Demographic Analysis

Migration:
Estimation Using Residual Methods - Internal and International Applications

Indirect Estimation of Migration Through Residual Methods

Outline of this session:

- Q - What is a residual method?
- A - An application of the demographic balancing equation on a broad scale.
  - Intercensal survival estimates for a sub-national area (CSRMig.xls or LTCSRMig.xls)
  - Life table survival estimates of net migration between two censuses (LTCSRMig.xls)
  - Estimation based on discrepancies with cohort component projections (Introduction to RUPCEN.xls and ResidualMigBetaZA.xls)
- Group activities

Indirect Estimation of Migration Through Residual Methods

The Basic Question: What is a residual method?

- As noted earlier, migration is very difficult to measure, and net migration is the component that it is hardest to measure among the components of the demographic balancing equation.

- Therefore, an indirect way of measuring net migration is to assume that all other components are correctly measured. If so, net migration will be the residual amount that allows the equation to balance …

Indirect Estimation of Migration Through Residual Methods

Pop.2 = Pop.1 + Births – Deaths + Net Migration
(T2) (T1) (B) (D) (NM)

Rearranging the demographic balancing equation allows us to estimate net migration as the

residual difference of the other components

Net Migration = Pop.2 – Pop.1 – Births + Deaths
(NM) (T2) (T1) (B) (D)

Questions About the Reliability of Residual Methods

Net Migration = Pop.2 – Pop.1 – Births + Deaths

(NM) (T2) (T1) (B) (D)

- How complete are population counts in T2 and T1? (absolute and relative)
- How complete are estimates of births?
- How complete are estimates of deaths?

Further Challenges in Applying Residual Methods at the *Sub-national level (rural, state, village, etc.)*

Net Migration = Pop – Pop – Births + Deaths

(NM) (T2) (T1) (B) (D)

- Completeness of census counts may vary strongly across localities.
- Birth and death records may not be available (and if derived from surveys, there is statistical uncertainty).
- Such uncertainties are compounded by *spatial sensitivity* – the less populous the locality, the more sensitive it is to migration flows.

The Residual Method Can be Applied to Each Cohort

EXAMPLE – Use residual methods to estimate net migration of the cohort aged 0-4 in 2000 by the time they reach 10-14.

Net migration would be zero if the decline in that cohort counted between 2000 and 2010 was equal to the number of deaths reported for that cohort ...

Net migration = Pop.10-14 – Pop.0-4 – Births + Deaths

(2010) (2000 (2000-10)

Measuring Internal Migration (Indirect Estimation)

A variety of indirect methods that apply residual methods are available to estimate net internal migration. The following are based on results of two censuses:

- Census survival ratio method (CSRMIG.xls or LTCSRMig.xls) for one subnational area
- Life table survival ratios from two censuses (LTCSRMig.xls)
  - Forward survival from an earlier census
  - Reverse survival
  - Composite
- Formal cohort component projections

Using Residuals to Estimate Net Migration

Spreadsheets ranked based on increasing detail and complexity of assumptions

- **Intercensal Survival (CSRmig.xls or LTCSRMig.xls)**
- **Life Table Survival (LTCSRMig.xls)**
- **Formal Cohort Component Projections (RUPCEN.xls or ResidualMigBetaZA.xls)**

Estimating Net Migration in a Sub-National Area

Inter-Censal Survival (CSRmig or LTCSRmig) – Computes Net Migration in a Sub-National Area Using 2 Censuses

- Requires population distributions by sex and 5-year ages for the nation and one sub-area at 2 points in time.
- Mortality by age is *computed* based on survival probabilities of cohorts in the national counts.
- National survival probabilities are applied to sub-national counts (by age) at the time of the first census to estimate the cohort counts at the second census.
- Discrepancies between the actual and estimates counts at the second census are presumed to indicate net migration in the sub-national area.

CSRMig – Enter Pop. By Age and Sex for 2 Points in Time; National and One Sub-area

Table
COUNTRY:
YEARS

Census Survival Rate Method
for Estimating Internal Migration

A. Reported Populations by Age, Sex, and Residence

Year and age	Male Total	Male Subarea	Female Total	Female Subarea
1971				
0-4	929,600	241,850	886,555	230,625
5-9	1,152,430	315,670	1,101,575	300,270
10-14	1,181,450	332,240	1,129,290	312,425
15-19	1,074,430	296,630	1,039,915	264,800
20-24	941,775	195,490	947,630	166,295
25-29	800,710	157,690	783,415	149,420
30-34	660,870	139,590	644,555	132,520
35-39	645,045	140,495	618,825	129,640
40-44	640,765	142,765	621,760	130,660
45-49	613,410	143,080	625,630	133,625
50-54	518,900	131,670	533,635	120,630
55-59	472,415	124,605	482,310	107,650
60-64	381,690	104,930	395,325	87,910
65-69	296,050	85,930	323,910	71,025
70-74	205,575	59,515	251,805	52,580
75+	280,150	78,580	386,920	76,730
Total	10,795,265	2,690,730	10,773,055	2,466,805

A. Reported Populations by Age, Sex, and Residence (continued)

Year and age	Male Total	Male Subarea	Female Total	Female Subarea
1981				
0-4	914,445	260,760	868,930	247,275
5-9	911,940	263,320	864,920	248,130
10-14	984,740	281,945	936,125	265,730
15-19	1,182,015	318,335	1,132,870	287,355
20-24	1,174,295	248,315	1,169,515	223,225
25-29	1,084,410	243,700	1,093,200	238,870
30-34	1,021,480	247,170	1,017,095	234,905
35-39	822,300	204,360	807,950	186,835
40-44	674,670	163,645	663,235	148,515
45-49	634,705	150,620	620,645	136,595
50-54	621,665	147,385	621,815	134,410
55-59	568,385	139,050	611,530	132,545
60-64	462,385	121,250	516,930	114,965
65-69	390,580	106,175	453,750	94,595
70-74	281,225	74,650	352,190	66,905
75+	339,050	83,945	544,185	91,765
	0	0	0	0
	0	0	0	0
Total	12,068,290	3,054,625	12,274,885	2,852,620

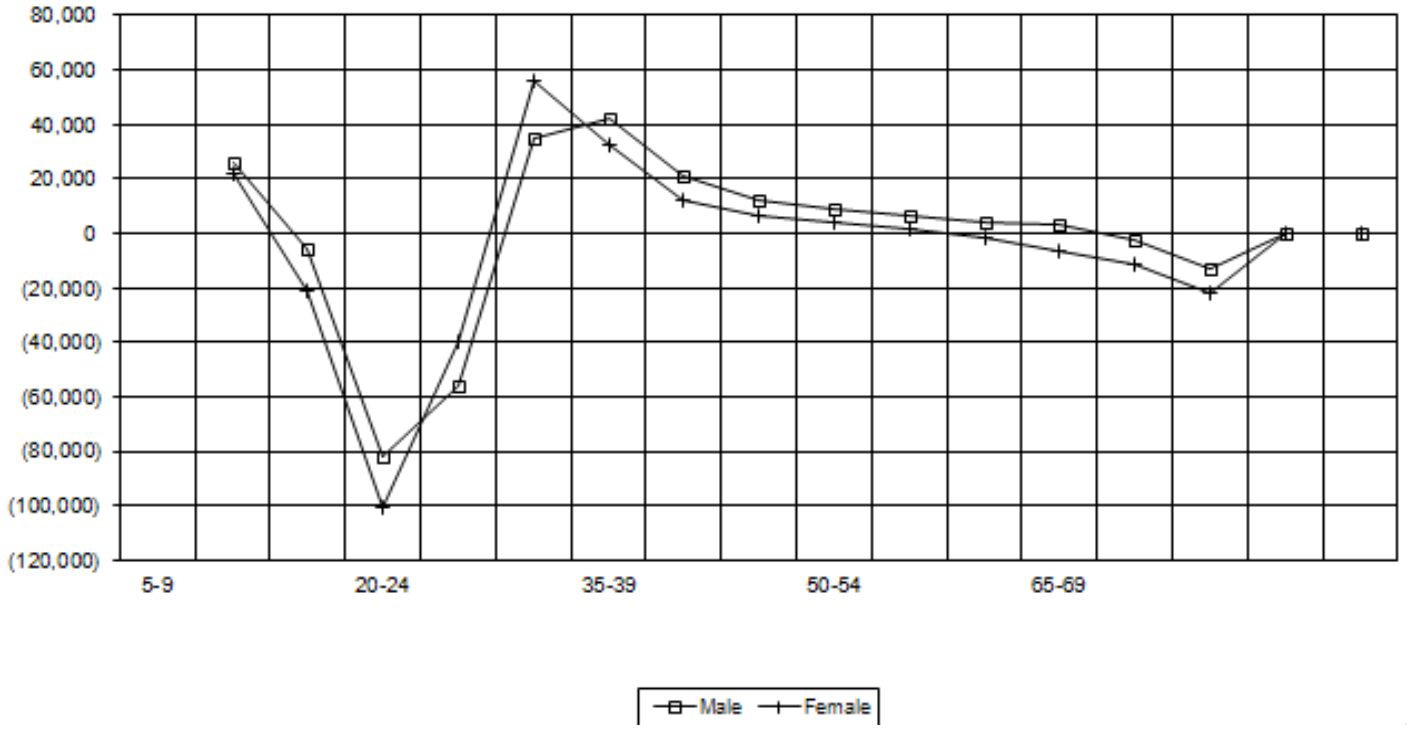
Source:

CSRMig – Output: Intercensal Survival Probabilities for National Cohorts

CSRMig – Output: Estimates of Net Migration for Sub-National Area Between the Census Dates

COUNTRY: YEARS

1. Net Number of Migrants, by Age/Sex



Net Migration Estimates for Manila Using CSRMig

TABLE 6. ESTIMATES OF NET MIGRATION OF FEMALES FOR MANILA, 1960-1970

Age group	Population of the Philippines 1960 (1)	Population of the Philippines 1970 (2)	Ten-year Survival (3)	Population of Manila 1960 (4)	Population of Manila 1970 (5)	Survivors from 1960 (6)	Net migration (7)
0-4	2 218 377	2 871 594	1.1172	80 275	85 870	-	-236
5-9	2 114 832	2 893 681	0.9915	70 875	83 054	-	-8 938
10-14	1 669 435	2 478 426	0.9729	63 250	79 489	89 685	-10 196
15-19	1 429 547	2 096 954	0.8893	85 618	101 410	70 276	31 134
20-24	1 264 441	1 624 113	0.8413	75 793	90 410	61 533	28 877
25-29	1 000 981	1 271 238	0.9571	60 037	56 055	76 137	-20 082
30-34	791 473	1 063 783	0.9513	34 813	44 648	63 765	-19 117
35-39	725 906	958 013	0.9042	31 927	36 963	57 460	-20 497
40-44	552 585	752 922	0.9295	24 297	28 873	33 117	-4 244
45-49	508 045	656 332	0.7966	20 207	23 678	28 867	-5 189
50-54	344 745	513 635	0.8770	13 714	19 063	22 584	-3 521
55-59	235 536	404 713	0.8352	9 366	14 484	16 097	-1 613
60-64	199 118	302 336	0.7116	7 921	10 205	12 027	-1 822
65-69	369 795	196 716	0.5624	11 114	6 405	7 822	-1 417
70-74		141 689			3 746	5 636	-1 890
75+		207 990			4 779	6 251	-1 472
All ages	13 424 816	18 434 135	-	589 207	689 132	551 258	-40 224

NOTES: Column (3) = population 1970, age x divided by population 1960, age x-10; column (6) = column (4) (age - 10) times survival rate in column (3); column (7) = column (5) minus column (6)

For ages under 10, net-migration estimates are derived as follows: for age 0-4: 1/4 (ratio of population 0-4 to female population aged 15-44) times net migration for females aged 15-44; for age 5-9: 3/4 (ratio of population 5-9 to female population aged 20-49) times net migration for females aged 20-49.

Using Residuals to Estimate Net Migration

Spreadsheets ranked based on increasing detail and complexity of assumptions

- Inter-Censal Survival (CSRmig.xls or LTCSRMig.xls)
- **Life Table Survival (LTCSRMig.xls)**
- Formal Cohort Component Projections (RUPCEN.xls or ResidualMigBetaZA.xls)

Using Residuals to Estimate Net Migration

Life Table Survival – Computes Net Migration based on 2 Censuses and Life Table Values

- If life table survival probabilities are available, one can apply these to census data by sex and 5-year ages
- Calculate net migration by 1) surviving the 1st census population to time of the second or 2) reverse surviving the 2nd census population to time of the first
- Discrepancies between the actual and estimated counts are presumed to indicate net migration
- This method can be used to estimate net migration for the nation and local areas.

Measuring Internal Migration (Forward Survival)

First census
P_{0-4}
P_{5-9}
. . .
P_{75-79}
P_{80+}

*

Life table survival ratios ${}_5S_{x,x+10}$
i.e.,
${}_5L_{x+10} / {}_5L_x$

=

Expected population
P_{10-14}
P_{15-19}
. . .
P_{80+} at second census

Expected population
P_{10-14}
P_{15-19}
. . .
P_{80+} at second census

-

Second census
P_{10-14}
P_{15-19}
. . .
P_{80+}

=

Implied migrants
P_{10-14}
P_{15-19}
. . .
P_{80+} , ages at second census

Measuring Internal Migration (Reverse Survival)

Second census
P_{10-14}
P_{15-19}
. . .
P_{80+}

*

Life table survival ratios $1/({}_5S_x)$ i.e., ${}_5L_x / {}_5L_{x+10}$

=

Expected population
P_{0-4}
P_{5-9}
. . .
P_{70+} at first census

Expected population
P_{0-4}
P_{5-9}
. . .
P_{70+} at first census

-

First census
P_{0-4}
P_{5-9}
. . .
P_{75-79}
P_{70+}

=

Implied migrants
P_{0-4}
P_{5-9}
. . .
P_{70+} , ages at first census

Measuring Internal Migration (Composite)

Successive census counts typically differ in their completeness. *Thus, for cohorts common to two censuses, forward survival estimates of migration from an earlier census will differ from backward survival estimates from a later census.*

If one census is more fully reported, migration estimates based on survival to/from that census should be more accurate.

If relative census completeness is unknown, one may take a composite of the above estimates.

Measuring Internal Migration (Composite)

$$\frac{\text{Implied migrants } P_{0\text{-}4},\ P_{5\text{-}9},\ \ldots,\ P_{70+}\text{, ages at first census} \;+\; \text{Implied migrants } P_{10\text{-}14},\ P_{15\text{-}19},\ \ldots,\ P_{80+}\text{, ages at second census}}{2} = \text{Implied migrants for cohort aged } P_x \text{ ages at mid-intercensal period}$$

Migration - Cohort vs. Age Pattern Perspectives

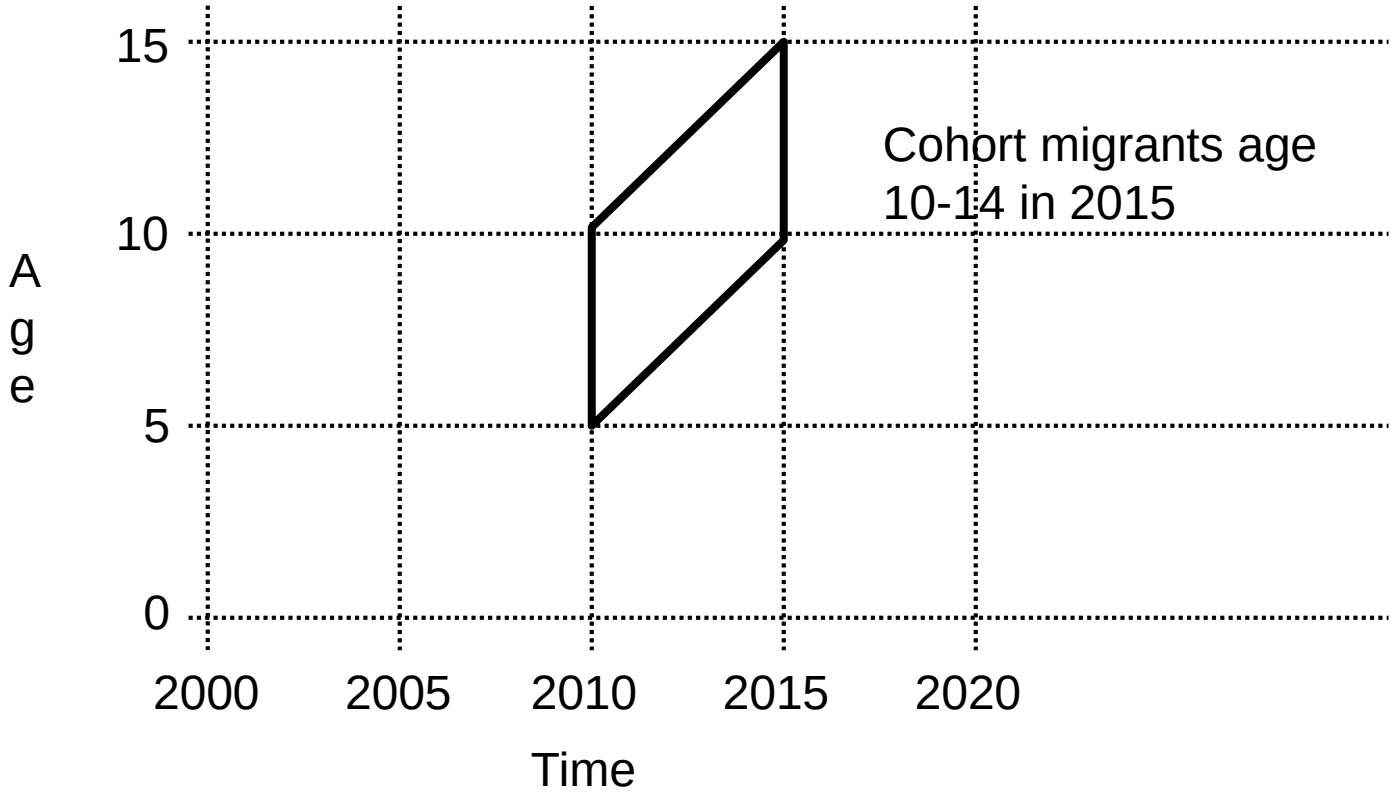
Remember the Lexis Perspective

These methods estimate net migration for a cohort that has been counted at two points in time.

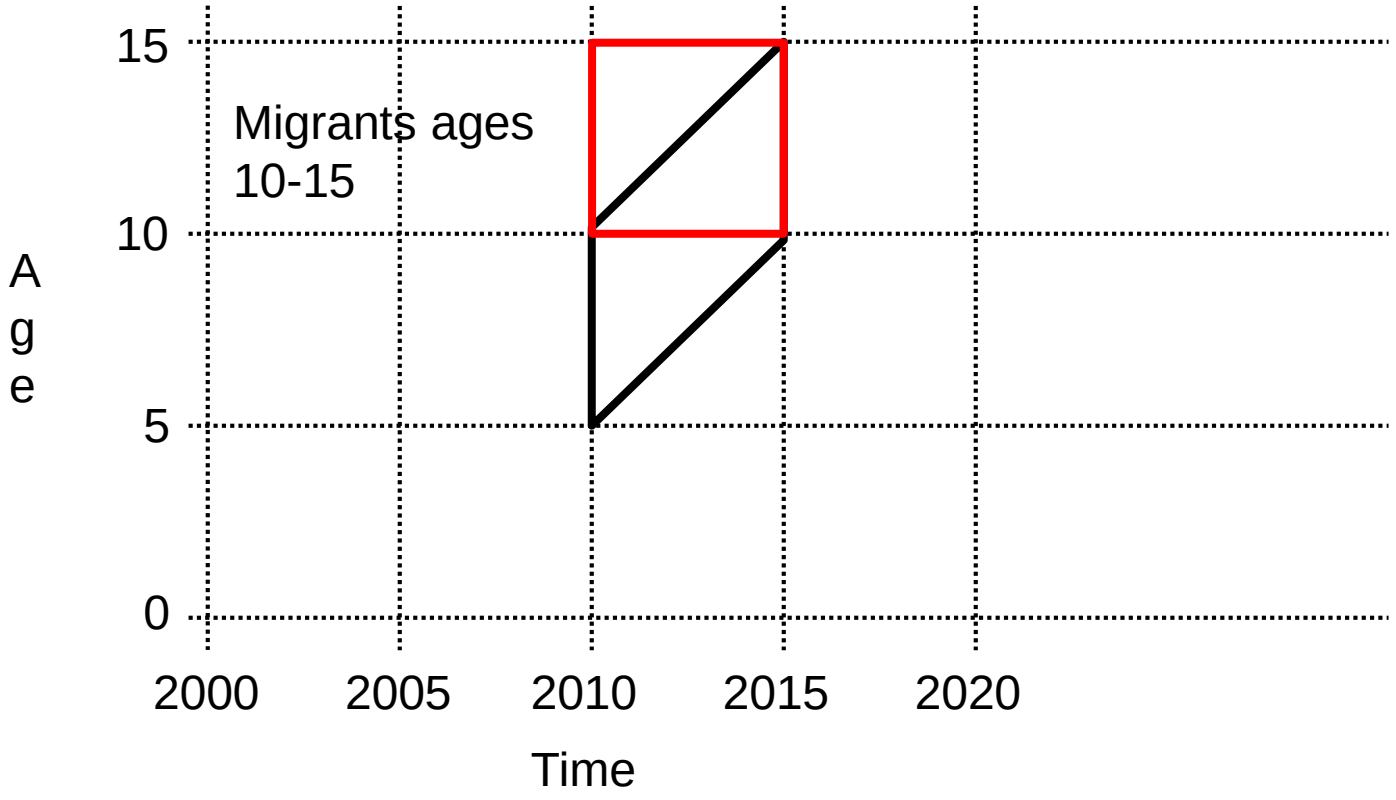
Such cohorts, however, typically pass through several age groups, across which migration rates may differ. These cohort-based estimates of net migration are consistent with any number of period-based rates for the age groups the cohort passes through.

Consider the lexis diagram ....

Lexis Diagram Disection of Cohort Migrants



Lexis Diagram Disection of Cohort Migrants



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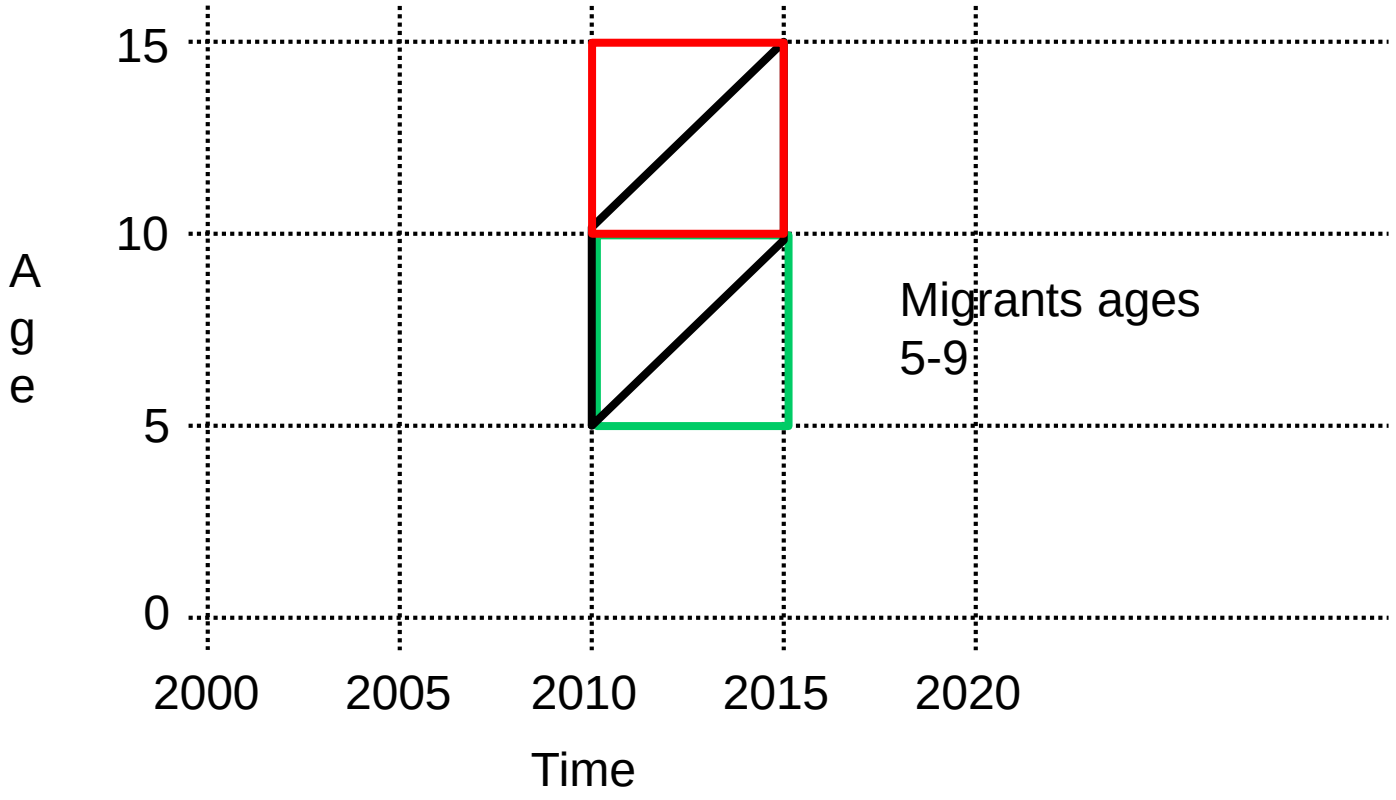

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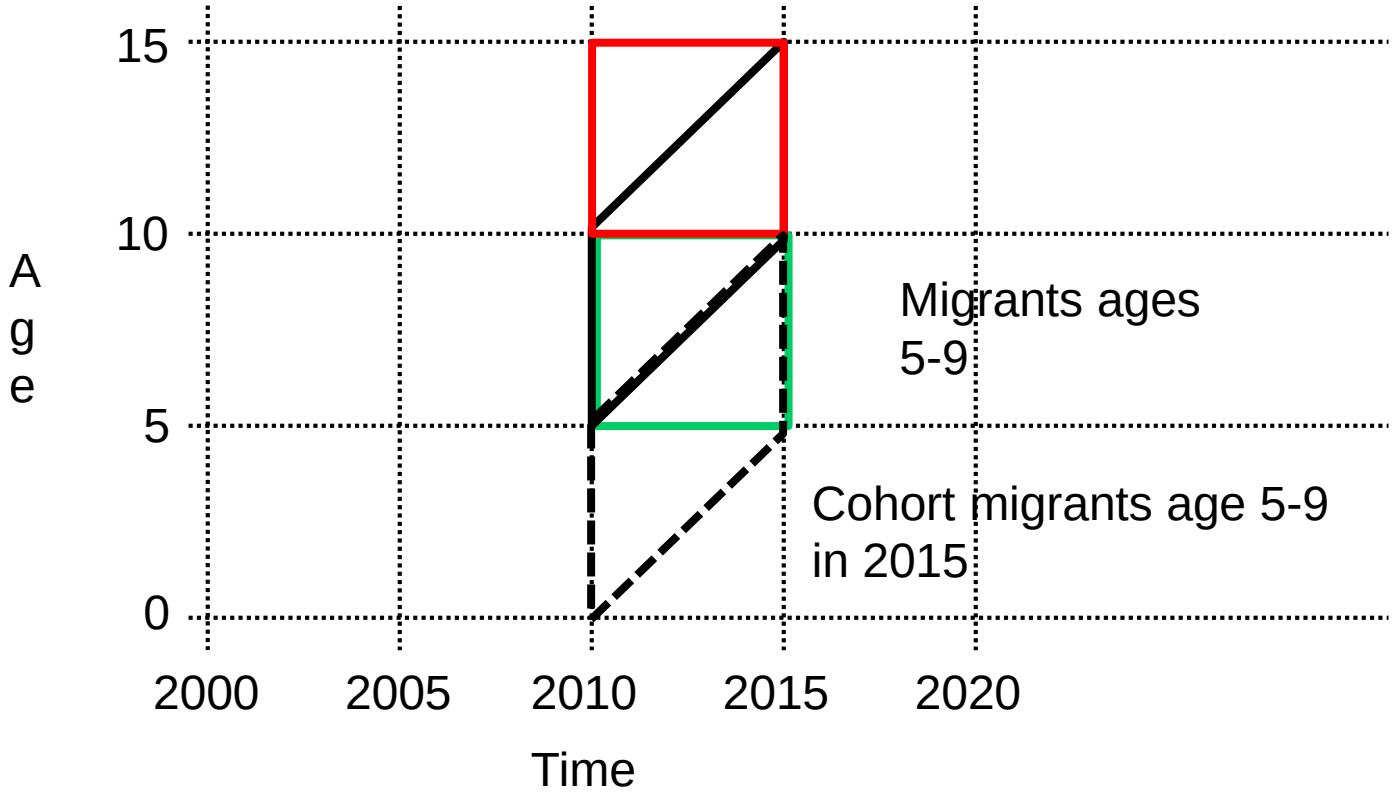
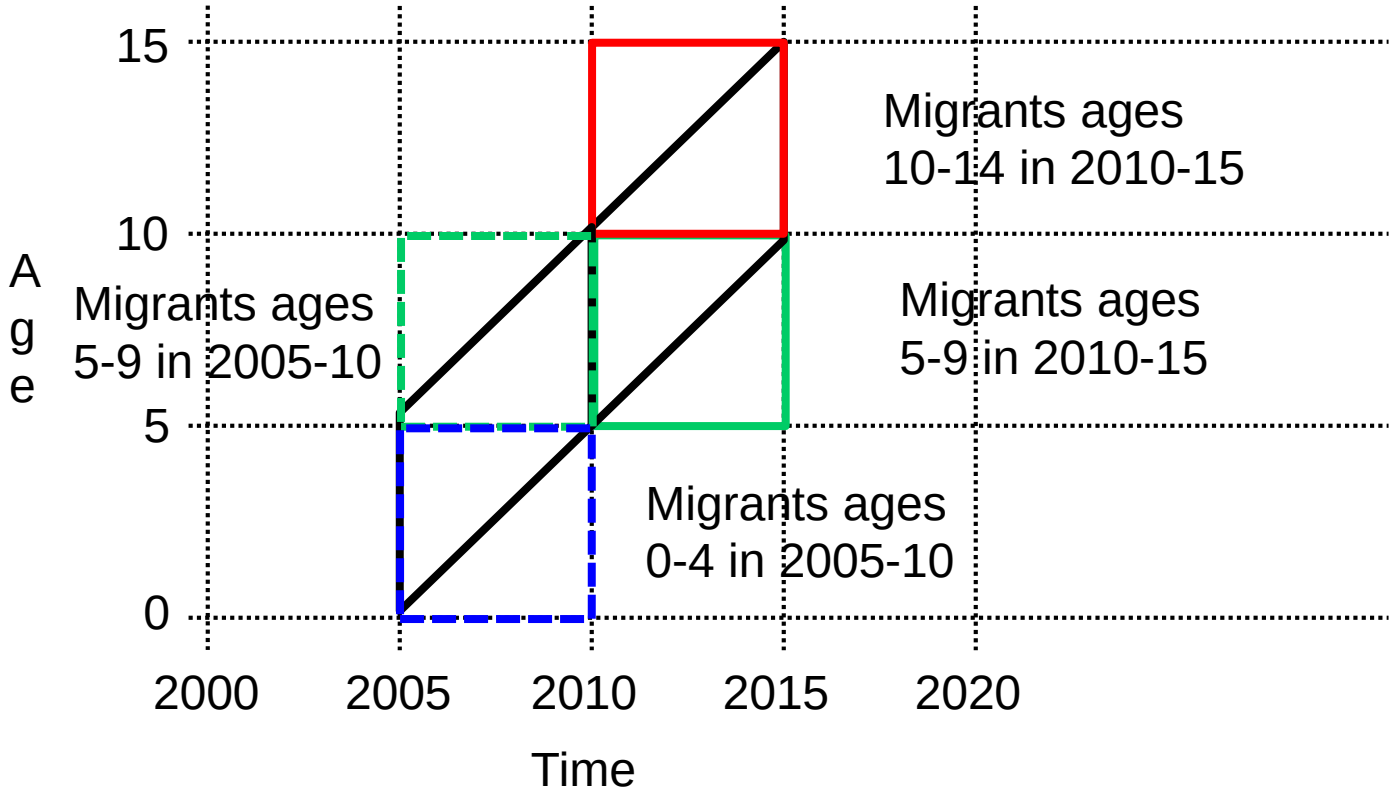


Lexis Diagram Disection of Cohort Migrants: 10-year Interncensal Period



Using Residuals to Estimate Net Migration

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Using Residuals to Estimate Net Migration

RUPCEN

More refined estimates of net migration by age and sex can be produced through cohort-component projections. Mean net migration by age/sex can be estimated using residual techniques:

1. When a new census is available, estimate the counts by projecting forward from an earlier census (assuming zero migration)
2. Determine the residual between the expected count and the projected count
3. Estimate the migration implied by that residual

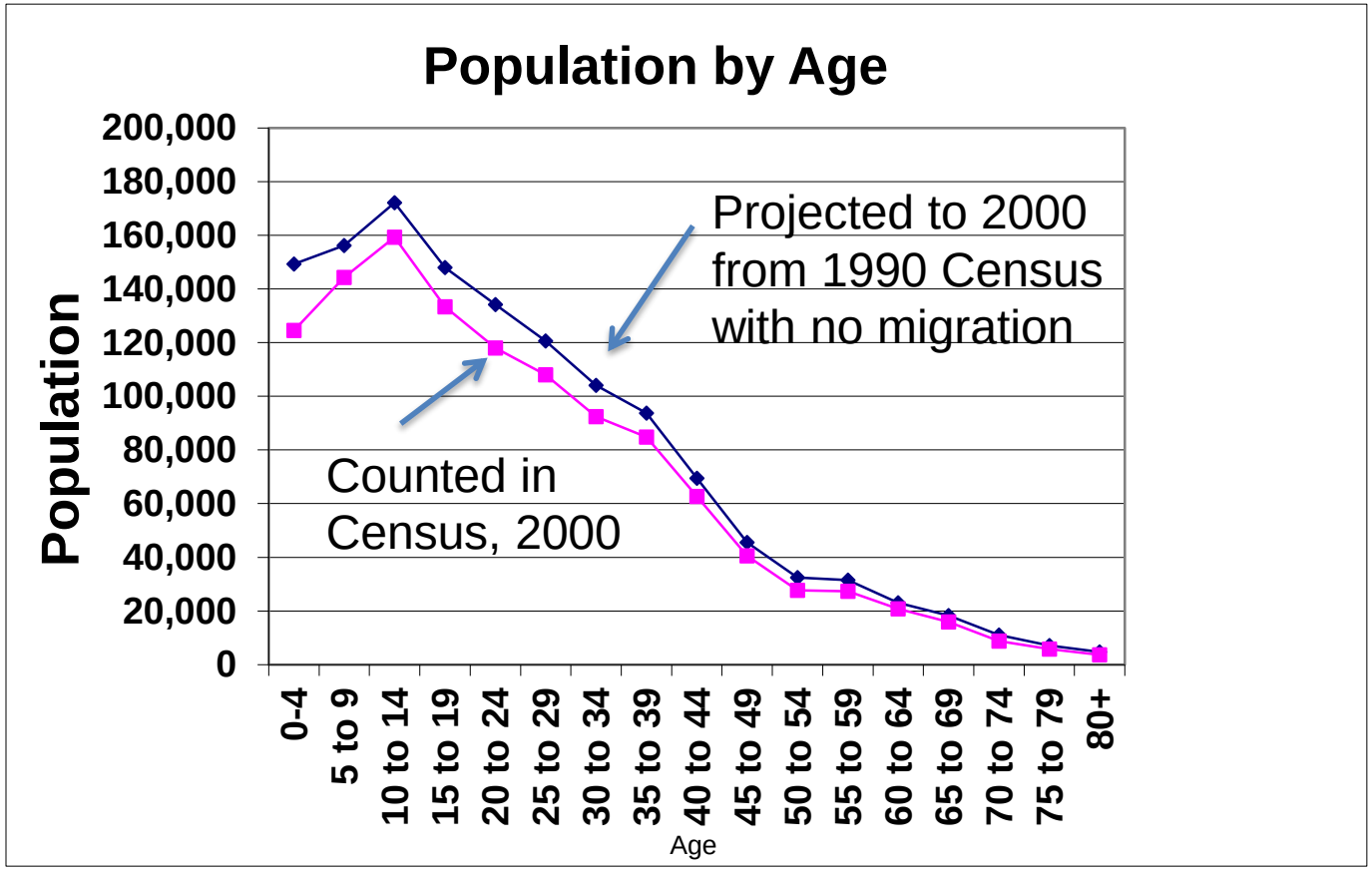
Using Residuals to Estimate Net Migration

RUPCEN

Compared to other methods, the main advantage of the cohort component approach is flexibility. For instance,

- Cohort projections generate annual cohorts of births, so net migration can also be estimated for young children
- Some projections software allow life table probabilities to change over time
- Other refinements and customization are available through **ResidualMigBetaZA**, which allows annual patterns of migration to vary

RUPCEN Output – Implied Net International Migration



Would use of residual methods here imply net in-migration or net out-migration 1990-2000?

Summary Features of Methods to Measure Net Migration Using Two Censuses

	Application	Survival based on	Flexibility
CSRMig.xls (PAS) or LTCSRMig.xls (SPToolkit)	Internal	Cohort survival	Lower
LTCSRMig.xls (SPToolkit)	Internal International	Life Tables	Medium
RUPCEN.xls or ResidualMigBetaZA.xls) (NewPAS)	Internal International	Life Tables (cohort component)	Highest

Exercises

- Estimate net migration as a residual based on the demographic balancing equation.

- Based on the components of the balancing equation in your country, what is your estimate of net intercensal migration (or internal migration for a subarea)? If you are uncertain about those components, what is a reasonable range of estimates?