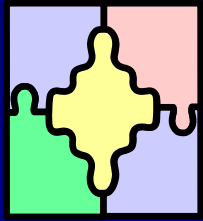


# Model Migration Schedules

**IIASA Research**

**First IIASA visit to Mexico**  
**INEGI**  
**Aguascalientes, 30 October 2015**

**Luis Javier Castro**



# Model Migration Schedules Research



**I. Measurement and Analysis**



**II. Model Migration Schedules**



**III. What the Age Composition  
Of Migrants can Tell Us**



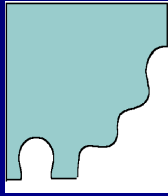
**IV. Simplified Model Migration  
Schedules**



**V. Future Research and Applications**



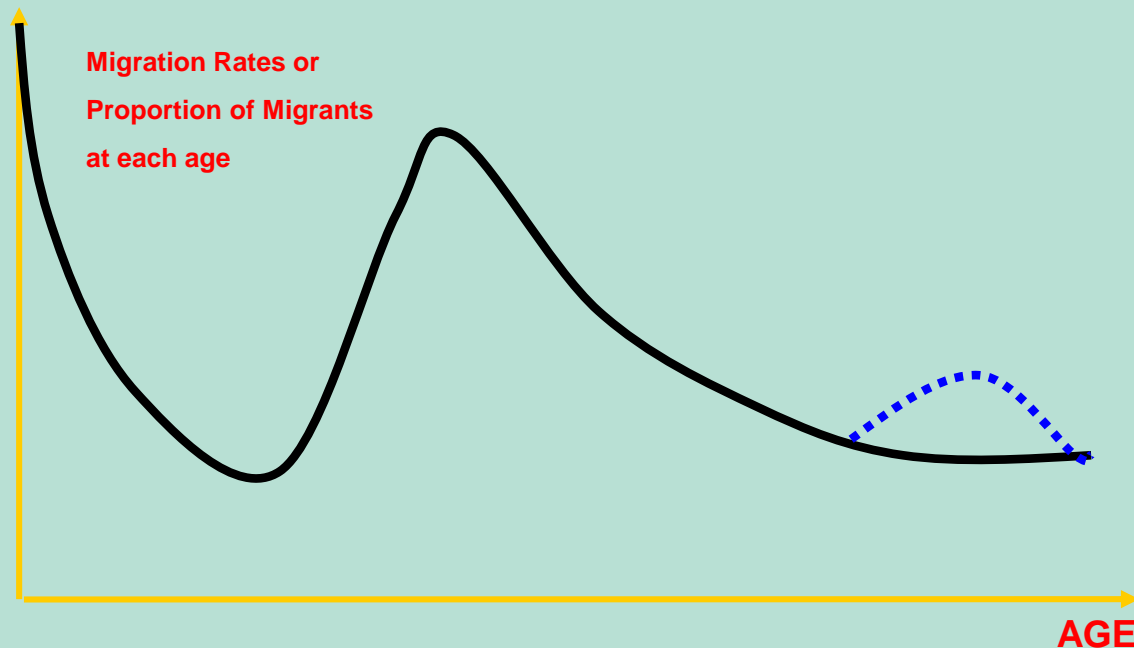
# **I. Measurement and Analysis**

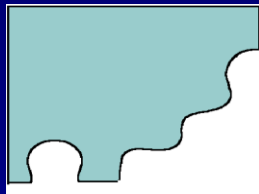


# I. MEASUREMENT AND ANALYSIS

## RESEARCH OBJECTIVE:

There are age-specific gross migration flows regularities as in fertility and mortality





# I. MEASUREMENT AND ANALYSIS

## References

**Model Multiregional Life Tables and Stable Populations, Andrei Rogers and Luis J. Castro, RR-76-9 (Laxenburg, Austria, IIASA, first printing May 1976; second printing, February 1981), p. 82.**

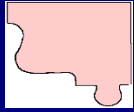
**Measurement of Age-Specific Migration with Incomplete Data: Model Schedules Approach, IIASA Conference on Analysis of Multiregional Population Systems: Techniques and Applications, Luis J. Castro (Laxenburg, Austria, IIASA, 19-22 September, 1978), p. 34.**

**Migration Age Patterns: Measurement and Analysis, Andrei Rogers and Luis J. Castro, WP-79-16, February 1979, p. 57.**

**Aggregated Data Transformation: Transition and Moves, WP-81-80, International Institute for Applied Systems Analysis, Laxenburg, Austria, Luis J. Castro (1980).**

**Age Patterns of Migration: Cause-Specific Profiles in Advances in Multiregional Demography, edited by A. Rogers, RR-81-6 (Laxenburg, Austria, IIASA, May 1981), p. 125.160.**

## **II. Model Migration Schedules (MMS)**

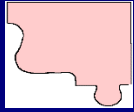


## II. MODEL MIGRATION SCHEDULES

### RESEARCH OBJECTIVE:

**The Migration regularities fit a mathematical function.**

Recognizing that most human populations experience rates of age-specific fertility and mortality that exhibit remarkably persistent regularities, it was found possible to summarize and codify migration regularities by means of mathematical expressions called Model Migration Schedules (MMS).



## II. MODEL MIGRATION SCHEDULES

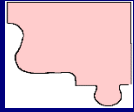
The full model schedule has 13 parameters:  $a_1$ ,  $\alpha_1$ ,  $a_2$ ,  $\mu_2$ ,  $\alpha_2$ ,  $\lambda_2$ ,  $a_3$ ,  $\mu_3$ ,  $\alpha_3$ ,  $\lambda_3$ ,  $\alpha_4$ ,  $\alpha_4$ , and  $c$ .

The profile of the full model schedule is defined by 8 of the 13 parameters:  $\alpha_1$ ,  $\mu_2$ ,  $\alpha_2$ ,  $\lambda_2$ ,  $\mu_3$ ,  $\alpha_3$ ,  $\lambda_3$ ,  $\alpha_4$ .

Its level is determined by the remaining 5 parameters:  $a_1$ ,  $a_2$ ,  $a_3$ ,  $a_4$ , and  $c$ .

A change in the value of the area under a particular model schedule alters proportionally the values of the latter but does not affect the former.





## II. MODEL MIGRATION SCHEDULES

### References

**Model Migration Schedules and Their Applications**, A. Rogers, R. Raquillet and Luis J. Castro, *Environment and Planning A*, Vol. 10 (London, Pion Limited, 1978), p. 475-502.

**Migration, Urbanization and Development: A Case Study of Mexico**, Donaldo Colosio, Luis J. Castro and A. Rogers, IIASA, WP-78-27, September 1978.

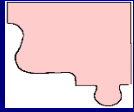
**Migration Age Patterns: Cause-Specific Profiles**, A. Rogers and Luis J. Castro, IIASA, WP-79-65, August 1979, p. 48.

**Analysis of Age-Specific Migration Flows: Model Schedules Approaches**, WP-11-80, International Institute for Applied Systems Analysis, Laxenburg, Austria, Luis J. Castro (1981).

**638 Model Migration Schedules: A Technical Appendix** A. Rogers and Luis J. Castro, IIASA, WP-81-23, March 1981, p. 84.

**Status-Specific Age Patterns of Migration**, Andrei Rogers and Luis J. Castro, IIASA, WP-81-60, May 1981. p. 28.

**Model Schedules in Multistate Demographic Analysis: The Case of Migration in Multidimensional Mathematical Demography**, edited by A. Rogers, and K. Land (New York, Academic Press, 1982), p. 113-154.



## II. MODEL MIGRATION SCHEDULES

### References

**Migración y Asentamientos Humanos editado por A. Rogers, Luis J. Castro and R. Ham, Demografía y Economía, El Colegio de México, Vol. XVI. Num. 3 (51), 1982.**

**Migration, Chapter 5, p.157-210, Migration and Settlement, edited by Andrei Rogers and Frank J. Willekens, D. Reidel Publishing Company, Boston, Andrei Rogers and Luis J. Castro (1982).**

**Patrones Modelo de Migración, Demografía y Economía, Vol. XVI, Num. 3 (51), El Colegio de México, México, Andrei Rogers y Luis J. Castro (1982).**

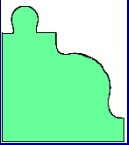
**Regional Migration Differentials in IIASA Nations, WP-83-40, International Institute for Applied Systems Analysis, Laxenburg, Austria, Andrei Rogers and Luis J. Castro (1983).**

**Age Patterns of Migration, Second Chapter in Migration, Urbanization, and Spatial Population Dynamics, Andrei Rogers Editor, London: Westview Press. Andrei Rogers and Luis J. Castro (1984).**

**Migration in Migration and Settlement: Multiregional Comparative Study, edited by A. Rogers and F. Willekens (Boston, Westview Press, 1985), p. 41-146.**



**III. What the Age  
Composition of Migrants  
can Tell Us**



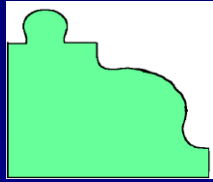
### **III. WHAT THE AGE COMPOSITION OF MIGRANTS CAN TELL US**

#### **RESEARCH OBJECTIVE:**

**MMS based on parameters that interpret migration behavior (Family Migration)**

#### **Parameters:**

- **Age at which first migration occurs as independent (head of family)**
- **Mean age of head family migrants**
- **Mean age of dependents migrants (children moving w/parents)**
- **Dependency Ratio**
- **Sex dependency (Women migrating with men)**



### III. WHAT THE AGE COMPOSITION OF MIGRANTS CAN TELL US

#### References

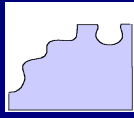
**Patterns of Family Migration: Two Methodological Approaches, WP-17-81, International Institute for Applied Systems Analysis, Laxenburg, Austria, Luis J. Castro and Andrei Rogers (1981).**

**What the Age Composition of Migrants Can Tell Us. Population Bulletin of the United Nations, No. 15 (New York, United Nations Sales Publication No. E. 83.XIII.4, 1983) in English, French and Spanish, p. 63-79.**

**Patterns of Family Migration: Two Methodological Approaches, Luis J. Castro and Andrei Rogers, Environment and Planning A, Vol. 15 (London, Pion Limited, 1983), p. 237-254.**



## **IV. Simplified MMS**



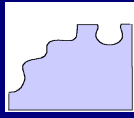
## IV. SIMPLIFIED MMS

### **RESEARCH OBJECTIVE:**

**MMS with few parameters representing demographic characteristics of the migrants**

### **PARAMETERS:**

- **Adult mean age**
- **Children mean age**
- **Proportion of children migrants**



## IV. SIMPLIFIED MMS

### References

**Model Migration Schedules A Simplified Formulation and an Alternative Parameter Estimation Method, Luis J. Castro and Andrei Rogers, IIASA, WP-81-63, May 1981.**

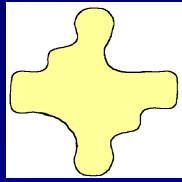
**The Prospects of World Urbanization: Revised as of 1984-1985, United Nations, New York, 1987, Sales No. E. 87.XIII.3, pag. 268.**

**Method of Migration Model Construction in World Population Prospects 1988, United Nations, New York, 1989, Sales No. E.88.XIII.7.**



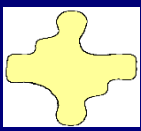


**V. Future Research  
and Applications**

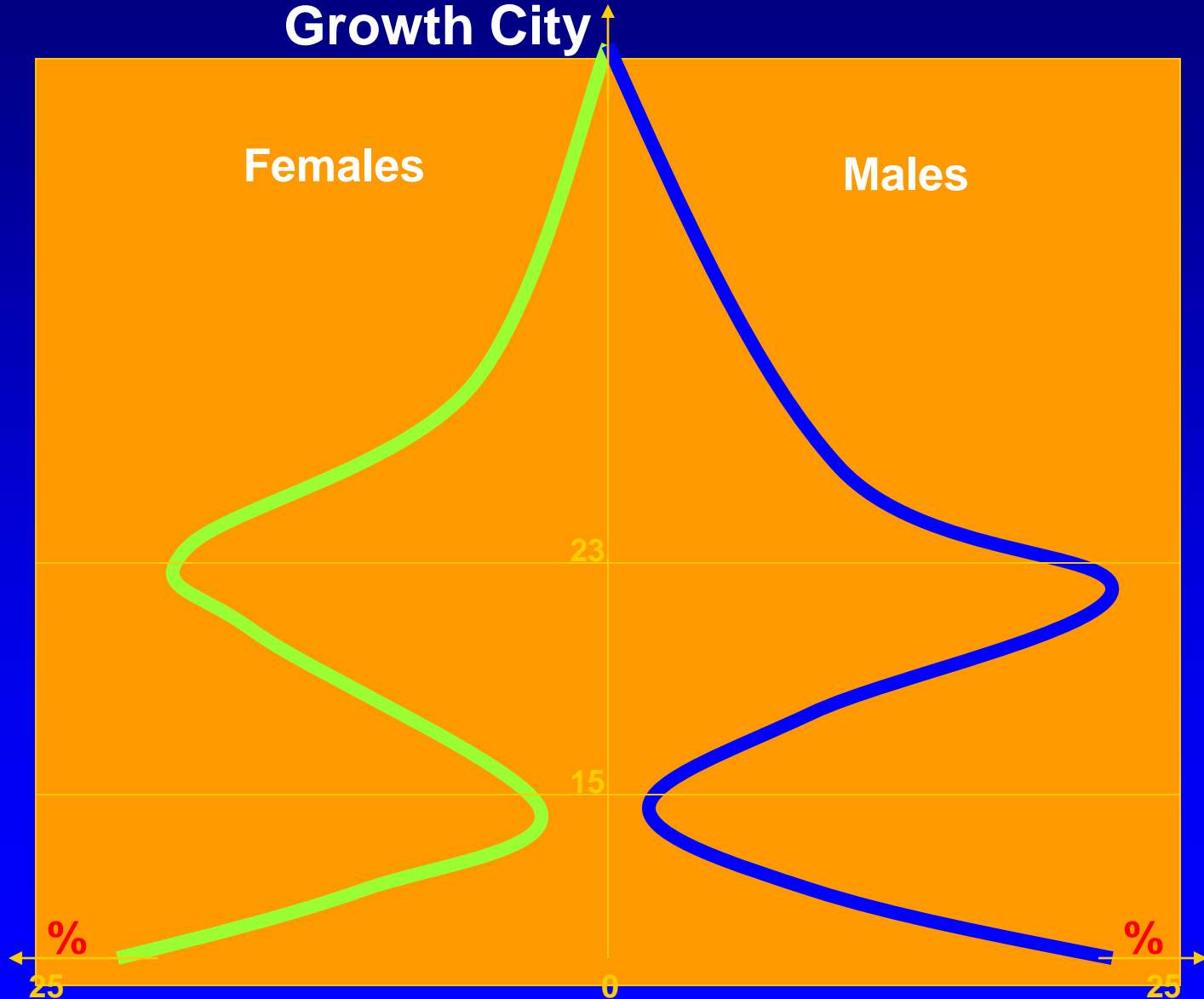


## V. FUTURE RESEARCH\_

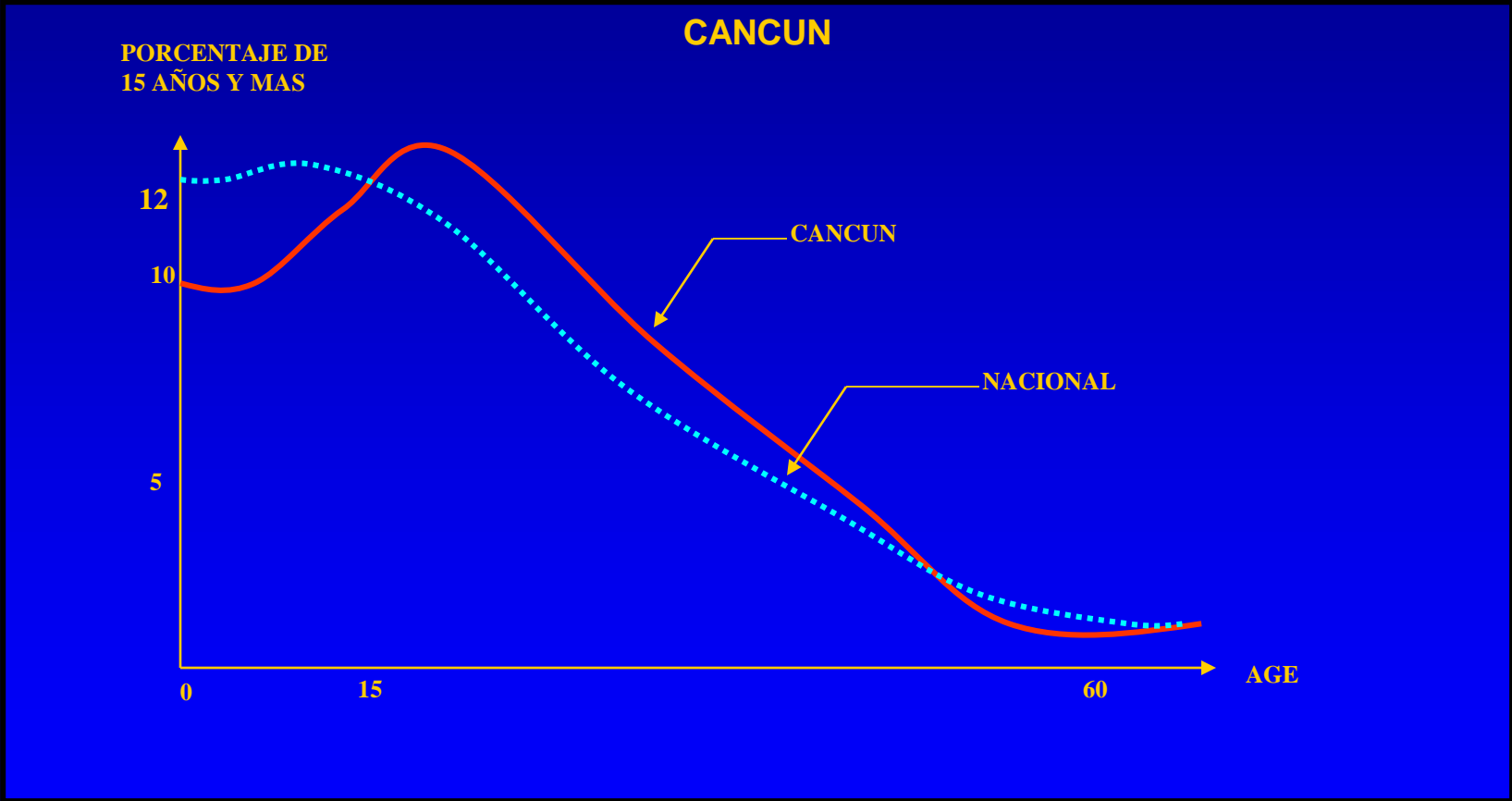
- **More Focus on Users in Developing Countries**
- **Local Population Analysis**
- **Modeling Migration Dynamics Analysis**
  - **Gross to Net Migration**
  - **Net to Gross Migration**
  - **Urbanization**
- **International Migration Modeling**

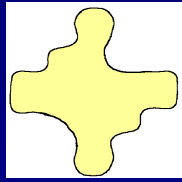


# Age Population Composition of a High Population Growth City

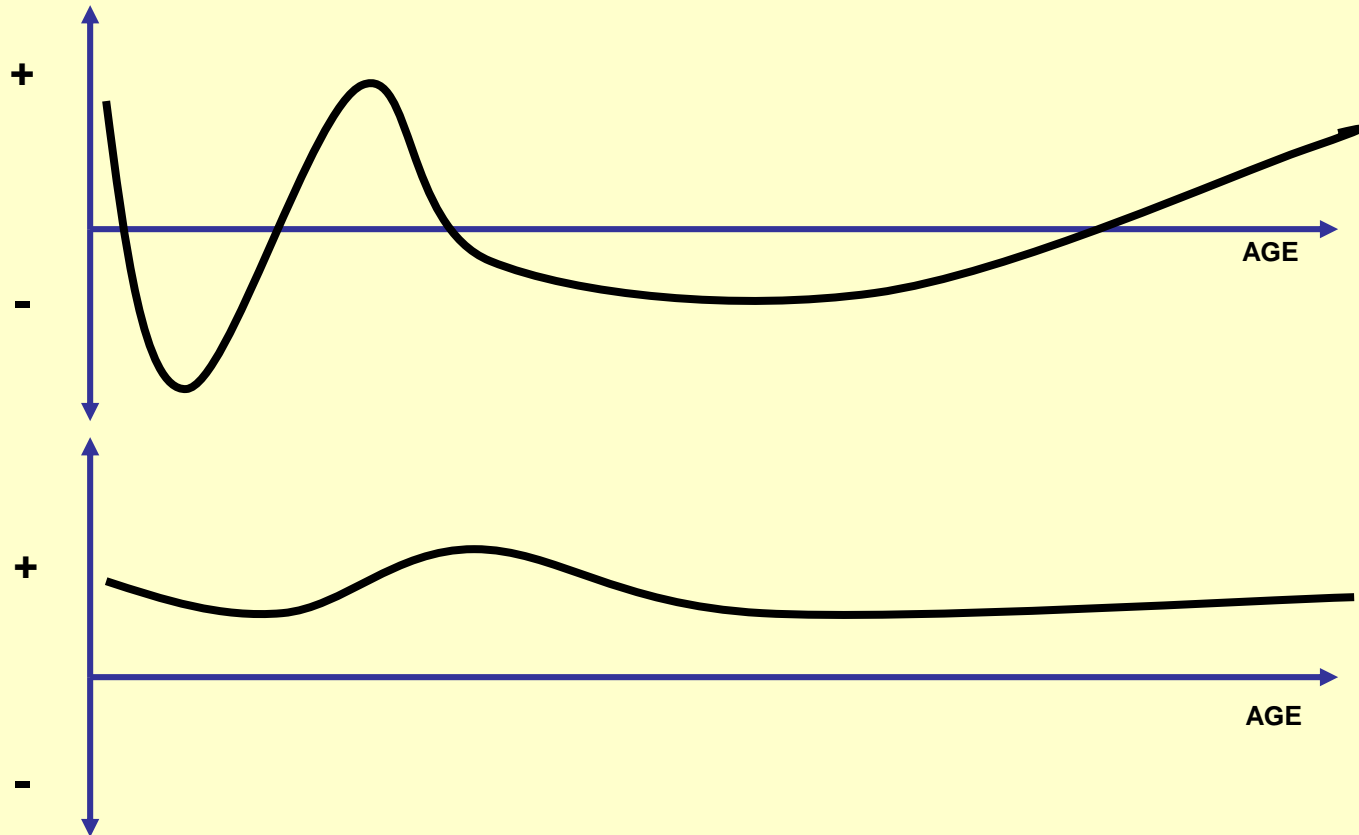


# Age Population Composition

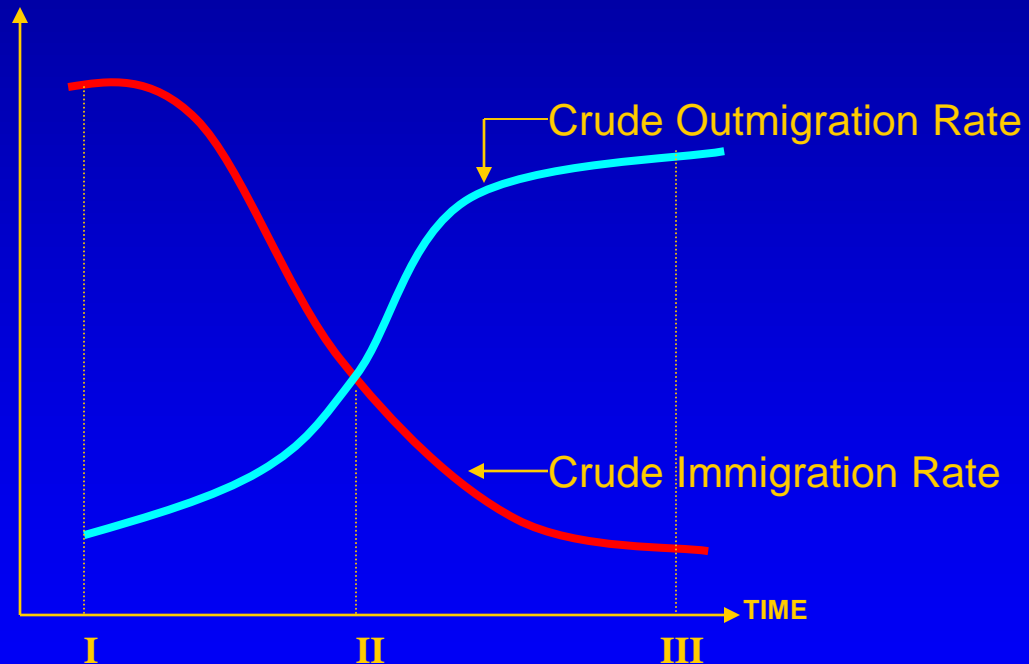




# V. FUTURE RESEARCH\_



# MIGRATION PHASES OF A CITY



## PHASES OF MIGRATION

I High Immigration City

II City in Equilibrium

III High Outmigration City

## AGE-SPECIFIC IN-MIGRATION DISTRIBUTION

$$i(x) = W_i c_i(x) + (1 - W_i) a_i(x)$$

where,

$$i(x) = I(x)/IT$$

$I(x)$  in-migrants at age  $x$

$IT$  Total of in-migrants

$a_i(x)$  proportion of adult in-migrants at age  $x$

$c_i(x)$  proportion of children in-migrants at age  $x$

$W_i$  total proportion of children in-migrants.

In similar way the age-specific out-migration distribution:

## AGE-SPECIFIC OUT-MIGRATION DISTRIBUTION

$$e(x) = W_e c_e(x) + (1 - W_e) a_e(x)$$

Where  $c_e(x)$ ,  $a_e(x)$ , y  $W_e$  are defined as in the in-migration distribution

In turn, the adult and children functions are defined as follow:

$$a(x) = [1/(ma-23)] \exp - [(x - 23)/(ma - 23)] - \exp[-0.2(x - 23)]$$

$$c(x) = (1/mc) \exp(-x/mc)$$

Where  $ma$  and  $mc$  are the adult and children mean age of migrants respectively

## AGE-SPECIFIC NET MIGRATION PROFILES

$$N(x)/K = [ \iota i(x) - \varepsilon e(x) ]$$

Where  $\iota$  and  $\varepsilon$  are the crude in- and out-migration rates respectively and  $K$  is total population. The crude rates are defined as:  $\iota = IT/K$  and  $\varepsilon = ET/K$



# HIGH IN-MIGRATION FLOW

## SMMS PARAMETERS:

### In-migration

ma= 30 yrs.

mc= 5 yrs.

W= 30% dependency ratio

### Out-migration

ma=35 yrs.

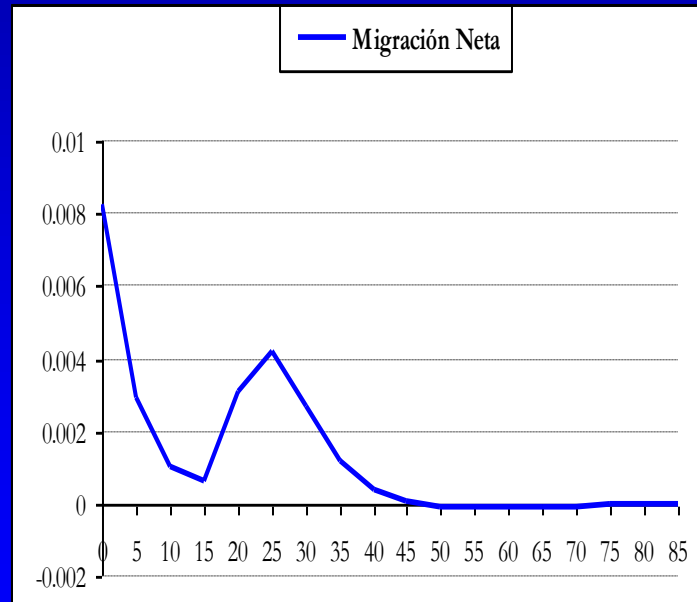
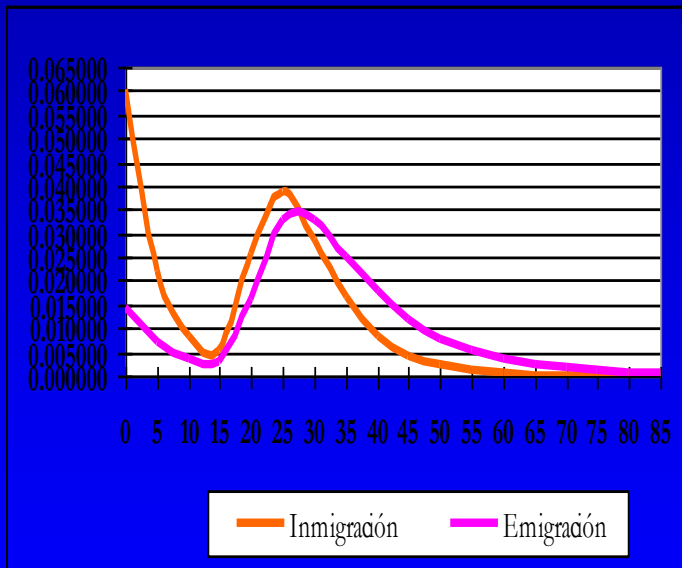
mc=7 yrs.

W= 10%

### Crude Rates

$\tau = 0.15$  (in-)

$\varepsilon = 0.05$  (out-)



# HIGH OUT-MIGRATION FLOW

## SMMS PARAMETERS

### In-migration

ma= 35 yrs.

mc= 7 yrs.

W= 30% dependency ratio

### Out-migration

ma=30 yrs.

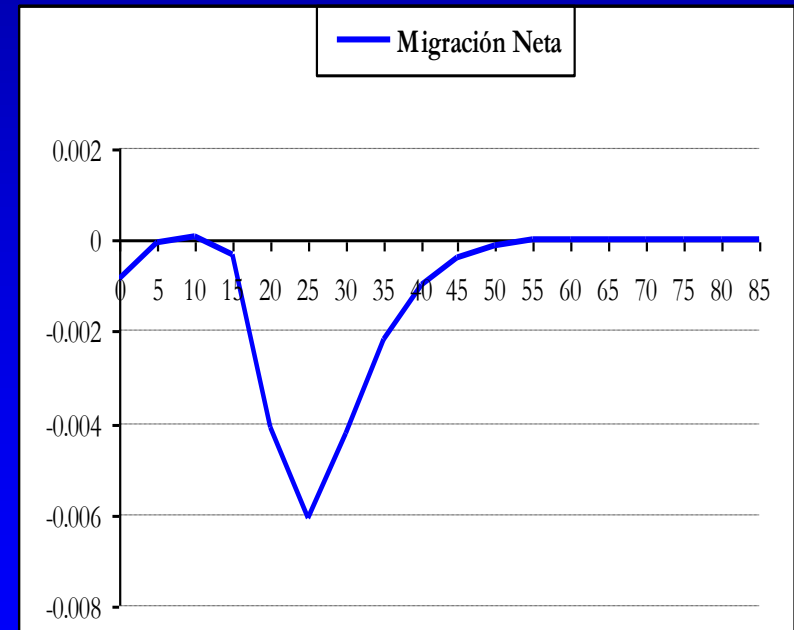
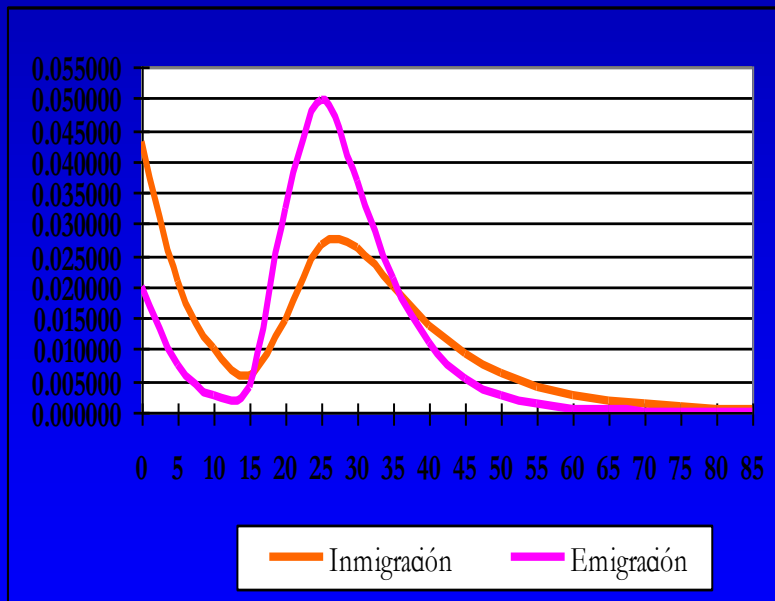
mc= 5 yrs.

W= 10%

### Crude Rates

$\tau = 0.05$  (in-migration)

$\varepsilon = 0.15$  (out-migration)



# SIMILAR IN AND OUT MIGRATION FLOWS

## SMMS PARAMETERS:

### In-migration

ma= 30 yrs.

mc= 7 yrs.

W= 30% dependency ratio

### Out-migration

ma=32 yrs.

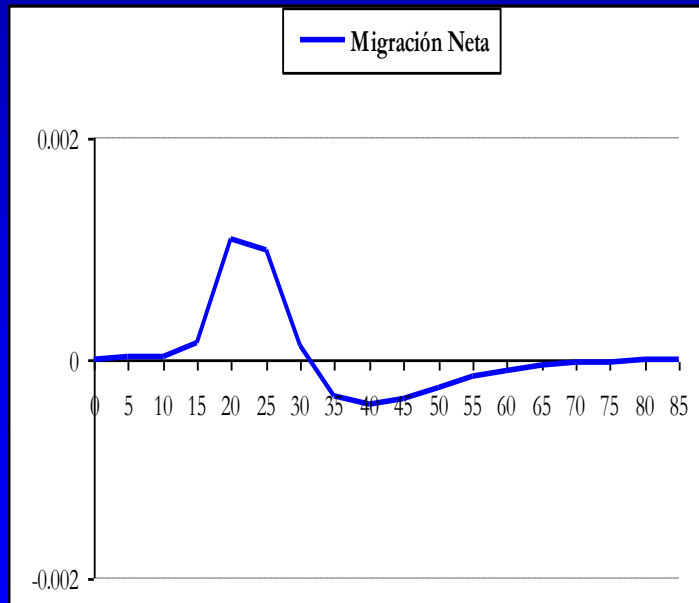
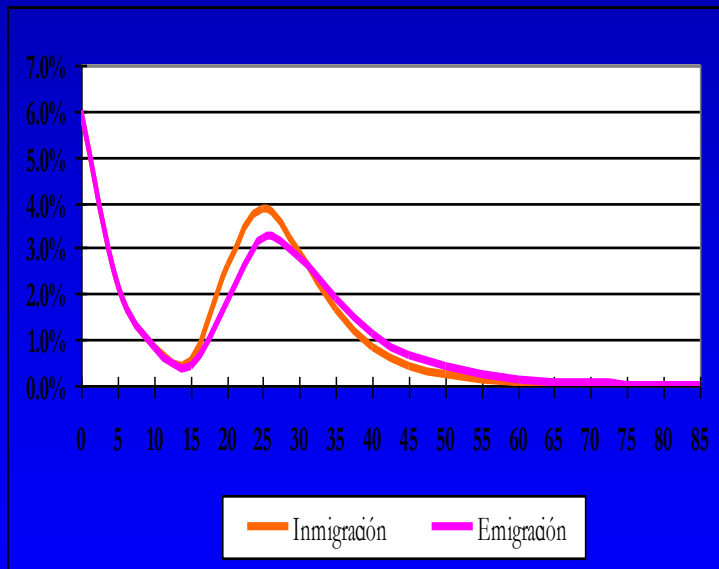
mc= 5 yrs.

W= 30%

### Crude Rates

$\tau = 0.15$  (in-migration)

$\varepsilon = 0.15$  (out-migration)



# LINEAR METHOD

$$N(x)/K = [ \tau i(x) - \varepsilon e(x) ]$$

## Multiple Regression or Linear Programming

1. Net migration estimation by age  $N(x)$  by a residual or Cohort-Component method (Dependent Variable)
2. SMMS by age  $i(x)$  y  $e(x)$  (Independent variables)

### Output:

Crude migration rates  $\tau$  y  $\varepsilon$  (Regression coefficients)

.

# NON LINEAR METHOD

$$N(x)/K = [ \iota i(x) - \varepsilon e(x) ]$$

## No-linear Parameter Estimation

1. Residual or Cohort-Component Method to obtain net migration by age  $N(x)$
2. SMMS for  $i(x)$  and  $e(x)$ .

### Outputs:

- Crude migration rates  $\iota$   $\gamma$   $\varepsilon$

### And for in- and out-migration flows:

- Adult mean age
- Children mean age
- Proportion of children migrants

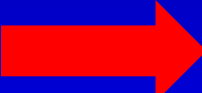
**METHODS**  
**MATERIALS**  
**DEMOGRAPHY**

Second  
Edition



Edited by

JACOB S. SIEGEL / DAVID A. SWANSON

Carnevale, S., 562, 597  
Carrier, N., 139, 151, 170  
Carter, L., 568, 573, 577, 595–596, 599  
Caselli, G., 169–170, 298  
Cassel, C., 599  
Casterline, J., 352, 366, 404, 428  
 Castro, L., 581, 597, 600, 706, 730–731  
Cavanaugh, J., 640  
Chadwick, B., 38  
Chahnazarian, A., 134, 170  
Chan, K., 123  
Chandra Sekar, C., 296–297, 404, 639–640