Demographic change and economic development at the local level in Brazil

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Outline

- Research question and background.
- Data and methods.
- Results.
- Robustness checks.
- Final considerations and future projects.
Research question

- **Main question:** What are the effects of changing age and educational compositions on male earnings in Brazil?

- Within the labor force (15–64 years of age), the population is getting older and better educated with regional variation.

- Age and education increase earnings.

- Larger proportion of older and more educated males causes:
  - Competition in the labor market.
  - Negative impacts on earnings of competing workers.
Main contribution

- Study accounts for variations in age-education structure, combined with regional differences, to predict male earnings.

- Brazil serves as a valuable case study and the models can be applied to other developing countries.

- The country has been experiencing:
  - Fertility decline.
  - An aging population.
  - Educational improvement.
  - Geographical variation.
Total Fertility Rate, 1970–2010

Source: Brazilian Census Bureau (IBGE, 2012).
Age composition, males, 1970–2010

Educational composition, males, 1970–2010

Regional variation

- This study takes into account geographical differences.

- The greater heterogeneity within developing countries facilitates the identification of effects on earnings.

- In Brazil, fertility decline has varied in timing and pace across states and municipalities (Potter et al., 2002; Potter et al. 2010).

- Educational attainment increased, but with a great deal of regional disparity (Riani, 2005; Rios-Neto and Guimarães, 2010).
Five regions & 502 micro-regions
Previous studies

- **Baby boom**: large cohorts entered the U.S. labor market with better education, decreasing relative earnings.
  (Berger, 1985; Bloom and Freeman, 1986; Bloom, Freeman, and Korenman, 1987; Easterlin, 1978; Freeman, 1979; Sapoznnikov and Triest, 2007; Welch, 1979)

- Changes in cohort size also had positive impacts on labor outcomes.
  (Autor, Katz, and Krueger, 1998; Katz and Autor, 1999; Katz and Murphy, 1992; Shimer 2001)

- Effects of cohort size on the labor market have been estimated for several **developed countries**.
  (Biagi and Lucifora, 2008; Borjas, 2003; Brunello, 2010; Korenman and Neumark, 2000; Skans, 2005)

- We know less about how changes in age-education structures affect earnings in **developing countries**.
Micro-data


- **Age** in years is categorized into four groups:
  - Youth population (15–24).
  - Young adults (25–34).
  - Adults (35–49).
  - Mature adults (50–64).

- **Education**: three groups indicating years of schooling:
  - No further than the first phase of elementary school (0–4).
  - Second phase of elementary school (5–8).
  - At least some secondary school (9+).

- **Earnings** from main occupation: converted to Jan. 2002.
Aggregate-level data

- **Database** is aggregated by micro-regions, census years, and age-education groups (24,096 observations):
  
  - 502 micro-regions * 4 years * 12 age-education groups.

- Cells with less than 25 people receiving income were excluded:
  
  - 19,727 observations remained.

- Only male population.
# Data setup

<table>
<thead>
<tr>
<th>Micro-region</th>
<th>Census year</th>
<th>Log of mean real earnings</th>
<th>Age-education group</th>
<th>Distr. of male pop.</th>
<th>P11</th>
<th>P12</th>
<th>P13</th>
<th>...</th>
<th>P43</th>
<th>Num. of obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>110006</td>
<td>1970</td>
<td>5.82</td>
<td>15–24 years &amp; 0–4 educ.</td>
<td>0.291</td>
<td>0.291</td>
<td>0</td>
<td>0</td>
<td>...</td>
<td>0</td>
<td>1616</td>
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<tr>
<td>110006</td>
<td>1970</td>
<td>6.21</td>
<td>15–24 years &amp; 5–8 educ.</td>
<td>0.041</td>
<td>0</td>
<td>0.041</td>
<td>0</td>
<td>...</td>
<td>0</td>
<td>207</td>
</tr>
<tr>
<td>110006</td>
<td>1970</td>
<td>6.75</td>
<td>15–24 years &amp; 9+ educ.</td>
<td>0.008</td>
<td>0</td>
<td>0</td>
<td>0.008</td>
<td>...</td>
<td>0</td>
<td>39</td>
</tr>
</tbody>
</table>

... ... ... ... ... ... ... ... ... ... ...

110006 1970 7.73 50–64 years & 9+ educ. 0.003 0 0 0 0.003 0 21

... ... ... ... ... ... ... ... ... ... ...

... ... ... ... ... ... ... ... ... ... ...
## Main models

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Baseline model</th>
<th>Composition model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logarithm of the mean real monthly earnings by age-education group, area, and time</td>
<td>( \log(Y_{git}) )</td>
<td>( \log(Y_{git}) )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Baseline model</th>
<th>Composition model</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 age-education indicators * time</td>
<td>((G_{11} - G_{43}) \ast \theta_t)</td>
<td>((G_{11} - G_{43}) \ast \theta_t)</td>
</tr>
<tr>
<td>Distribution of male population into 12 age-education groups * time</td>
<td>((P_{11} - P_{43}) \ast \theta_t)</td>
<td>((P_{11} - P_{43}) \ast \theta_t)</td>
</tr>
<tr>
<td>2008 area-time fixed effects</td>
<td>(\alpha_{it})</td>
<td>(\alpha_{it})</td>
</tr>
</tbody>
</table>
Assumptions

1. Relative sizes of age-education groups in a micro-region are assumed as exogenous to the scale of production:
   - However, more skilled workers are likely to be located in areas with better job opportunities.
   - Any differences in labor demand across micro-regions and years are controlled by the area-time fixed effects.

2. Educational attainment is assumed as exogenous:
   - However, young people may seek higher levels of schooling, as returns to education increase.
   - If these workers were in the labor market, the impacts of composition on earnings would be even stronger.
Brazilian male working-age population


- Description of 15–64 year-old males:
  - Mean real monthly earnings in main occupation, 2000.
Age-education composition, 1970–2000

15–24

25–34

35–49

50–64

Proportion with 9+ years of schooling, 1970

Source: 1970 Brazilian Demographic Census.
Proportion with 9+ years of schooling, 1980

Source: 1980 Brazilian Demographic Census.
Proportion with 9+ years of schooling, 1991

Proportion 9+
- < 0.01
- 0.01 - 0.05
- 0.06 - 0.10
- 0.11 - 0.30
- > 0.30

Source: 1991 Brazilian Demographic Census.
Proportion with 9+ years of schooling, 2000

Source: 2000 Brazilian Demographic Census.
Mean real monthly earnings in main occupation, 2000

Source: 2000 Brazilian Demographic Census.
Estimating the impacts of relative group size on male earnings

- **Baseline model:**
  - Effects of age-education indicators ($G_{11}$–$G_{43}$), 2000.

- **Composition model:**
  - Effects of age-education indicators ($G_{11}$–$G_{43}$), 2000.
Effects of age-education indicators \((G_{11} - G_{43})\) on earnings from baseline model, 2000

Effects of age-education indicators \((G_{11}-G_{43})\) on earnings from composition model, 2000

Effects of group proportions in 502 micro-regions (P_{11}–P_{23}) on earnings, 1970 and 2000

15–24 years

0–4 education

5–8 education

9+ education

25–34 years

0–4 education

5–8 education

9+ education

Effects of group proportions in 502 micro-regions ($P_{31}-P_{43}$) on earnings, 1970 and 2000

35–49 years

0–4 education

Predicted earnings vs. Proportion

5–8 education

Predicted earnings vs. Proportion

9+ education

Predicted earnings vs. Proportion

50–64 years

0–4 education

Predicted earnings vs. Proportion

5–8 education

Predicted earnings vs. Proportion

9+ education

Predicted earnings vs. Proportion

Robustness checks

- Extra models included as independent variables:
  
  - Cross effects.
  
  - Population size of micro-regions.
  
  - Female workers:
    
    - Accepted for publication in *Poverty & Public Policy*.
  
- **Original impacts** of distribution of males into age-education groups ($P_{11}$–$P_{43}$) remained negative and significant.
Inter-micro-regional migration

- Analysis at the **local level** (502 areas): need to consider the impact of internal migration.

- Migration generates **spatial-economic equilibrium**.

- **Without migration:**
  - Sending areas would have even lower earnings.
  - Receiving areas would have even higher earnings.

- **Hypothesis:** negative impacts of proportions on earnings would be more negative when controlling for migration.

- Submitted for publication in *Space Populations Societies*. 
Reverse causality

Migration $\leftrightarrow$ Earnings

- In-migration increases competition and affects earnings.
- Availability of jobs and income levels influence migration.
- An exogenous measure of migration was estimated.
- Data on municipality of residence five years before the census (1991 and 2000) was used:
Methodological steps for migration

1. Estimate exogenous **level of migration** with gravity models between micro-regions.

2. Compute **age-specific in-migration rates** \((ASI\text{MR})\) between the five regions.

3. Model **ASI\text{MR}** to obtain smooth curves representing **patterns of migration**.

4. **Integrate** level and pattern of migration, as in an exercise of standardization.

5. Calculate a measure of **exogenous force of migration** for each micro-region, year, and age-education group.
1. Estimating level of migration

- **Gravity models** take into account distances among areas as an instrumental variable for predicting migration.

- **Poisson regression** for each year and education group:

  \[ M_{ij} = \exp(b_0 + b_1 \log P_i + b_2 \log P_j + b_3 \log d_{ij}) + \varepsilon_{ij} \]

  - \( M_{ij} \): migrants at the end of the period with 20–24 years of age between micro-regions of origin and destination: 
    \( n=251,502 \) (502*501).

  - \( P_i \): population at the beginning of the period with 15–19 years of age for micro-regions of origin.

  - \( P_j \): population at the end of the period with 20–24 years of age for micro-regions of destination.

  - \( d_{ij} \): distance between micro-regions.
2. Estimating age pattern of migration

- The estimation of migration patterns for all combinations of micro-regions and years would generate low rates.

- Then, migration patterns were estimated among the five regions in each year (1991 and 2000): 5*5*2=50.

- Age-specific in-migration rates ($ASIMR_{x,ij}$) consider populations ($K$) in regions of origin ($i$) and destination ($j$):

$$ASIMR_{x,ij} = \frac{\sum K_{x,ij}}{t \sum \frac{(K_{x,j} + K_{x,jj})}{2} + (K_{x,j})}$$
3. Modeling age pattern of migration

- A mathematical equation was used to smooth the rates:
  (Raymer and Rogers, 2007; Rogers and Castro, 1981; Rogers and Jordan, 2004)

  - Negative exponential curve in the first age groups.
  - Parabola in labor ages.
  - Constant term in post-labor ages.
  - Rates were modeled for men between 15–64 years of age.

Source: 1991 and 2000 Brazilian Demographic Censuses.
Observed and estimated proportional ASIMR, Southeast to Northeast, 1991 and 2000

Source: 1991 and 2000 Brazilian Demographic Censuses.
4. Integrating level and pattern of migration

- **Micro-region levels**: applied to regional patterns.

- **Assumption**: micro-regional flows have the same patterns as the regional flows.

- **Ratio** of migration level to migration pattern was calculated (20–24 years of age) for flows between micro-regions by year and education group.

- Rates of other age groups from migration pattern were multiplied by this ratio.
5. Exogenous force of migration

- An exogenous **force of migration** was estimated for each micro-region, year, and age-education group.

- The exogenous measure of migration was included in the models as independent variables.

- In general, the coefficients of group proportions \( (P_{11} - P_{43}) \) became more negative than the previous estimates.
Estimated elasticities of proportions in age-education groups ($P_{11} - P_{43}$), 1991

For each pair, black bars were controlled for migration

Source: 1991 and 2000 Brazilian Demographic Censuses.
Estimated elasticities of proportions in age-education groups \((P_{11} - P_{43}), 2000\)

For each pair, black bars were controlled for migration.

Source: 1991 and 2000 Brazilian Demographic Censuses.
Final considerations

- **Cohort size matters**: negative effects on earnings are greater for workers under age 50.

- **Education matters**: greatest impact on middle group (5–8).

- **Low-educated men**: these groups are decreasing over time, but their earnings are not increasing.

- **Time**: effects are becoming less negative over the years.

- **Control for migration**: influence of cohort size is stronger.

- **In line with theory**: larger cohort-education size generally depresses earnings.

- **Compositional approach**: can be applied to future studies that address economic development.
Implications

- Compositional changes reduced **economic inequality:**
  - More better-educated men reduced income differentials in relation to lower-educated men.
  - The presence of fewer younger men prevented greater negative impacts on the earnings of this group.

- Impacts of **employed females** decreased gender gap.

- **Public policies:**
  - Improve educational attainment in areas that still have large proportions of people with lower levels of schooling.
  - Stimulate further increases in female employment.
Research papers

- Published:
  - *Demographic Research* (2013)
    Main models
    Decomposition of effects
    Projection exercise

- Accepted:
  - *Poverty & Public Policy* (2013)
    Models with women

- Submitted:
  - *Space Populations Societies*
    Models with migration
  - *Social Forces*
    Effects of race and increasing proportion of Protestants
Future projects

- **2010 Brazilian Census:** make data compatible with the 502 micro-regions.

- **Other countries (IPUMS-International):** India, Indonesia, South Africa, Mexico, Chile, and Argentina.

- **Women in both sides of equation:** use instrumental variables to predict distribution of female workers.

- **Multinominal models:** estimate impacts of composition on:
  - Having a formal job.
  - Having an informal job.
  - Being self-employed.