Using data from repeated cross-sections of a large Brazilian household survey (PNADs) from 1977 to 1998, this study intends to analyze the effects of age and sex structure changes on income inequality and the importance and effectiveness of public policies designed to best reduce such inequality.

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A Brief Literature Review

Although many international scholars have focused their research on the issue of income distribution, in Brazil the effects of demographic changes on income inequality has been little explored in the literature. This section is dedicated to review important studies that deal with the relationship between demographic changes and inequality.

Paglin's 1975 relevant study about the measurement and trend of inequality highlights the fact that changes in the population's age structure has an impact on measures of income inequality. He points out that, since the individuals in the population are positioned in distinct points of their income life cycles, part of the inequality observed in a society must be ascribed to income differences by age. His arguments are based on the idea that in any society exist a typical cycle of income, that is, the income of people in the work force tends to increase until it reaches a maximum point, or a plateau. After that, it tends to either stabilize or decrease. In this sense, the income differences due to age are a problem totally distinct from the income inequality related to population well-being.

Considering the implications of a rapid population growth and changes in the age structure on distributional issues, Lam (1987) argues that the effects of changes in the population's age structure have two particular components, one is the "direct effect over the welfare" and, the other is the "composition effect". In his view, most of the studies attempting to explore the relationship between population growth and inequality confound these effects. According to Lam, changes in the population's age structure can have a "direct effect over the welfare", but these changes can have, before anything else, a "pure composition effect" over the inequality measures. The later effect is the result of changes in the relative participation of income groups, since the different age groups have distinct mean incomes. A modification in the relative size of age groups alters, consequently, the relative size of income groups. Lam points out that changes in the age structure can not be viewed as directly affecting people's welfare, since it does not imply alteration in their actual incomes. Furthermore, he observes that income inequality depends on the

combination between the intra and inter-cohort inequality, which are affected in different ways by changes in the population structure by age and sex.

In an empirical study, Langoni (1973) explores the hypothesis that changes in the age and sex composition of the work force may explain the deterioration of income inequality indicators, observed in Brazil between 1960 and 1970. He argues that, although the relative growth of women and young people's participation in the work force increased the relative weight of the lowest incomes, the impact over the crescent global inequality was notably reduced. One main reason that explain this phenomenon lies on the fact that the inequality within women's and young people's groups is relatively smaller, and it sort of compensates the impact of low incomes' high frequencies.

In an attempt to isolate the effects of age structure on income inequality, Simonsen (1978) calculates the Paglin-Gini coefficient for the 1970 and 1980 Brazilian individual income distribution. Through this coefficient, proposed by Paglin (1975), it is possible to reduce, from the conventional Gini coefficient, the inequality quota that must be assigned to variation in income due to age. The results achieved by Simonsen show that, for 1970, the Paglin-Gini coefficient increased from 0.366 to 0.380 (3.8%), while the conventional Gini raised from 0.500 to 0.568 (13.6%)[3]. From these data, he concludes that the income-age effect was the main reason of the increase observed in the traditional Gini coefficient. According to him, two points may explain this phenomenon: first, a great vertical mobility in the society and, second, high rates of population growth that increases the proportion of young people in the work force (Simonsen, 1978:13).

Wajnman (1989), analyses the demographic structure of the work force and income distribution in Brazil between 1970 and 1980. Her first conclusion is that the measures of inequality are affected by the structure of the work force and that the direction of this effect is very difficult to be foreseen, since it is a result of multiple composition effects that may act in opposite ways. Her second conclusion is that the pure composition effect of changes in the age structure, during the period included in the study, is towards a reduction in the income inequality distribution. However, according to Wajnman, this composition effect is

compensated by the effect of augmented wage differentials inter age groups. The effects of changes in the population sex composition, on the other hand, favored the growth of inequality.

In an analyze about the determinants of inequality in Brazil, Barros and Mendonça (1996) allege that important regularities in the relationship between income inequality and experience in the labor market were observed by a series of relevant studies. They point out that in Brazil, as well as in other countries, the relationship between income and inequality assumes an inverted-U shape. It demonstrates, according to them that, initially, incomes grow with experience at decreasing rates. After 25 or 30 years of experience in the labor market, incomes tend to decrease along with the worker's experience. The same line of argument can be used if experience is considered as a proxy for age.

In a more recent study, Barros et al. (2000) present an analysis about the impact of the size and the age composition of the population on the level of poverty in Brazil. By considering the demographic changes that occurred over previous decades, they estimate the impact of these transformations on the distribution of income and, consequently, on the level of poverty. The results achieved in their study show evidence that the changes in the size and in the age structure of the population led to a continuous reduction of the poverty. Furthermore, according to their estimates, they conclude that overall demographic changes tend to have much greater impact on poverty than differences in the time and in the speed of demographic transition across regions and between poor and rich families.

Methods

For measuring income inequality, the exercises in this study are performed with data from repeated cross-sections of a large Brazilian household survey (PNADs). This investigation uses the income from the individual's main activity in the work force as its unit of analysis. The period included in this research goes from 1977 to 1999.

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[3] Information extracted from Langoni (1973).

Generally, studies of inequality are carried out taking into account the behavior and trends of some measures of inequality such as, for example, the Gini coefficient of income inequality and the Index's Theil. The former is a measure that includes everything that affects the income distribution, making impossible to distinguish whether or not the differences are due to changes in the population's demographic composition. Unlike the Gini coefficient, the Theil Index allows the decomposition of the inequality in within and between groups. Based on this difference, the Theil Index is employed in this study.

In order to assess the effects of changes in the Brazilian age structure and labor force sex ratio on the income inequality, the empirical strategy used in this investigation involves four steps. In the first one, the labor force distribution by age, sex and income profile is examined. In the second step, the Theil Index of overall inequality is estimated and decomposed into inequality within and between age and sex groups. This index of global inequality can be specified as:

$$L = -\frac{1}{n} * \sum_{i=1}^{n} \ln \frac{x_i}{\mu} \, ,$$

where L denotes the Theil Index of overall inequality; n denotes the population of *n* individuals; x_i denotes the n-th individual's income, and μ represents the mean income.

Since the Theil Index is the logarithm of the ratio between the arithmetic and the geometric mean, it is defined that greater values of L depict worse levels of inequality. When the L value is equal zero, it means that the income distribution is completely equal. One of the main advantages of using the Theil L Index resides in the fact that it allows the desegregation of the inequality in two groups: the inequality within the group and the inequality between the groups. In order to perform this desegregation the following expression is used:

$$L = \sum_{j=1}^{n} f_j \ln(f_j / X_i) + \sum_{j=1}^{k} f_j L_j \, ,$$

where L denotes the overall Theil L; L_j denotes the Theil Index for the group j; f_j, that is the same as n_j/n, represents the proportion of the population from the j group in relation to

the total population, and x_i represents the proportion of group's j income in relation to the total income.

By performing this decomposition, it is possible to distinguish which are the components of inequality that can be explained by the demographic features of the labor force, and which ones can be explained by other factors.

The third step in this study is a counterfactual data analysis for assessing how the earning inequality would look like if the age and sex composition had remained at the 1979 level. The fourth and last step in this study is performed for verifying how much would be the Theil Index if the earnings profile by age and sex had not changed since 1979.
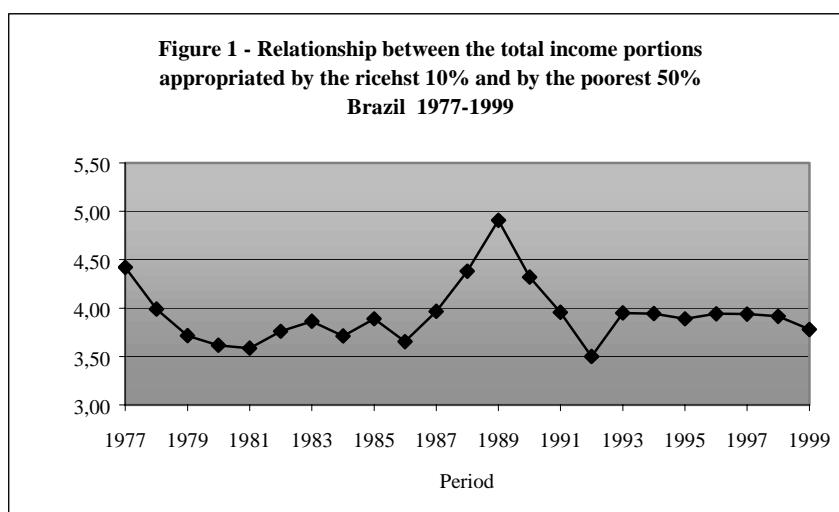
This method allows to estimate not only the effect of demographic changes on inequality, but also to separate the effects that are due to the population's age and sex composition (composition effects) and those that are due to the average earnings of groups (income effects). Furthermore, from labor force demographic projections and from the assumptions about the evolution of income differentials by age and sex, this method permits to make projections about the expected behavior of inequality for the next years. As a consequence, it also allows a relevant discussion about public policies, which are oriented towards the reduction of inequality.

Results

As many studies have demonstrated (Barros and Mendonça, 1996 Barros et al. 2000), Brazil has one of the highest levels of income inequality worldwide. Figure 1 illustrates this fact showing the appropriation of income by the richest 10 percent and by the poorest 50 percent of the Brazilian population between 1977 and 1999. As can be observed in this figure, the behavior of income concentration is practically stable during the period under analysis. The richest 10 percent of the population concentrate an income four times higher than the poorest 50 percent of the population. In percentage terms it is means that the 10 percent of the population with the highest income concentrate 48 percent of the total income, while the poorest 50 percent secure around 12 percent. In short, the

bulk of the nation's total income during these years was appropriated by a small portion of the Brazilian population, while a great of the county's inhabitants made do with far less.

Although the pattern presented in Figure 1 is basically stable, it shows a significant fluctuation between 1986 and 1992. The increased income disparity observed in this period is certainly a result of changes in the economy. Some of the changes in the Brazilian economy that underlie this trend are the 1986 "Plano Cruzado I and II"; the 1987 "Plano Bresser"; the 1989 "Plano Verão"; the 1990 "Plano Collor"; the 1991 "Plano Collor 2"; and finally the President's impeachment in 1992. Several Brazilian scholars (Barros, Henriques and Mendonça 2000; Ramos and Vieira 2000) performed studies investigating the inequality trends and behavior during this period.

Figure 1 - Relationship between the total income portions appropriated by the ricehst 10% and by the poorest 50% Brazil 1977-1999

Source: IPEADATA online (01/12/00) - www.ipeadata.gov.br

After the economic plan adopted in 1994, denominated "Plano Real", the series assumes again a stable trend until 1999, when it shows a mild decline indicating a decline in the income appropriated by the richest 10 percent in relation to the poorest 50 percent.

The remarks above are corroborated through the results displayed by the Gini Index and the Theil-L Index, showed in Figure 2 and Figure 3, respectively. These figures show that in the latest years the income inequality followed an "almost stable" trend.
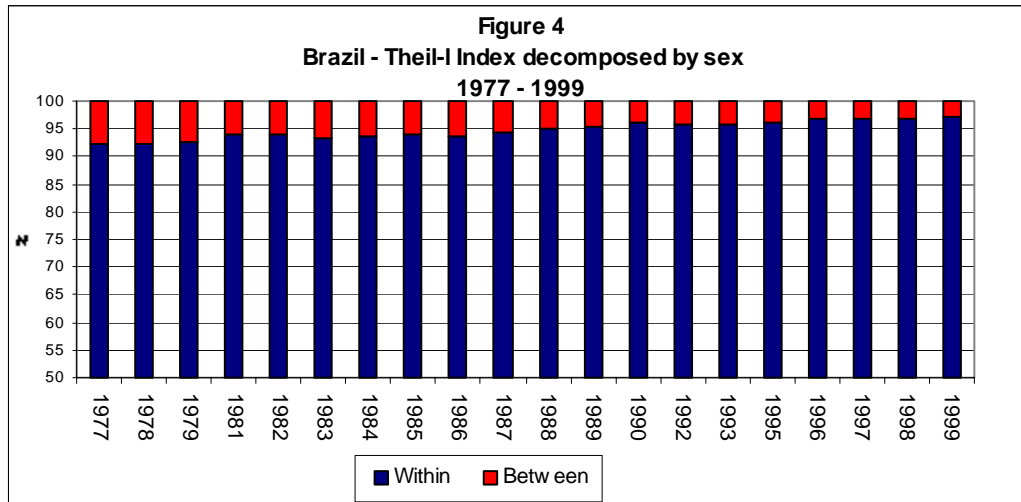
**Figure 2 - Gini Index
Brazil 1977-1999**

Source: IPEADATA online (01/12/00) - www.ipeadata.gov.br

**Figure 3 - Theil-L Index
Brazil 1977-1999**
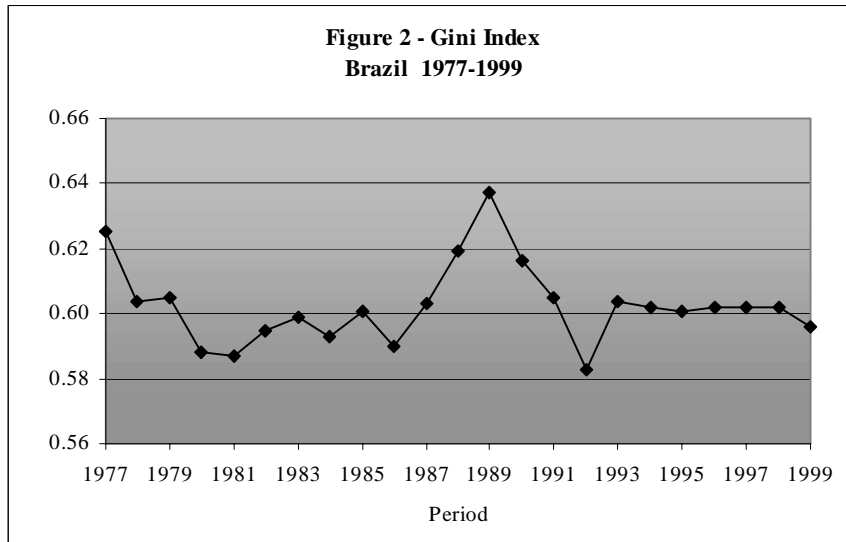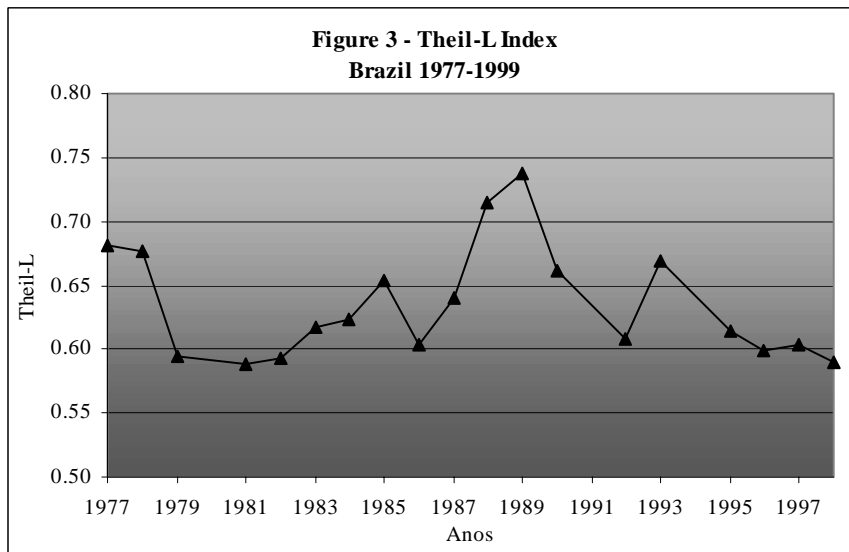
Source: FIBGE, PNAD 1977 a 1979, 1981 a 1990, 1992, 1993 e 1995 a 1999.

The results of the decomposition by sex can be observed in Figure 4, displayed next.

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Figure 4
Brazil - Theil-I Index decomposed by sex
1977 - 1999

Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Figure 4 makes clear that the income inequality within groups participating in the work force in Brazil during the period under analysis is higher than the income inequality between groups of different sex. The Theil Index shows that this inequality achieves the mark of 97%. In other words, same sex individuals experience expressive differences in their incomes, resulting in significant income inequality within the group.

Figure 5 presents the results achieved when the Theil Index is decomposed by groups of age. Similarly as when it is decomposed by sex, it is possible to note that the income inequality within groups of different ages holds remarkable levels and that it is also relevant between the different groups of age. According to the Theil Index, age differences explain 85% of the total income inequality.

When Figure 4 and Figure 5 are compared, it is worthwhile to argue that the weight of the income inequality within groups is increasing along the years, suggesting that incomes between groups of distinct sex and age are converging.

The aforementioned information brings to light the issue that even if a political effort were made for improving the income distribution between the groups, the country's

overall inequality would be reduced by an insignificant amount since the main inequalities are observed within the group (specially among women's groups).

Figure 5
Brazil - Theil-I Index decomposed by groups of age
1977 - 1999
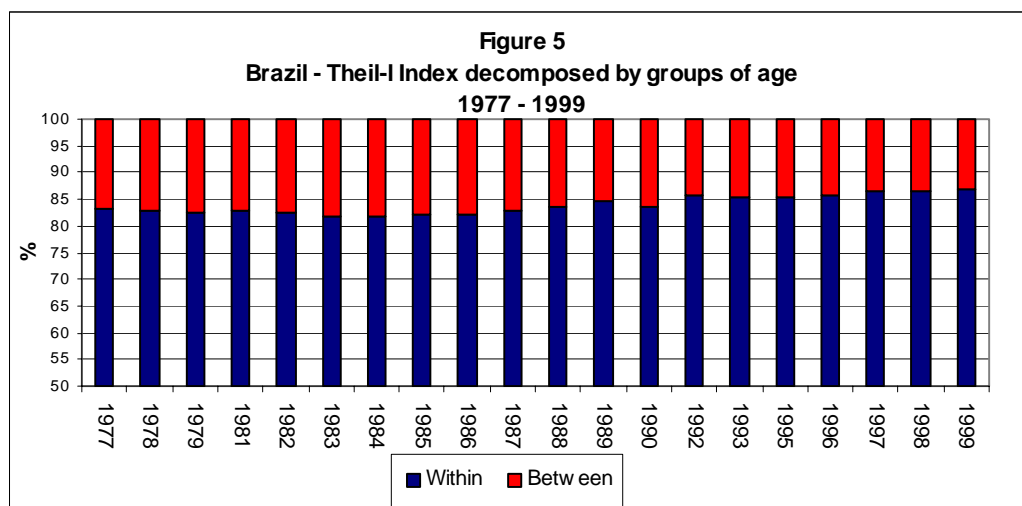
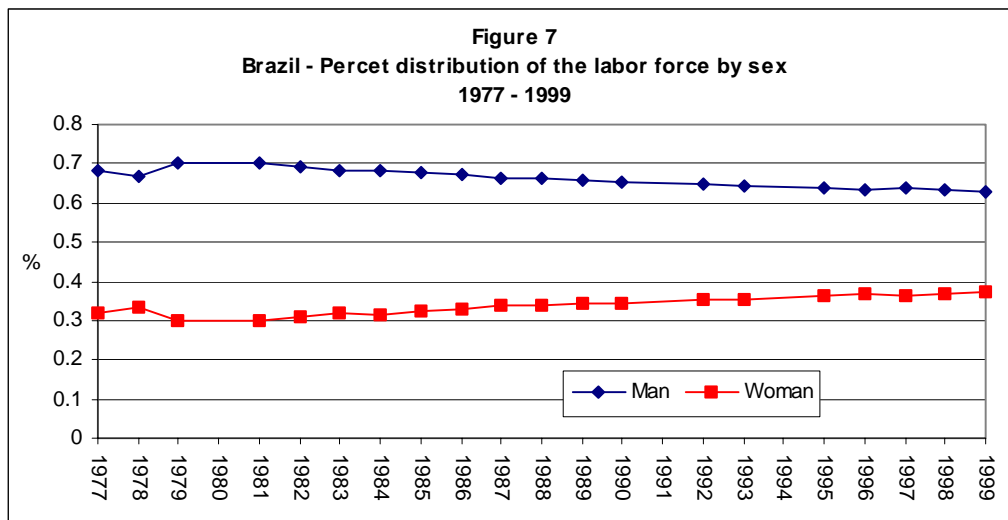Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Taking into account the huge transformations occurred in the Brazilian population age structure since the 60s, and considering the role played by demographic structures in determining the behavior of inequality, the aim of this study is now twofold. First, it proposes to exam the magnitude of the age structure transformation on levels of inequality and, second, it intends to verify the composition effects on inequality levels. Figure 6 shows the Brazilian work force percent distribution by sex in 1979 and in 1989 and 1999.

Figure 6, presenting the work force percent distribution by age groups for the three selected periods, shows, clearly, the impact of the new reproductive behavior adopted by the Brazilian women breaking the age structure observed along the two decades in issue. Furthermore, it is possible to observe the increasing decline of the relative weight of groups until 29 years old em relation to older groups of age, that is age groups between 30 and 59 years old.

Figure 6
BRAZIL - Percent distribuition of the labor force by age groups
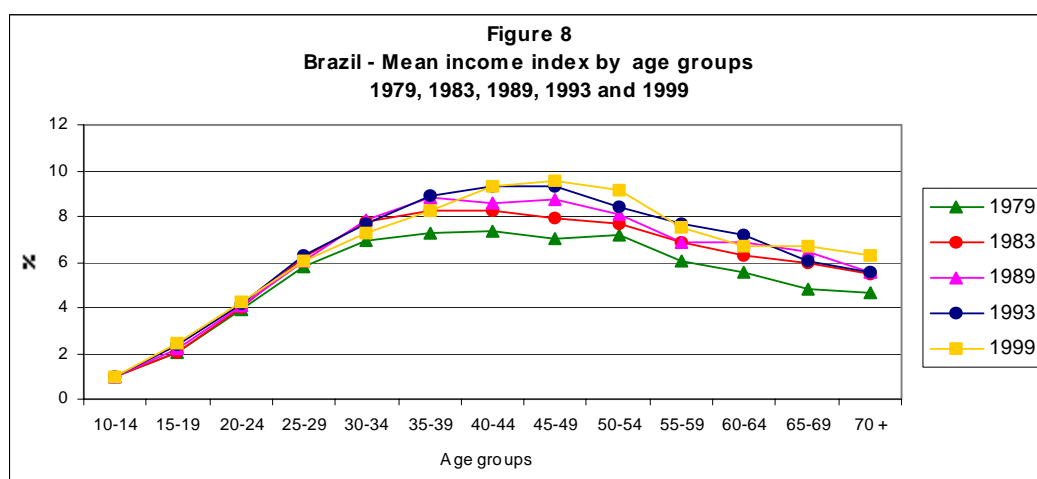**1979, 1989 and 1999**
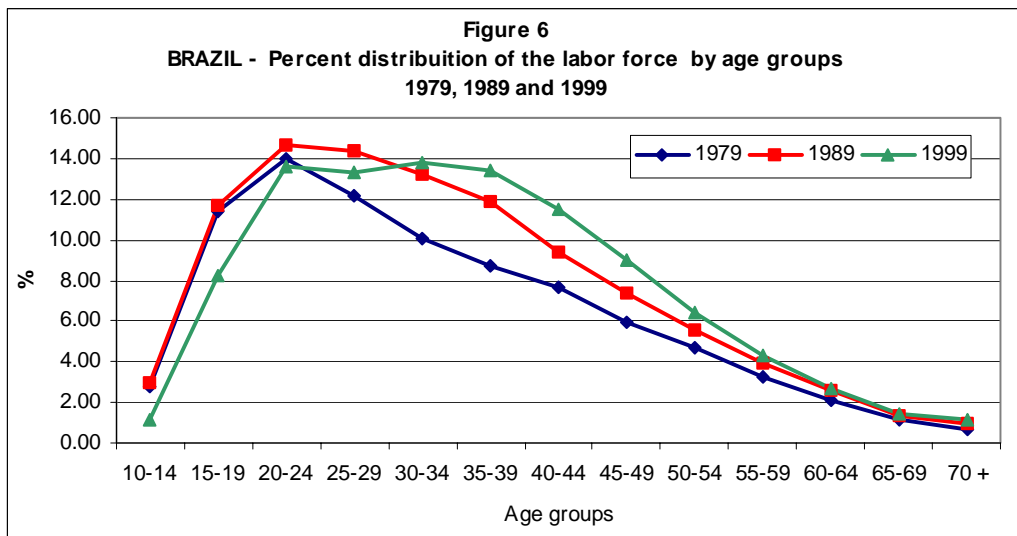
Source: FIBGE, PNAD 1979, 1989 and 1999.

Figure 7 shows the Brazilian work force percent distribution by sex from 1977 to 1999. As displayed in this figure, the distribution of the work force, by age, presents a differentiated behavior along the period in study. The total composition of the work force illustrates a boosting percent of women due to their crescent participation in the labor market. Both the change in the age structure as well as women's increasing participation in the work force can determine distinct effects over each one of the inequality index analyzed before, since this index is a combination of inequality between and within group. It is possible to note these existent differences by observing the pattern of income distribution and inequality by age groups.

Figure 7
Brazil - Percet distribution of the labor force by sex
1977 - 1999

Figure 8 displays the mean income distribution, by age groups. It exhibits the typical life cycle of individuals, when the working force income tends to increase until it reaches a plateau, when the individual is around 40 years old. After this, a situation of "almost stability" is achieved, being possible to observe, even, a slight decline. Furthermore, the figure shows that the differential among the age groups is augmenting allowing the distribution to become less flattened.
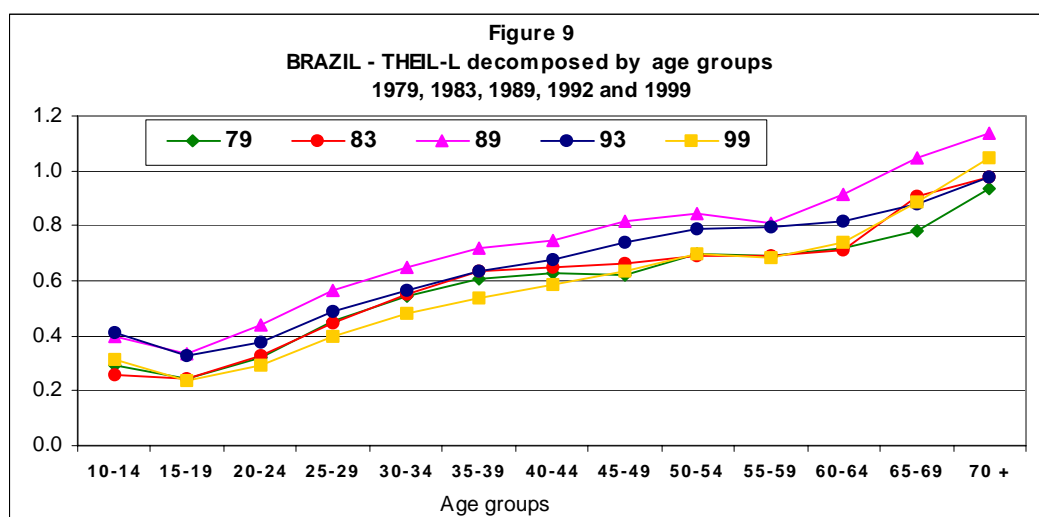
Figure 8
Brazil - Mean income index by age groups
1979, 1983, 1989, 1993 and 1999

Figure 9 presents the inequality behavior presented by the relative Theil Index (age groups mean income divided by the 10-14 age group mean income). This figure shows the crescent inequality differentials within the work force, that is, it demonstrates that the within group inequality raises with age. In this sense, it is possible to state that besides the increase in the mean income, the income's dispersion also augmented.

The declining participation portrayed by the three first age groups (10-14, 15-19, 20-24) can have two effects over the general inequality. Since these groups have the lowest incomes, specially the first one, their reduced participation leads to a fall in the between group inequality. On the other side, it is important to emphasize that, as showed by the estimated Theil Index, these groups present the smallest inequalities. As a consequence, a reduction in their participation may result in an increase in the total between group dispersion.

Unlike the previous groups, the 24 to 59 years old groups show an increase in their participation, particularly those in the 30 to 49 years. Because these groups present levels of inequality relatively closer and elevated, it is possible to observe an increase in the within groups of age inequality. However, since these groups incomes are similar and above the mean for all distribution, the between group inequality may decrease.

Figure 9
BRAZIL - THEIL-L decomposed by age groups
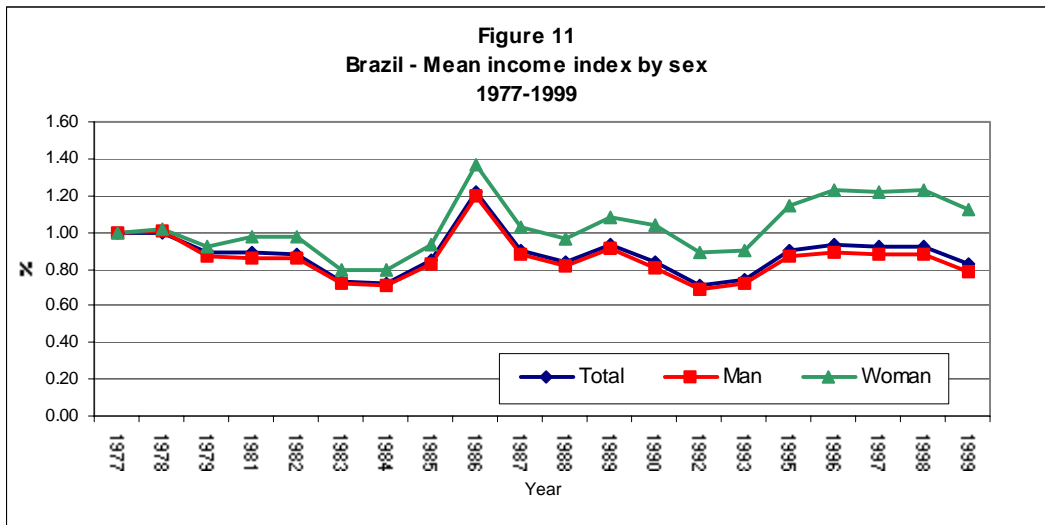**1979, 1983, 1989, 1992 and 1999**

Source: FIBGE, PNAD 1979, 1983, 1989, 1993 and 1999.

Figure 10 and Figure 11 show, respectively, the mean income distribution by sex for the whole period, and the mean income index estimated considering the 1977 income by sex. These figures display interesting peculiarities in the patterns of income distribution between men and women. While male workers usually occupy better positions in the labor market, what allows them to receive better incomes, women's achieved earnings along the two decades in issue, especially in the more recent period. It is even possible to note that, in some epochs, women's earns moves towards positive direction while men's goes in the opposite direction.

Figure 10
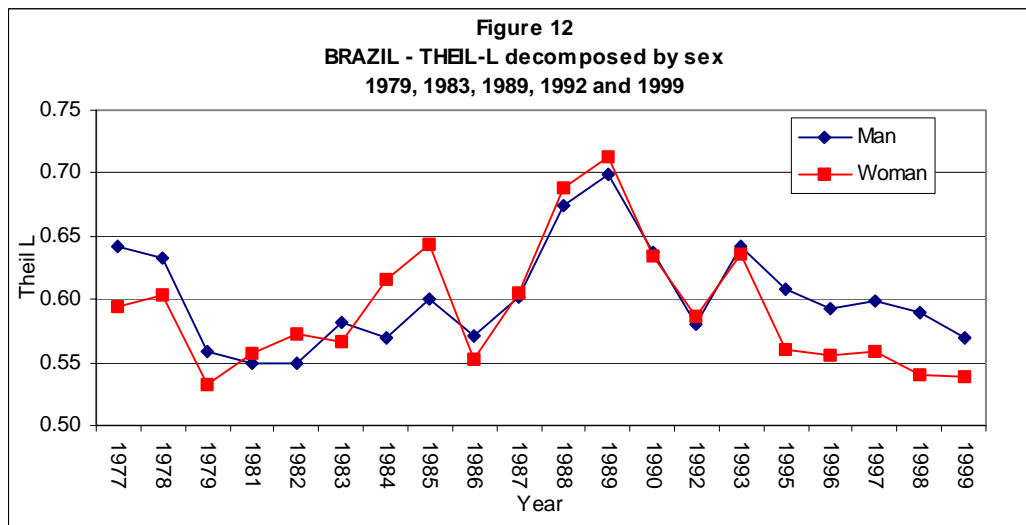**Brazil - Mean income by sex**
1977-1999
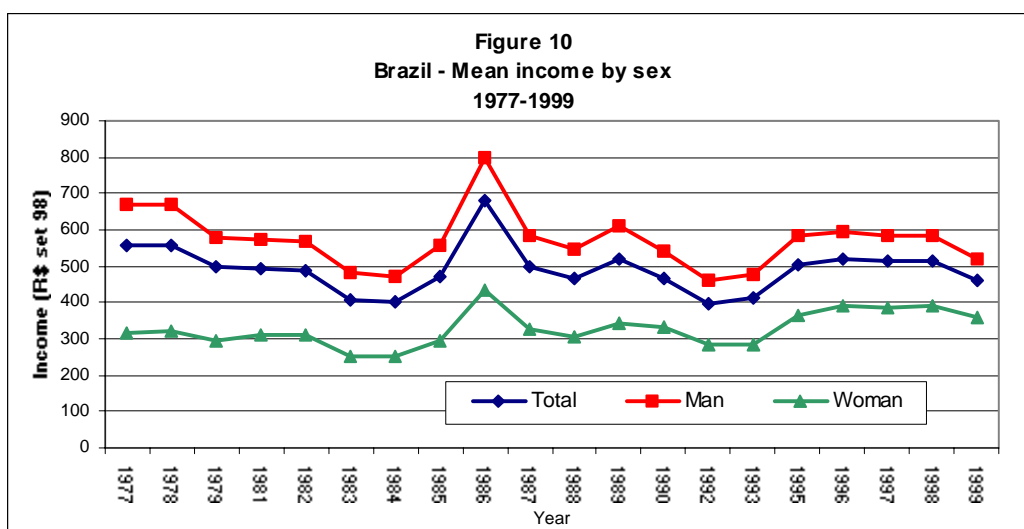
Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Considering the 90s as the reference, when the between sex groups inequality is clearly smaller, and taking into account the crescent females' work force participation it is expected that the component between groups decline. On the other side, since women have lower incomes than men, an increase in the between groups inequality may occur due to the greater relative women's earnings comparative to men's.

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Figure 11
Brazil - Mean income index by sex
1977-1999

Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Figure 12
BRAZIL - THEIL-L decomposed by sex
**1979, 1983, 1989, 1992 and 1999**

Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

One way to capture the composition effect resulting from changes in the work force age structure is to compare the inequality measures from the time series in question, taking the 1979 age and sex structure as the standard. The idea implied in this procedure is that when the work force age and sex structure are modified, the mean income and inequality within groups still unchanged. Moreover, the income structure is maintained fixed as a way

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to examine its composition effect. For this, the 1979 income profiles by age groups and sex was considered.

Changes in the Work Force Age Profile

The composition effects related to the age structure show that the impact of a younger age structure over the inequality, measured by the Theil-L, is dependent on the between and the within groups components that, in this study, go on distinct directions. In one side, a younger age structure increases the participation of working groups with lower incomes, raising the between groups component of the total inequality. On the other side, considering that the within groups inequality tends to growth with age, the participation increase of younger workers results in a diminution in this component. Figure 13 shows the effects resulting from the change in the age structure on the between and within groups components.

Figure 13
BRAZIL - Change effects of the age structure on the within and between components (age structure 1979)
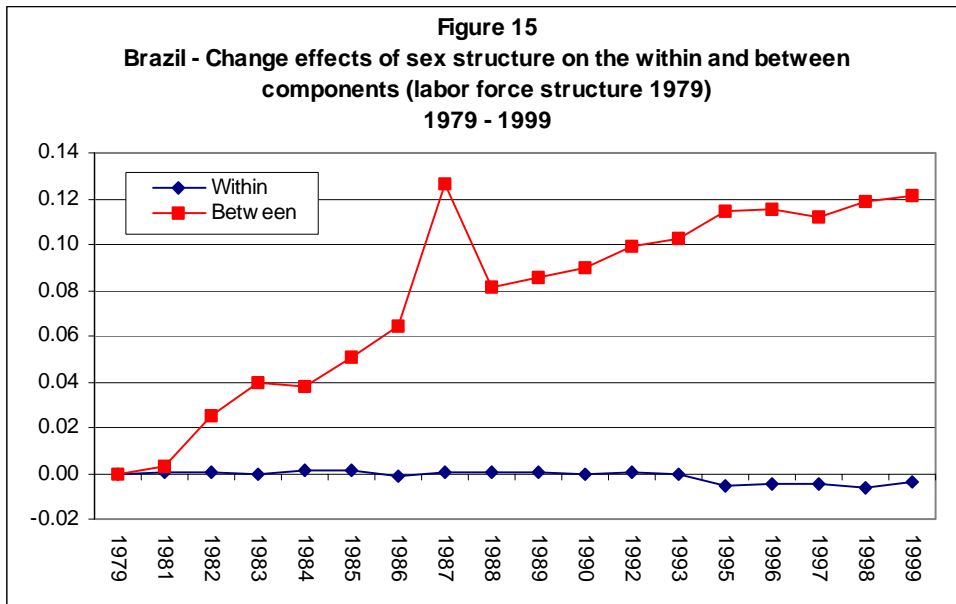1979 - 1999
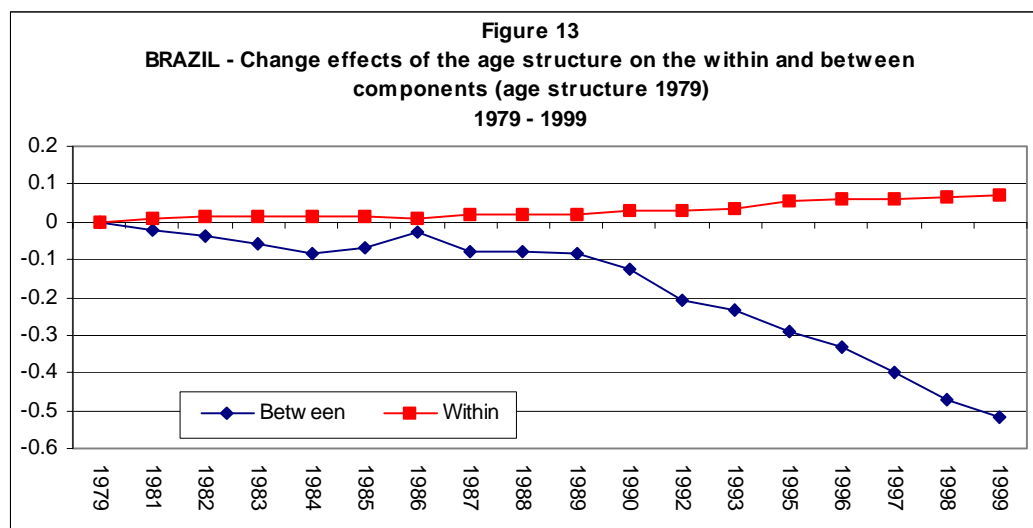
Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Figure 14 shows the original and standardized Theil Index by sex from 1977 to 1999. The composition effects associated to the working force structure, by sex, suggests that a greater male participation in the work force (1979 profile) would have a quite small reflex over the within group component. It was more likely to be observed until the beginning of the 90s, when the inequality by sex had a very similar level. On the other side, being males' income higher than those earned by women, an enlargement in men's participation in the work force would generate an increase in the between groups component. However, the effect of this component over the global inequality is inexpressive, given its small weight over the total.

Figure 14
Brazil - Original and standardized Theil I Index (age structure 1979)
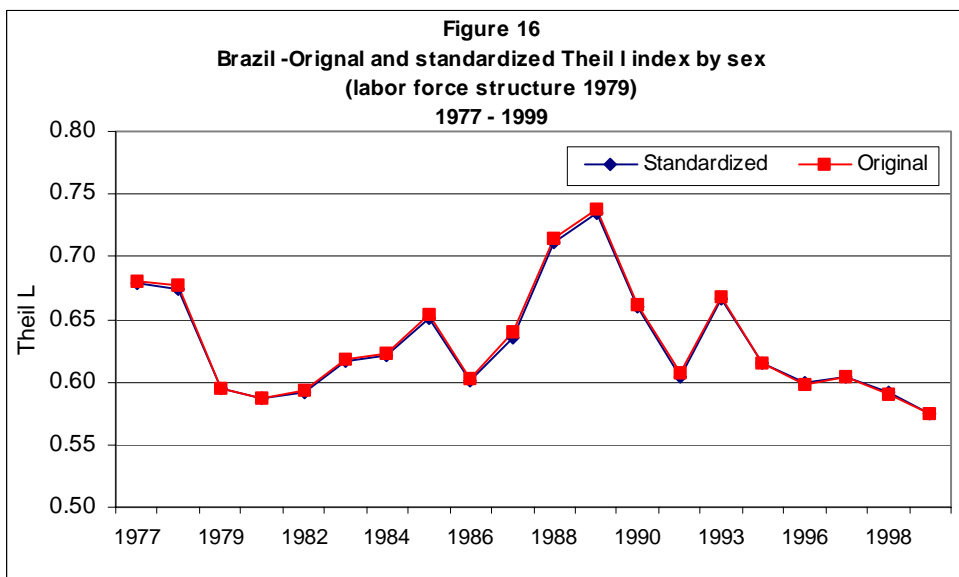**1977 - 1999**
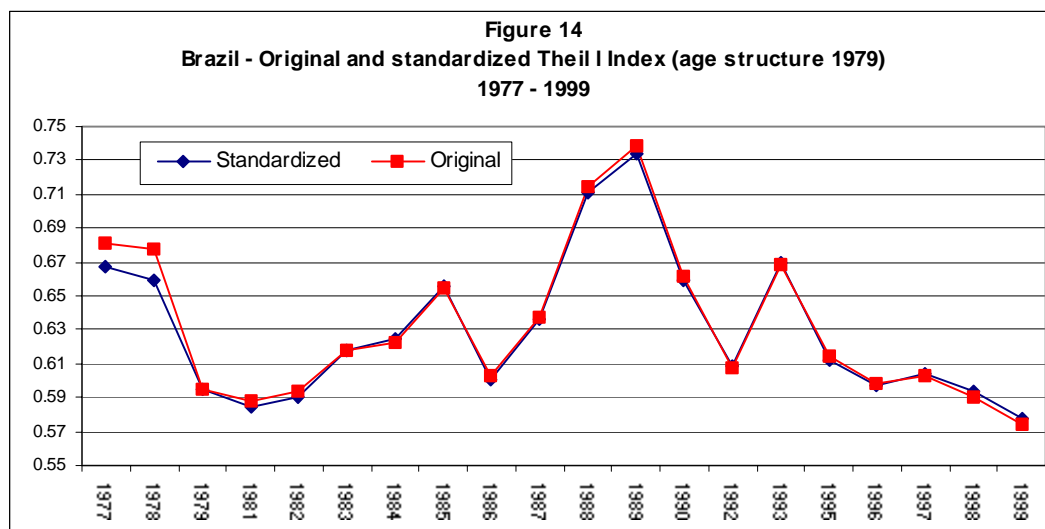
Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Figure 15 exposes the results of changes in the labor force structure by sex over the between and within groups components.
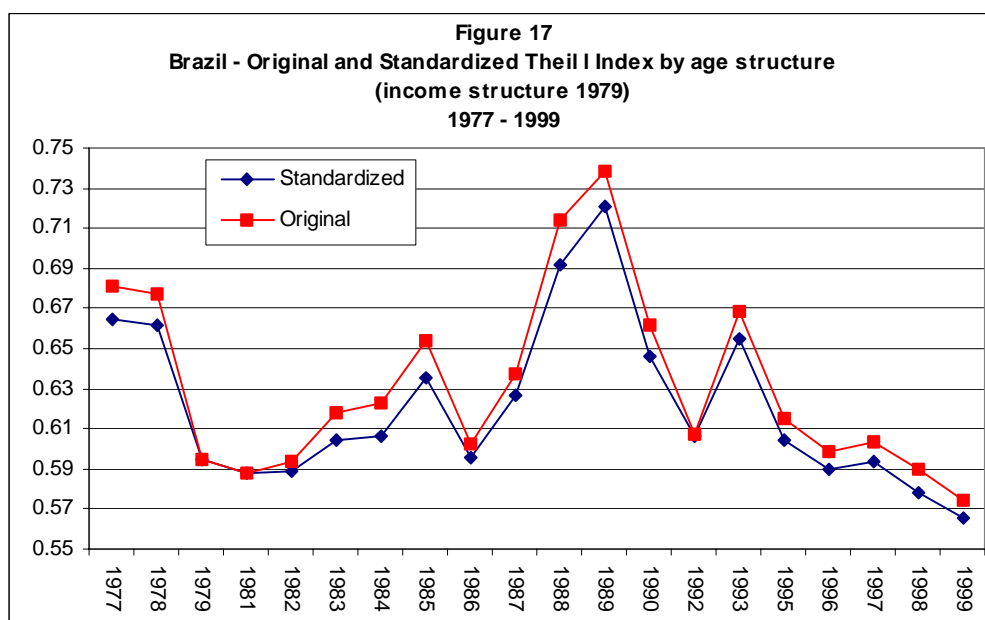
Figure 15
Brazil - Change effects of sex structure on the within and between
components (labor force structure 1979)
1979 - 1999

Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Figure 16
Brazil -Orignal and standardized Theil I index by sex
(labor force structure 1979)
1977 - 1999

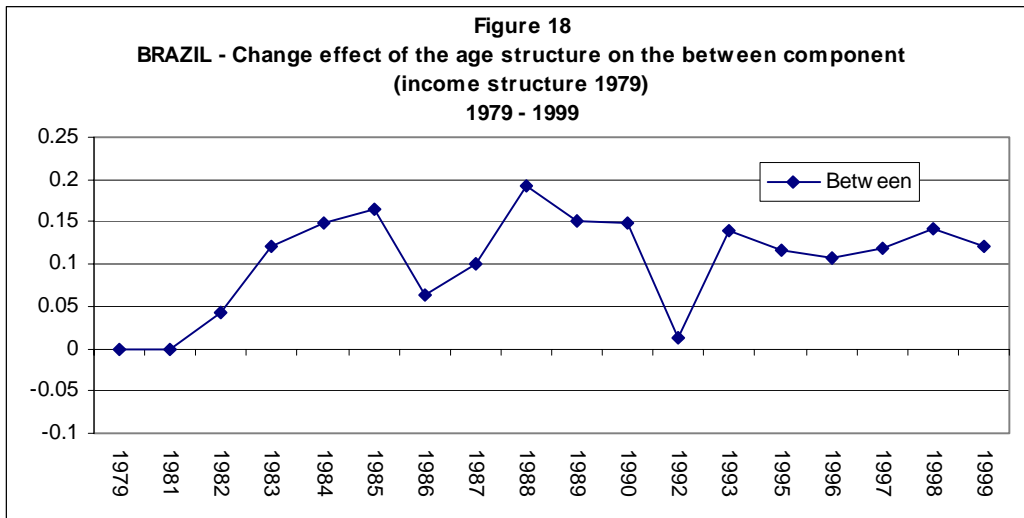Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Changes in the Work Force Mean Income Profiles

Considering that the age structure is maintained the same, the within groups inequality, that is a weighted mean from the within groups inequalities, will be the same. On the other hand, the between groups component will be reduced since the firsts ages groups had their participation reduced in relation to older ones, where income differentials are smaller. The final effect over the Theil L Index would be, then, a quite small level reduction as can be observed in Figure 17.

Figure 17
Brazil - Original and Standardized Theil l Index by age structure
(income structure 1979)
1977 - 1999

Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Figure 18 shows the variation resulting from changes in the income profile vis-a-vis the standardization hypothesis.

Figure 18
BRAZIL - Change effect of the age structure on the between component
(income structure 1979)
1979 - 1999

The standardization by sex results in a distinct situation. When the 1979 income structure is used as the standard one, it is possible to note an increase in the between groups component. Considering the relevant differential existent for this year and the rise in women's work force participation, the effect would be, then, an increase in the between groups inequality and, consequently, in the global Theil L Index, as displayed in Figure 19.
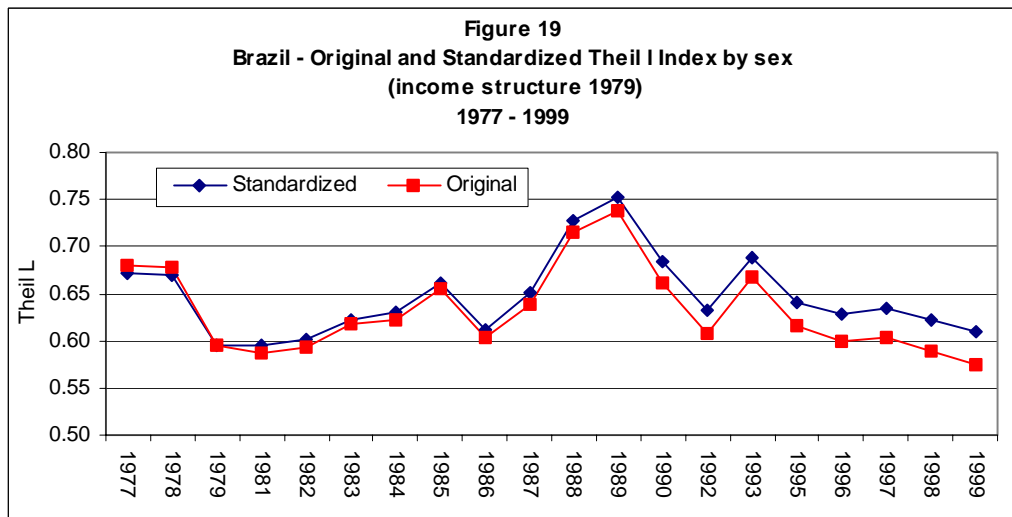
Figure 19
Brazil - Original and Standardized Theil l Index by sex
(income structure 1979)
1977 - 1999

The income profile changing effect caused a reduction in the total inequality, as showed in the descendant curve present in the Figure 20.

Figure 20
Brazil - Change Effects of the age struture by sex (income structure 1979)
1979 - 1999
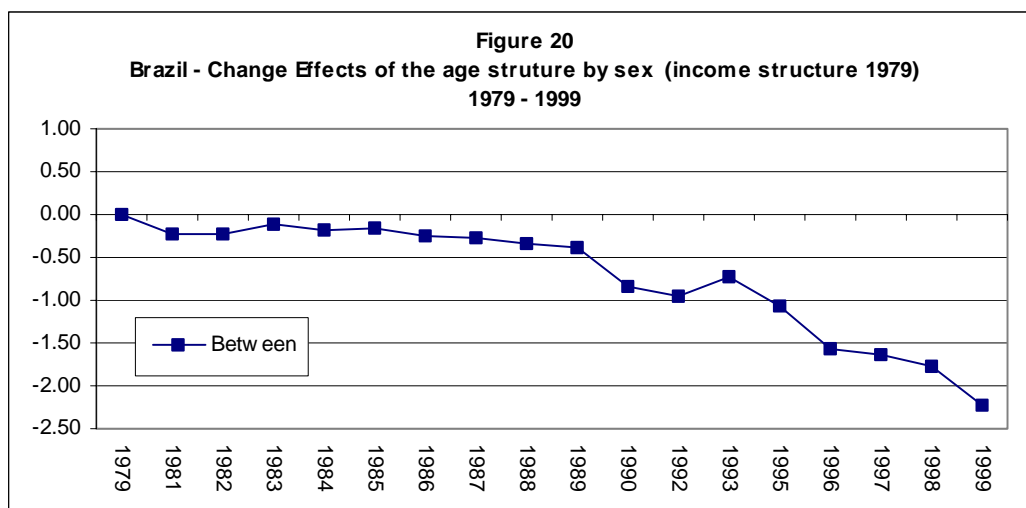
Source: FIBGE, PNAD 1977-1979, 1981-1990, 1992, 1993, and 1995-1999.

Conclusions

In a general way, it is possible to argue that the age and sex structure of the work force affect the income distribution measures. But they interfere in this process through different forms. Considering that they result from multiples composition effects, they may act in opposite ways, as the specific case of the standardization by the age structure.

Although the relative participation of young people in the work force has increased the relative weight of the lowest incomes, no impact was observed over the increase global inequality. It happens because the inequality within the younger groups is relatively smaller. Considering the global effect, this fact compensates the impact caused by the participation of lower incomes. Furthermore, the income profile, along the period under study, presented a behavior of increased inequality. That is, the dispersion between the mean incomes by age increased, provoking an augmentation, consequently, in the weight of the between groups component.

When the analysis rely on the combination between the inequality within and between groups, standardized by participation by sex the results show that, even increasing the between component, since male incomes are higher than those received by their female counterparts, the global inequality changes are not expressive. It happens because the between group component assumes a relative weight practically meaningfulness, in this case, in the final composition of the index.

For the income profile, the results showed, clearly, that the between groups component presents opposite directions when analyzed by age and sex groups. By fixing the income structure according to the 1979 age groups results in a reduction in the between groups component, because an income distribution with smaller variation emerges and a greater proportion of adults can be observed. The final effect over the global index is a reduction on its level. In this way, the effect caused by changes in the income profile (a greater variation) during the period in study responds by the increase in the between group component. Consequently, it also responds by the rise in the level of inequality, comparatively to the standardized.

On the other hand, through the income standardization by sex it is possible to see that the greater differential observed and the crescent raise of the women in the total work force, enlarge the component between groups. The final effect is a growth in the inequality comparatively to the initial value observed. The, the reduction in the income differential between man and woman, especially by the crescent earnings of the last group reduces the global inequality.

References

Barros, Ricardo Paes and Rosane mendonça. 1996. "Os Determinantes da Desigualdade no Brasil,"in *A Economia Brasileira em Perspectiva,* Vol. 2. Rio de Janeiro: IPEA, pp. 421-474.

Barros, Ricardo, Carlos Corseuil, Rosane Mendonça and Maurício Cortez Reis. 2000. "Poverty, Inequality and Macroeconomic Instability."IPEA discussion paper 750.

Barros, Ricardo Paes, Ricardo Henriques and Rosane mendonça. 1999. "A Estabilidade Inaceitável: Desigualdade e Pobreza no Brasil," in *Desigualdade e Pobreza no Brasil.* R. Henriques ed. Rio de Janeiro: IPEA.

Barros, Ricardo Paes, Sérgio Firpo, Roberta Guedes, Phillipe Leite. 2000. "Demographic Changes and Poverty in Brazil." IPEA discussion paper 775.

Lam, David. 1987. "Distribution Issues in the Relationship Between Population Growth and Economic Development," in *Population Growth and Economic Development: Issues and Evidence.* D.G. Jonhson and R.D. Lee, eds. Wisconsin: The University of Wisconsin Press.

Langoni, Carlos Geraldo. 1973. *Distribução e Desenvolvimento Econômico no Brasil*. Rio de Janeiro: Expressão e Cultura.

Paglin, Morton. 1975. "The Measurement and Trend of Inequality: A Basic Revision,"American Economic Review 65:3, pp. 520-531.

Ramos, Lauro and maria Lúcia Vieira. 2000. "Determinants da Desigualdade de Rendimentos no Brasil nos Anos 90: Discriminação, Segmentação e Heterogeneidade dos Trabalhadores," in Desigualdade e Pobreza no Brazil. R. Henriques ed. Rio de Janeiro: IPEA.

Simonsen, Mário Henrique. 1978. "Desigualdade e Mobilidade Social, "in Ensaios de Opinião. Suplicy et al., eds.

Wajnman, Simone. 1989. Estrutura Demográfica da População Economicamente Ativa e Distribuição de Renda: Brasil - 1970/1980. Master Thesis in Demography, CEDEPLAR, Federal University of Minas Gerais.