

# Estimating Primary, Return, and Repeat Migration in the United States: A Comparison of Two Structural Models

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# Outline

- Introduction
- The multiplicative component model
- The birthplace-specific survivorship ratio model
- A comparison of the two estimation models
  - 2005-2010 projection results
  - Estimation of known flow data (i.e., 1995-2000)
- Summary and discussion

# Goals and significance

- **Goals**

- Demonstrate regularities in spatial and migrant type structures over time
- Present and assess two migration estimation models

- **Significance**

- Understanding population change
- Population projections

# U.S. migration flow data

- Censuses
  - 1940, 1960, 1970, 1980, 1990, 2000
- Variables
  - Place of residence at time of census (destination)
  - Place of residence five years prior to census (origin)
  - Place of birth
- Geography
  - Regions
  - Divisions
- Migrant types
  - Primary
  - Return
  - Repeat

# Two estimation models

- Multiplicative component model

$$n_{ijk} = T O_i D_j B_k O D_{ij} O B_{ik} D B_{jk} O D B_{ijk}$$

- Birthplace-specific survivorship ratio model

$$\begin{bmatrix} {}_1K_1^{t+5} \\ {}_1K_2^{t+5} \\ {}_2K_1^{t+5} \\ {}_2K_2^{t+5} \end{bmatrix} = \begin{bmatrix} {}_1\alpha_{11}({}_1K_1^t) & {}_1\alpha_{21}({}_1K_2^t) & 0 & 0 \\ 0 & 0 & {}_1\alpha_{12}({}_1K_1^t) & {}_1\alpha_{22}({}_1K_2^t) \\ {}_2\alpha_{11}({}_2K_1^t) & {}_2\alpha_{21}({}_2K_2^t) & 0 & 0 \\ 0 & 0 & {}_2\alpha_{12}({}_2K_1^t) & {}_2\alpha_{22}({}_2K_2^t) \end{bmatrix} \begin{bmatrix} \bar{S}_{11} \\ \bar{S}_{21} \\ \bar{S}_{12} \\ \bar{S}_{22} \end{bmatrix}$$

# The Multiplicative Component Model

## **Components:**

Overall level:  $T$

Main effects:  $O_i$ ,  $D_j$ , and  $B_k$

Interactions:  $OD_{ij}$ ,  $OB_{ik}$ ,  $DB_{jk}$ , and  $ODB_{ijk}$

# Interpreting the multiplicative components

**Example:** Return migrants from the Northeast to the South during the 1995-2000 period

$$\begin{aligned}n_{432} &= T O_4 D_3 B_2 O D_{43} O B_{42} D B_{32} O D B_{432} \\ &= (10,219,318)(0.2194)(0.4306)(0.3105) \\ &\quad (1.2676)(1.2764)(0.8120)(1.0861) \\ &= 427,813\end{aligned}$$

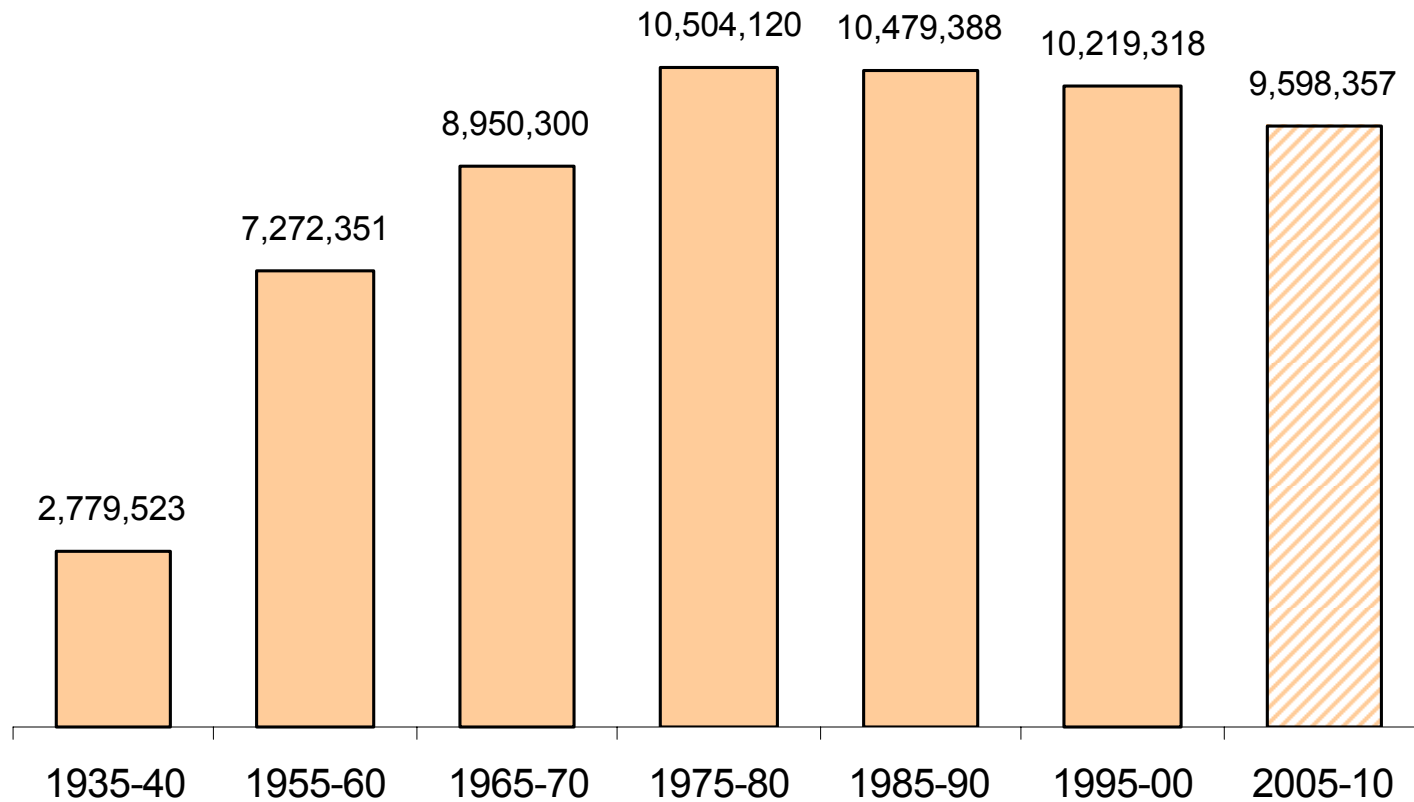
# Estimating the multiplicative components

- Estimate (or impose) component values
- Use component estimates to predict migration flows
- Use predicted migration flows as offset in a log-linear main effects model

$$\hat{n}_{ijk} = n_{ijk}^* \tau \tau_i^O \tau_j^D \tau_k^B$$

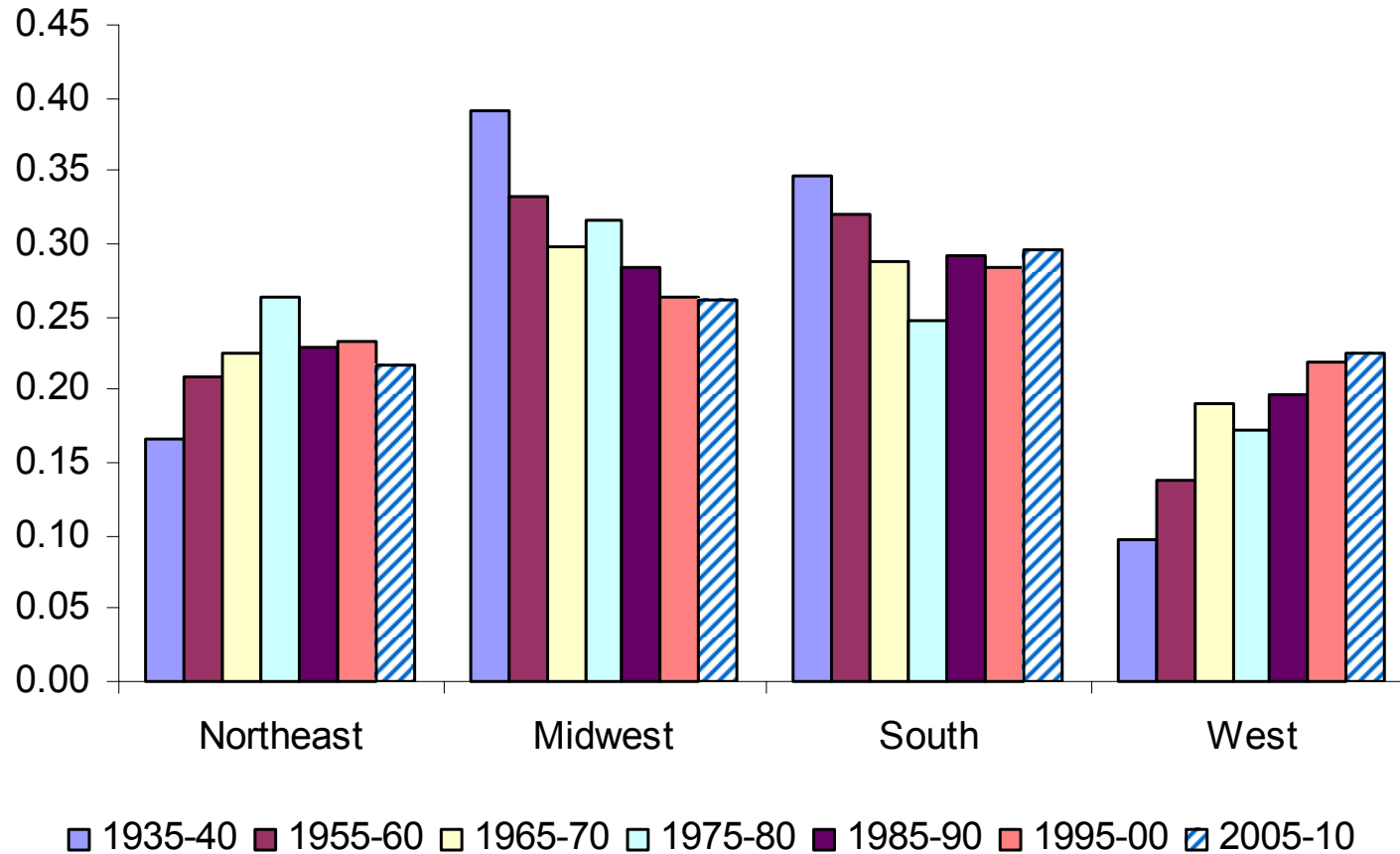
- Recalculate to obtain “revised” component values

# The overall levels of interregional migration in the United States: 1935-1940 to 2005-2010\*



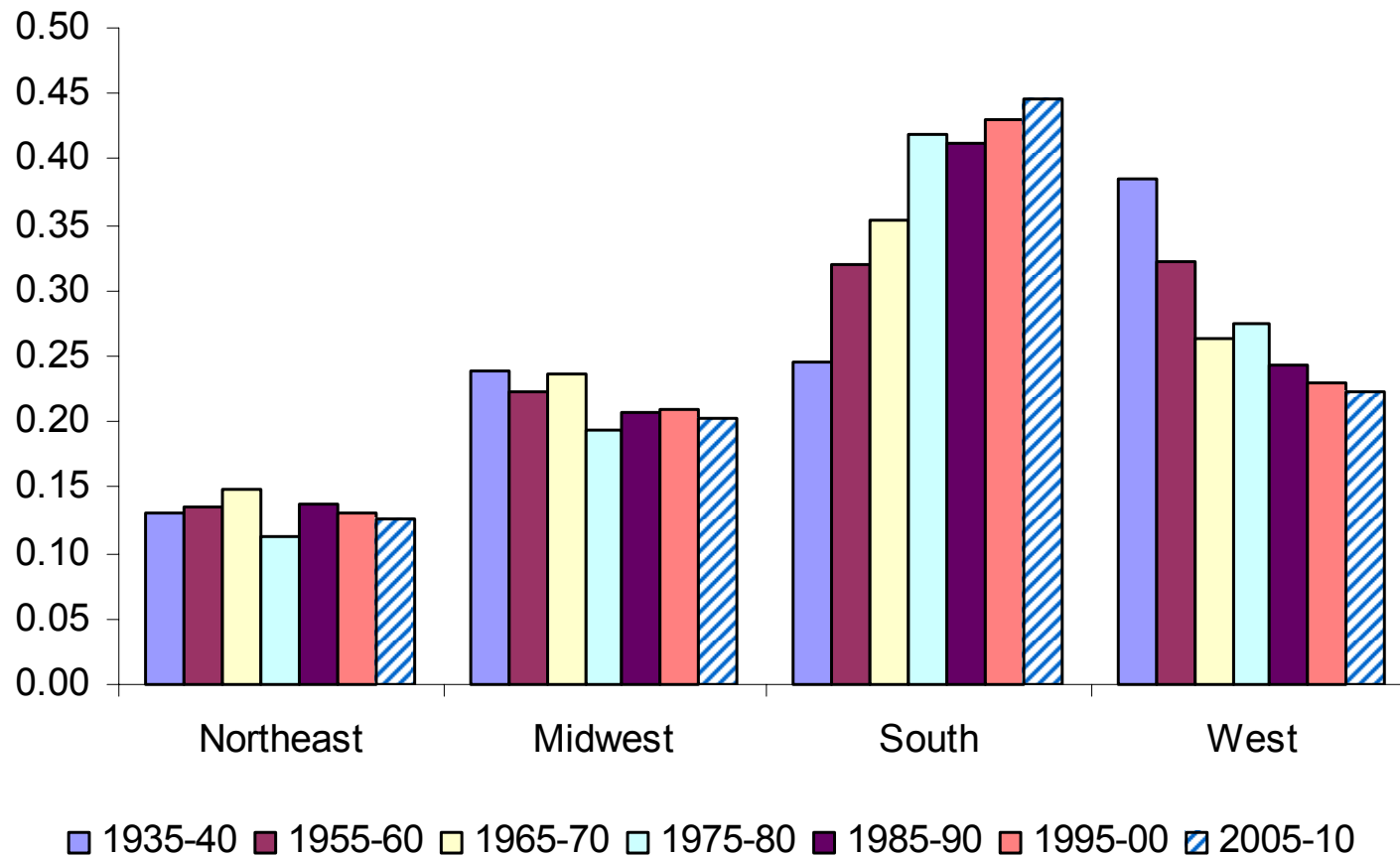
\*Projected

# Proportions of all migrants in the United States by region of origin: 1935-1940 to 2005-2010\*



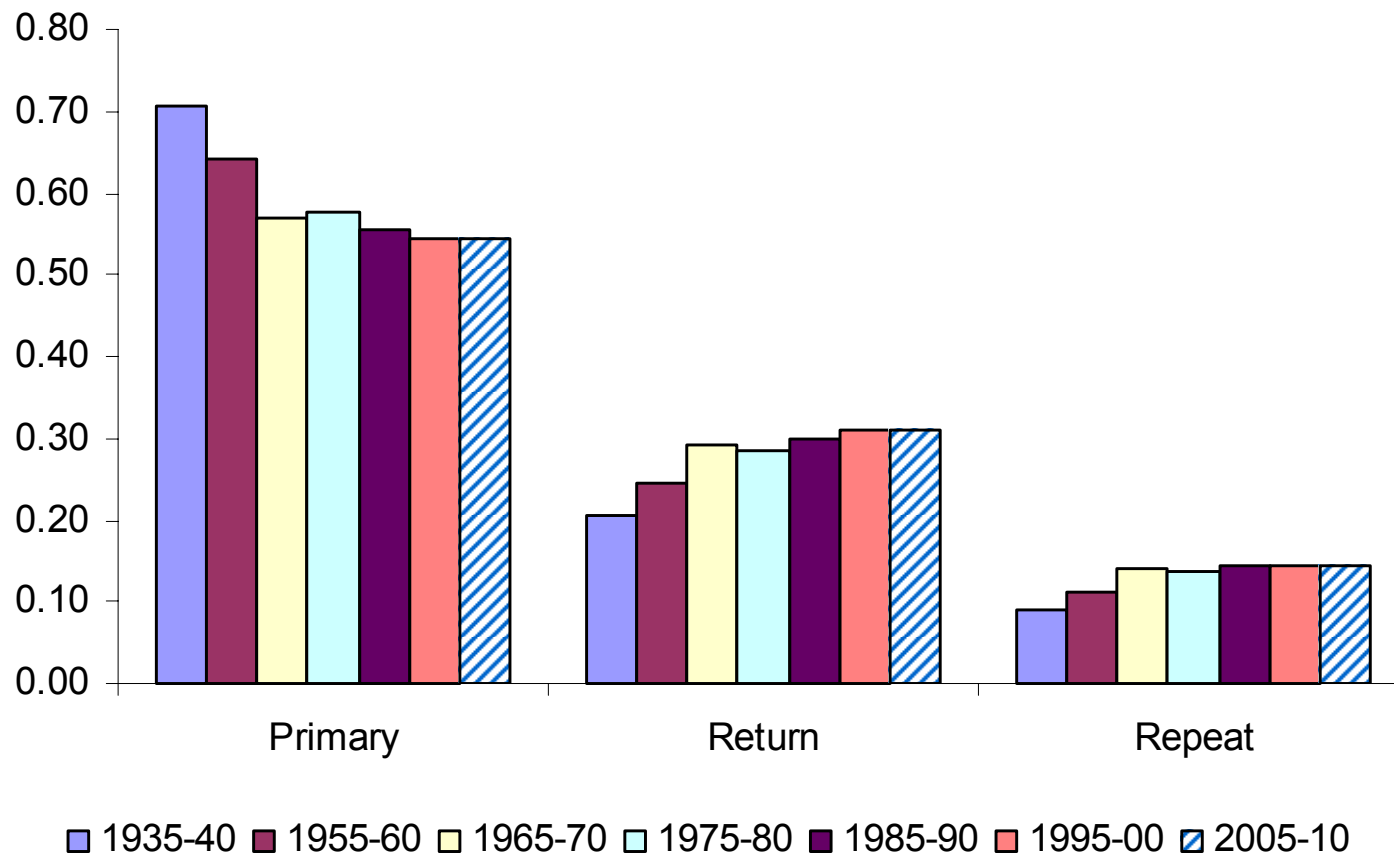
\*Projected

# Proportions of all migrants in the United States by region of destination: 1935-1940 to 2005-2010\*



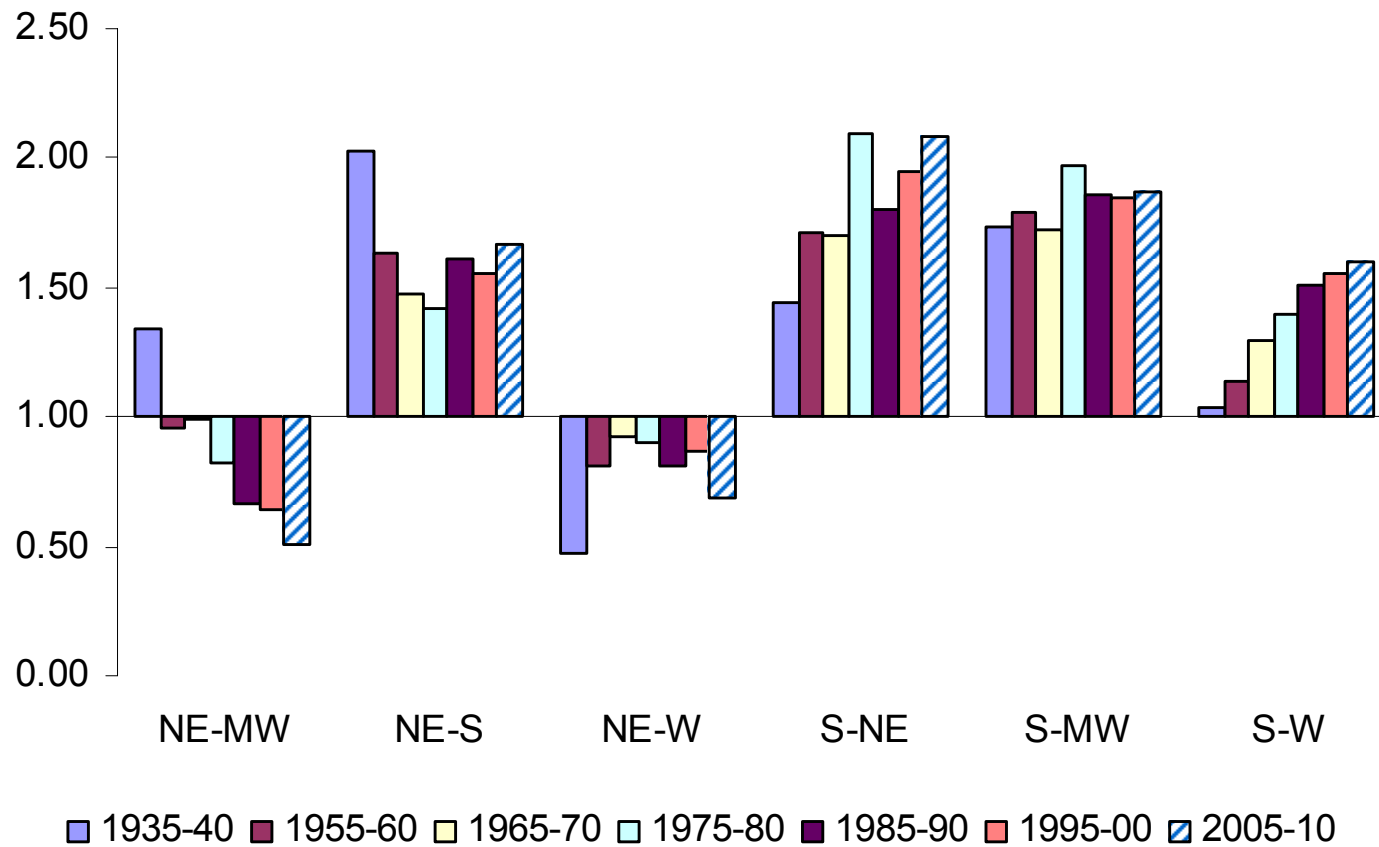
\*Projected

# Proportions of all migrants in the United States by migrant type: 1935-1940 to 2005-2010\*



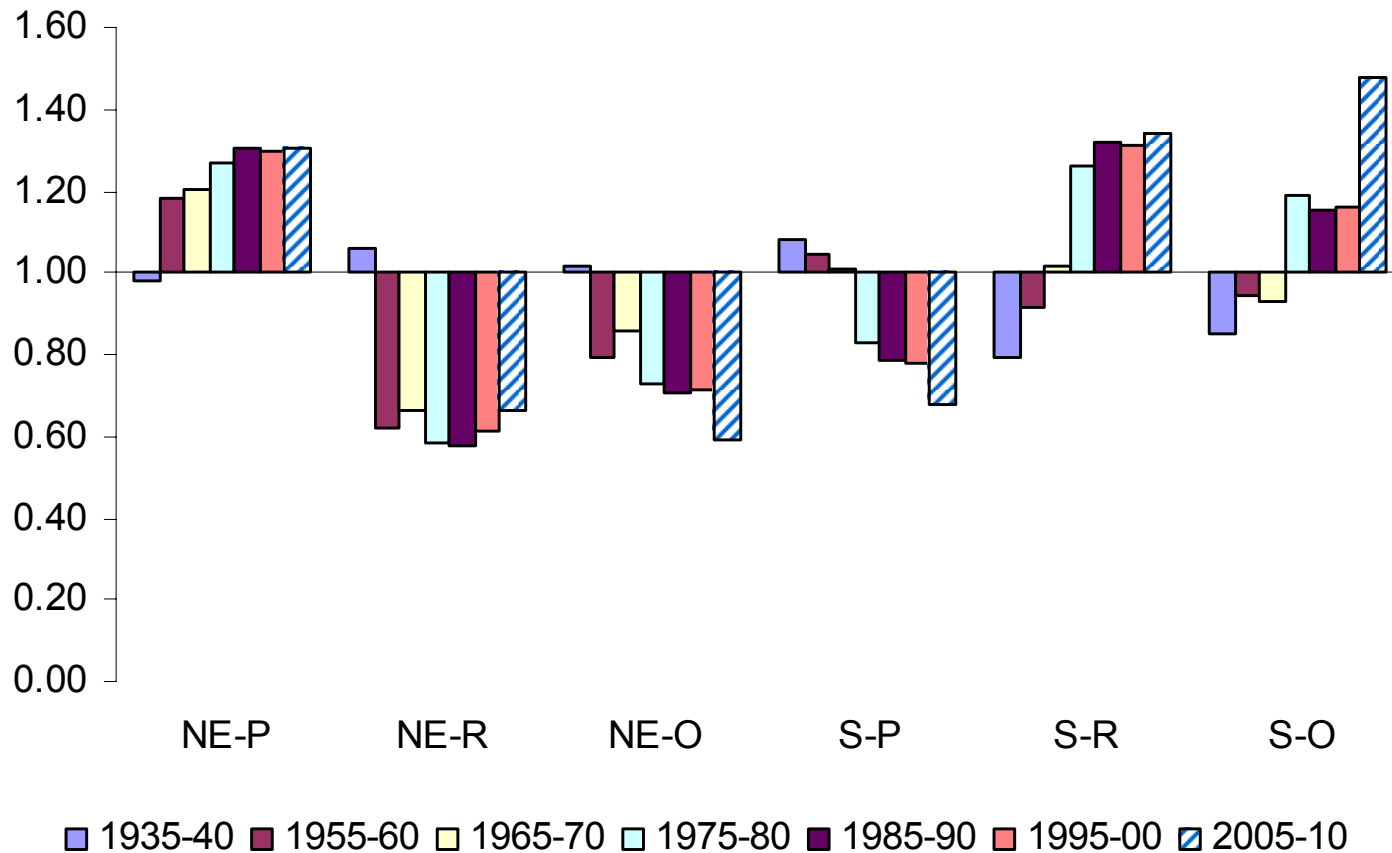
\*Projected

# The origin-destination interaction components of migration from the Northeast and South: 1935-1940 to 2005-2010\*



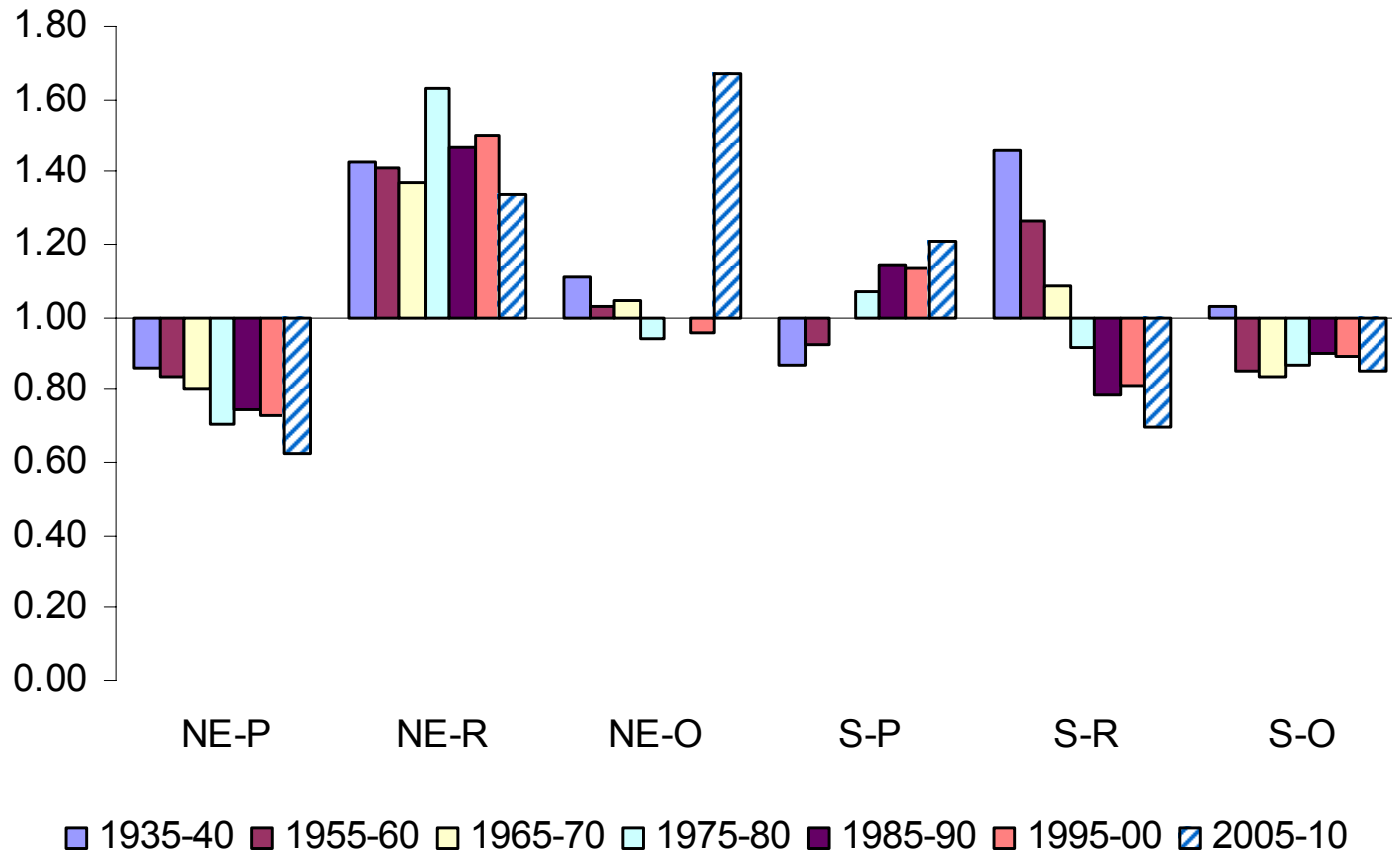
\*Projected

# The origin-migrant type interaction components of migration from the Northeast and South: 1935-1940 to 2005-2010\*



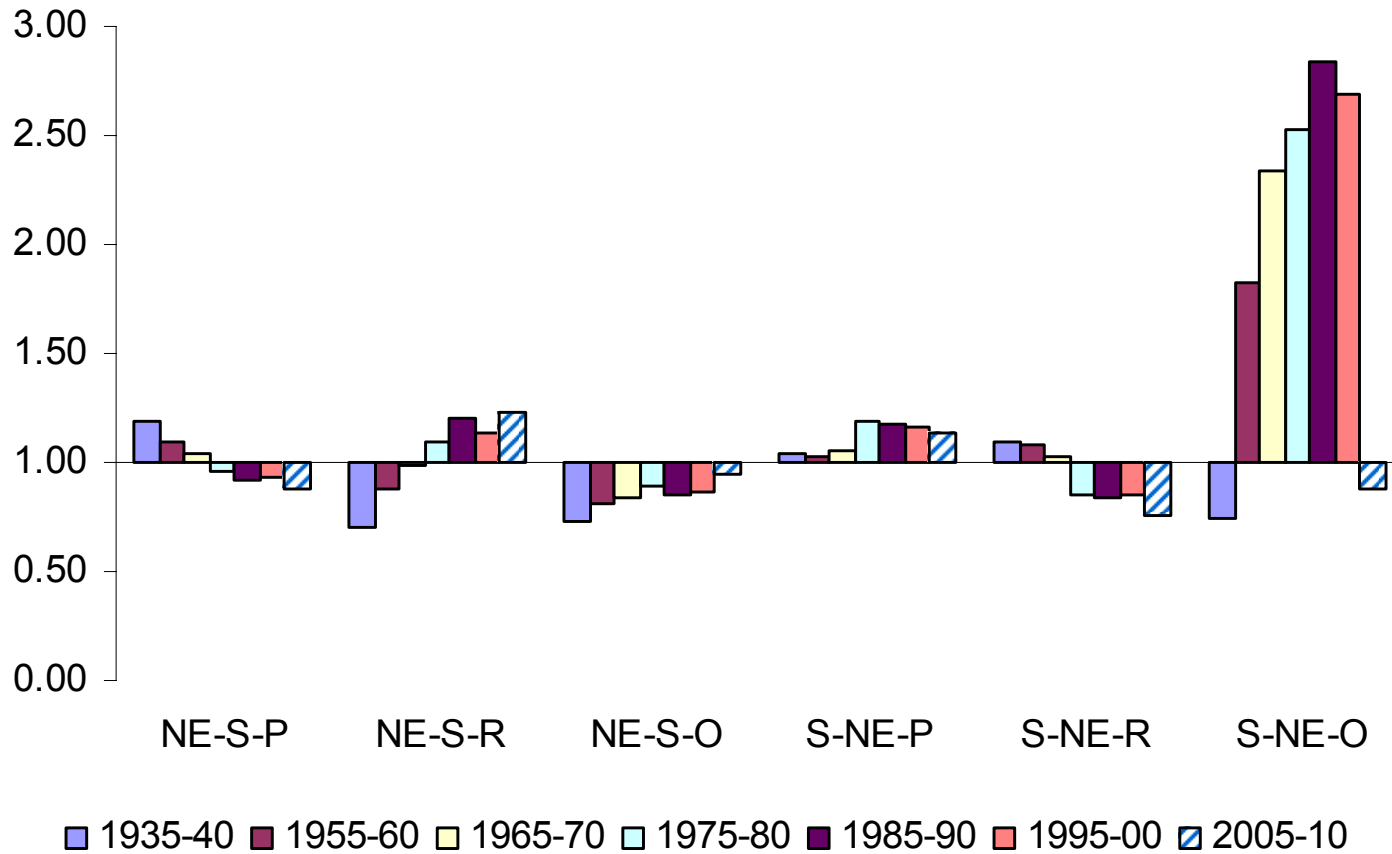
\*Projected

# The destination-migrant type interaction components of migration from the Northeast and South: 1935-1940 to 2005-2010\*



\*Projected

# The origin-destination-migrant type interaction components of migration from the Northeast to the South and the South to the Northeast: 1935-1940 to 2005-2010\*



\*Projected

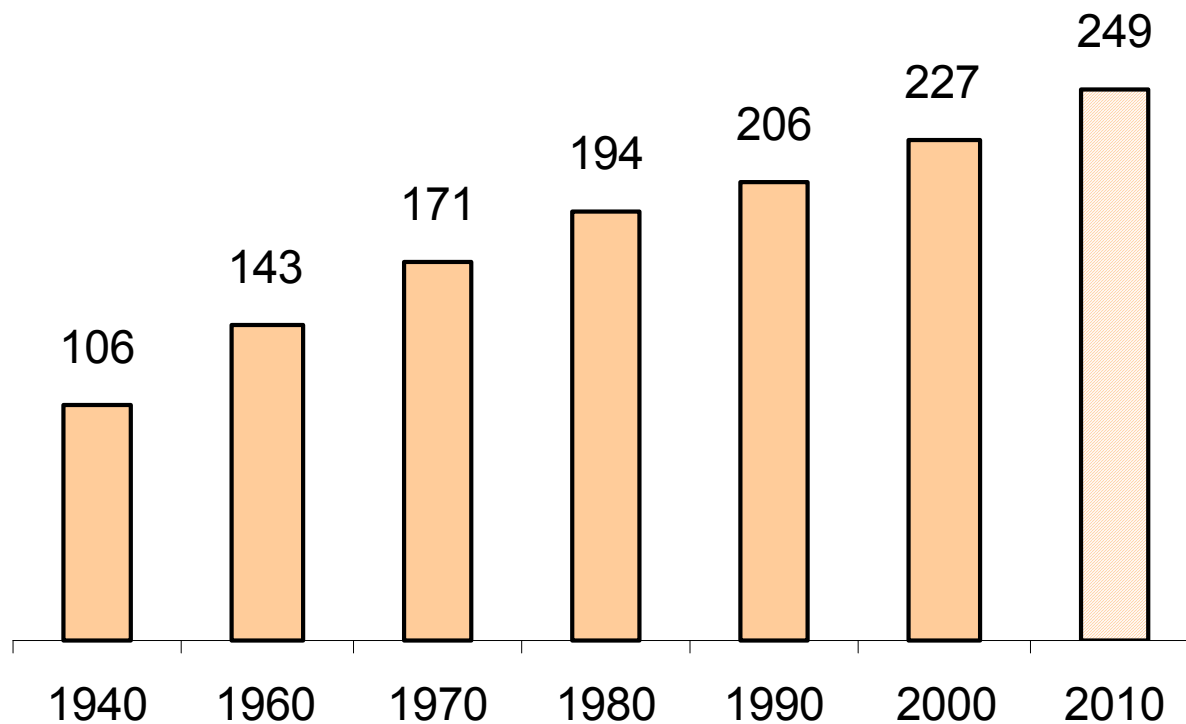
# The Birthplace-Specific Survivorship Ratio Model

$$\begin{bmatrix} {}_1K_1^{t+5} \\ {}_1K_2^{t+5} \\ {}_2K_1^{t+5} \\ {}_2K_2^{t+5} \end{bmatrix} = \begin{bmatrix} {}_1\alpha_{11}({}_1K_1^t) & {}_1\alpha_{21}({}_1K_2^t) & 0 & 0 \\ 0 & 0 & {}_1\alpha_{12}({}_1K_1^t) & {}_1\alpha_{22}({}_1K_2^t) \\ {}_2\alpha_{11}({}_2K_1^t) & {}_2\alpha_{21}({}_2K_2^t) & 0 & 0 \\ 0 & 0 & {}_2\alpha_{12}({}_2K_1^t) & {}_2\alpha_{22}({}_2K_2^t) \end{bmatrix} \begin{bmatrix} {}_1\bar{S}_{11} \\ {}_2\bar{S}_{21} \\ {}_1\bar{S}_{12} \\ {}_2\bar{S}_{22} \end{bmatrix}$$

# Estimating the birthplace-specific survivorship ratio model inputs

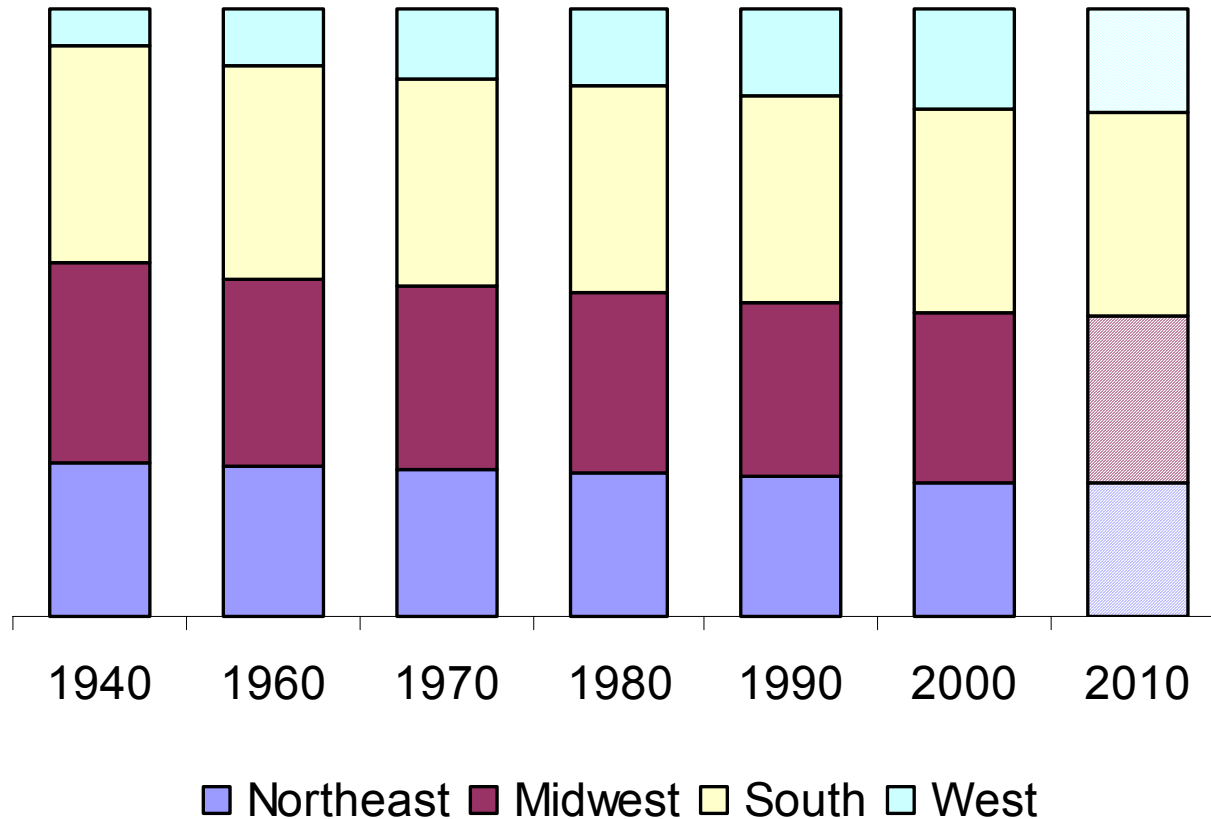
- Estimate birthplace-specific population stocks
  - Total (age 5+) population (at time of census, i.e., 2010)
  - Proportion born in each region (at time of census, i.e., 2010)
  - Proportion of persons living in each region according to their region of birth (at time of census and mid-census, i.e., 2005 and 2010)
- Estimate (or impose) secondary to primary ratios

# U.S. population (age 5+), 1940-2010\*



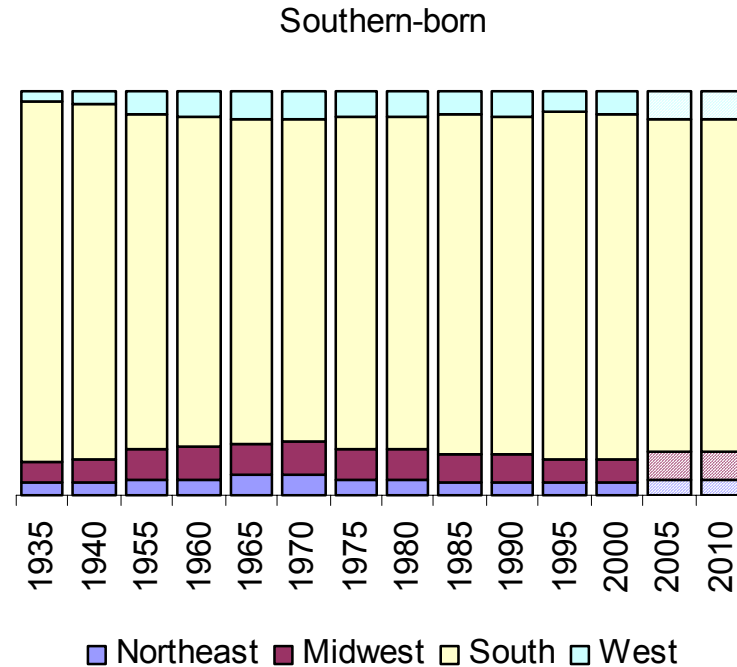
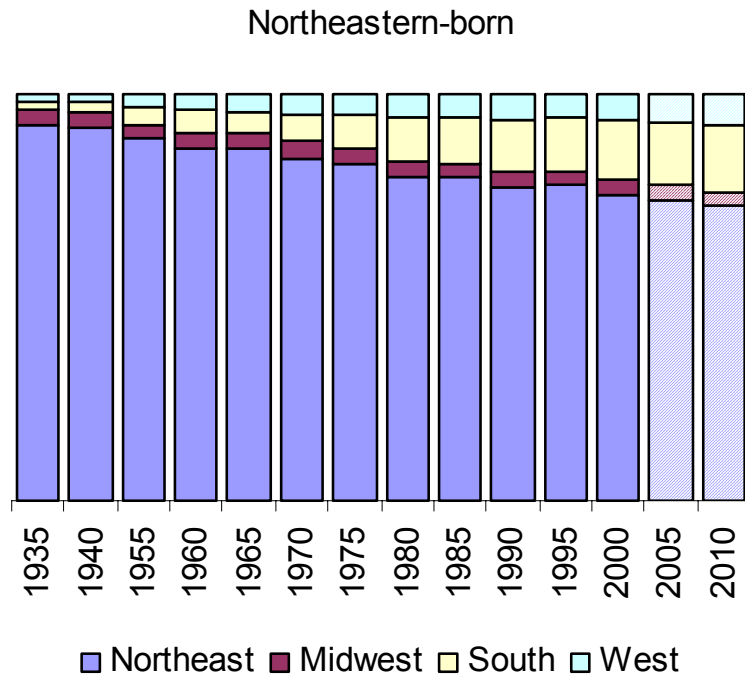
\*Projected

# Proportion of U.S. population (age 5+) born in each region, 1940-2010\*



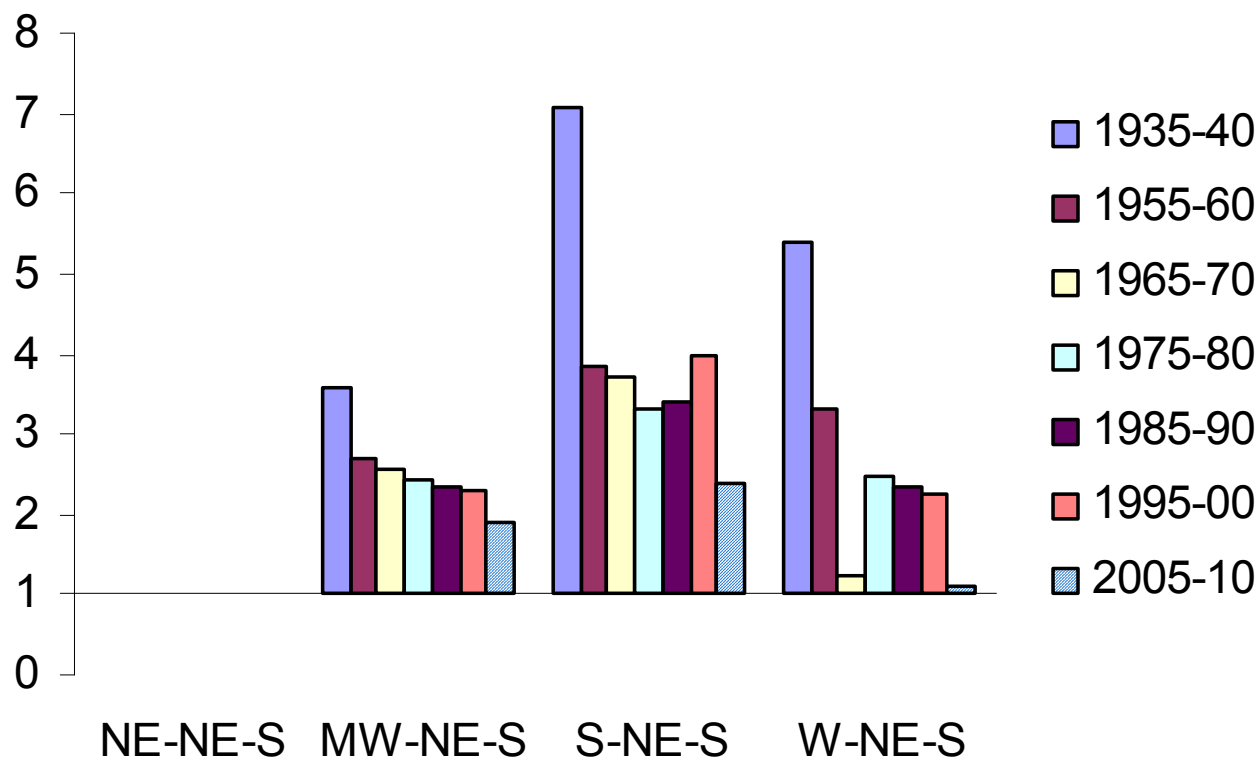
\*Projected

# Proportion of Northeastern-born and Southern-born (age 5+) born in each region, 1935-2010\*



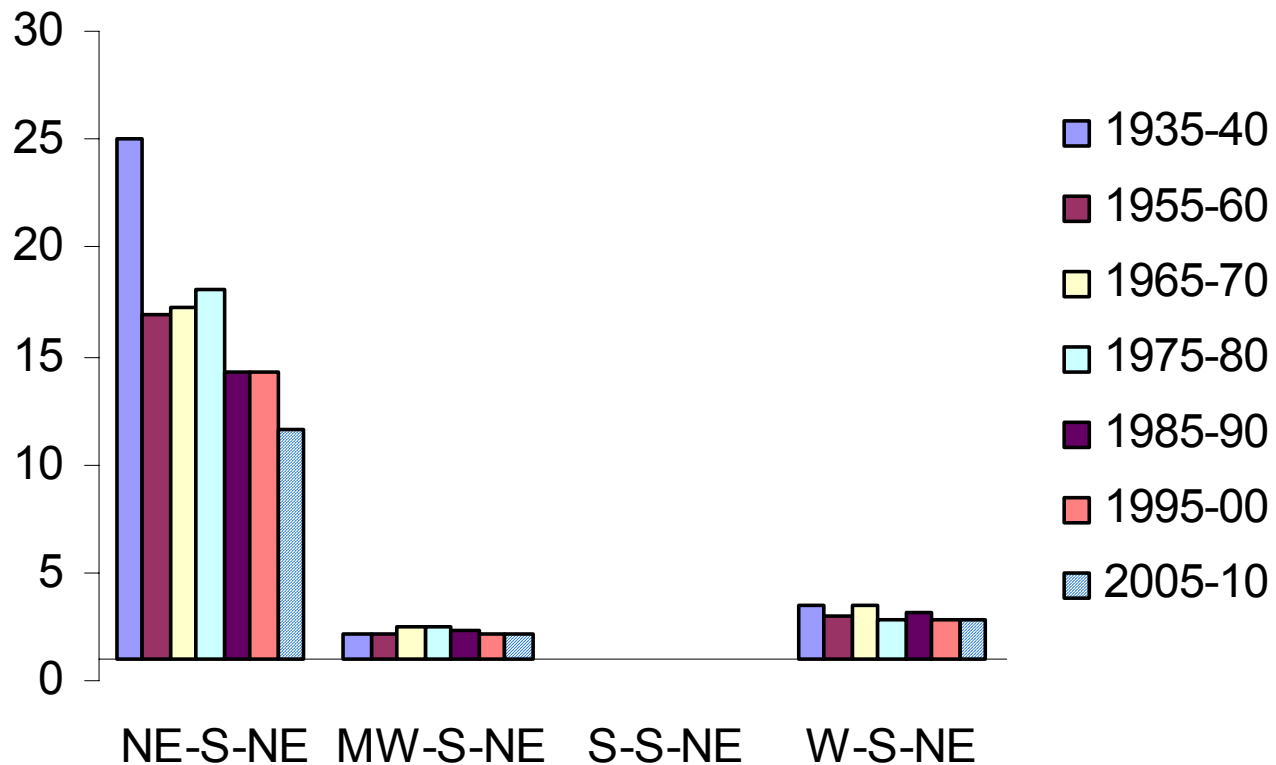
\*Projected

# Ratios of secondary to primary conditional survivorship proportions of birthplace-specific migration between Northeast and South, 1935-40 to 2005-10\*



\*Projected

# Ratios of secondary to primary conditional survivorship proportions of birthplace-specific migration between South and Northeast, 1935-40 to 2005-10\*



\*Projected

# A Comparison of the Two Estimation Models

- A. Projecting the 2005-2010 migration flow patterns
- B. Estimating the 1995-00 known migration flow patterns

# A comparison of the 2005-2010 projected interregional migration flows: Numbers

Region of Origin	Region of Destination				Total
	Northeast	Midwest	South	West	
A. Multiplicative Component Model					
Northeast	0	212,289	1,558,272	319,859	2,090,420
Midwest	185,138	0	1,518,470	814,635	2,518,243
South	750,159	1,070,849	0	1,015,826	2,836,834
West	285,051	660,151	1,207,658	0	2,152,860
Total	1,220,348	1,943,289	4,284,400	2,150,320	9,598,357

## B. Birthplace-Specific Survivorship Ratio Model

Northeast	0	322,611	1,531,939	561,050	2,415,599
Midwest	285,784	0	1,909,356	763,067	2,958,207
South	916,124	1,383,456	0	1,594,587	3,894,167
West	471,795	658,971	1,538,284	0	2,669,050
Total	1,673,702	2,365,038	4,979,578	2,918,704	11,937,023

# A comparison of the 2005-2010 projected interregional migration flows: Multiplicative components

Region of Origin	Region of Destination				Total
	Northeast	Midwest	South	West	
A. Multiplicative Component Model					
Northeast	0.000	0.502	<b>1.670</b>	0.683	<b>0.218</b>
Midwest	0.578	0.000	1.351	<b>1.444</b>	<b>0.262</b>
South	<b>2.080</b>	<b>1.864</b>	0.000	1.598	0.296
West	1.041	<b>1.515</b>	1.257	0.000	0.224
Total	<b>0.127</b>	<b>0.202</b>	<b>0.446</b>	0.224	<b>9,598,357</b>

## B. Birthplace-Specific Survivorship Ratio Model

Northeast	0.000	<b>0.674</b>	1.520	<b>0.950</b>	0.202
Midwest	<b>0.689</b>	0.000	<b>1.547</b>	1.055	0.248
South	1.678	1.793	0.000	<b>1.675</b>	<b>0.326</b>
West	<b>1.261</b>	1.246	<b>1.382</b>	0.000	<b>0.224</b>
Total	0.140	0.198	0.417	<b>0.245</b>	<b>11,937,023</b>

# Estimation of the 1995-00 migration flows based on 1985-90 structures

- Interregional migration by migrant type
  - Multiplicative component model
    - Chi-square = 184,263
  - Birthplace-specific survivorship ratio model
    - Chi-square = 85,187
- Interdivisional migration by migrant type
  - Multiplicative component model
    - Chi-square = 284,008
  - Birthplace-specific survivorship ratio model
    - Chi-square = 412,538

# Estimation of the 1995-00 migration flows based on 1985-90 structures: Comparing the flows

Dest.	Origin					
	New England			South Atlantic		
	Observed	Component	Ratio	Observed	Component	Ratio
N.E.	8,857,703	8,832,432	8,843,877	67,407	77,541	71,412
M.A.	70,042	73,154	66,874	13,859	14,106	10,818
E.N.C.	25,488	25,378	24,253	8,197	9,382	8,416
W.N.C.	8,881	10,697	8,648	2,886	3,493	4,185
S.A.	173,380	193,451	181,402	986,427	965,949	972,295
E.S.C.	11,959	9,968	10,206	7,262	8,918	7,791
W.S.C.	18,644	20,504	22,089	7,255	10,372	10,053
MTN	30,505	31,328	30,885	7,989	8,516	10,307
PAC	46,408	46,096	54,777	12,165	15,169	18,167

# Summary and discussion

- Contributions
- Practical issues
- Next steps