Internal Migration and Life Course Transitions in Brazil

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Abstract. The aim of this paper is to investigate the association between transitions of the life course and the age pattern of internal migration in Brazil between 1986 and 2010. This relationship has its pillar in the premise – discussed in the literature – that physical, economic and social contextual changes would affect migration levels, while the age pattern of migration relates to transitions in the lifetime of individuals. In order to understand the association between migration and life course transitions, we extract period data from the Demographic Censuses of 1991, 2000 and 2010. From these data, cohort metrics were constructed on the life course transitions (completion of basic education, entry into labor market, first marriage and first child). Parameters developed in the Rogers-Castro model was used to evaluate the age pattern of the migration. This analysis allowed the construction of six hypotheses about the relationship between the transitions of the life course and the age pattern of the migration. The results point to a strong association between migration and other transitions in the life course, especially regarding timing of the first union. In addition, the results show that distance between origin and destination of migrants, a proxy for the cost of mobility, is an important variable since it exposes the immobility of young people, especially those of school age, and discriminates typical age patterns, such as individual or family migration.

Keywords. Age profile of migration, life course transitions, Rogers-Castro model, Brazil.

Introduction

This paper aims uses data from the Brazilian population censuses of 1991, 2000 and 2010 to analyze the relationship between migration age profile and life course transitions. Following Santos (2019), we argue that this relationship assumes the assumption, built upon the literature, that contextual changes over the physical, social and economic environment impact migration levels, while the migration age profile is related to life course transitions of the individuals (Bell, et al., 2015; Santos, 2019; Rogers, Raquillet, & Castro, Model migration schedules and their applications, 1977; Rogers & Castro, Model Migration Schedules, 1981).

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We assume that migration is an instrumental action and synchronic with other life course transitions, and period data allow us to build and model the relationship between migration and life course transitions. Regarding the last, while cohort measures from longitudinal data would be the best methodological option (Kley, 2010; Willekens F. J., 1999; Willekens F. , 1991), surveys generating these data are expensive and of hard implementation in country with the scale of Brazil. The alternative is to use census data to estimate cohort functions and measures from period data (Hajnal, 1953; Wachter, 2006; Modell, Furstenberg, & Hershberg, 1976). This strategy involves the estimation of parameters of the Rogers-Castro migration function (Rogers & Castro, Model Migration Schedules, 1981) as well as life curse metrics suggested in the literature (Hajnal, 1953; Modell, Furstenberg, & Hershberg, 1976; Wachter, 2006) to estimate intraregional, interregional migrants, as well as non-migrants and total population.

The Rogers-Castro model (Rogers & Castro, Model Migration Schedules, 1981) synthesize the migration age profile given the calibration of the parameters that allow the analysis of the variation of the rates by age, between different populations or in different moments in the same population. It is a multiexponential model expressed in 7, 9, 11 and 13 parameters (Rogers, Raquillet, & Castro, Model migration schedules and their applications, 1977; Rogers & Castro, Model Migration Schedules, 1981; Rogers & Watkins, General versus elderly interstate migration and population redistribution in the United States, 1987).

$$\underbrace{M_{(x)}}_{Emigration\ Rate} = \underbrace{a_1 e^{-\alpha_1 x}}_{\substack{Components \\ of \\ Pre-laboral\ migration}} + \underbrace{a_2 e^{-\alpha_2 (x-\mu_2) - e^{-\lambda_2 (x-\mu_2)}}}_{\substack{Component \\ of\ Labor\ Force}} + \underbrace{a_3 e^{-\alpha_3 (x-\mu_3) - e^{-\lambda_3 (x-\mu_3)}}}_{\substack{Compoment \\ of\ the\ Migration\ Peak\ around\ Retirement\ Age}}$$
$$+ \underbrace{a_4 e^{\lambda_4 x}}_{\substack{Component \\ Ascendent\ in\ the\ Post-Retirement\ Ages}} + \underbrace{c}_{Constant}$$

(eq. 1)

We used the model proposed by Hajnal (1953) to estimate the mean age at first marriage, one of the metrics of transitions in the life course. According to Wachter (2006), this metric can be adapted to other dimensions of the human life, which follow the same assumptions (Wachter, 2006; Tomás, Oliveira, & Rios-Neto, 2008). Originally, it was conceived from the proportion of people that experienced marriage along the life course - *Singulate Mean Age at First Marriage* (SMAFM) (Hajnal, 1953; Wachter, 2006). Generalizing to the mean age at the transition – to the first job, first child, first union or conclusion of the basic education – we estimate the *singulate mean age* (π) as (Wachter, 2006):

$$\pi = n\sum_{x=0}^{\omega} 1 - (F_{\left(x+\frac{n}{2}\right)}/F_{(ult)})$$

(eq. 2)

Where $F_{(x+2,\,5)}$ is the proportion of people who made the change from age group *x* and *x+n* or, by approximation, the mean expected proportion at age *x+2,5*. $F_{(ult)}$ is the *prevalence* of the cohort transition, that is, the maximum expected proportion of the hypothetical cohort that will make transition. This value can be defined from the mean of the las ages or by another criterion, such as the observed proportion in the age function. The complement of the fraction $F_{(x+2,5)}/F_{(ult)}$ is the share of the population by age group that did not make the transition, considering that this population will eventually make the transition until the end of the life. Finally, the mean age at the transition is estimated by integrating all the estimated values by age groups and multiply them by the length of the five-year interval. It is worth mentioning that despite being a metric estimated with period data, π is a cohort metric and is not affected by the age structure and, given that it uses proportions by ages, they do not include the mortality effects.

The metric *spread* uses the function of people who did not experienced the transition at each age ($G_{(x)}$):

$$G_{(x+2,5)} = 1 - (F_{(x+2,5)}/F_{(ult)})$$

(eq. 3)

We obtain the values in Equation 3 from the proportions extracted from demographic censuses. We obtain the values by single ages in the function $G_{(x)}$ through interpolations using cubic spline. Thus, we estimated the ages in which 25% and 75% of the population experienced the transition. From the difference between these two ages, it was possible to define the metric *spread*) and combine them to estimate the *congruence* between the two transitions (Modell, Furstenberg, & Hershberg, 1976).

$$\tau = K\left(\bigcap_{k=1}^{K} \Omega_k\right) \Big/ \sum_{k=1}^{K} \rho_k$$

(eq. 4)

Where τ is the metric of *spread*, *K* is the number of transitions to be compared, Ω_k is the set of all ages that define the spread (ρ) of a transition *k* (Modell, Furstenberg, & Hershberg, 1976).

Preliminary data analysis helped us to define six hypotheses regarding the relationship between life course and internal migration in Brazil. We discuss these hypotheses and the methods to test them in the next section.

Hypotheses and Methods

We define six hypotheses about the relationship between migration age profile and life course. The literature on migration age profile has highlighted its association between life course events (Bernard, Bell, & Charles-Edwards, Life-course transitions and the age profile of internal migration, 2014b). Some authors associate temporally migration with schooling transitions (Wilson, 2010), marriage market (Mulder & Wagner, 1993), constitution of a new household (Guinnane, 1992), entrance in the labor market (Amaral, Rios-Neto, & Potter, 2016) or retirement (Rogers & Watkins, General versus elderly interstate migration and population redistribution in the United States, 1987; Campos, 2010). This association is affected by contextual factors (Bernard, Bell, & Charles-Edwards, Life-course transitions and the age profile of internal migration, 2014b), and consequently the social structure can induce exogenous shocks in the relationship between migration and life course transitions.

Thus, we define six hypotheses that allow us to understand this relationship and to assess if it is observed in Brazil in the las decades, as well as its spatial pattern.

<u>Hypothesis 1</u>: *there is a stability in the migration age profile over time.*

We evaluate the stability of migration age profile in Brazil and its regions over time, considering that the level and structure can change independently and the estimate of one does not necessarily implies changes in the behavior of the other (Rogers, Raquillet, & Castro, Model migration schedules and their applications, 1977; Bernard, Bell, & Charles-Edwards, Life-course transitions and the age profile of internal migration, 2014b). If there is stability in the age profile, the structural factors are acting more on the migration *quantum* and less on the migration *tempo*. Thus if the age profile is stable, even with small fluctuations, the proximate determinants of migration are probably acting with higher intensity than structural factors s (Bernard, Bell, & Charles-Edwards, Life-course transitions and the age profile of internal migration, 2014b).

We evacuate this hypothesis through the estimation of the Rogers-Castro model to the male and female intraregional migration and inter-regional emigration in Brazil, considering the fixed-date question in the 1991, 2000 and 2010 Brazilian censuses.

Hypothesis 2: *The migration age profile of a region polarized in the territory has, overall, smaller children dependency and higher symmetry in the labor force compared to the emigration age profile in the same region*.

The literature on migration has discussed the effects of the spatial distribution of production factors on population distribution, including the role of the concentration and deconcentration of economic activities and migration flows that result of such movements of production factors (Perroux, 1977; Diniz, 1993; Matos, 2002). On the other hand, Rogers and Castro (1981) discuss the empirical regularities on migration age profiles and how, besides levels, they follow a regular pattern that are related to life course events, such as the search of a new job or the constitution of a new household.

According to Rogers and Castro (1981), the migration flows to the most dynamic economic areas also show higher infant dominance and higher symmetry in the labor force if compared to the emigration flows from these areas. In some cases, it is possible to assume that the mean age also has a differential: those flowing the dynamic area are younger, and emigrants from these regions are older and consequently in another life course (including retirement). Thus, it is possible in some cases to identify a *retirement peak* in the emigration function.

In Brazil, the state of São Paulo has been historically the most capital intensive and concentrated production factors (Fundação Getúlio Vargas, 1949; Diniz, 1993; Matos, 2002). Thus, we estimate emigration and out-migration for São Paulo. For comparison purposes between the functions, we considered the parameters asymmetry, regularity, dominance and mean and modal ages of the migration model function.

Hypothesis 3: *the emigration profile in different regional scales is different only by level, not in its pattern*.

Roger and Castro (1981) suggest a regularity in the migration age profile according the territorial level. Changes in scale usually changes the level but not the migration pattern since the reduction in the size of the territorial unit make residence changes in residence in smaller units be considered migration.

We estimated migration model functions for Brazil, states, great regions (clusters of states according to geographic location), macro regions (clusters of municipalities within each state), micro regions (clusters of municipalities within each macro region) and municipalities for the 1991, 2000 and 2010 Brazilian censuses (Figure 1). We expect that the smaller the territorial unit, the higher the migration intensity and thus we would identify change in parameters that describe the level of the migration model function. However, there would not be substantial changes in the parameters of the pattern (Rogers & Castro, Model Migration Schedules, 1981).

Figure 1: Delimitation of the study regions in Brazil

The relationship between the territorial level and the migration age pattern can be affected by the *modifiable unit area problem – MAUP*, in which the population size or the size of the different territorial units can affect the estimates. The question here is if the *MAUP* is sufficient to break the pattern in several territorial levels in the last decades in Brazil. The evaluation of migration in several territorial levels show that there are changes which are function of the dimension of the areas, and the effects of measuring movements of shorter distances when we consider smaller territorial units.

Hypothesis 4: *the mean age of the labor force is higher for males compared to females, reflecting age differences in the marriage Market.*

The migration model functions proposed by Rogers and Castro (1981) show regularities over the age profile that can be considered universal. One of the arguments is that the mean age of the labor force is higher for males compared to females, and this is a consequence of the age difference in the marriage market (Rogers & Castro, Model Migration Schedules, 1981)

The relationship with marriage can be real if migration is an instrumental transition between marriage and the constitution of a household in the short run, or even Family migration at later stages in the life course. However, if migration shows dominance in the labor Market, this difference can be smaller, do not exist or even express differences between males and females regarding who leaves the origin household first (Mulder & Wagner, 1993). Mulder & Wagner (1993) emphasize the role of the distance between origin and destination areas in the relationship between life course transitions and age differences by sex. The authors found evidences of synchronization between migration and marriage events at shorter distances, while at longer distances differences by sex decrease (Mulder & Wagner, 1993). The comparison between parameters that describe the migration component of the labor force between sex and regions, as well as the mean ages at life course transitions, will help us to elucidate these questions. We use the three demographic censuses to compare the mean and modal ages between the migration functions by sex in relation to distance.

Hypothesis 5: *there is selectivity in the life course transitions according to the migratory condition of the individual, making explicit that the synchrony between events happens only in the migrant population*.

Migration selectivity is a widely used concept in the literature that suggests that the occurrence of migration s at least in part determined by specific attributes and characteristics of the individuals. Age is a key attribute affecting selectivity and the probability of a demographic event. In a life course perspective, age differences is expressed by a sequence of social roles and transitions over the life (Elder, 1975). The presence of selectivity in life course transitions, according to the migratory condition, suggest[s that there would be differences in the *timing* of the transitions of migrants and non-migrants. This selectivity can happens in all dimensions of life or in some of them.

Thus, we estimate the mean ages and spread of the transitions, as well as the congruence of each type of transition – entrance in the labor market, conclusion of the basic education, first union and first child – between migrants and non-migrants for both sexes. The aim was to verify incongruences in the transitions between migrants and non-migrants and, if they exist, to state that migrants have specific trajectories and consequently cannot be compared to the evolution of migration with the mean life course.

Hypothesis 6: *there is an association between the timing of the life course transitions and the age of higher migration propensity.*

The social, economic, environmental cultural and political contexts determine life course trajectories of the individuals. Regional differences in Brazil as well as its interdependence make the migration flows shaped by according to the origin and destination of migrants. Thus, if the context denotes limited resources or low employment, it can prevail emigration among the youngest and a small correlation between migration of adults and children. Another example is that with the distance between the events "first child" and "first union", migration can be synchronic with one of the transitions and become more distant from the other. In any case, life course transitions behave as proximate determinants of the migration age profile (Bernard, Bell, & Charles-Edwards, Life-course transitions and the age profile of internal migration, 2014b).

Bernard, Bell and Charles-Edwards (2014b) propose indicators of timing and spread of the transitions, putting together conclusion of basic education, entrance in the labor Market, first union and first child, and compare them with metrics of the migration age profile. However, besides selectivity in the transitions by migratory condition, we must consider that migration can be more synchronic with some transitions and less on others and such relationship can change over time.

Thus, we use age in which there is higher propensity to migrate in the comparison with timing and in the spread of the transitions. The aim is to understand such temporal association according the last three demographic censuses.

Results

We discuss the results of testing the six hypotheses in this section. We used algorithms in R language; detailed results and programming are in Santos (2019).

Hypothesis 1: *there is stability in the migration age profile over time.*

We observed stability in the migration age profile over time, especially in the intermunicipal migration. However, this stability does not mean that the age profile is similar in all regions of Brazil.

We estimates dissimilarity indexes to understand the evolution of age profiles (CARVALHO, LAURETO, *et al.*, 2013), by comparing the patterns of age functions (not the level). We also estimated the Rogers-Castro model to analyze and compare the parameters of the function. The results suggest three types of behaviors: i) small variations between the three censuses (1991, 2000 and 2010) but all around the same pattern (e.g. East); ii) the pattern is constant over time (e.g. interregional emigration in the Northeast); iii) transition of the migration age profile (e.g. inter-regional migration in the South). The results are in Table 1.

The analysis of the five-year periods 1986-1991, 1995-2000 e 2005-2010 show a trend of growth in the correlation between children and adult migration in Brazil. We identified a value for β_{12} (correlation between children and adult migration) that grows over time for both sexes. There are high values for children dependency (δ_{12} – ratio between the level of children and adult migration) – above 0.44; the mean age pattern of internal migration in Brazil is of young adults, probably also related to family migration. There is also a growth in the trend of participation of this group given the composition of the flows: the greater importance of return migration is related to flows of high children dependency and a typically family mobility.

The analysis of the patterns of intraregional migration reveals four regularities in the migration flows in the intervals 1986-1991, 1995-2000 e 2005-2010. The first two refer to the indicator B (*jump* – difference between the higher adult and the smaller adolescent migration rate), its evolution over time and differences by sex. We show that B tends to grow over time, and exhibit values higher values for females compared to males.

In a cohort perspective, migration as an instrument of transition of the youngest to the adult life is intensifying over time, and the intensity of female migrations higher compared to males. In a period perspective, the propensity to migrate of adults seems closer to those of smaller children – seen by the increase in β_{12} – and less related to the youngest in school ages. This result help us to explain the growth in the gap between x_l (age of smaller propensity to migrate between adolescents) and x_h (modal age of migration).

The third regularity refers to asymmetry of the component labor force (σ_2). Given that it refers to the ration between λ_2 (growing rate of the component labor force) and α_2

(descending rate of the component labor force), we can associate the increasing values of the asymmetry by the increase in the numerator or decline in the denominator. Males show a higher relative propensity to migrate after the modal labor force age and, in this sense, the value of α_2 tends to be smaller. By its turn, the female function tends to concentrate the migration propensity around the age modal labor force, showing a gig her symmetry. This can means, in a life course perspective, that the synchrony of migration with other transition events is more intense for females, and female life course transitions can be more concentrated in the time (and thus influencing the role of transitions in the propensity to migrate).

Table 1: Parameters estimated from the Rogers-Castro model for intraregional migration of both sexes – Brazil, 1986-1991, 1995-2000 e 2005-2010

Region	Period	Sex	μ_2	*GMR*	β_{12}	σ_2	δ_{12}	x_h	x_l	*X*	*B*	*A*
Midwest	1986-1991	Males	23,22	7,342	0,612	1,462	0,518	25,00	12,00	13,00	0,004	27,21
Midwest	1986-1991	Females	16,80	6,828	0,454	2,213	0,641	20,00	9,00	11,00	0,005	24,15
Midwest	1995-2000	Males	19,30	7,333	0,636	8,043	1,323	25,00	14,00	11,00	0,004	31,66
Midwest	1995-2000	Females	20,16	6,829	0,139	1,398	0,708	21,00	9,00	12,00	0,005	27,62
Midweast	2005-2010	Males	19,02	5,119	0,882	3,656	0,740	24,00	12,00	12,00	0,005	28,18
Midweast	2005-2010	Females	17,62	4,848	0,879	2,334	0,594	21,00	10,00	11,00	0,006	24,43
East	1986-1991	Males	25,09	4,475	0,459	1,262	0,461	26,00	13,00	13,00	0,006	29,46
East	1986-1991	Females	21,62	4,441	0,494	1,088	0,380	21,00	9,00	12,00	0,007	26,68
East	1995-2000	Males	20,54	4,774	0,798	3,451	0,631	25,00	13,00	12,00	0,005	31,52
East	1995-2000	Females	19,71	4,693	0,509	1,670	0,384	22,00	10,00	12,00	0,007	28,86
East	2005-2010	Males	19,73	3,689	0,814	2,635	0,500	24,00	12,00	12,00	0,007	29,89
East	2005-2010	Females	18,47	3,634	0,744	2,161	0,435	22,00	10,00	12,00	0,008	27,44
Northeast	1986-1991	Males	24,78	5,092	0,633	1,272	0,414	25,00	10,00	15,00	0,004	33,08
Northeast	1986-1991	Females	18,82	5,274	0,553	1,107	0,241	19,00	5,00	14,00	0,008	30,60
Northeast	1995-2000	Males	18,86	4,634	0,650	6,670	1,016	25,00	12,00	13,00	0,005	35,73
Northeast	1995-2000	Females	16,43	4,666	0,371	2,318	0,368	20,00	8,00	12,00	0,008	31,05
Northeast	2005-2010	Males	18,41	3,514	1,256	3,099	0,523	23,00	11,00	12,00	0,007	29,74
Northeast	2005-2010	Females	16,19	3,573	0,861	2,579	0,370	20,00	9,00	11,00	0,010	27,94
North	1986-1991	Males	17,30	5,892	0,409	8,110	1,447	23,00	12,00	11,00	0,005	34,17
North	1986-1991	Females	14,02	5,564	0,171	3,502	1,047	18,00	8,00	10,00	0,006	26,85
North	1995-2000	Males	18,39	6,480	0,213	5,038	1,381	25,00	10,00	15,00	0,004	39,73
North	1995-2000	Females	15,53	6,104	0,480	2,388	0,413	19,00	6,00	13,00	0,006	31,68
North	2005-2010	Males	17,29	4,638	0,775	5,005	0,526	22,00	12,00	10,00	0,006	32,11
North	2005-2010	Females	15,66	4,499	0,814	2,600	0,409	19,00	9,00	10,00	0,008	26,64
São Paulo	1986-1991	Males	26,84	5,010	0,395	1,118	0,476	27,00	14,00	13,00	0,005	29,03
São Paulo	1986-1991	Females	23,53	4,824	0,447	1,079	0,472	23,00	12,00	11,00	0,005	25,22
São Paulo	1995-2000	Males	21,96	5,013	0,627	3,499	0,600	27,00	15,00	12,00	0,005	32,50
São Paulo	1995-2000	Females	25,22	4,796	0,397	1,030	0,400	25,00	12,00	13,00	0,005	28,45

São Paulo	2005-2010	Males	23,06	3,630	0,843	2,059	0,425	27,00	14,00	13,00	0,007	32,72
São Paulo	2005-2010	Females	25,26	3,413	0,593	1,034	0,405	25,00	12,00	13,00	0,007	28,38
South	1986-1991	Males	19,12	7,077	0,599	3,064	0,646	23,00	12,00	11,00	0,006	27,75
South	1986-1991	Females	18,86	7,165	0,490	1,586	0,398	21,00	10,00	11,00	0,008	26,04
South	1995-2000	Males	18,45	6,788	0,658	4,805	0,717	23,00	13,00	10,00	0,007	29,94
South	1995-2000	Females	17,84	6,767	0,553	2,341	0,430	21,00	10,00	11,00	0,009	27,56
South	2005-2010	Males	20,74	5,683	0,649	1,987	0,426	24,00	12,00	12,00	0,008	29,84
South	2005-2010	Females	19,07	5,671	0,671	1,800	0,393	21,00	10,00	11,00	0,010	27,06

Source: IBGE, Demographic Census of 1991, 2000 e 2010.

The fourth regularity considers the difference between males and females in terms of the modal age (x_h) and the mean age (μ_2) of the component labor force. As suggested by Rogers and Castro (1981), the mean age of males is, in most cases, superior to that of females, what tends to be similar to differences in the marriage market. This regularity is identified in the intraregional flows that can be, in some way, an approximation to the migration age pattern of short and middle range distances. However, Mulder and Wagner (1993) suggest that this regularity tends to appear exactly in shorter distances, and in more diverse ways at longer distances.

Not all regularities in the intraregional migration appear in interregional emigration profiles. The inter-regional migration age profile of males and females have smaller differences compared to the intraregional profile, with a reduction in the differences of asymmetries between sexes. There is also a trend of maintenance of indicator *B* over time. Still in this scenario, there is a trend of smaller difference between sexes in terms of mean and modal migration age. This reduction in the difference is also spatial since interregional emigration has smaller differences compared to the intraregional migration.

These trends suggest a potential future scenario regarding the migration age profile, and are thus an important input for population projections being simpler methods that use symptomatic variables, such as gravitational models (ZIPF, 1946; STEWART, 1948).

Hypothesis 2: *The migration age profile of a region polarized in the territory has, overall, smaller children dependency and higher symmetry in the labor force compared to the emigration age profile in the same region*.

São Paulo has historically the higher economic dynamism in Brazilian among the six regions in analysis. Related to this, São Paulo has been the main destination for migration flows in the Brazil since the 20th century.

The comparison between migration age profiles, from other regions to São Paulo, confirms the regularities suggested by Rogers and Castro (1981). The migration age profile is predominantly of young adults (x_h between 20 and 25 years), with labor force dominance and, consequently, low children dependency. Furthermore, there is a high concentration in the propensity to migrate around the modal age of the immigration function when compared to emigration flows, shown by both smaller asymmetry and higher *Jump* (*B*). The emigration function, by its turn, presents higher children dependency, with modal age of the labor force component above 25 years and higher asymmetry of the labor force. This pattern can be seen in the three periods of analysis (1991, 2000 and 2010) in all Brazilian territory.

Table 2: Parameters estimated from the Rogers-Castro model for emigration and immigration in São Paulo, by sex – Brazil, 1986-1991, 1995-2000 e 2005-2010

	Parameters	1986-1991		1995-2000		2005-2010	
		Females	Males	Females	Males	Females	Males
Immigration	μ_2	19,80	17,50	19,40	18,05	19,21	17,53
	x_h	20,00	20,00	20,00	21,00	21,00	21,00
	σ_2	1,046	2,687	1,280	2,587	1,488	3,171
	δ_{12}	0,241	0,247	0,221	0,339	0,189	0,192
	α_2	0,189	0,137	0,164	0,134	0,139	0,105
	λ_2	0,198	0,367	0,210	0,346	0,207	0,333
Emigration	μ_2	26,66	25,12	22,96	21,23	30,07	23,00
	x_h	26,00	28,00	26,00	28,00	28,00	29,00
	σ_2	1,096	1,961	2,384	12,480	1,068	5,891
	δ_{12}	0,657	0,570	0,875	1,330	0,840	1,273
	α_2	0,126	0,080	0,079	0,022	0,099	0,038
	λ_2	0,138	0,157	0,189	0,272	0,106	0,224

Fonte: IBGE, Censos Demográficos de 1991, 2000 e 2010

This stability in the profile was followed by changes in the levels of internal migration flows. Despite the reduction in the level of interregional migration, São Paulo and the Northeast were the only regions increasing the participation in the interregional flows compared to the intermunicipal emigration. Besides this growth, São Paulo increased the emigration flows compared to the emigration flows, especially those with destination in the Northeast, probably due to the growth of return migration (particularly towards the Northeast). In other words, and differently from other countries, the presence of migrations in older ages – including those around retirement ages – do not mean the search for amenities in other regions; in Brazil, return migration is usually the main explanation. Thus, the reduction in the net migration of São Paulo is not due only to the industrial deconcentration since the 1980s but also due to the composition of flows, with the return of bigger and older to the origin. This shows that life course events, in the case of return migration, affect the level and not only the timing of migration.

Hypothesis 3: *the emigration profile in different regional scales is different only by level, not in its pattern*.

We estimated this hypothesis from Rogers-Castro model to migration in several territorial scales: great regions, states, mesoregions, micro regions and municipalities. We also estimated dissimilarity indexes between territorial levels. The results show small differences between the territorial levels in terms of the function when we analyze the whole national territory. We did the same for each region, in terms of municipalities, mesoregions and micro regions, and the results show similar migration functions, independently of the level. However, the differences between territorial levels appeared with systematic greater differences correlated with greater differences in the number of territorial units.

We identified systematic differences in the inverse correlation between migration level – proportional to the number of territorial units and inverse to the area – and in the difference between the smaller propensity to migrate between adolescents and higher propensity of young adults (B). The regional evaluation also show that the this relationship is common to both sexes, following the national scale, but the value B tends to be higher for females compared to males.

Except for São Paulo – which did not present differences between sexes and neither significant difference between profiles in terms of the territorial level, the regional analysis shows two regularities. First, females have a more abrupt change in the propensity to migrate between the youngest and the adults, showing that it is possible that females are more affected by the timing of life course transitions. The regional evaluation of the transitions corroborates this hypothesis since the time of spread (ρ) of the female transitions are superior to those for males.

Table 3: Parameters estimated from the Rogers-Castro model by territorial scales and sex – Brazil, 1986-1991, 1995-2000 e 2005-2010

	Parameters	1986-1991		1995-2000		2005-2010	
		Females	Males	Females	Males	Females	Males

Municipalities	x_h	20,00	23,00	21,00	24,00	21,00	23,00
	μ_2	19,82	18,56	18,98	18,64	18,68	18,47
	β_{12}	0,463	0,684	0,470	0,730	0,770	0,948
	σ_2	1,261	3,402	1,746	5,182	1,869	3,630
	δ_{12}	0,348	0,555	0,386	0,725	0,401	0,517
Microregions	x_h	20,00	22,00	21,00	23,00	21,00	22,00
	μ_2	18,30	17,16	18,02	17,47	18,71	17,77
	β_{12}	0,485	0,722	0,469	0,677	0,760	0,925
	σ_2	1,495	4,894	1,959	6,956	1,775	4,113
	δ_{12}	0,342	0,601	0,390	0,822	0,378	0,502
Mesoregions	x_h	20,00	22,00	21,00	22,00	21,00	22,00
	μ_2	17,64	16,85	17,60	17,21	18,85	17,63
	β_{12}	0,488	0,684	0,472	0,661	0,762	0,901
	σ_2	1,703	5,541	2,139	7,535	1,755	4,213
	δ_{12}	0,345	0,592	0,390	0,812	0,372	0,485
Federation Units	x_h	20,00	21,00	21,00	22,00	22,00	22,00
	μ_2	17,57	16,62	17,65	17,05	19,21	17,39
	β_{12}	0,439	0,730	0,500	0,802	0,759	0,945
	σ_2	1,964	6,798	2,354	8,271	1,810	4,996
	δ_{12}	0,380	0,591	0,453	0,845	0,402	0,527
Regions	x_h	20,00	21,00	21,00	22,00	22,00	22,00
	μ_2	16,95	16,54	17,82	17,01	18,85	17,12
	β_{12}	0,477	0,644	0,409	0,658	0,752	0,899
	σ_2	2,413	7,260	2,271	7,565	1,996	5,712
	δ_{12}	0,385	0,531	0,438	0,750	0,404	0,503

Fonte: IBGE, Censos Demográficos de 1991, 2000 e 2010.

The second regularity is that the territorial level seems an approximation of the distance of migration. In other words, the greater the size of the territorial unit we expect, on average, that the greater the distance an individual will make (and change residence) in order to identify him or her as a migrant. In this sense, we estimated the Rogers-Castro model as a function of the Euclidian distance between the centroids of the origin and destination municipalities. This approach allows concluding that the greater the migration distance, the greater the jump (*B*). In a cohort perspective, this means to assume that there is a greater effect of the migration as a transition to adulthood in the long-range migration, while for shorter distances there is smaller difference between adults and adolescents – in this case, probably denoting family migration.

Over time, we observe a reduction in the intensity of the effect of distance in relation to the growth of *B* (difference between the smaller propensity to migrate between the youngest and adolescents at age x_l, and the greater propensity of the youngest and adults, x_h).This can be explained by the growing participation of emigration from São Paulo – a pattern of family migration, with high children dependency and smaller value of B – among the types of migration. Overall, the effect of distance can also be observed in the difference by sexes in the migration age profiles.

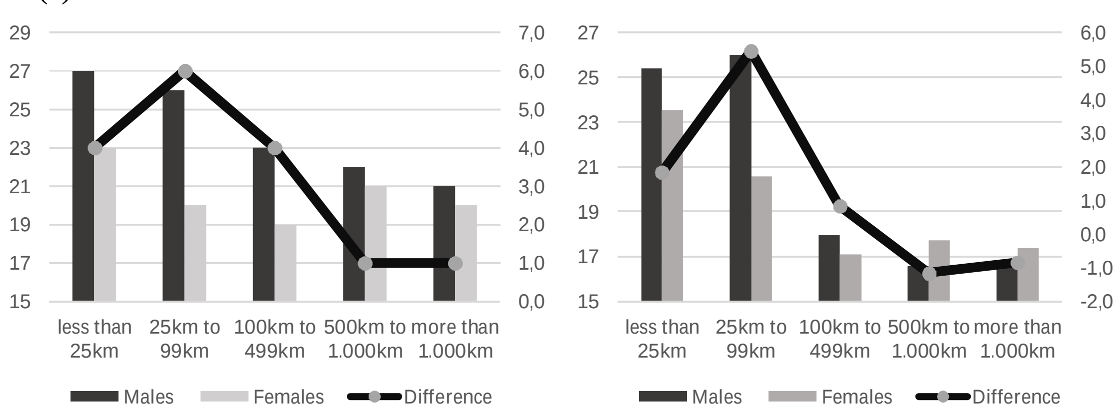
Hypothesis 4: *the mean age of the labor force is higher for males compared to females, reflecting age differences in the marriage Market.*

From the estimation of the migration model functions by groups of Euclidian distance we extracted the parameters μ_2 and x_h for both sexes. The modal and mean ages of labor force show a trend of reduction in the age difference by sex, with increase in the distance between origin and destination municipalities. We also show a trend of smaller mean and modal ages of the migrants the higher the distance, approaching the mean age of entry in the labor market. St the same time, short distance migrants are older, closer to the mean age at first union except for the 1986-1991 estimates for 25 – 99 km.

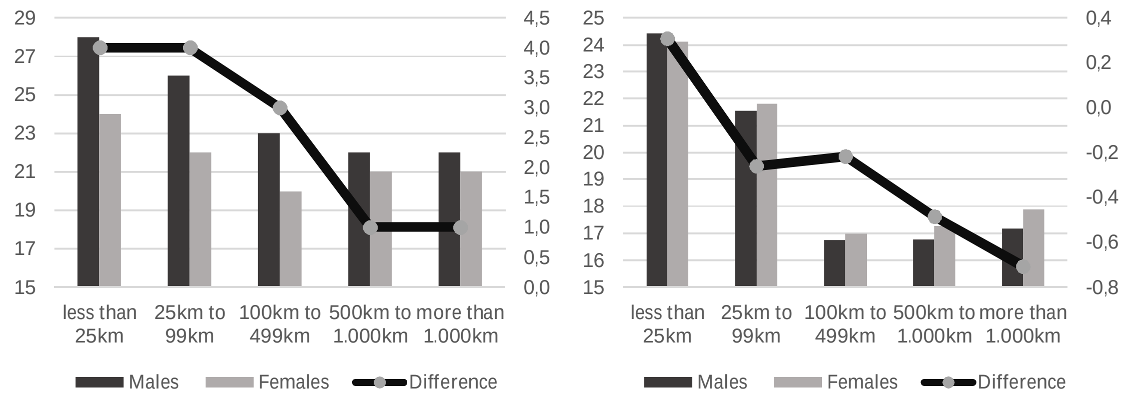
The results suggest the validation, in the Brazilian case, of the age-sex-distance hypothesis described by Mulder and Wagner (1993). In other words, there is a difference in age between sexes for the short distance migration that is similar to the marriage market, while long-term migration shows almost null age differences between males and females, which are similar to the pattern observed in the labor market (MULDER & WAGNER, 1993). Besides the decrease in the age differences between males and females, the number of single females increases as a function of distance, even if this pattern was losing intensity in the group of female migrants over time.

Graphic 1: Modal age (x_h) (left) and mean (μ_2) (right) of the labor force by sex and distance between municipalities of origin and destination – Brazil, 1986-1991, 1995-2000 e 2005-2010

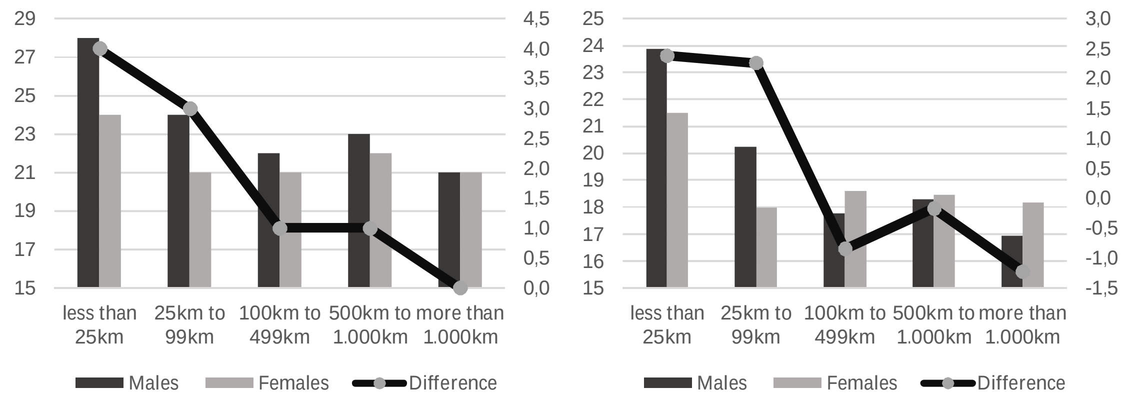
(a) 1986-1991



(b) 1995-2000



(c) 2005-2010



Fonte: IBGE, Censos Demográficos de 1991, 2000 e 2010

The validation of the age-sex-distance hypothesis is followed over time by the participation of females in the labor market and the reduction in the effect of distance. These changes are followed by the reduction in the number of couples of same origin – these are probably a proxy of joint family migration. These characteristics indicate that other dimensions besides labor market may be responsible for the reduction in the differences between migrant males and females. These dimensions can be in the combination between marriage market and transition to entry into labor market, but also van is associated to changes in the composition of migration flows with the reduction of the Northeast-São Paulo flow (historically the most important inter-regional flow in Brazil) and the increase, proportionally, of the São Paulo-Northeast migration.

Hypothesis 5: *there is selectivity in the life course transitions according to the migratory condition of the individual, making explicit that the synchrony between events happens only in the migrant population*.

There is a difference between migrants and non-migrants in terms of first union. Migrants tend to transit to first union before non-migrants. Differences by migration status in 1999 are greater between transitions, but there is a convergence between 1991 and 2010. It remains a great difference in first union.

Even with the trend of convergence of migration status, the regional analysis shows that the North and Northeast do not show convergence in terms of indicators of transition to the conclusion of basic education for males. Furthermore, only the North did not converge regarding females. In the same way as the interregional migration, the mean age of entry in the labor market for inter-regional migrants of the South increased systematically between 1991 and 2010.

Table 4: mean age, prevalence spread and congruence between migrant and non-migrant females – Brazil, 1991, 2000 e 2010

Life Course Transition	Year	Prevalence (P)		Spread (ρ)		Mean age (π)		Congruence (τ)
		Emigrants	Non migrants	Emigrants	Non migrants	Emigrants	Non migrants	
Completion of basic education	1991	0,264	0,280	4,6	3,6	21,1	20,1	0,756
	2000	0,335	0,389	4,1	3,5	19,5	19,2	0,925
	2010	0,599	0,605	4,4	3,9	19,0	19,1	0,936
Entry into the labor market	1991	0,457	0,476	3,5	4,8	15,0	17,0	0,571
	2000	0,606	0,640	4,1	4,6	16,7	17,1	0,828
	2010	0,688	0,704	5,3	5,4	17,7	18,2	0,899
First Union	1991	0,938	0,920	6,4	7,5	21,4	23,6	0,688
	2000	0,949	0,931	6,8	7,7	21,1	23,5	0,654
	2010	0,944	0,923	7,4	8,4	21,0	23,7	0,632
First Child	1991	0,923	0,909	7,9	8,1	22,1	22,8	0,895
	2000	0,908	0,901	8,4	8,2	23,0	24,0	0,883
	2010	0,885	0,879	11,2	9,5	24,8	25,2	0,920

Fonte: IBGE, Censos Demográficos de 1991, 2000 e 2010

The pattern of transition to first union remains the main difference between migrants and non-migrants, even regionally. We highlight here, again, that the female population transits fatly compared to the male population, showing a concentration of the timing of migration around the mean age. Related to that, there is a greater concentration of females in the migration flows in shorter distances, with age differences between sexes close to the marriage market. This scenario was raised by Bernard, Bell and Charles-Edwards (2014b) to 27 countries, including Brazil. The likely explanation for this scenario is the social role that women play, more rigid in the Brazilian society than those played by men, as well as the strong association to intra-household gender inequalities.

Table 5: mean age, prevalence spread and congruence between migrant and non-migrant males – Brazil, 1991, 2000 e 2010

Life course Transition	Year	Prevalence (P)		Spread (ρ)		Mean age (π)		Congruence (τ)
		Emigrants	Non migrants	Emigrants	Non migrants	Emigrants	Non migrants	
Completion of basic education	1991	0,241	0,233	5,3	3,9	21,9	20,8	0,780
	2000	0,288	0,297	4,5	3,5	20,6	19,5	0,873
	2010	0,495	0,509	4,4	3,8	19,2	19,5	0,911
Entry into the labor market	1991	0,971	0,964	4,4	5,3	16,3	17,1	0,828
	2000	0,943	0,933	4,5	5,1	16,7	17,2	0,898
	2010	0,915	0,896	5,0	5,6	17,6	18,3	0,868
First Union	1991	0,947	0,940	6,8	7,6	24,9	26,5	0,797
	2000	0,962	0,946	6,8	7,8	24,6	26,5	0,751
	2010	0,946	0,924	7,5	8,8	24,5	26,6	0,738

Fonte: IBGE, Censos Demográficos de 1991, 2000 e 2010

Hypothesis 6: *there is an association between the timing of the life course transitions and the age of higher migration propensity.*

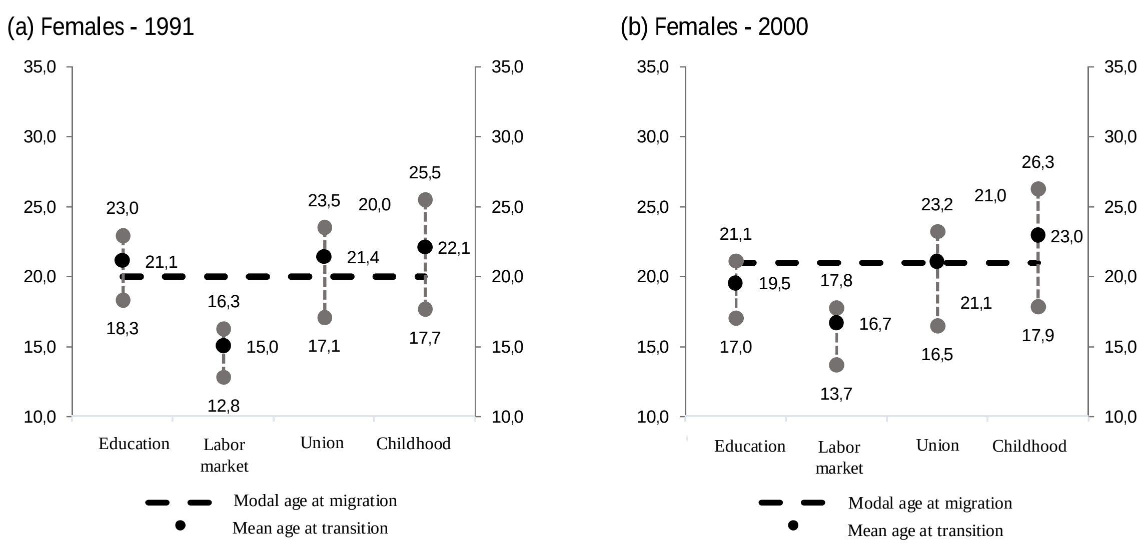
The analysis of selectivity shows that migrants have a specific behavior in terms of life course transition. It is higher in the past and has concentrated, in the last years, around the transition to first union. From all life course transitions, first union is the most stable over time, even between regions. There are also differences between the age pattern and transitions of intraregional and interregional migrants. For example, the Northeast shows small age difference by sex in long-range migration, what is expected in terms of labor market, while short-term migration shows differences similar to the marriage market. On the other hand, the Midwest shows a migration pattern that happened on average, after the life course transitions, but converged with time especially with the timing of first union.

These results indicate that migration in the North is status-dependent – of the entry in the labor Market to the intraregional migration, and all transitions to the inter-regional emigration. The order of events in the Midwest suggest that intraregional migration and inter-regional emigration are distinct events and with different synchronization over the life course. The values of x_h are relatively stable over time and show synchronic values in terms of intraregional migration and first union, as well as an interval relatively stable over time in terms of the modal age of interregional migration. In this sense, inter-regional emigration seems associated to family format, after first union and close to first child.

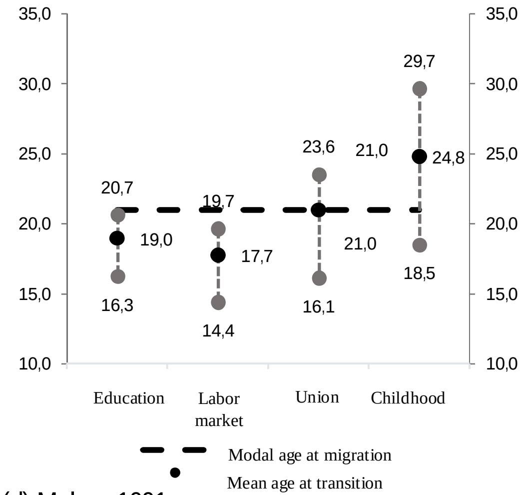
Regarding the regions, São Paulo shows particular characteristics regarding life course transitions. Interregional emigration shows values of x_h above 25 years of age in the three years, with stable modal ages of migration and values for males greater than those for females. Furthermore, modal ages of migration are stable in the three years, with greater values for males compared to females. Furthermore, both sexes have values of x_h above the mean age in all transitions. It worth mentioning that this result indicates that inter-regional emigration do not tend to be synchronic to none of transitions evaluated and can have a status-dependent relationship or even be event-dependent of a non-observed transition.

The East showed a trend closer to the average behavior, with higher proximity of migration to the timing of first union, as well as the loss of synchrony with the other transitions over time. The South showed a systematic increase in the modal age of interregional migration, with a modal age for males above to those observed for females. For both sexes, the modal age was above the mean age at first union.

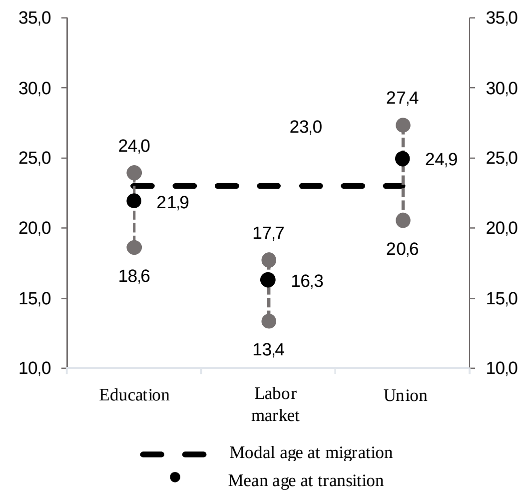
Graphic 2: Modal age of the migration function (x_h), mean age at transition (π) and spread (ρ) of intermunicipal migrants by sex – Brazil, 1991, 2000 e 2010



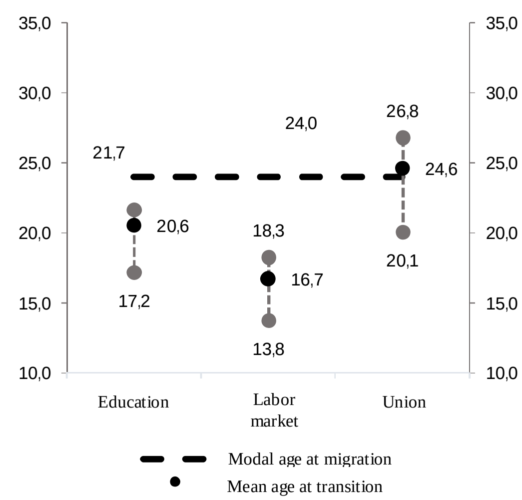
(c) Females - 2010



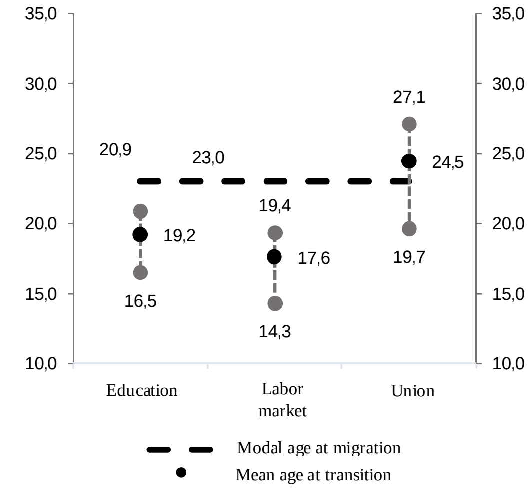
(d) Males - 1991



(e) Males - 2000



(f) Males - 2010



Fonte: IBGE, Censos Demográficos de 1991, 2000 e 2010

Conclusions

Understanding life course transitions allows understanding how changes in the status of individual trajectories change population characteristics and behavior. Age is probably the most important predictive behavior in terms of demographic change. Age in which individuals leave home, marry, conclude the middle school, beginning a job are important individual transitions which are constrained and influenced by the context.

In this paper, our study on the association between life course transitions and migration age profile in Brazil allow understanding the behavior of migration functions by age and identify possible generalizations to build more accurate estimates and projections. Using period data requires some assumptions, but it is a pertinent strategy to observe changes and stabilities in the Brazilian territory over time. The results show that migration age profiles follow changes in life course transitions, especially transition to the first union. However, there are region al variations showing that the association between migration age profiles and life course transitions behave differently among regions in Brazil. Furthermore, the association between events changed over time and, in some regions, it is possible to identify that migration shows a synchronic relationship with unobserved transitions, or even, a status-dependent relationship with the same transitions.

The use of period data and not longitudinal data to observe causality between events did not jeopardize the purpose of identifying and analyzing migration age pattern in Brazil as well as the synchrony between migration and life course transitions. This association, however, happens differently in each region, including its evolution over time. In all regions – even in those with changes in the migration age profile, we observe changes in migration levels in all territorial scales between 1991 and 2010. However, the migration age profile of the inter-regional emigration in the South show aging of x_h, as well as the participation of return migration in the inter-regional emigration in São Paulo, allows questioning the existence of tempo effects of migration, such as those verified in European countries Bernard and Pelikh (2019). Tempo effect for migration profile would be alike to those discussed in fertility studies (Bongaarts & Feeney, 1998), in which changes in the age profile of the function implies changes in the *quantum* of migration in period metrics (Bernard & Pelikh, Distinguishing tempo and ageing effects in migration, 2019).

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