Time decompositions of the adjusted headcount ratio

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Oxford Poverty and Human Development Initiative

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Introduction

- The adjusted headcount ratio, M0, has nice decomposability properties, e.g. by regions, groups, etc.
- In this class we will explore the nice decomposability properties of $\Delta^\%M0$ and its components: $\Delta^\%H$ and $\Delta^\%A$. 
The adjusted headcount ratio, $M_0$, has nice decomposability properties, e.g. by regions, groups, etc.

In this class we will explore the nice decomposability properties of $\Delta\%M_0$ and its components: $\Delta\%H$ and $\Delta\%A$.

This material is based on Apablaza, Ocampo and Yalonetzky (2010), and on Apablaza and Yalonetzky (2011).
Introduction

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- Then we will discuss more decompositions relevant to panel datasets.
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- Then we will discuss more decompositions relevant to panel datasets.
- And show some results from Apablaza and Yalonetzky (2011).
Introduction

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- Then we will show some results from Apablaza, Ocampo and Yalonetzky (2010).
- Then we will discuss more decompositions relevant to panel datasets.
- And show some results from Apablaza and Yalonetzky (2011).
- We will finish with some remarks on comparability from Apablaza, Ocampo and Yalonetzky (2010).
Basic Notation

The weighted sum of deprivations
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The weighted sum of deprivations

\[ c_n = \sum_{d=1}^{D} w_d I(x^t_{nd} \leq z_d) \]
Basic Notation

The weighted sum of deprivations

$$c_n = \sum_{d=1}^{D} w_d I(x_{nd}^t \leq z_d)$$

Multidimensional poverty headcount:

$$H(X^t; Z) \equiv \frac{1}{N^t} \sum_{n=1}^{N^t} I(c_n \geq k)$$
Basic Notation

Average deprivation of the poor:
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\[ A(X^t; Z) \equiv \frac{1}{DN^tH} \sum_{n=1}^{N^t} I(c_n \geq k)c_n \]
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Average deprivation of the poor:

\[ A(X^t; Z) \equiv \frac{1}{DN^t} \sum_{n=1}^{N^t} I(c_n \geq k)c_n \]

The adjusted headcount ratio, M0:

\[ M^0(X^t; Z) \equiv H^t A^t = \frac{1}{DN^t} \sum_{n=1}^{N^t} I(c_n \geq k)c_n \]
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The adjusted headcount ratio, M0:

\[ M^0(X^t; Z) \equiv H^tA^t = \frac{1}{DN^t} \sum_{n=1}^{N^t} I(c_n \geq k)c_n \]

\[ \Delta\%_a M^0(t) \equiv \frac{M^0(X^t; Z) - M^0(X^{t-a}; Z)}{M^0(X^{t-a}; Z)} \]
Basic decomposition of $M_0$

$$\Delta\%_a M_0(t) = \Delta\%_a H(t) + \Delta\%_a A(t) + \Delta\%_a H(t) \Delta\%_a A(t)$$

- $\Delta\%_a H(t)$ and $\Delta\%_a A(t)$ are not generally independent, but sometimes a change in one may not produce a change in the other.
Basic decomposition of M0

\[ \Delta \%_a M^0(t) = \Delta \%_a H(t) + \Delta \%_a A(t) + \Delta \%_a H(t) \Delta \%_a A(t) \]

- \( \Delta \%_a H(t) \) and \( \Delta \%_a A(t) \) are not generally independent, but sometimes a change in one may not produce a change in the other.
- E.g. if \( k = D \): \( \Delta \%_a A(t) = 0 \), and \( \Delta \%_a M(t) = \Delta \%_a H(t) \).
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- or if $k < D$ it is possible that $\Delta \%_a H(t) = 0$ and $\Delta \%_a A(t) \neq 0$. 
Basic decomposition of M0

\[ \Delta \%_a M^0(t) = \Delta \%_a H(t) + \Delta \%_a A(t) + \Delta \%_a H(t) \Delta \%_a A(t) \]

- \( \Delta \%_a H(t) \) and \( \Delta \%_a A(t) \) are not generally independent, but sometimes a change in one may not produce a change in the other.
- E.g. if \( k = D \): \( \Delta \%_a A(t) = 0 \), and \( \Delta \%_a M(t) = \Delta \%_a H(t) \).
- or if \( k < D \) it is possible that \( \Delta \%_a H(t) = 0 \) and \( \Delta \%_a A(t) \neq 0 \).
- As \( k \) goes from 1 to \( D \), \( H \) decreases and \( A \) increases "mechanically". Hence as \( k \) increases toward \( D \), it is more likely to find higher \( \Delta \%_a H(t) \) and lower \( \Delta \%_a A(t) \).
Basic decomposition of H

H is decomposable into the multidimensional headcounts of subgroups:

\[ H(X^t, Z) = \sum_{i=1}^{G} \psi^t_i H^i(X^t_i, Z) \]
Basic decomposition of $H$

$H$ is decomposable into the multidimensional headcounts of subgroups:

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Where $\psi^t_i \equiv \frac{N^t_i}{N^t}$
Basic decomposition of $H$

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$$H(X^t, Z) = \sum_{i=1}^{G} \psi^t_i H^i(X^t_i, Z)$$

Where $\psi^t_i \equiv \frac{N^t_i}{N^t}$

In turn:

$$H^i(X^t_i, Z) = \frac{1}{N^t_i} \sum_{n=1}^{N} I(c_n \geq k) I(n \in i)$$
Basic decomposition of $H$

$$\Delta\%_a H(t) = \sum_{i=1}^{G} \Delta\%_a [\psi^t_i H^i(X^t_i, Z)] r_i(t - a)$$
Basic decomposition of H

\[
\Delta \%_a H(t) = \sum_{i=1}^{G} \Delta \%_a [\psi_t^i H^i(X_t^i, Z)] r_i(t - a)
\]

Where \( r_i(t - a) \equiv \frac{\psi_{i - a}^t H^i(X_{i - a}^t, Z)}{H(X_{t - a}^t, Z)} \)
Basic decomposition of $H$

$$\Delta \%_a H(t) = \sum_{i=1}^{G} \Delta \%_a [\psi_i^t H^i(X_t^i, Z)] r_i(t-a)$$

Where $r_i(t-a) \equiv \frac{\psi_i^{t-a} H^i(X_t^{t-a}, Z)}{H(X_t^{t-a}, Z)}$

Then:

$$\Delta \%_a H(t) = \sum_{i=1}^{G} r_i(t-a)[\Delta \%_a \psi_i^t + \Delta \%_a H^i(X_t^i, Z) + \Delta \%_a \psi_i^t \Delta \%_a H^i(X_t^i, Z)]$$
Basic decomposition of $A$

$$\Delta \%_a A(t) = \sum_{d=1}^{D} \Delta \%_a [\theta_d A_d (X^t, Z)] s_d (t - a)$$
Basic decomposition of $A$

$$\Delta\%_a A(t) = \sum_{d=1}^{D} \Delta\%_a [\theta_d A_d(X^t, Z)] s_d(t - a)$$

Where $\theta_d \equiv \frac{w_d}{D}$ and $s_d(t - a) \equiv \frac{\theta_d A_d(X^{t-a}, Z)}{A(X^{t-a}, Z)}$
Basic decomposition of $A$

\[
\Delta \%_a A(t) = \sum_{d=1}^{D} \Delta \%_a [\theta_d A_d(X^t, Z)] s_d(t - a)
\]

Where $\theta_d \equiv \frac{w_d}{D}$ and $s_d(t - a) \equiv \frac{\theta_d A_d(X^{t-a}, Z)}{A(X^{t-a}, Z)}$

And $A_d(X^t, Z) \equiv \frac{\sum_{n=1}^{N_t} I(c_n \geq k \land x_{nd}^{t} \leq z_d)}{N(t)H(t)}$
Then:

$$
\Delta \%_a A(t) = \sum_{d=1}^{D} s_d(t-a)[\Delta \%_a \theta_d A_d(X^t, Z)] = \sum_{d=1}^{D} s_d(t-a)[\Delta \%_a A_d(X^t, Z)]
$$
Then:

$$\Delta^{\%}_a A(t) = \sum_{d=1}^{D} s_d (t-a) [\Delta^{\%}_a \theta_d A_d(X^t, Z)] = \sum_{d=1}^{D} s_d (t-a) [\Delta^{\%}_a A_d(X^t, Z)]$$

Because, by construction, $\Delta^{\%}_a \theta_d = 0$
Then:

\[
\Delta \%_a A(t) = \sum_{d=1}^{D} s_d (t-a) [\Delta \%_a \theta_d A_d(X^t, Z)] = \sum_{d=1}^{D} s_d (t-a) [\Delta \%_a A_d(X^t, Z)]
\]

Because, by construction, \( \Delta \%_a \theta_d = 0 \)

In practical comparisons, we divide the changes by the year-gaps to improve comparability.
Data

<table>
<thead>
<tr>
<th>Country</th>
<th>Years</th>
</tr>
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<td>Colombia</td>
<td>1995-2005</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>2000-2005</td>
</tr>
<tr>
<td>Ghana</td>
<td>2003-2008</td>
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<tr>
<td>India</td>
<td>1999-2005</td>
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<tr>
<td>Morocco</td>
<td>1992-2004</td>
</tr>
<tr>
<td>Nepal</td>
<td>2001-2006</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1999-2003</td>
</tr>
<tr>
<td>Tanzania</td>
<td>2005-2008</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1997-2002</td>
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The variables

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<tr>
<th>Variable</th>
<th>B</th>
<th>C</th>
<th>E</th>
<th>G</th>
<th>I</th>
<th>M</th>
<th>Ne</th>
<th>Ni</th>
<th>T</th>
<th>V</th>
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<tr>
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<td>✓</td>
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<td>✓</td>
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<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
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<td>Asset</td>
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<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

B=Bangladesh; C=Colombia; E=Ethiopia; G=Ghana; I=India
M=Morocco; Ne=Nepal; Ni=Nigeria; T=Tanzania; V=Vietnam
Decomposition of M0 for 10 countries and k=3
The impact of the choice of k: the case of Bangladesh
The impact of the choice of k: the case of Colombia
The impact of the choice of $k$: the case of Ethiopia
The impact of the choice of k: the case of Ghana
The impact of the choice of $k$: the case of India
The impact of the choice of k: the case of Morocco
The impact of the choice of k: the case of Nepal
The impact of the choice of $k$: the case of Nigeria
The impact of the choice of k: the case of Tanzania
Time decompositions of the adjusted headcount ratio

Results

Basic decomposition of MPI

The impact of the choice of k: the case of Vietnam
Decomposition of H for k=3
Decomposition of A for k=3
More general results for $\Delta%_a M0$

Consider now the censored headcount, $CH_d(t)$:

$$CH_d(t) \equiv \frac{1}{N_t} \sum_{n=1}^{N_t} I(c_n \geq k \land x_{nd}^t \leq z_d)$$
More general results for $\Delta \%_a M^0$

Consider now the censored headcount, $CH_d(t)$:

$$CH_d(t) \equiv \frac{1}{N_t} \sum_{n=1}^{N^t} I(c_n \geq k \land x_{nd}^t \leq z_d)$$

Then:

$$A_d = \frac{CH_d(t)}{H(t)} \quad \text{and} \quad M^0(t) = \sum_{d=1}^{D} \theta_d CH_d(t)$$
More general results for $\Delta_0 M_0$

We get additional results that rely on $\Delta_0 CH_d(t)$:
More general results for $\Delta\%_a M_0$

We get additional results that rely on $\Delta\%_a CH_d(t)$:

$$\Delta\%_a A_d = \frac{1 + \Delta\%_a CH_d}{1 + \Delta\%_a H(t)} - 1$$
More general results for $\Delta\%_aM0$

We get additional results that rely on $\Delta\%_aCH_d(t)$:

$$
\Delta\%_aA_d = \frac{1 + \Delta\%_aCH_d}{1 + \Delta\%_aH(t)} - 1
$$

$$
\Delta\%_aA = \frac{1 + \sum_{d=1}^{D} s_d(t - a)\Delta\%_aCH_d}{1 + \Delta\%_aH(t)} - 1
$$
More general results for $\Delta\%_a M^0$

We get additional results that rely on $\Delta\%_a CH_d(t)$:

$$\Delta\%_a A_d = \frac{1 + \Delta\%_a CH_d}{1 + \Delta\%_a H(t)} - 1$$

$$\Delta\%_a A = \frac{1 + \sum_{d=1}^{D} s_d (t - a) \Delta\%_a CH_d}{1 + \Delta\%_a H(t)} - 1$$

$$\Delta\%_a M^0(t) = \sum_{d=1}^{D} s_d (t - a) \Delta\%_a CH_d$$
Linking changes to transition probabilities

Now we can link this chain of changes to changes in the transition probabilities of $H$ and $CH$. 
Linking changes to transition probabilities

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First we have the two "laws of motion":

\[
\Delta \% a H(t) = P[c t n \geq k | c t - a n < k] \left[ 1 - H(t - a) \right] - P[c t n < k | c t - a n \geq k] \\
\Delta \% a CH(t) = P[c t n \geq k \land x t nd \leq z d | c t - a n < k \lor x t - a nd > z d] \left[ 1 - CH(t - a) \right] - P[c t n < k \lor x t - a nd > z d | c t - a n \geq k \land x t - a nd \leq z d]
\]
Linking changes to transition probabilities

Now we can link this chain of changes to changes in the transition probabilities of $H$ and $CH$.

First we have the two "laws of motion":

\[
\Delta \%_a H(t) = P[c_n^t \geq k | c_n^{t-a} < k] \left[ \frac{1 - H(t - a)}{H(t - a)} \right] - P[c_n^t < k | c_n^{t-a} \geq k]
\]
Linking changes to transition probabilities

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First we have the two "laws of motion":

$$\Delta \%_a H(t) = P[c_n^t \geq k \mid c_n^{t-a} < k] \left[ \frac{1 - H(t - a)}{H(t - a)} \right] - P[c_n^t < k \mid c_n^{t-a} \geq k]$$

$$\Delta \%_a CH(t) = P[c_n^t \geq k \land x_{nd}^t \leq z_d \mid c_n^{t-a} < k \lor x_{nd}^{t-a} > z_d] \left[ \frac{1 - CH(t - a)}{CH(t - a)} \right]$$

$$- P[c_n^t < k \lor x_{nd}^t > z_d \mid c_n^{t-a} \geq k \land x_{nd}^{t-a} \leq z_d]$$
Decomposition of Alkire-Foster statistics based on transition probabilities
Two final results

\[ \Pr[c^t_n < k \mid c^{t-a}_n \geq k] \quad \text{and} \quad \Pr[c^t_n \geq k \mid c^{t-a}_n < k] \]
Two final results

\[ \Delta^{\%} M^{0} \]

\[ \Delta^{\%} \text{CH}(1), \ldots, \Delta^{\%} \text{CH}(D) \]

\[ \Pr[x_{nd}' \leq z_{d} \land c_{n}' \geq k \mid x_{nd}'^{i-a} > z_{d} \lor c_{n}'^{i-a} < k] \]

\[ \Pr[x_{nd}' > z_{d} \lor c_{n}' < k \mid x_{nd}'^{i-a} \leq z_{d} \land c_{n}'^{i-a} \geq k] \]
The Young Lives dataset

We use the three waves: 2002, 2006/7, 2010.

<table>
<thead>
<tr>
<th>Wave</th>
<th>Original sample</th>
<th>Selected Sample</th>
<th>Mean Age</th>
<th>% Females</th>
<th>% rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia 1</td>
<td>1000</td>
<td>868</td>
<td>7.88</td>
<td>49.1%</td>
<td>61.2%</td>
</tr>
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<td>2</td>
<td>980</td>
<td>868</td>
<td>12.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>973</td>
<td>868</td>
<td>14.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andhra Pradesh 1</td>
<td>1008</td>
<td>944</td>
<td>7.98</td>
<td>50.6%</td>
<td>75.6%</td>
</tr>
<tr>
<td>2</td>
<td>994</td>
<td>944</td>
<td>12.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>975</td>
<td>944</td>
<td>14.72</td>
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<td></td>
</tr>
<tr>
<td>Peru 1</td>
<td>714</td>
<td>660</td>
<td>7.93</td>
<td>47.0%</td>
<td>26.1%</td>
</tr>
<tr>
<td>2</td>
<td>685</td>
<td>660</td>
<td>12.31</td>
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<td>678</td>
<td>660</td>
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<td>Vietnam 1</td>
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<td>50.4%</td>
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<td>974</td>
<td>957</td>
<td>14.73</td>
<td></td>
<td>n.a.</td>
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## Choice of variables

<table>
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<tr>
<th>Indicator</th>
<th>Description (threshold)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Related</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child Labour♦</td>
<td>Any &quot;commercial&quot; activity before 13 / Light activity from 13 (2 hours per day)</td>
<td>1/12%</td>
</tr>
<tr>
<td>School Attendance</td>
<td>No attendance to the school according to National Law</td>
<td>1/12%</td>
</tr>
<tr>
<td>Attachment</td>
<td>Any contact with parents mum or dad</td>
<td>1/12%</td>
</tr>
<tr>
<td>Nutrition◊</td>
<td>Less than 2 standards deviations (BMI)</td>
<td>1/12%</td>
</tr>
<tr>
<td>Household Related</td>
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<tr>
<td>Electricity</td>
<td>No electricity</td>
<td>1/12%</td>
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<tr>
<td>Cooking Fuel</td>
<td>MDG definition (Branches/ Charcoal/ Coal/ Cow dung /Crop residues / Leaves/ None /Other)</td>
<td>1/12%</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>MDG definition (Unprotected/ Well/ Spring/ Pond/ River/ Stream / Canal)</td>
<td>1/12%</td>
</tr>
<tr>
<td>Toilet</td>
<td>MDG definition (Forest/ field/ Open place / Neighbours toilet/ Communal pit latrine/ Relative’s toilet/ Simple latrine on pond/ Toilet in health post/ Other)</td>
<td>1/12%</td>
</tr>
<tr>
<td>Floor</td>
<td>MDG definition (Earth/ Sand)</td>
<td>1/12%</td>
</tr>
<tr>
<td>Assets</td>
<td>Less than one (Radio/ Fridge/ Table/ Bike/ Tv/ Motorbike/ Car/ Phone)</td>
<td>1/12%</td>
</tr>
<tr>
<td>Overcrowding♦</td>
<td>3 or more Individuals per room</td>
<td>1/12%</td>
</tr>
<tr>
<td>Child Mortality◇</td>
<td>Any dead Children in the Household</td>
<td>1/12%</td>
</tr>
</tbody>
</table>
Time decompositions of the adjusted headcount ratio

Results

Transition probabilities
Transition probabilities and $\Delta\%H$
Concluding remarks on time comparisons with M0 across countries

When time periods differ three potential problems of comparability arise: (Apablaza, Ocampo and Yalonetzky, 2010)
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