CST 310 / SER 417: Population, Space & Environment

Spatial Approaches in Population Studies: Analytical Methods and Representation Techniques

Basic Concepts and Measures in Demography
Fecundity, Growth & Demographic Transition

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Natality & Fecundity

Natality: relationship between live-born and total population

Fecundity: relationship between live-born and women of reproductive age women.

- **Fertility**: Women's reproductive potential
- **Fecundity**: real result of Women's reproductive potential

- The greater the control over the **size of offspring** the greater the distance between Fecundity and Fertility;
- Even without controlling: Fecundity << Fertility

causes: Onset and frequency of sexual intercourse and fetal loss)

Natality & Fecundity

Natality: relationsship between live-born and total population

Gross Natality Rate (TBN) - ratio of the number of children born alive during one year to the total population.

$$TBN_j = \frac{N_j}{Q_j} 1000$$

* Usually this ratio is expressed per thousand inhabitants.

Natality & Fecundity

Gross Natality Rate (TBN)

The denominator is the total population in the middle of the year
(approximation of the number of person-years).

TBN can be determined by sex, relating the respective birth and population numbers.

It depends on >> **the Intensity with which women have children at each age**;
n women of childbearing (*idade fértil*) age (proportion of total pop)

Relative age distribution of women in the reproductive period

∴ It is not a good indicator to analyze differentials of Fecundity levels between populations.

It is not a risk measure -> not all people in the denominator are liable to become parents in the year in question.

The risk measure is given by *Fecundity rates*!

Natality & Fecundity

General fecundity rate(TFG)

- GFR in a given year (j) is: the *ratio* between the number of **live-borns *Nj*** and the **female population at reproductive** or fertile age - childbearing.
- The fertile age of the female population: women between 15 and 49 years old.

$$TFG_j = \frac{N_j}{{}_{35}Q_{15,f,j}}$$

${}_{35}Q_{15,f,j}$ is the number of women between 15 to 49 y.

TFG - depends on:

- intensity of women have children at each age AND
- proportional age distribution of women within the range of 15 to 49 years of age

Natality & Fecundity

General fecundity rate(TFG)

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TFG - depends on:

- intensity of women have children at each age AND
- proportional age distribution of women within the range of 15 to 49 years of age

It is not a good measure to compare differentials of Fecundity levels among populations whose age distributions of women of childbearing age are different

Natality e Fecundity

Specific Fecundity Rate (TEF)

TEF - in a given year, by the woman age, is:

the ratio between the number of live–borns from mothers at a given age and the number of women at that age or age group (x, x + n)

$$ {}_nTEF_{x,j} = \frac{{}_nN_{x,j}}{{}_nQ_{x,f,j}} $$

TEFs : refined age-specific rate and marital status by sex, by birth order, etc.

TEFs - Could be be possible by individual age of women, but the most common is to calculate or estimate them **by five-yearly** (*quinquenal*) age groups, starting at 15-19 and ending at 45-49 years.

Natality e Fecundity

What about men ????

Conceptually, it would not be difficult to consider Fecundity in relation to the male population, but ...

- the longest male fertile period
- indefinite upper limit
- Less certainty about the child's paternity ...

➔ Fecundity rates refer to the <u>female population at risk</u>

Natality e Fecundity

Total Fecundity Rate (TFT)

Because it is difficult to work with a set of five five-year TEFs for each population, TFT is used.

Average number of children that a woman would have at the end of the reproductive period.

TFT depends on the TEFs set:

$$TFT_j = n\sum_x {}_nTEF$$

Natality e Fecundity

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TFT depends on the TEFs set:

$$TFT_j = n\sum_x {}_nTEF$$

Since TFT is not influenced by the age distribution of women (the reference-population)

→ They depend only on FTEs and do not depend on the real age distributions.

TFTs from different populations can be used to compare Fecundity levels

Natality & Fecundity

TEF: in average, 0,0526 live-born by women of **15 -19y**

(or 52,6 live-born at each 1000 women)

TFT = 2.6015

Meaning: the average number of live-born at the end of fertile period , of a hypothetical generation , considering the current fecundity rate

(RS , 1980).

The total RS population estimated for July 1, 1980 was 7,753,921 people.

The total number of live-born observed was 173,960.

TAXAS ESPECÍFICAS DE FECUNDUDADE,
DE FECUNDIDADE GERAL E DE FECUNDIDADE TOTAL (TFT)
RIO GRANDE DO SUL, 1980

Grupo etário	População feminina (1/7/80)	Nascidos vivos (ambos os sexos)	Taxa específica de fecundidade (TEF)	Taxa de fecundidade geral (TFG)
15-19	447.604	23.542	0,0526	-
20-24	398.691	54.676	0,1371	-
25-29	337.085	48.114	0,1427	-
30-34	278.654	28.762	0,1032	-
35-39	231.700	13.602	0,0587	-
40-44	206.117	4.601	0,0223	-
45-49	180.169	663	0,0037	-
15-49	2.080.020	173.960	-	0,0836
TFT	-	-	2,6015	-

Fontes: Dados elaborados a partir de: ESTATÍSTICA DO REGISTRO CIVIL, 1980 e 1981. Rio Janeiro: IBGE; Censo demográfico: dados gerais, migração, fecundidade, mortalidade, Rio Grande do Sul. Rio de Janeiro: IBGE 1982. (IX Recenseamento Geral do Brasil, 1980, v.1, t. 4, n. 22)

TBN = 22.44 per 1000 (1980)

For every thousand people of the population that year

22.44 children would have been born

TFT: sum of TEF * n years
or 0.5203 * 5anos = 2,6015

TFG = 173960 **/** 2080020= 0.8363

Natality & Fecundity

Total Fecundity Rate (TFT) - average number of live-borns that a woman would have at the end of her reproductive period

The projection **of IBGE population, announced in 2013** (PROJECTION ..., 2013) TFT Brazil:

2000 = 2.39 children per woman,

2013 = 1.77 ➔ a drop of 26% in this indicator.

At rates **above** population replacement level (2.10):

in Acre (2.59 children per woman),

Amapá (2.42), Amazonas (2.38), Roraima (2.34), Maranhão (2.28), and Pará (2.20)

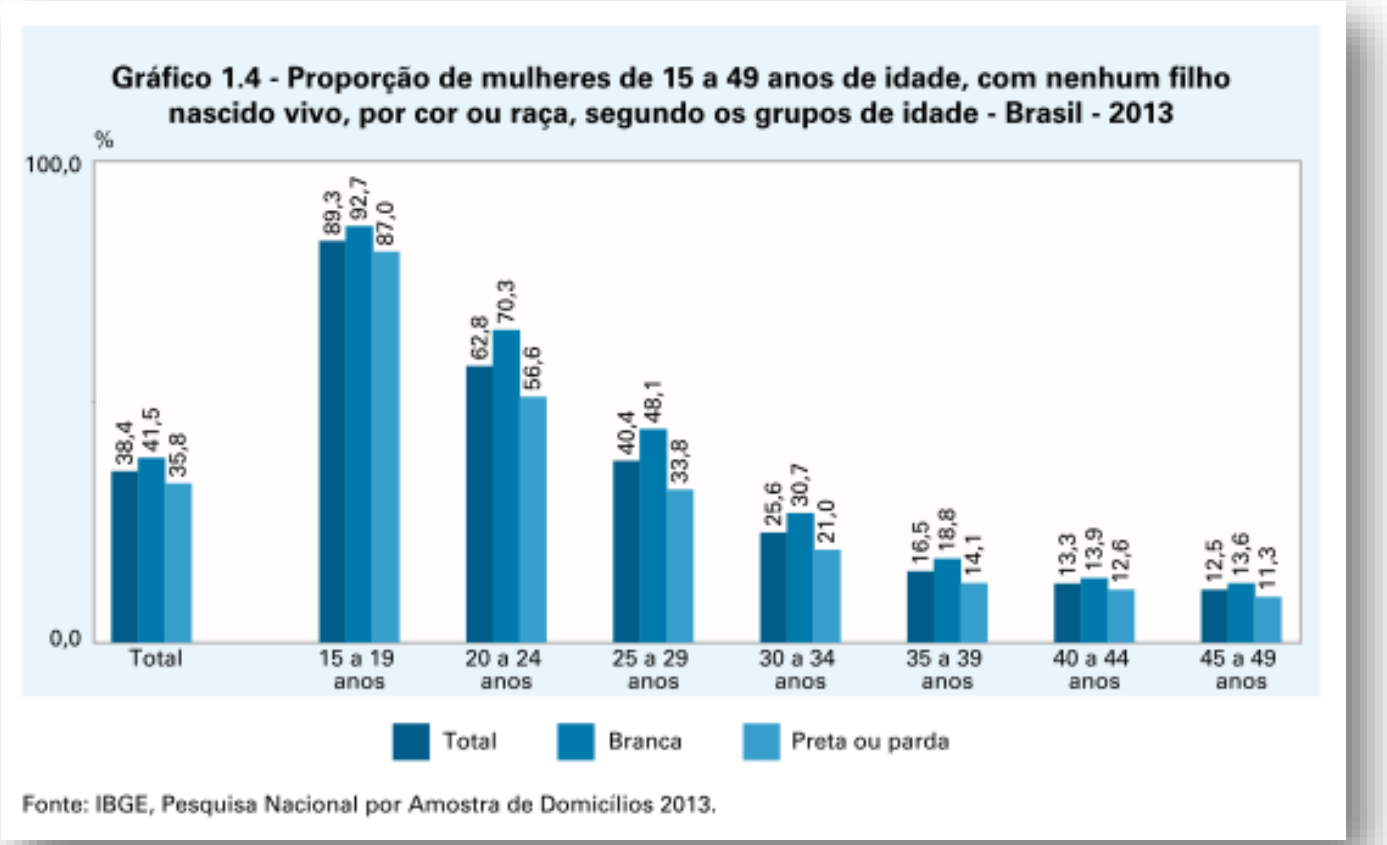
- The **lowest** values in this indicator were observed: in Santa Catarina (1.58 children per woman), Federal District (1.59), Rio Grande do Sul (1.60), Rio de Janeiro (1.62) and São Paulo and Minas Gerais (1,63)

Natality & Fecundity

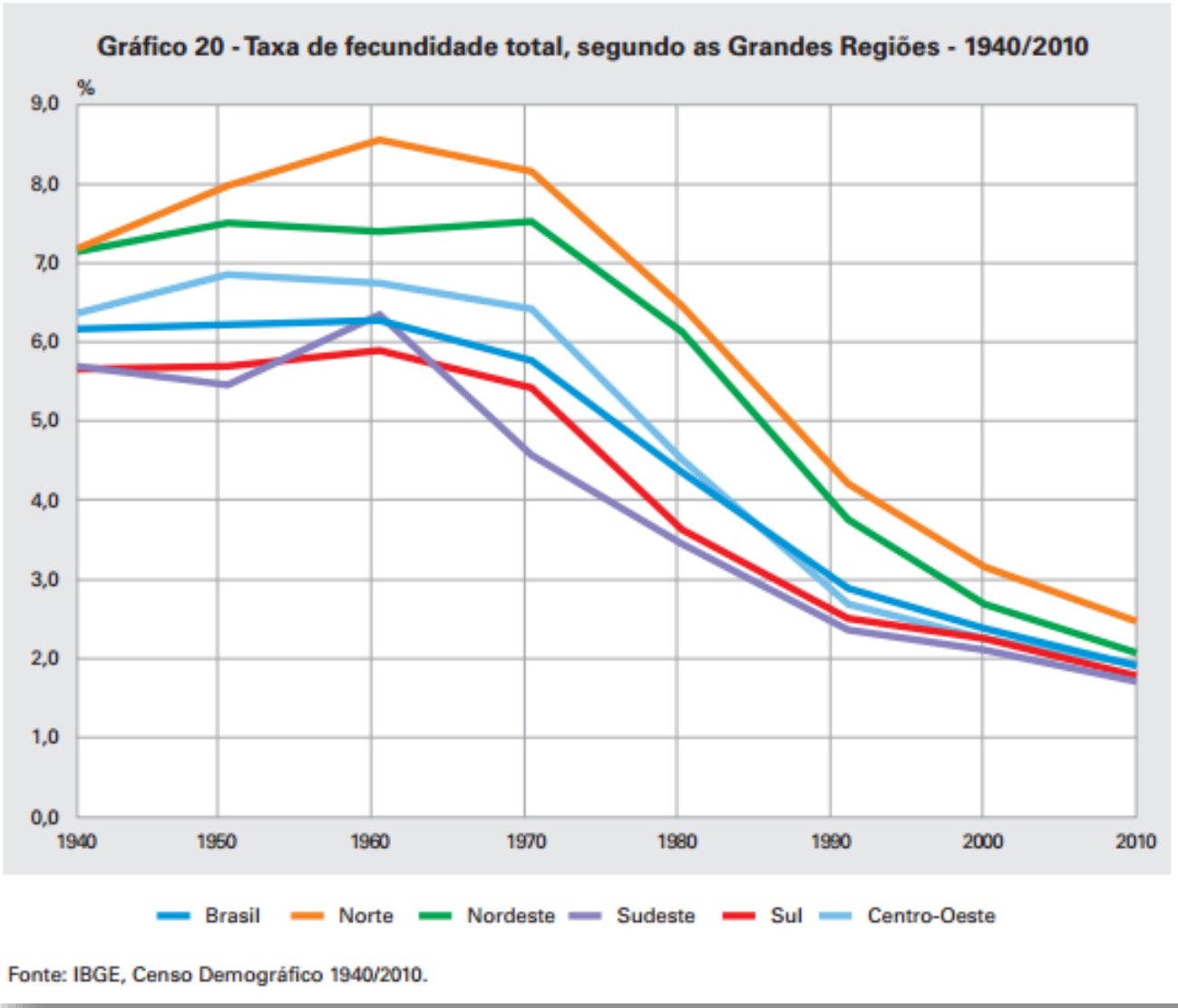
Another indicator related to **Fecundity** is the proportion of women, in the different age groups, **who did not have live-born children**

According to PNAD data, in 2013:

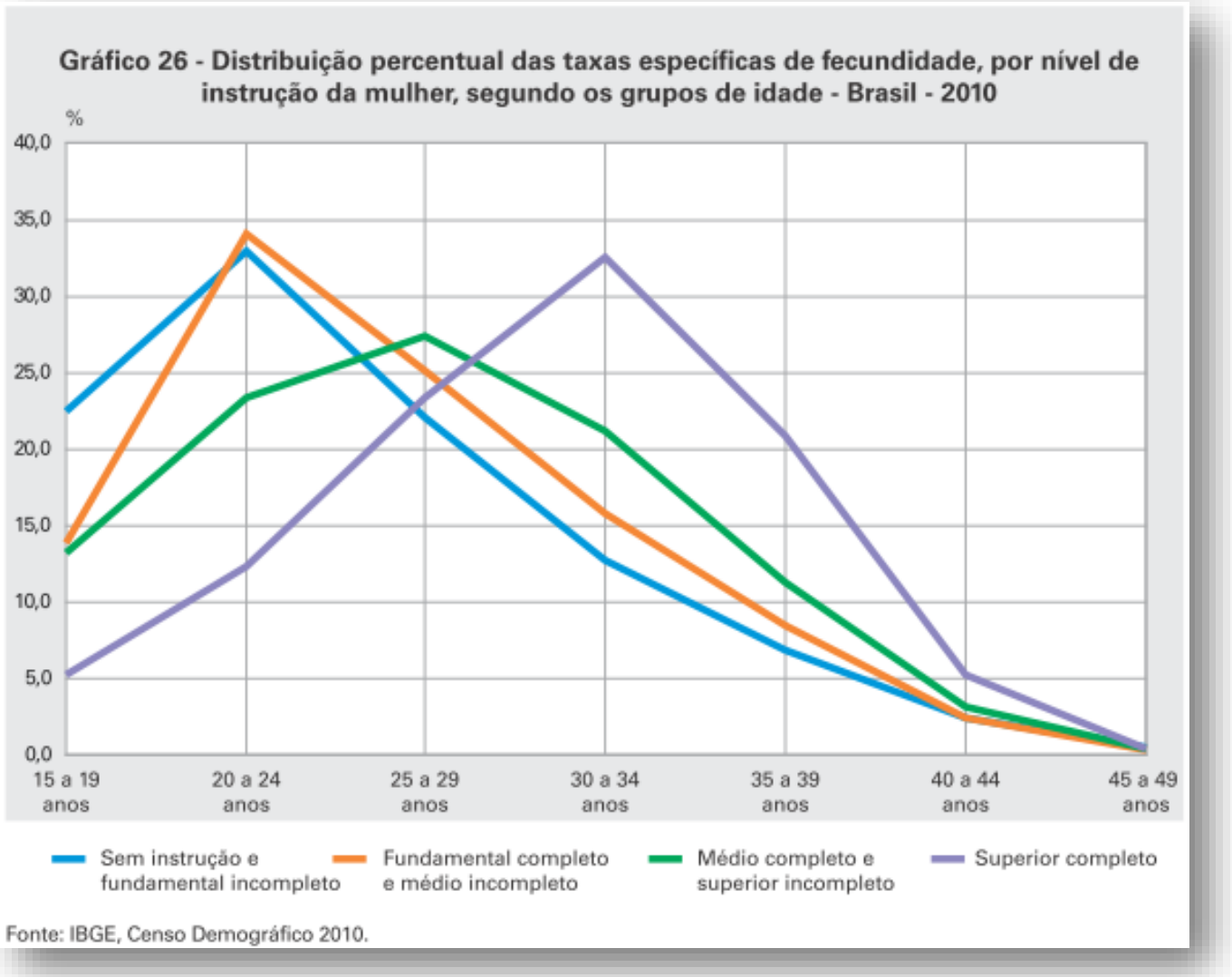
38.4% of women aged 15-49 had no live births



Natality & Fecundity



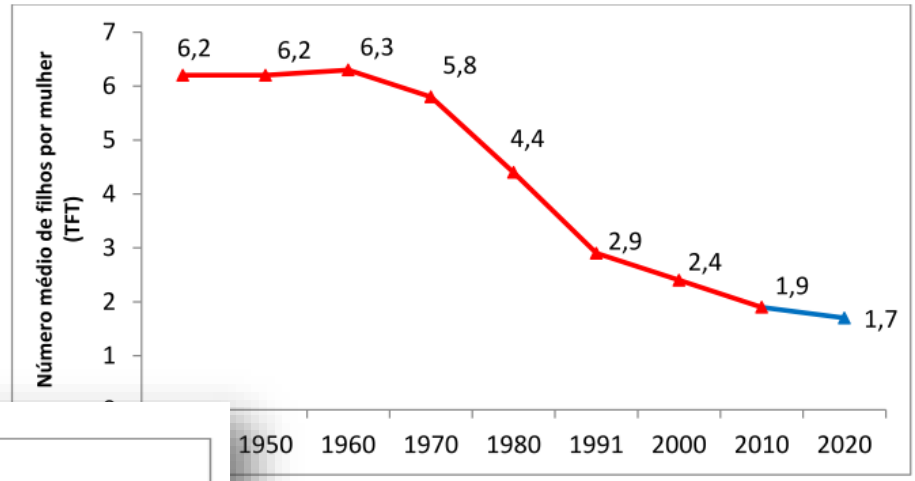
Natality & Fecundity



Natality & Fecundity

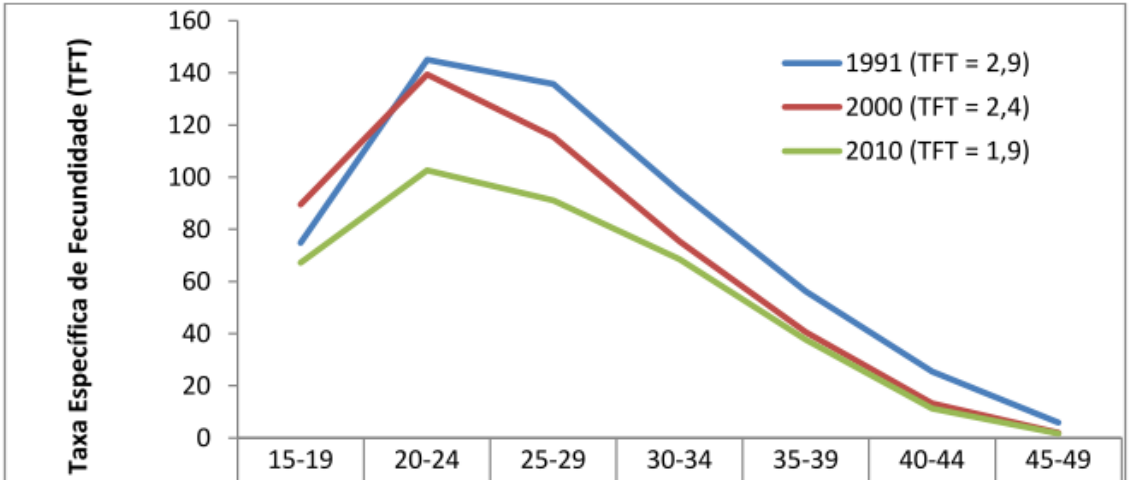
The transition of Fecundity and the reproductive pattern in Brazil

Gráfico 8: Transição da Fecundidade no Brasil: 1940-2020



ráficos do IBGE 1940 a 2010 e projeção em 2020

Gráfico 9: Taxas Específicas de Fecundidade (TEF)no Brasil: 1991-2010

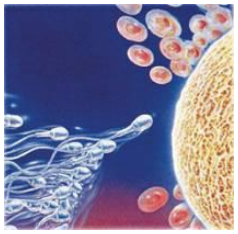


	15-19	20-24	25-29	30-34	35-39	40-44	45-49
1991 (TFT = 2,9)	74,8	145,0	135,7	94,3	56,1	25,4	5,9
2000 (TFT = 2,4)	89,5	139,4	115,5	75,3	40,5	13,3	2,0
2010 (TFT = 1,9)	67,2	102,6	91,1	68,5	37,7	11,3	1,7

Fonte: Censos demográficos do IBGE 1991 a 2010

Alves e Cavenaghi (2012)

Reproduction



TFT can not be reproduction measure since they include birth of boys !

With the sense of *replacement*

Comparison: The size of the generation of the daughters with

The size of women generation to which the mothers belong

(usually only the female sex)

Gross Reproduction Rate (TBR)

Similar to TFT but incorporating concept of reproduction

$$TBR_j = n\sum_n TEF_{x,f}$$

It is the average number of live-born daughters of surviving women at the end of the reproductive period, who belong to a generation of a certain set of FTEs (female births only)

When there is no birth data separated by sex, usually it is used the estimates of the Sex Ration at Birth **(RSN)**

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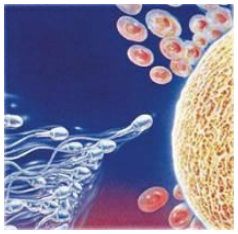

Sex Ration at Birth **(RSN)**

- ratio between births of male and female children.

- Index is always very stable within the same population, and usually ranges between 1.02 and 1.06.

The factor [1 / (1 + RSN)] is the proportion of births of female children in total births.

$$TRB = n\sum_{x\ n} TEF_{x,f}$$

$$= \frac{1}{1 = RSN} n\sum_{x\ n} TEF_{x}$$

$$= \frac{1}{1 + RSN} TFT$$

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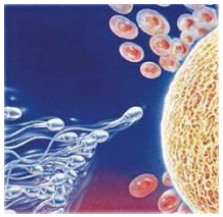


Gross Reproduction Rate (TBR)

TBR = sum of TEFs * (n years interval)

(0,02547 *5) = (1,273)

Circa (RSN=1.05):

TFT * (1/(1+1.05) = 1.269

(TFT=2.6015 from previous table)

If a generation of women experienced FTFS observed in Rio Grande do Sul in 1980,

by the end of the reproductive period,

on average,

they would have given birth to approximately **1.27 live-born girls**

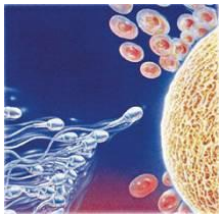
PROCEDIMENTOS PARA O CÁLCULO
DA TAXA BRUTA DE REPRODUÇAO (TBR)
RIO GRANDE DO SUL, 1980

Grupo etário	População feminina (1/7/80)	Nascidos vivos (femininos)	Taxas específicas de fecundidade feminina
15 -19	447604	11474	0,0256
20-24	398691	26666	0,0669
25-29	337085	23663	0,0702
30-34	278654	13975	0,0502
35-39	231700	6711	0,0290
40-44	206117	2254	0,0109
45-49	180169	334	0,0019
TBR			1,2731

0,02547

Fontes: Dados elaborados a partir de ESTATISTICAS do Registro Civil, 1980. Rio de Janeiro, v. 7,1981; CENSO DEMOGRAFICO: dados gerais, migração, fecundidade, mortalidade, Rio Grande do Sul. Rio de Janeiro : IBGE, 1982. (IX Recenseamento Geral do Brasil, 1981, v. 1, t. 4, n. 22).

Reproduction



Net Reproduction Rate (TLR)

Replacement - generation of daughters that will replace mothers.

TBR is not good for assessing replacement because one can have death at any age.

Net Reproduction Rate (TLR)

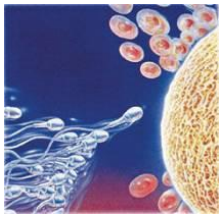
It takes into account female mortality:

It relates to the initial size of the generation of mothers (age zero),

the number of daughters born alive from a generation of women,

submitted to a certain set of TEF_{sf}, and of TEM_{sf}, (Specific Rates of Female Mortality)

Reproduction



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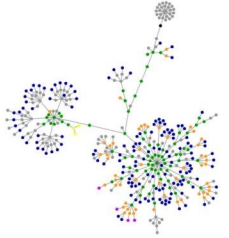
TLR represents well the reproduction capacity of a population

To calculate it: a set of **female TEFs** and **a female life table** have to be available

Population Structure



Analysis of the **composition** of the population under a given characteristic

Sex and **age** are the most common, marital status and home (rural / urban) **situation** are also important

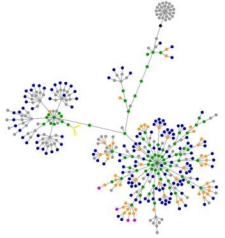
Other: nationality, naturalness, religious affiliation and schooling

The population total is decomposed into subpopulations according to the categories of the variables under study.

Subpopulations may have different demographic characteristics

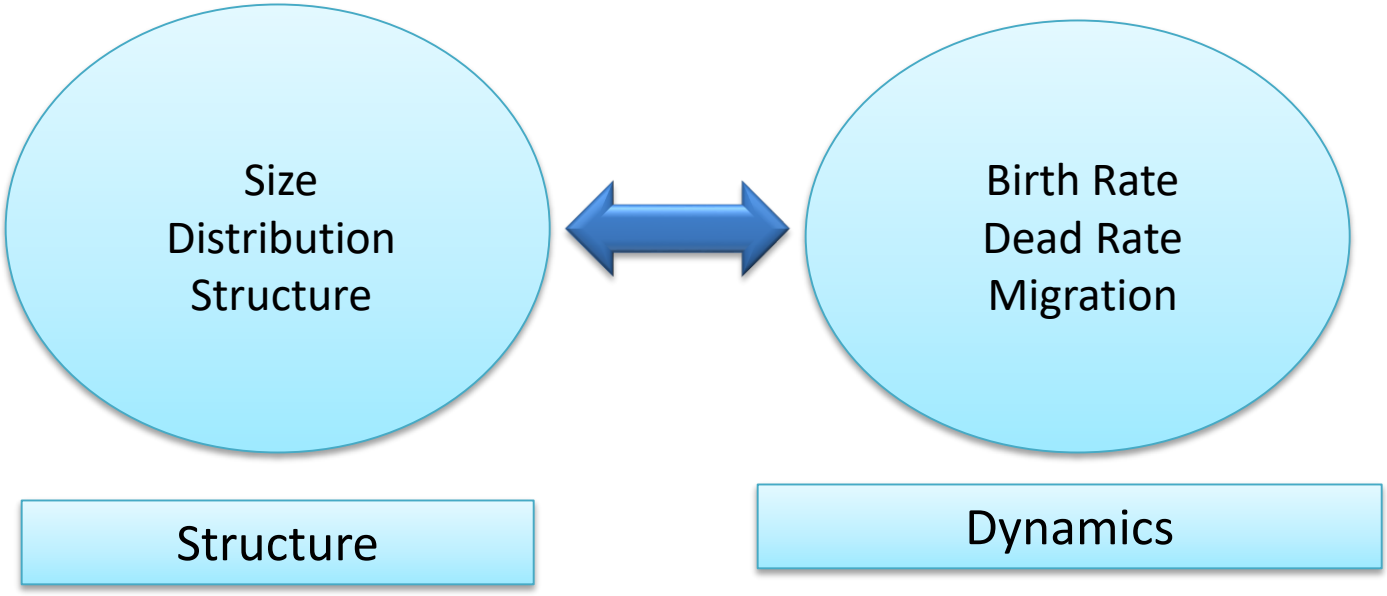
- Ex: distinct birth and death rates for urban and rural populations

Population Structure

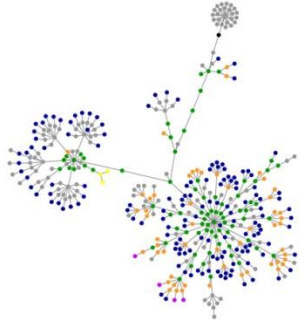


Analysis of the **composition** of the population under a given characteristic

Structural analysis studies the interrelationships between the static and dynamic structure of the population.



Population Structure



Consider two situations:

- Evolution of the agricultural frontier in the Amazon region
- Persistence of drought in the Northeastern *agreste*

What are the relationships between Natality, Fecundity, mortality and migration and the composition of the population as to sex and age ??

Hence the importance of studying the structure of the Population ...

Population Structure - Sex

Categories: male and female

Principal measure: Sex Rate (RS) (*Índice de Masculinidade***)

$$RS = \frac{P^m}{P^f} \times 100$$

RS > 100 excess of men

RS = 100 equilibrium between men and women

RS < 100 excess of women

It can be calculated for subgroups of the population, e.g. by age.

In most countries Sex Rate at Birth (RSN):

RSN >100;

~105 in industrialized countries;

~102 in developing countries.

Population Structure - Sex

Sex Rate: Sex Rate at Birth (RSN)

Countries with low to moderate Natality:

RS decreases progressively,

but mortality is greater than females at all ages;

Tabela 4.1 – Razão de Sexo (x 100 mulheres) por alguns grupos de idade e países, em anos próximos a 2000.

País	Grupo de idade (em anos)					
	ao nascer	<1	15-50	50-70	70 e +	Todos
Brasil (2000)	105,1	103,7	97,9	89,9	75,9	96,9
Canadá (1998)	105,5	105,5	101,9	96,7	67,1	98
França (1997)	105,5	104,8	100,6	94,2	61,8	94,9
México (1995)	101,8	104,2	94,4	93,5	87,7	97
Guatemala (1998)	103,3	104,2	100,6	97,6	90,1	101,7
Japão (1999)	105,6	105,4	102,7	95,1	63,7	95,8
N. Zelândia (2000)	106,2	106,7	97,7	98,6	71,1	96,6
Equador (1998)	104,8	104,2	101,4	98,5	81,5	100,9
Egito (1999)	106,5	105,0	103,3	104,9	105,8	0

Population Structure - Sex

Sex Rate: RS by resident situation (rural/urban):

Tabela 4.2 - Razão de Sexo (RS), população por sexo e situação de domicílio Paraná, 1980

Situação de Domicílio	Homens	Mulheres	RS
Urbano	2 201 067	2 271 494	96,9
Rural	1 649 590	1 507 241	109,4
Total	3 850 657	3 778 735	-

In general, rural is greater than 100 → migration of women to the city

Very large deviations (below 90 or above 110) → local characteristics, such as military base, if there is no explanation, one can suspect the data.

Population Structure - Sex

Sex Rate: RS by resident situation (rural/urban):

Tabela 1: População total e percentual da população brasileira por situação de domicílio, sexo e razão de sexo: 1970-2007

População	1970	1980	1991	2000	2007
Total	93.134.846	119.011.052	146.825.475	169.799.170	189.820.000
Urbana	55,9	67,6	75,6	81,2	83,5
Rural	44,1	32,4	24,4	18,8	16,5
Masculina	49,7	49,7	49,4	49,2	48,8
Feminina	50,3	50,3	50,6	50,8	51,2
Urbana masculina	27,1	33,0	36,7	39,4	40,1
Rural masculina	22,6	16,7	12,7	9,8	8,7
Urbana feminina	28,8	34,6	38,9	41,9	43,3
Rural feminina	21,4	15,7	11,7	8,9	7,9
Razão sexo total	99,0	98,8	97,5	96,9	95,3
Razão sexo urbana	94,0	95,2	94,3	94,1	92,6
Razão sexo rural	105,7	106,6	108,3	110,2	110,0

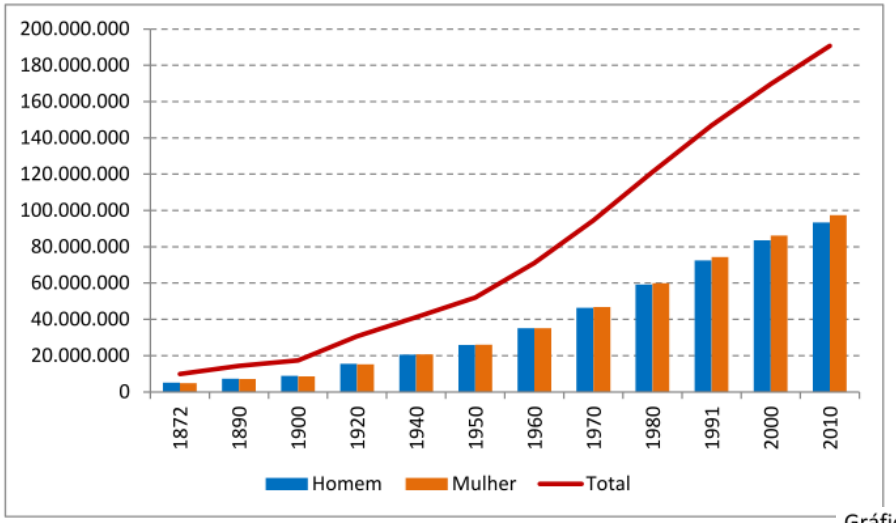
Fonte: Censos demográficos 1970, 1980, 1991 e 2000 e PNAD 2007, do IBGE

(Alves, 2009) http://www.ie.ufrj.br/aparte/pdfs/art_64_transicao_urbana_07nov09.pdf

Population Structure - Sex

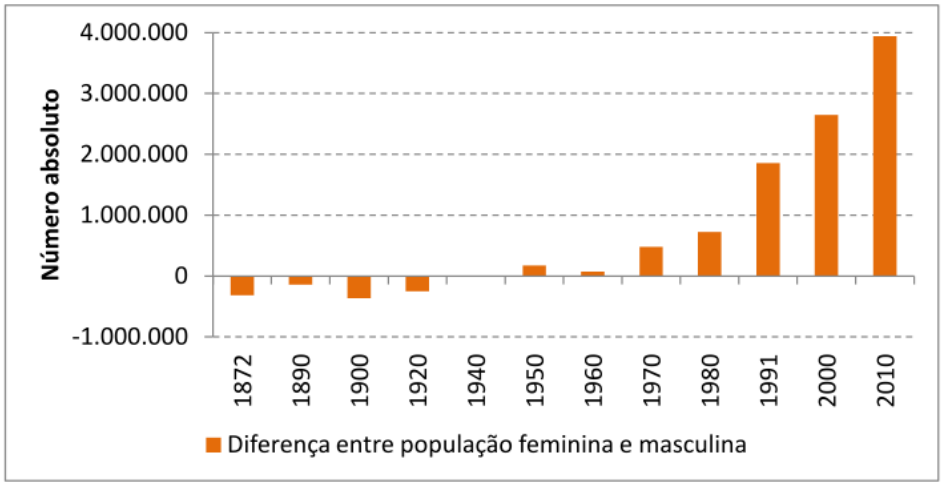
RS - Differences implies different consumption patterns

Gráfico 1: População brasileira total e por sexo, 1872-2010



Fonte: Censos demográficos do IBGE

Gráfico 2: Déficit e superávit feminino na população brasileira, 1872-2010



Fonte: Censos demográficos do IBGE

Population Structure - AGE

Basic Knowledge - to analyze trends in population evolution:
growth and **aging**

Age structure → consequence of changes in Mortality, Natality and Migration at earlier times.

Demographic transition → a phenomenon in which

the age structure changes from young to older,

by declining in Fecundity and dropping in mortality, increasing the likelihood of survival even for the more advanced ages.

(to be treated later)

Population Structure - AGE

Age structure → consequence of changes in Mortality, Natality and migration at earlier times.

Measures:

1) Median age (Me) - for grouped data

i: interval containing the median

L_i : lower limit of the interval i

a_i : size of interval i

P: total population

F_{i-1} : Cumulative interval frequency i-1

f_i : interval frequency

$$\text{Me} = L_i + a_i \left(\frac{\frac{P}{2} - F_{i-1}}{f_i} \right)$$

Find the median by: (P+1)/2 if P is odd , or P/2 if P is even

Meaning: 50% of pop is young than Me, and 50% is older

IF: Me ≤ 20 y → relatively young population

20 < Me ≤ 30 y → intermediate population

Me ≥ 30 y → relatively old population

Population Structure - AGE

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Population Structure - AGE

2) Dependency Ratio (RD) -

For a living in geographical area, in a certain year – the Ratio between:

$$\frac{\text{the age group of economically dependent population (<15 years and >65 * and over)}}{\text{the potentially productive age group population (between 15 and 59 years)}}$$

RDT = (Dependent Population/ Active age population)*100

- It measures the relative participation of the potentially inactive population contingent, which should be **sustained** by the portion of the potentially productive population.
- High values indicate that the population of productive age must support a large proportion of dependents, which means considerable care expenses costs for society

*60 years = standard for elderly - RIPSA - *Rede Integrada de Informações para a Saúde*

Population Structure - AGE

2) Dependency Ratio (RD)

The **Total Dependency Ratio (RDT)** can be decomposed into

Youth Dependency Ratio **(RDJ)** and

RDJ = Population <15 years / Population between 15 and 64y)*100

Elderly Dependency Ratio **(RDI)**

RDI = Population >65y and over/ Population between 15 and 64y)*100

Population Structure - AGE

2) Dependency Ratio (RD)

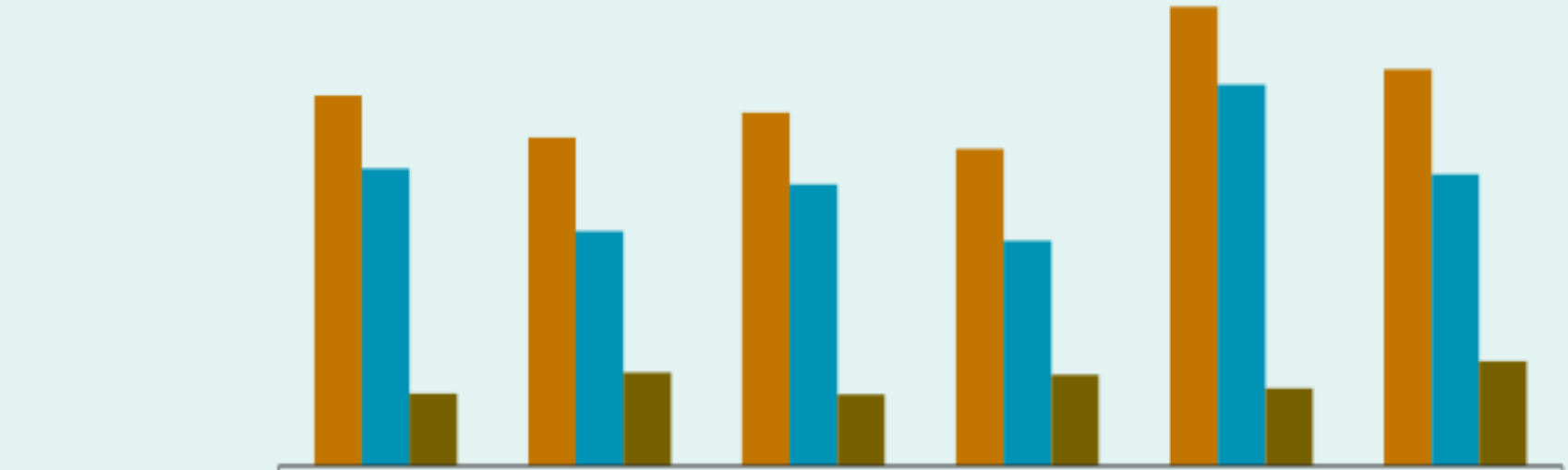
Tabela 4.2 – Razão de Dependência (x 100) por situação de domicílios, regiões – Brasil

Regiões	Urbano			Rural			Todas		
	1980	1991	2000	1980	1991	2000	1980	1991	2000
Norte	88,1	77,6	63,4	105,2	93,2	83,9	96,0	83,7	69,1
Nordeste	81,3	71,9	58,2	103,4	94,2	76,4	91,6	80,1	63,5
Sudeste	58,6	55,5	48,5	82,1	82,1	58,6	62,2	57,1	49,4
Sul	61,4	57,2	49,9	77,2	77,2	55,4	67,0	58,5	50,9
Centro-Oeste	71,7	61,5	51,1	85,8	85,8	57,6	75,6	62,7	52,0
Brasil	65,4	60,8	52,1	92,1	92,1	68,8	73,2	65,4	54,9

Population Structure - AGE

2) Dependency Ratio (RD)

Gráfico 1 – Razão de dependência (%)



	2004	2013	2004	2013	2004	2013
	Total		Urbana		Rural	
Dependência total	51,0	45,2	48,7	43,7	63,2	54,6
Dependência jovem	41,0	32,3	38,8	31,0	52,5	40,2
Dependência dos idosos	10,0	12,9	9,9	12,6	10,7	14,5

Fonte: Pnad/IBGE

http://www.bcb.gov.br/pec/boletimregional/port/2015/01/br201501b3p.pdf

Population Structure - AGE

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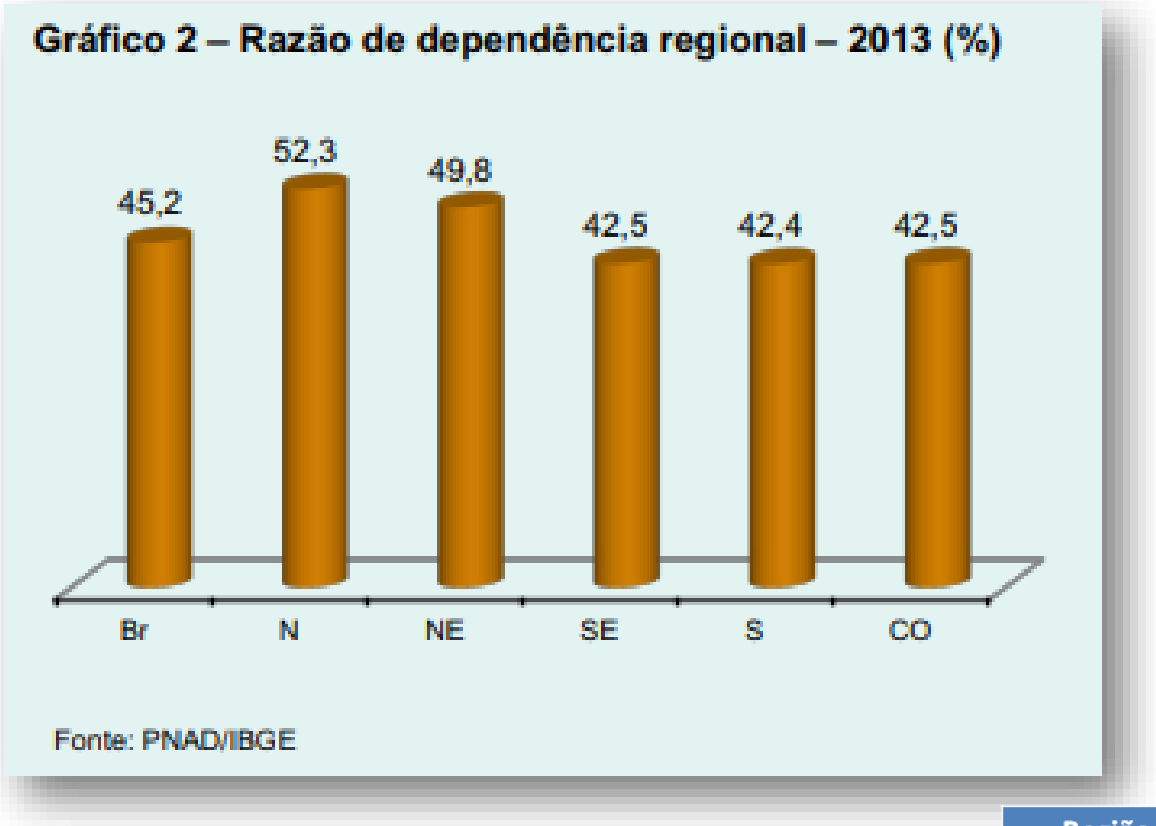
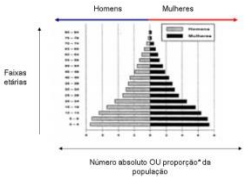


Região	RD 2000	RD 2010
Brasil	54,95	45,9
Nordeste	63,51	50,94
Ceará	65,88	50,33

http://www.bcb.gov.br/pec/boletimregional/port/2015/01/br201501b3p.pdf

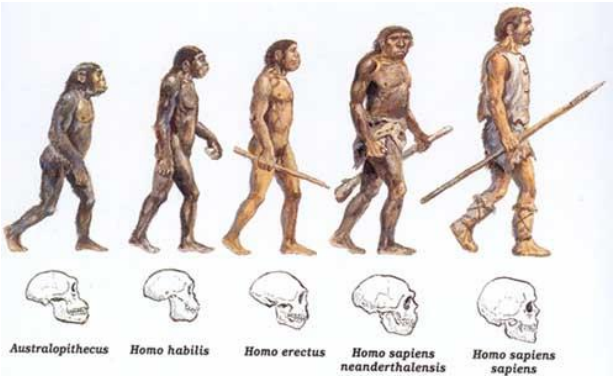
Population Structure – AGE & Sex



The composition of the population by age and sex

(despite the static aspects),

is a reflection of the history of population dynamics, from a relatively distant past.

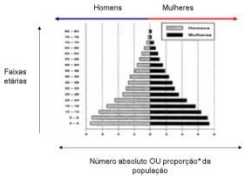


What is the number of people, in a closed population, for age *x* ??

It will depends on:

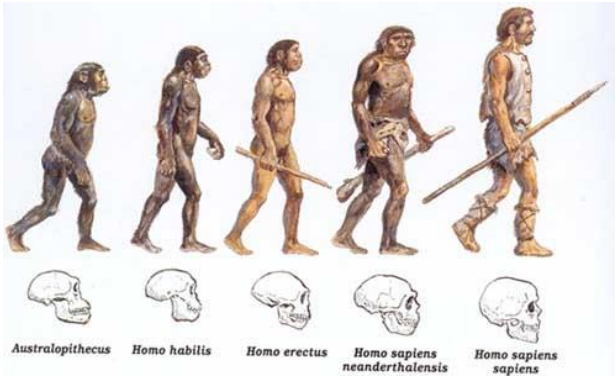
- Number of births at *x* year ago
- Mortality Rates since they were born …

Population Structure – AGE & Sex



EX

For a closed population:



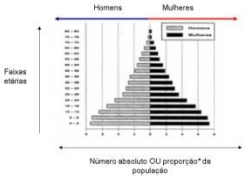
N of 35-year-old women by 1980 will depend on:

- n girls born between 1 July 1944 and 1 July 1945;
- n deaths that occurred between them from birth to July 1, 1980

N of surviving children of these women at the time of the 1980 census, who will be part of the population aged 0-19, will depend on:

- Fecundity experienced by these women since they entered the reproductive period
- differential mortality by age, from 0 to 19 years, to which their children were subjected from birth until the date of the census.

Population Structure – AGE & Sex



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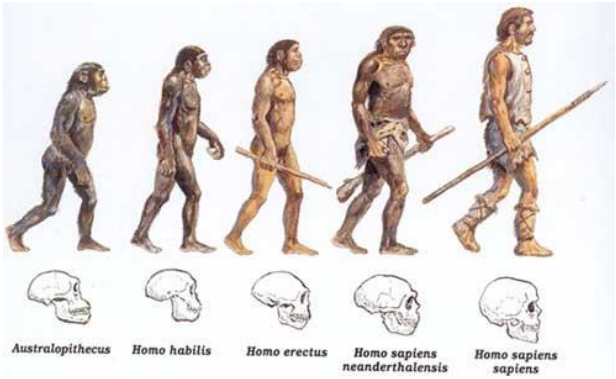

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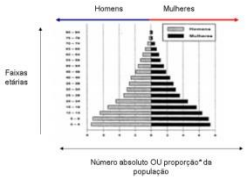
Population Structure – AGE & Sex

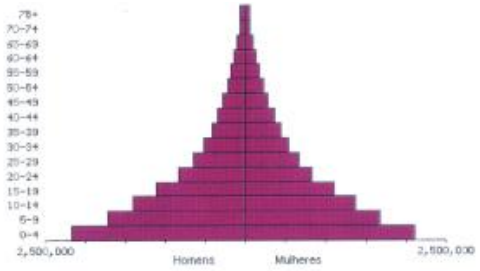


The age structure and the population dynamics allow to classify the populations in:

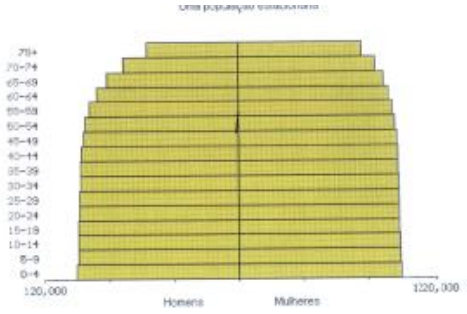
Stable population - age structure and population growth do not change over time (constant population growth rate)

Stationary population - a stable population with constant size (constant and zero population growth rate)

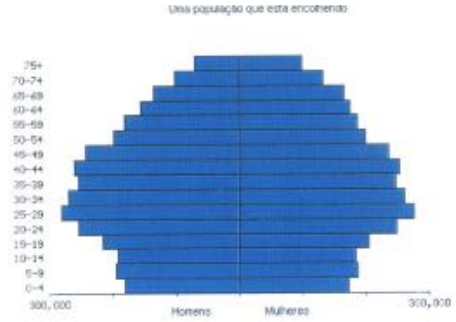
Growing Population



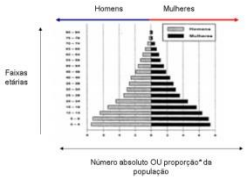
Stationary Population



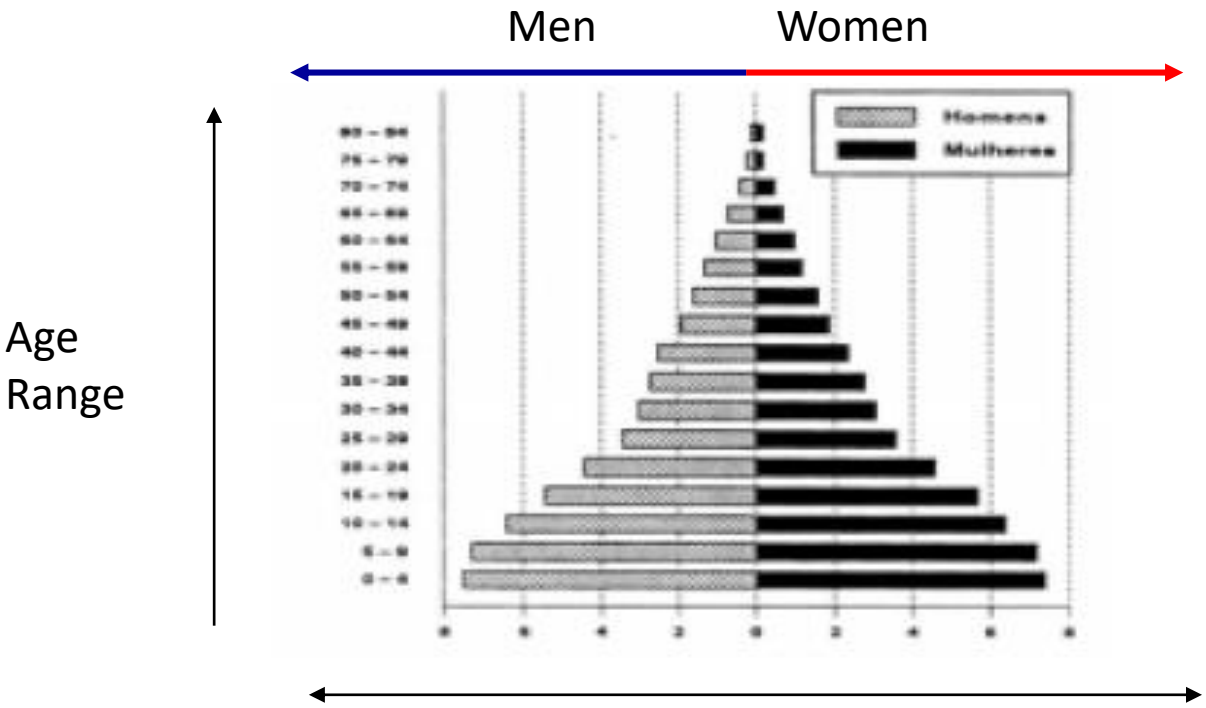
Population in Decline



The AGE Structure

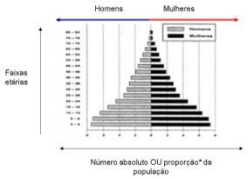


Age pyramid - represents the structure of the population by age and sex.

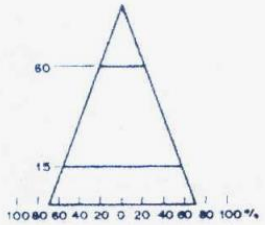


When using proportion → Total Population (never man/woman pop)

The AGE Structure

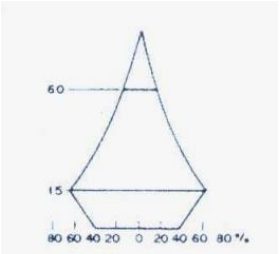


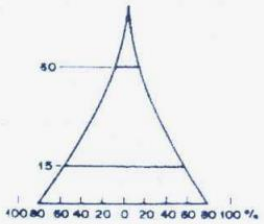
Age pyramids of several countries that approach the Thompson and Lewis types (1964)



(*a*)

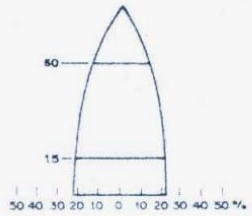
alta natalidade e
alta mortalidade;
baixa idade mediana;
elevada razão da dependência à custa dos jovens
Exemplo — Índia em 1951





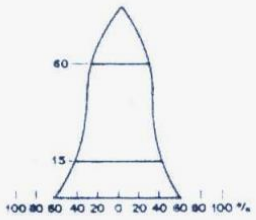
(*b*)

alta natalidade;
acentuado crescimento populacional devido à marcante redução da mortalidade infantil e na infância;
idade mediana das mais baixas do mundo;
razão de dependência das maiores do mundo
Exemplo — Ceilão, 1955



(*c*)

baixa natalidade e
baixa mortalidade;
idade mediana das mais elevadas;
razão de dependência das mais baixas e seu maior componente de dependência é constituído pelo grupo de idades avançadas.
Exemplo — França, 1959



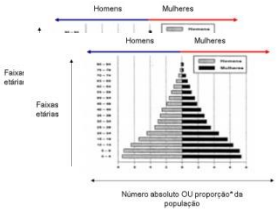
(*d*)

depois de mais de 100 anos de declínio da natalidade e da mortalidade a fecundidade começa a subir e a mortalidade continua baixa ou caindo;
idade mediana em declínio;
razão da dependência aumentando à custa da proporção crescente de jovens;
trata-se de um tipo de transição.
Exemplos — Estados Unidos e Canadá.

:)

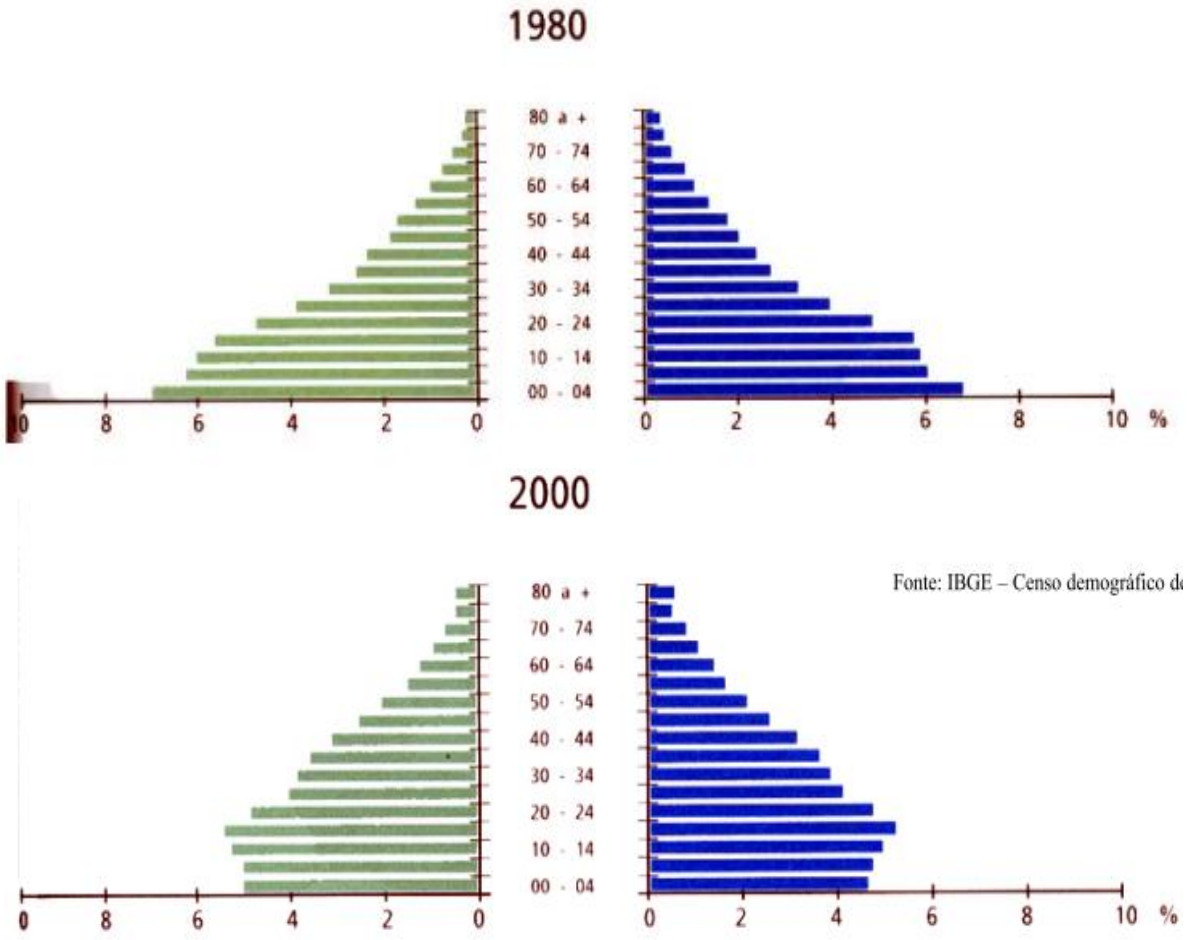
população experimentando um declínio rápido e marcante na fecundidade; se a tendência continuar, apresentará uma redução absoluta na população;
idade mediana elevada;
razão de dependência baixa, tipo de transição.
Exemplos — Japão. Na década de 1930, França e Estados Unidos.

Age structure and pop dynamics

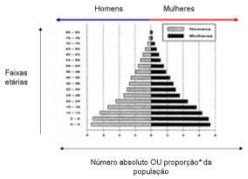


Age pyramid - represents the structure of the population by age and sex.

Brasil - Demographic Census 1980 and 2000

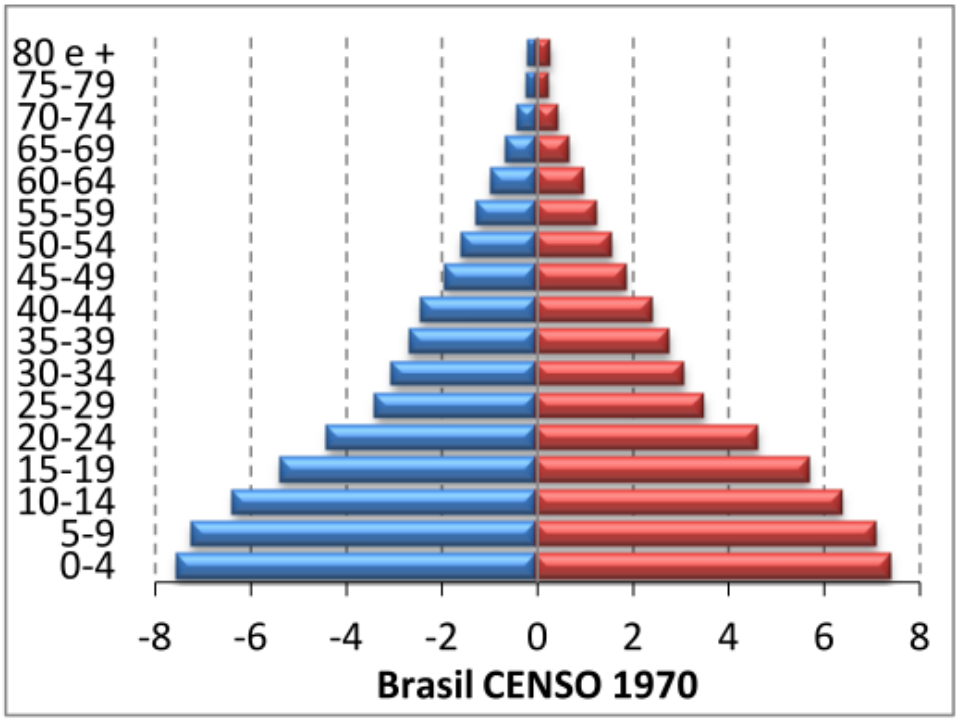


Age structure and pop dynamics

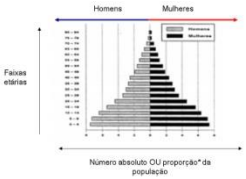


Brasil 1970:

- typical of high and almost constant Fecundity in the past
- although it already shows reflections of the fall of Fecundity that began in the second half of the 1960s.
- Note that the base of the pyramid (0 to 4 years) is relatively narrow, compared to the other age ranges

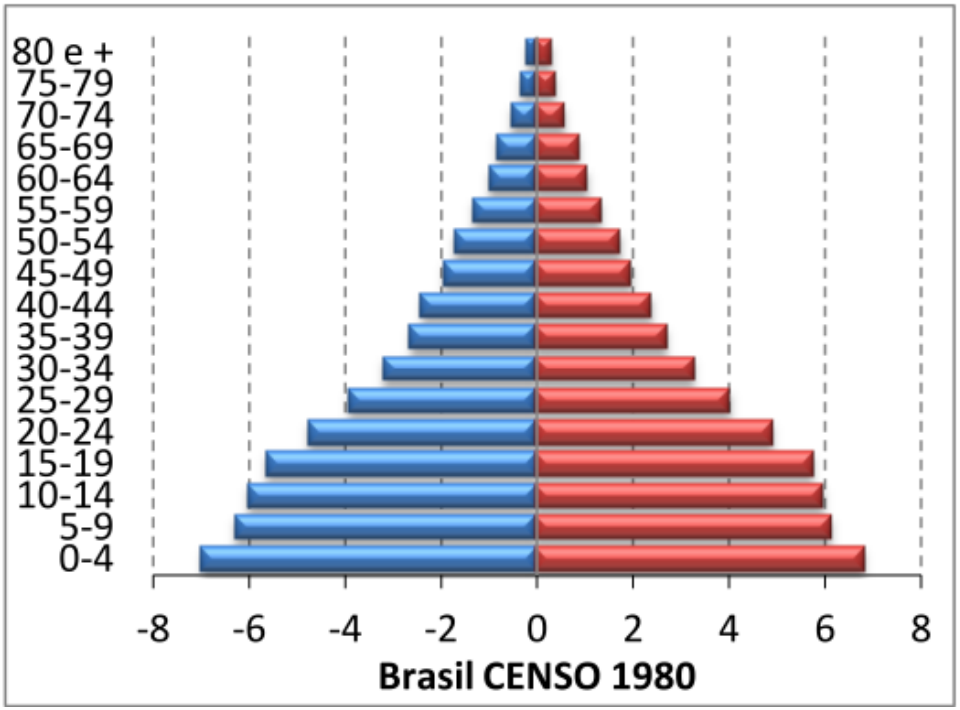


Age structure and pop dynamics



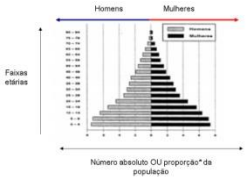
Brasil 1980

- Shows the link between Fecundity, Natality and age distribution.
- Fecundity fell significantly between 1970 and 1975, and remained constant until the end of the decade.
- Between 1975 and 1980 there was an increase in the number of women of reproductive age (~ 3% per year) and stability of the level of Fecundity



➔ led to an increase in births over the same period and to a population of 0-4 years old in 1980, relatively large, compared to 5 to 9 years.

Age structure and pop dynamics



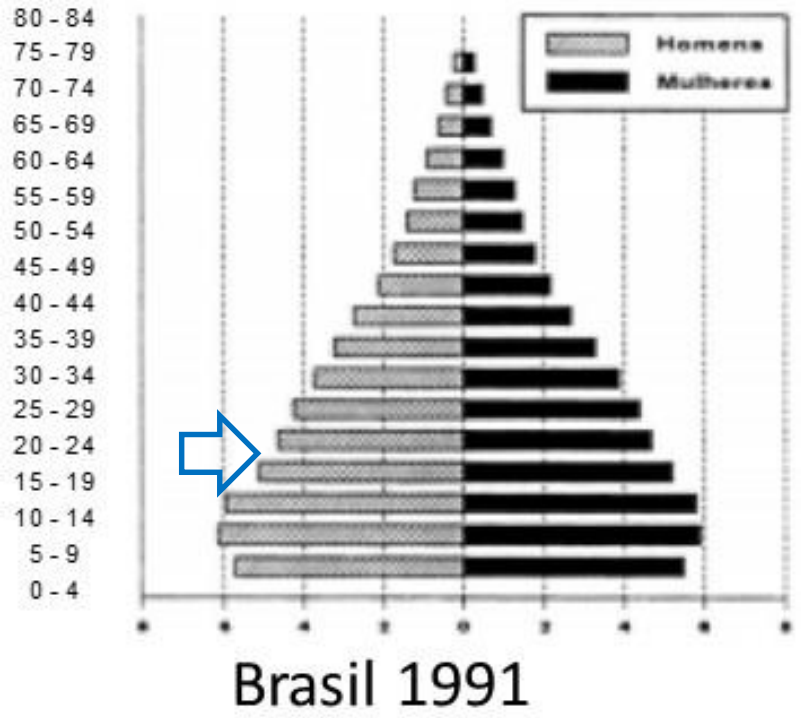
Brasil 1991

Fecundity decline occurred until 1980, impacted the structure by age

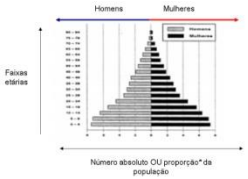
→ decrease in the proportions of quinquennial age groups between 10 and 25 years

→ Indicates that the decline in Fecundity continued during the 1980s

(there was a significant decrease in the proportions of groups 5 to 9 and 0 to 4 years.)



Age structure and pop dynamics

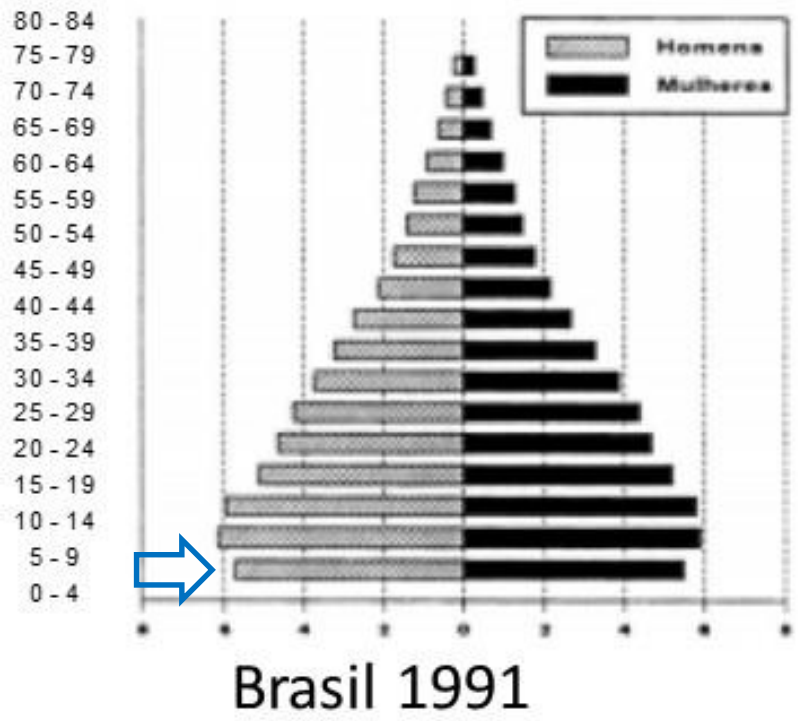


Brasil 1991

Age Range 0 to 4 < 5 to 9 years →

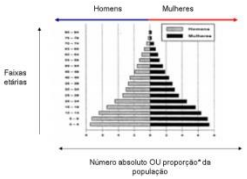
indicates that there would have been an acceleration in the decline of Fecundity in the second half of the 1980s

→ That was higher than the increase in the absolute number of women of reproductive age.



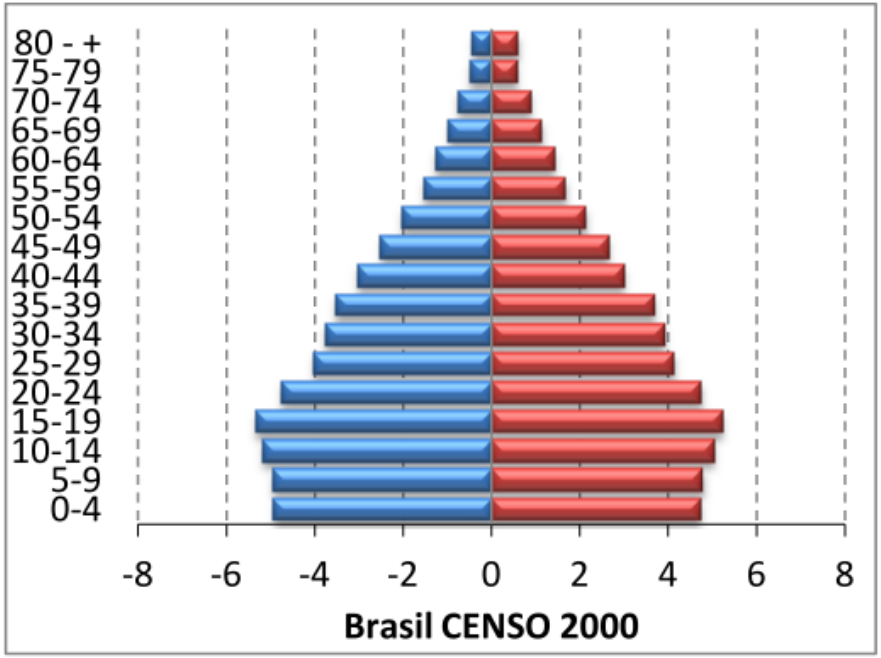
Brasil 1991

Age structure and pop dynamics



Brasil 2000

- Fecundity declining
- Population growing old

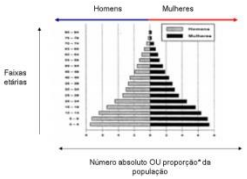


Proporção da população por grandes grupos de idade – Brasil, 1970, 2000 e 2020

	1970	2000	2020
Menores de 10 anos	29,33%	19,40%	15,76%
10 a 59 anos	65,55%	72,04%	71,80%
Maiores de 60 anos	5,12%	8,56%	12,44%
Total	100,00%	100,00%	100,00%

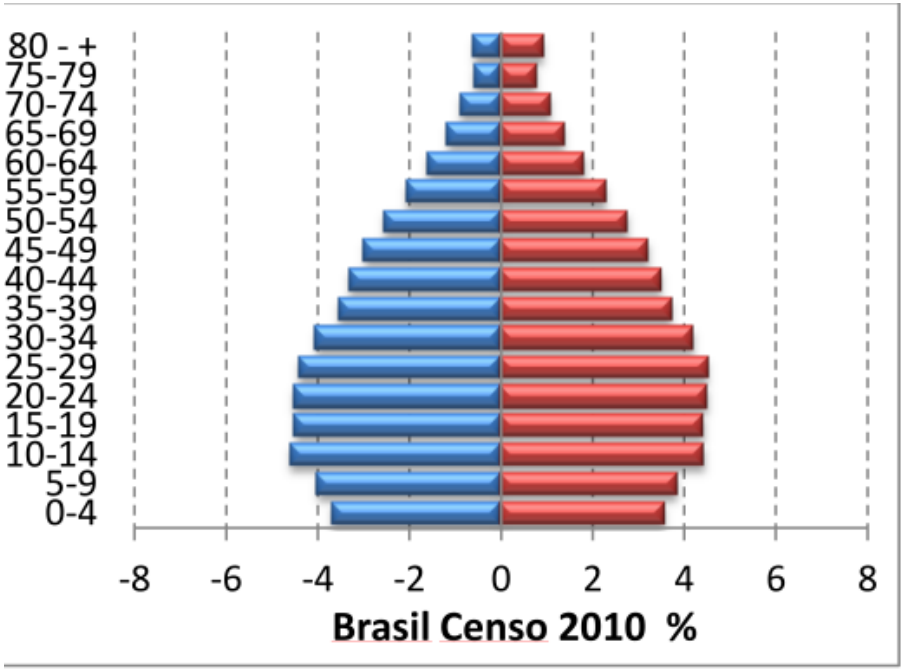
Fonte: IBGE, Censos Demográficos de 1940, 1950, 1960, 1970, 1980, 1991 e 2000; Cedeplar, Projeções Populacionais, 2001.

Age structure and pop dynamics



Brasil 2010

- Fecundity declining
- Population growing old



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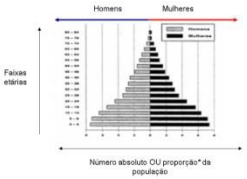
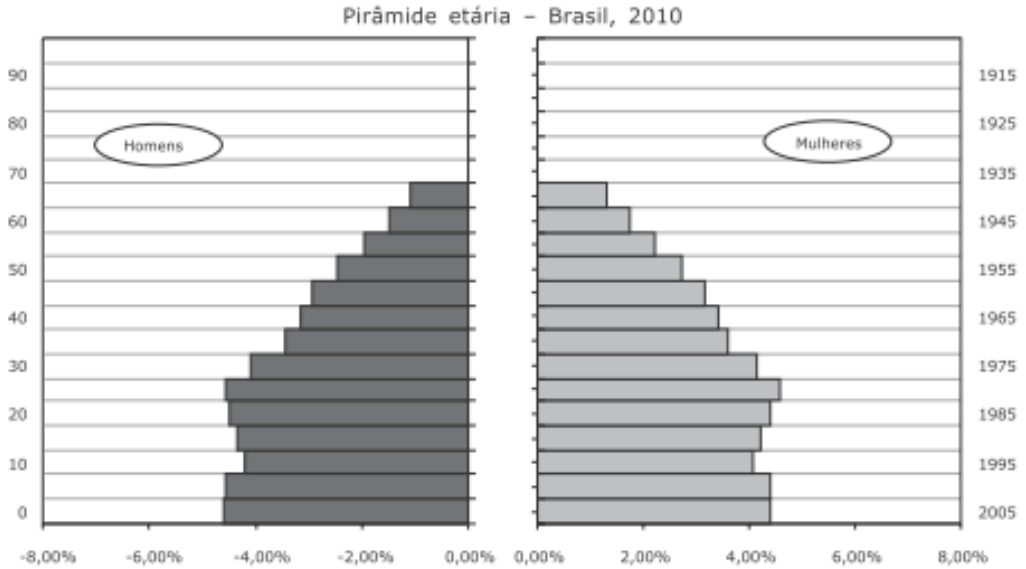
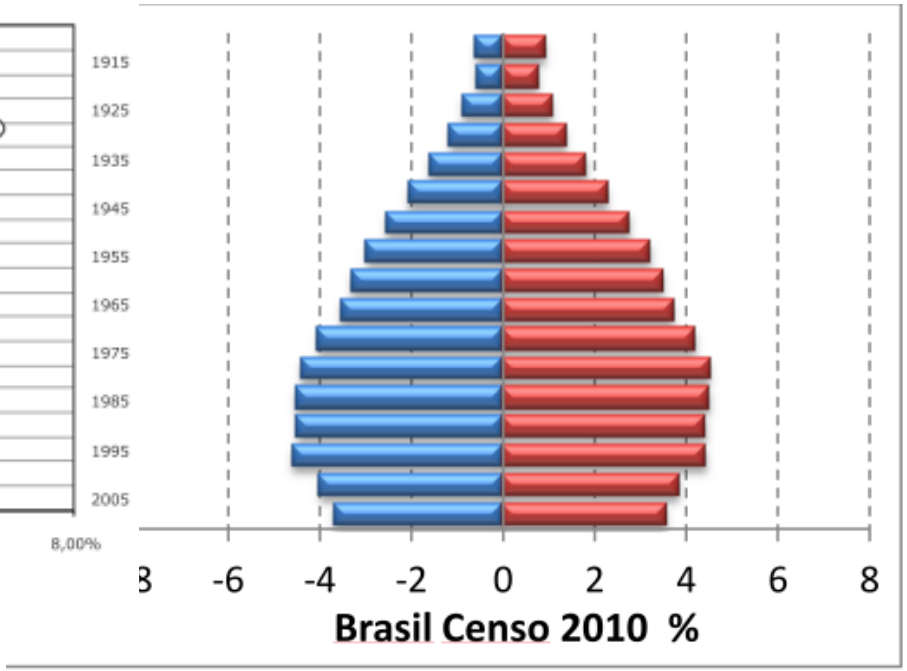


Brasil 2010 - Projection



Fonte: Cedeplar, Projeções Populacionais, 2001.



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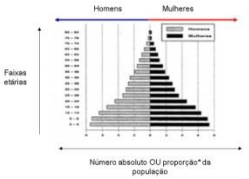
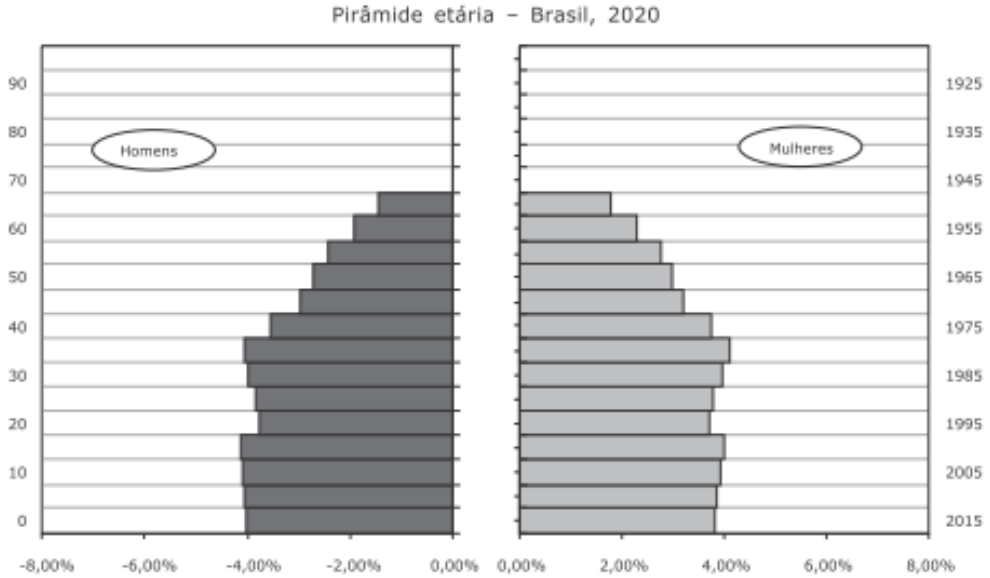
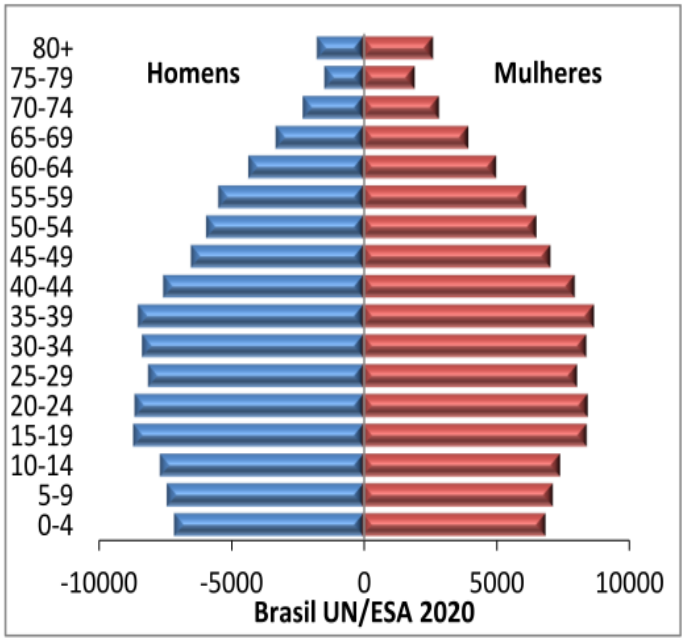
Age structure and pop dynamics



Brasil 2020 – Projection



Fonte: Cedeplar, Projeções Populacionais, 2001.



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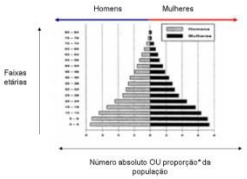
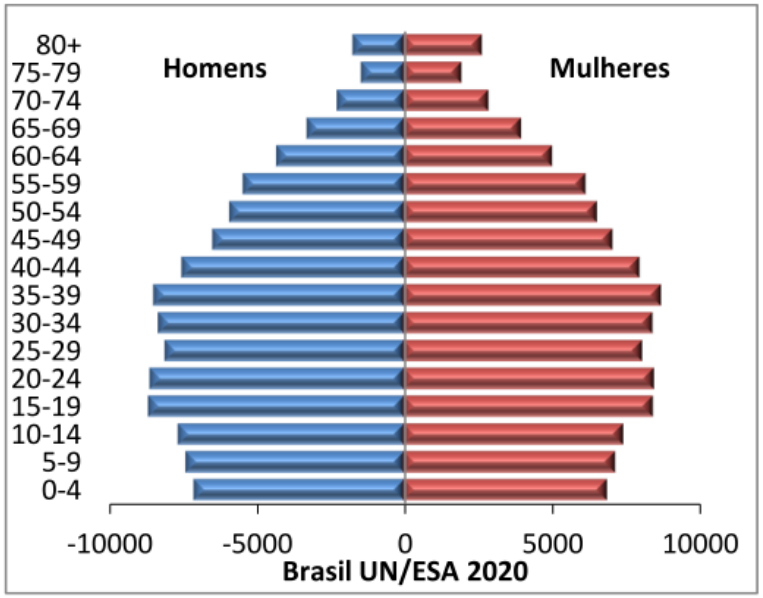
Fonte: IBGE, Censos Demográficos de 1940, 1950, 1960, 1970, 1980, 1991 e 2000; Cedeplar, Projeções Populacionais, 2001.

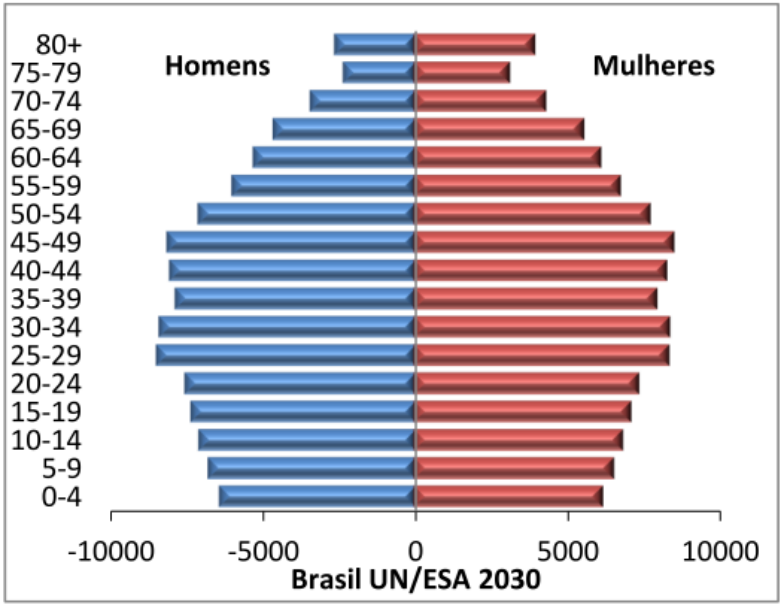
The relative proportions of young people decrease; higher contribution of the more advanced age groups

Age structure and pop dynamics

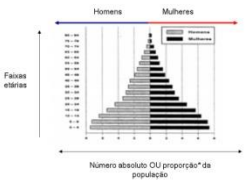


Brasil 2030 – Projection



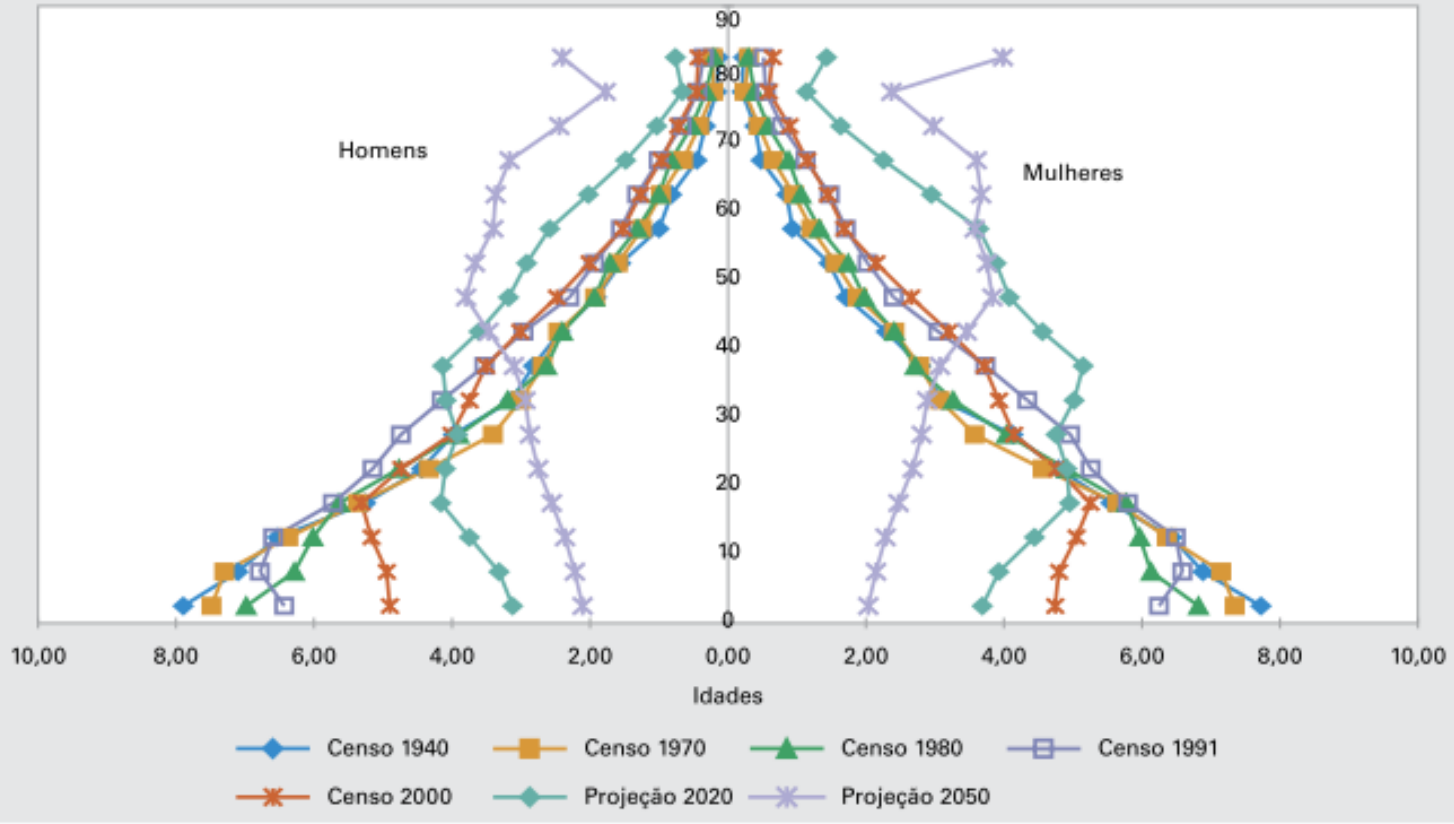


Age structure and pop dynamics



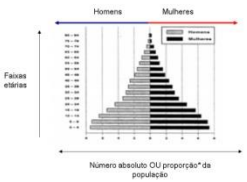
Brasil – Synthesis of Evolution and Projection

Gráfico 4 - Estrutura relativa, por sexo e idade - Brasil - 1940/2050



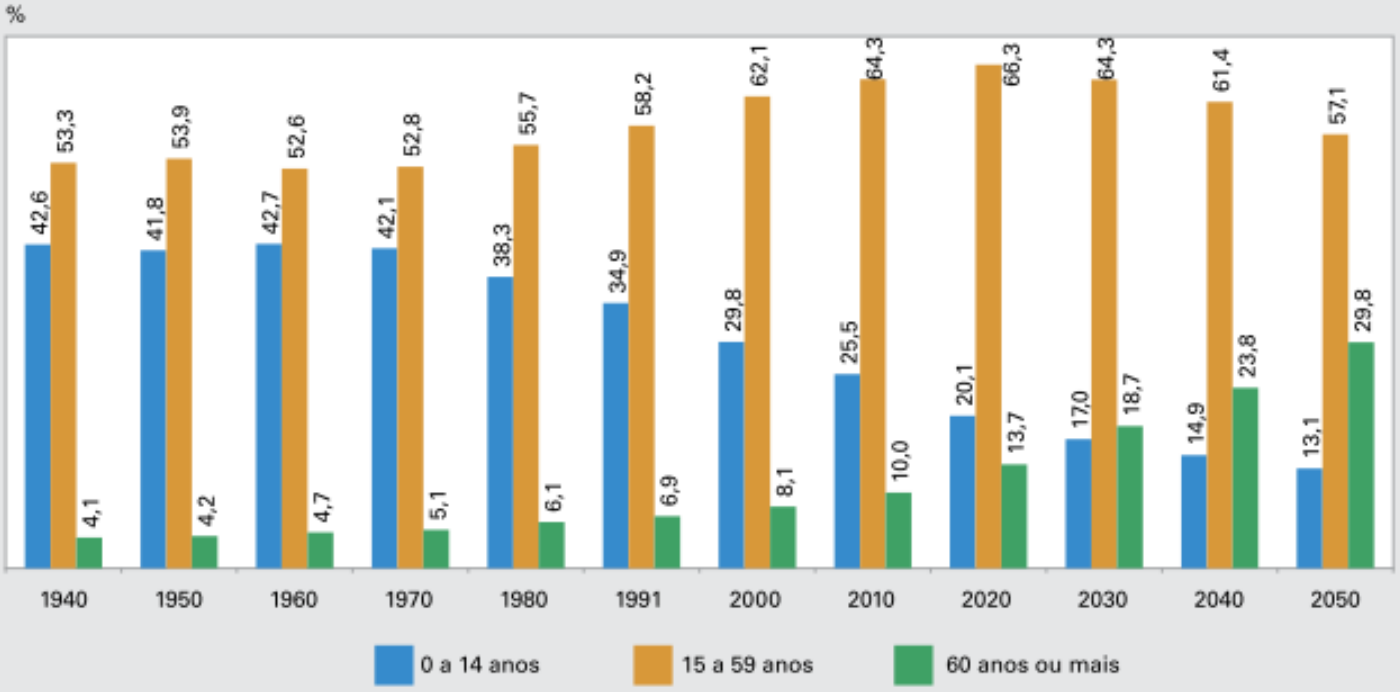
Fontes: IBGE, Censo Demográfico 1940/2000 e Projeção da População do Brasil por Sexo e Idade para o Período 1980-2050 – Revisão 2008.

Age structure and pop dynamics



Brasil – Synthesis of Evolution and Projection

Gráfico 6 - Proporção de crianças, jovens-adultos e de idosos em relação ao total da população - Brasil - 1940/2050



Fontes: IBGE, Censo Demográfico 1940/2000 e Projeção da População do Brasil por Sexo e Idade para o Período 1980-2050 – Revisão 2008.

Intrinsic Growth Rate

Consider a female population (clesed pop, det year):

Current growth rate is the difference between gross Natality and Mortality rates:

TBMf - TBNf

(depends on the TEMsf and TEFsf, and the proportional age distribution of the population in the year).

In a closed population:

- Given a Fecundity function and a Mortality function (TEMs), if they are held **constant**, whatever the initial age distribution, the population will tend, in the long run, to have:
- a constant relative age structure and, consequently, TBN, TBM and constant growth rate, thus transforming into a **stable population**.

The intrinsic growth rate is the growth rate of the stable population

Stable Population

Stable Population will only be reached if:

- the specific Fecundity and Mortality rates remain constant
- there are no migratory flows

A stable population is reached by establishing the set of TEMs and TEFs, which define a TLR (Net Reproduction Rate).

TLR > 1 → positive long-term population growth

TLR = 1 → null growth

TLR < 1 → negative growth.

Intrinsic Growth Rate (TIC) of the stable population.

In any population and at any time, there is a set of TEM and TEF, which defines a specific TLR, which is related to a certain TIC and a certain stable population.

Stable Population

When only the mortality function varies over time, the actual age structure of the population and its rate of growth are very similar to those of the stable population

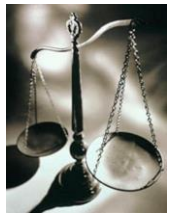
➔ A near-stability situation is then characterized.

This was the case of the Brazilian population between 1940 and 1970.

- The stable population distribution indicates **the future trend** of the actual distribution if the Fecundity and Mortality functions no longer change.

- Each time a change is made, another stable population is automatically defined.

Near-Stability and Destabilization



Proportional age distribution of a closed pop, in any time, results from the Fecundity and Mortality of the past.

High fecundity in the past → the age distribution will be young,

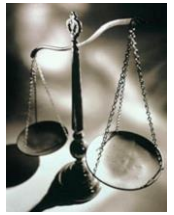
Minor fecundity → the age distribution will be aged

For any levels of mortality (mortality is secondary) the Fecundity of the past is what matters!

Pop is called near-stable: constant Fecundity of the past → pop with approximately constant age structure, regardless of the behavior of mortality.

In this situation the **current rate of population growth** becomes close to its **intrinsic rate**.

Near-Stability and Destabilization

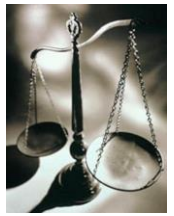


If Fecundity decline begins → the process of destabilizing the age distribution, with increasing divergences between the current and intrinsic rates of growth.

Only after Fecundity again stabilizes, will the population again become near-stable, with an approximation of current and intrinsic rates.

Brazil case…..

Near-Stability and Destabilization



Brazil

until the end of the **1960s the Fecundity level remained** approximately constant, with a significant drop in mortality from the 1940s.

As international migratory flows were small, there were conditions for the near-stability of its population.

Between **1940 and 1970** the proportional age distribution of the Brazilian population practically did **not change**.

The population under 20 years old always remained between 52 and 53% of the total population and over 65 years between 2.4 and 3.1%.

A near-stability situation.

Near-Stability

Brazil

Similarity of age distribution:

census population 1970

and

stable population

(defined by the specific Fecundity and Mortality rates of the 1960/70 period)

DISTRIBUIÇÃO ETÁRIA PROPORCIONAL
DAS POPULAÕES ESTAVEL E OBSERVADA
BRASIL, 1970 E 1980

Grupo Etário	1970		1980		1991	
	Estável	Observada	Estável	Observada	Estável	Observada
0-4	16,6	15,5*	13,6	14,3*	9,5	11,6*
5-9	13,8	14,4	12,0	12,6	9,0	11,8
10-14	11,9	12,7	10,8	11,9	8,6	11,6
15-19	10,3	10,9	9,7	11,3	8,2	10,2
20-24	8,8	8,8	8,6	9,6	7,8	9,2
25-29	7,5	6,9	7,7	7,9	7,4	8,6
30-34	6,4	6,0	6,8	6,4	7,0	7,5
35-39	5,4	5,4	6,0	5,3	6,6	6,4
40-44	4,5	4,9	5,3	4,8	6,2	5,3
45-49	3,7	3,8	4,6	3,9	5,8	4,2
5054	3,1	3,2	3,9	3,4	5,3	3,5
55-59	2,5	2,5	3,2	2,6	4,8	2,9
60-64	1,9	1,9	2,6	2,0	4,2	2,5
65-69	1,4	1,3	2,0	1,7	3,6	1,9
70+	2,1	1,8	3,2	2,3	6,2	2,9
Total	100,0	100,0	100,0	100,0	100,0	100,0
Taxa de crescimento	2,7**	2,8***	2,1**	2,4***	0,9**	1,9***

Fontes: CARVALHO, J. A. M. de. O tamanho da população brasileira a sua distribuição etária: uma visão prospectiva. In: ENCONTRO NACIONAL DE ESTUDOS POPULACIONAIS, 6, 1988, Olinda. Anais. Belo Horizonte : ABEP, 1988. v. 1, p. 37-66; CARVALHO, J. A. M. de. Crescimento populacional e estrutura demográfica no Brasil. Belo Horizonte : CEDEPLAR/ UFMG. mimeo.

Notas: * população enumerada foi corrigida com um aumento de 5%.

** taxa intrínseca de crescimento anual.

***taxa media anual da década (observada).

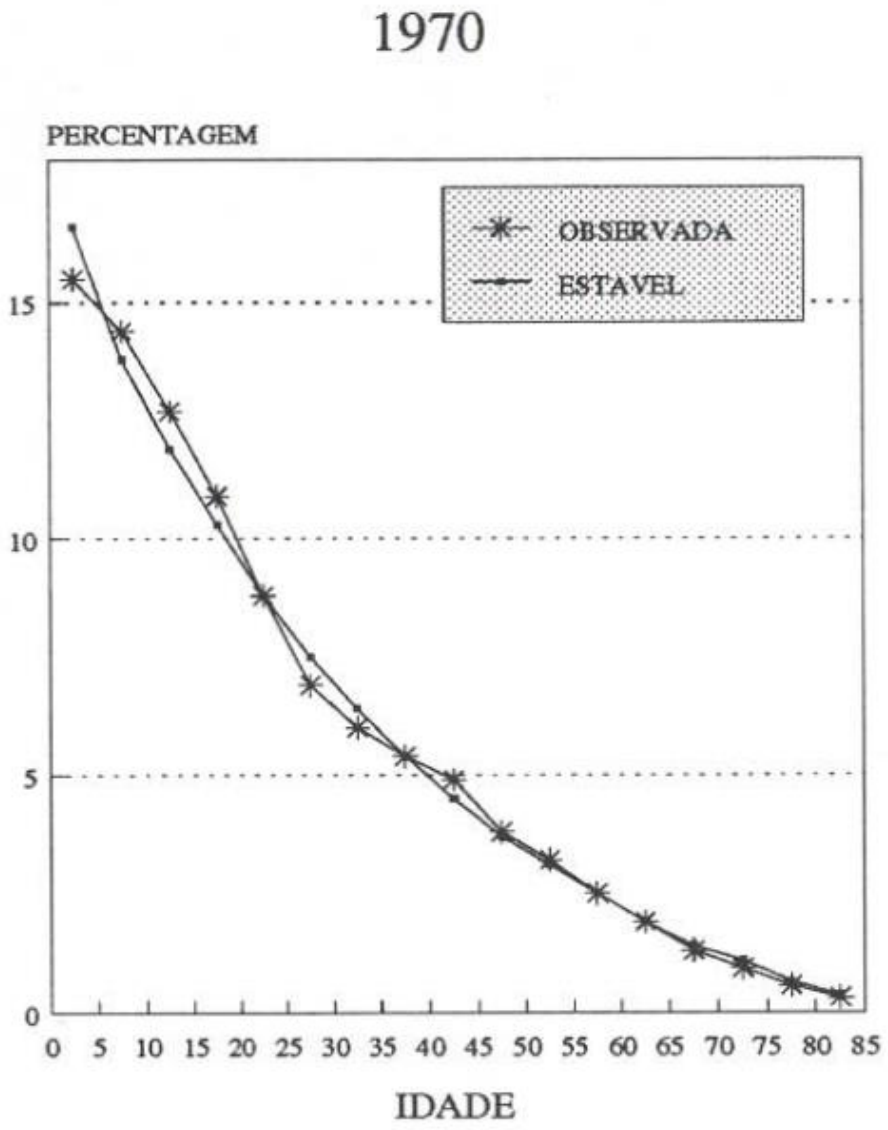
Near-Stability

Brazil, 1970:
Significant decline in mortality during the previous three decades;

Fecundity remained constant, 1970 = quasi-stability

Similarity between the proportional age distribution of the real population and the stable population,

Similarity between real and intrinsic rates of growth.



Destabilization

Brazil, 1980

Decade of the 70s - decline in Fecundity: TFT falls from 5.8 to 4.4.

The process of **destabilizing** the age structure begins

The average annual growth rate observed between 1970 and 1980 = 2.4%, and the intrinsic rate = 2.1%.

In the following decade, the annual growth rate fell to 1.9%, the intrinsic rate fell to 0.9% per year.

DISTRIBUIÇÃO ETÁRIA PROPORCIONAL
DAS POPULAÕES ESTAVEL E OBSERVADA
BRASIL, 1970 E 1980

Grupo Etário	1970		1980		1991	
	Estável	Observada	Estável	Observada	Estável	Observada
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Notas: * população enumerada foi corrigida com um aumento de 5%.

** taxa intrínseca de crescimento anual.

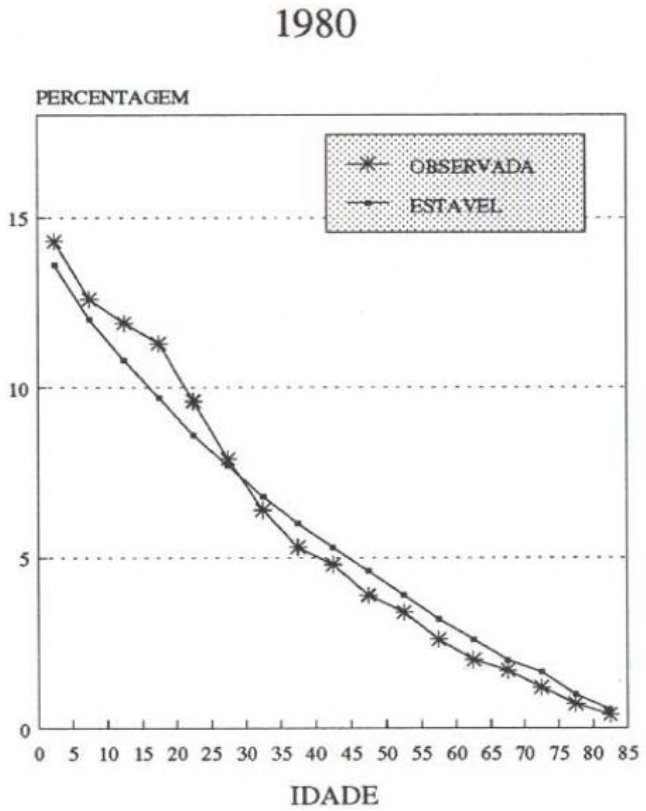
***taxa media anual da década (observada).

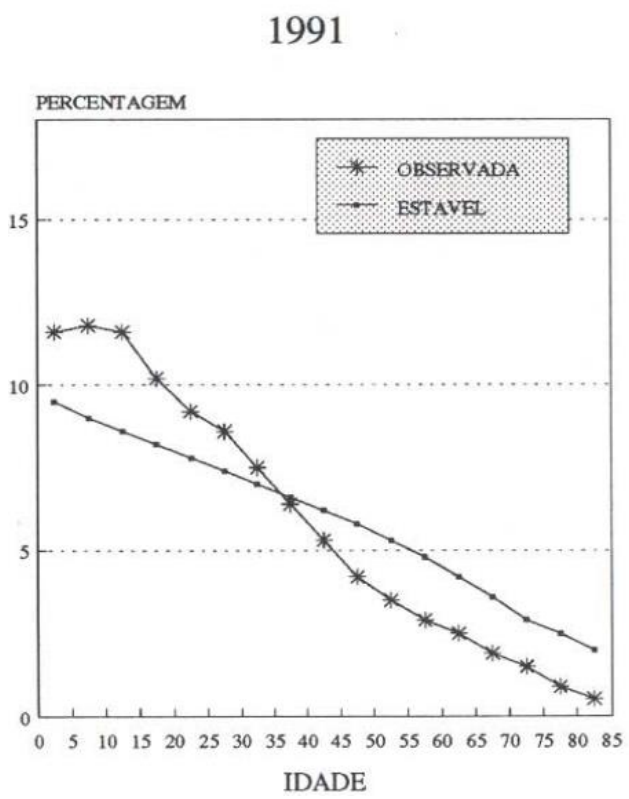
Destabilization

The proportional age distribution of the observed population x stable:

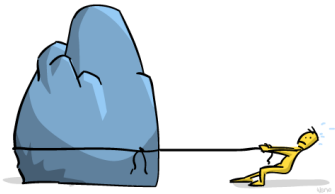
in the younger age groups: Observed >> stable pop;
in advanced ages: Observed << of stable pop

The age distribution of the stable population indicated the future of the Brazilian population: its relative aging.





Destabilization



The "inertia of population growth":

the population born before the decline of Fecundity (in 1980, the one with more than 10 years, in 1990, the one with more than 20 years, etc.) belongs to a pyramid originally of **broad base**.

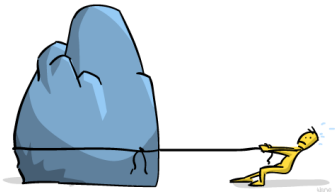
This type of age distribution leads to a **TBN greater than that of the stable population** as long as there are women of reproductive age belonging to generations born before the decline of Fecundity.

Hence, the gap between observed and intrinsic rates of growth, which produces an increase, in the short term, **"artificially" high population**.

This phenomenon is known as "***the inertia of population growth*".**

The gap between the real growth rate and the intrinsic growth rate will continue to increase until there is a reversal of the process of distancing between the age distribution of the real population and that of the stable population.

Destabilization

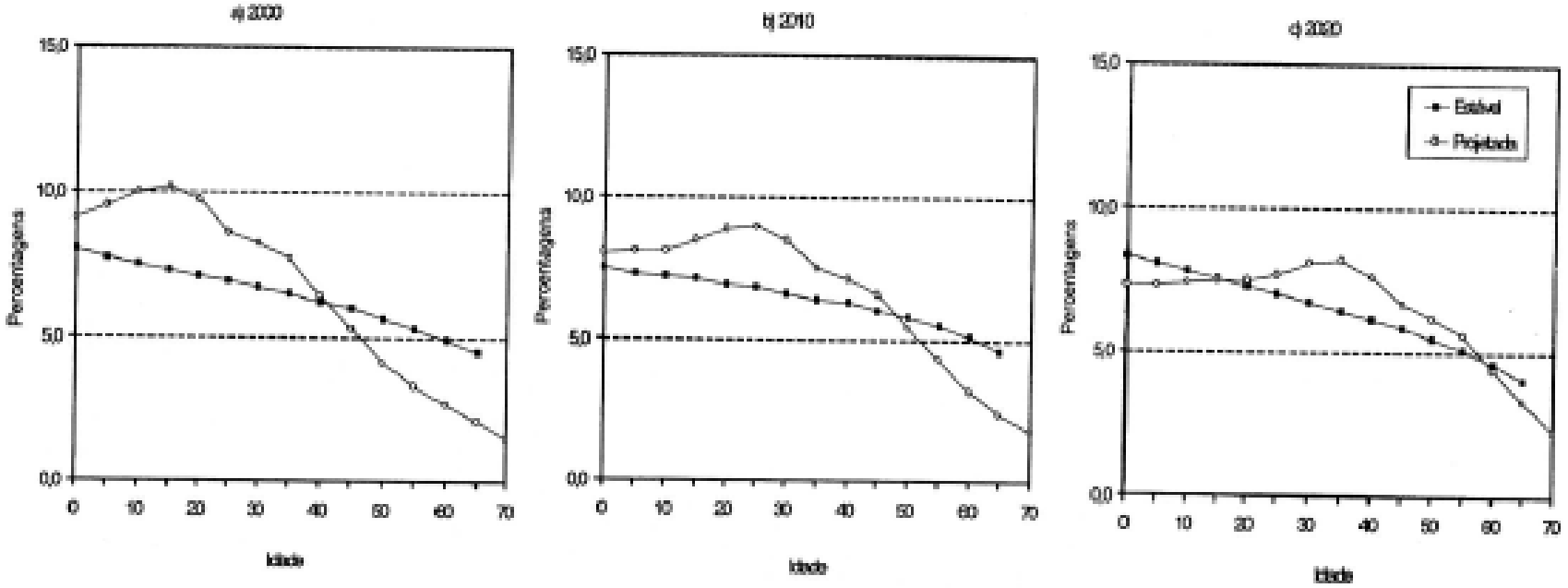


The "inertia of population growth":

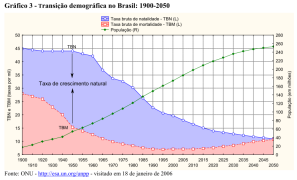
Relative aging of the population will only NOT be higher due to residue of age distribution (consequence of high Fecundity before 1970).

Reversal: declining Fecundity (unlikely) or international migratory flows

The stable population of 2020 is showing us a tendency to reach a total population with 27.3% of people under 20 years and 15.3% over 65 years



Demographic Transition



Theory of the demographic transition: the global population growth would be in phases:

1. Traditional (or pre-transitional) demographic regime

- High Natality and Mortality rates → small vegetative growth

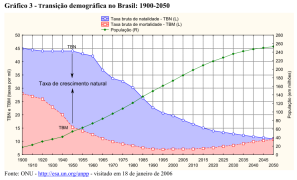
2. Transition period

- developed countries - with the Industrial Revolution,
- underdeveloped countries - only in the middle of the 20th century
- Mortality falls first → intense pop growth → Population explosion
- Regulation of Natality → Fertility Transition → Stability

3. Modern (or Post-Transitional) demographic regime

- Decline in Natality and Mortality Rates

Demographic Transition



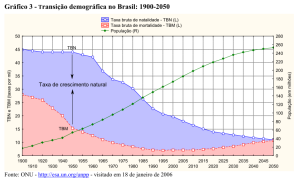
Brazil - classic scenario of the demographic transition phenomenon:

During the first half of the twentieth century - Gross Mortality Rates (**TBM**) **decreased** significantly, especially after the end of the two great World Wars.

In this period the Natality Gross Rates (**TBN**) **remained high** and only dropped steadily from the mid-1960s.

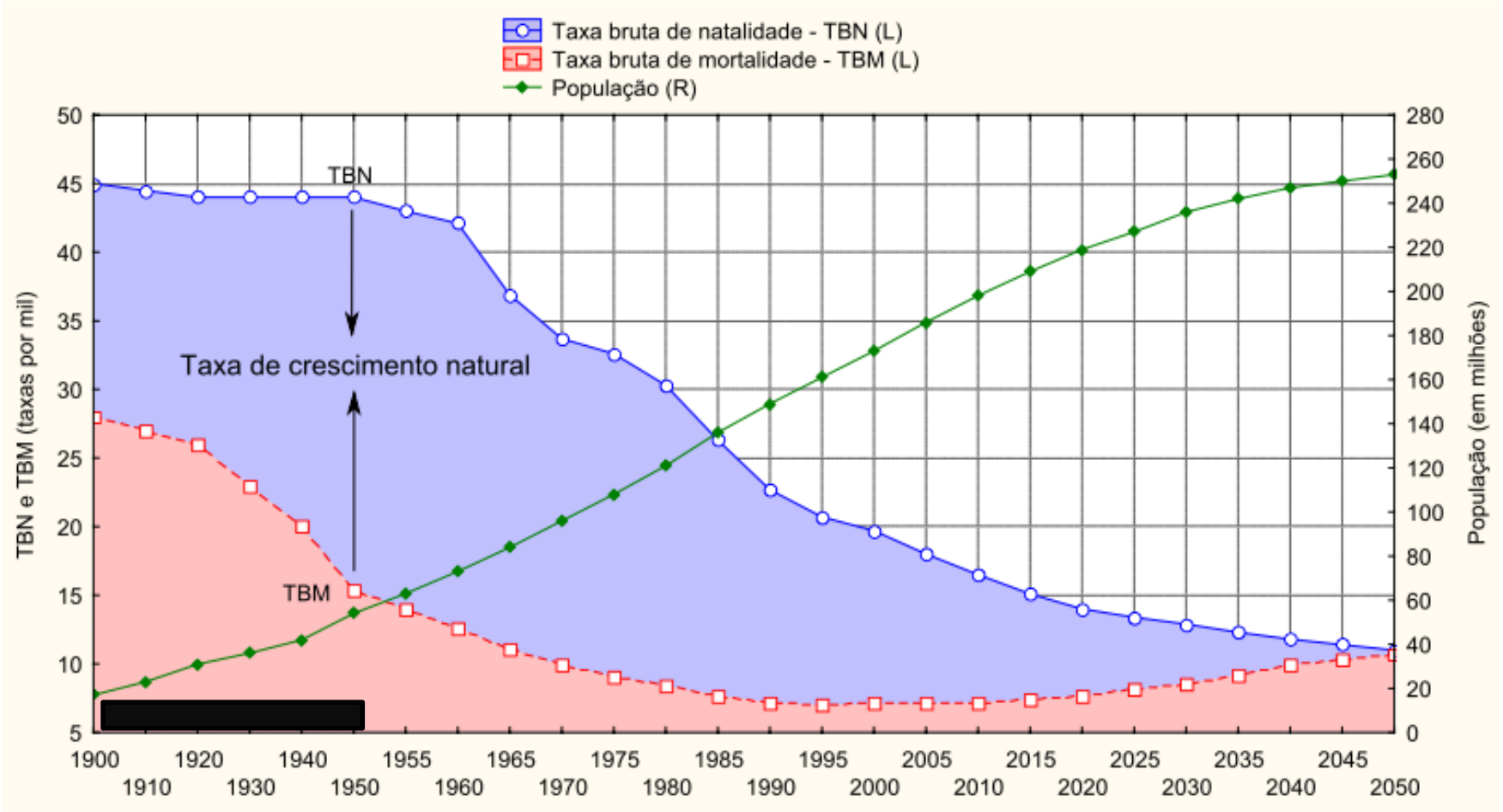
As **mortality** rates have **declined** early and at a faster rate **than Natality** rates, there has been an acceleration of the population's vegetative growth in relation to all previous historical periods.

Demographic Transition



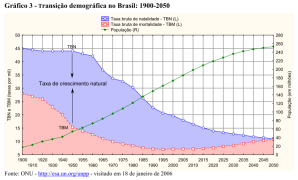
Brazil - classic scenario of the demographic transition phenomenon:

Gráfico 3 - Transição demográfica no Brasil: 1900-2050



Fonte: ONU - http://esa.un.org/unpp - visitado em 18 de janeiro de 2006

Demographic Transition



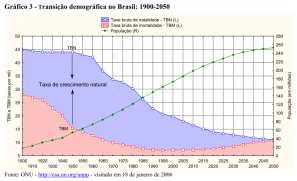
Brazil - classic scenario of the demographic transition phenomenon:

- In the 1950s and 1960s the population grew by about 3% a year.

- Even taking into account this deceleration of population growth from the second half of the 1960s:

- from **1950 to 1980** there was the **greatest vegetative growth** in all Brazilian history, with an average growth rate of **2.8%** per year.

Demographic Transition



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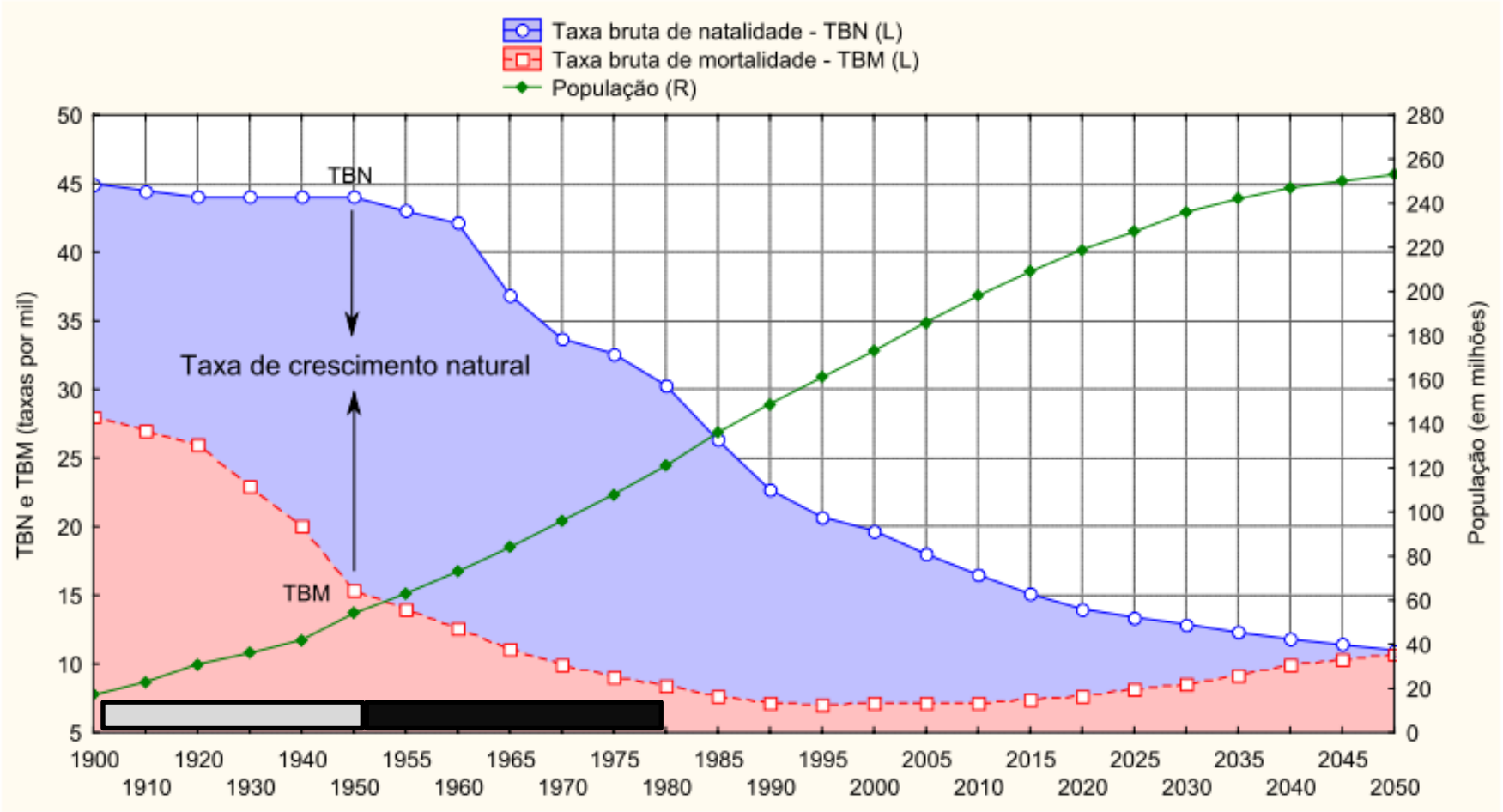

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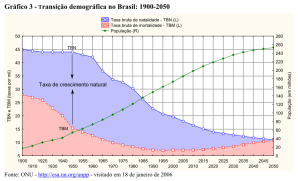
Demographic Transition

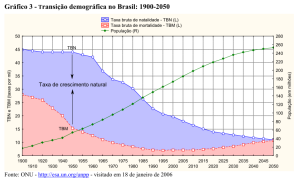


Brazil - classic scenario of the demographic transition phenomenon:

- **Natality rates**, from the start of their decline, show a downward trend throughout the period.

- **Mortality rates** reach their lowest point in the first decade of the twenty-first century, after which there is a slight upward trend, not due to any worsening of health conditions, but due to the aging process of the population.

Demographic Transition



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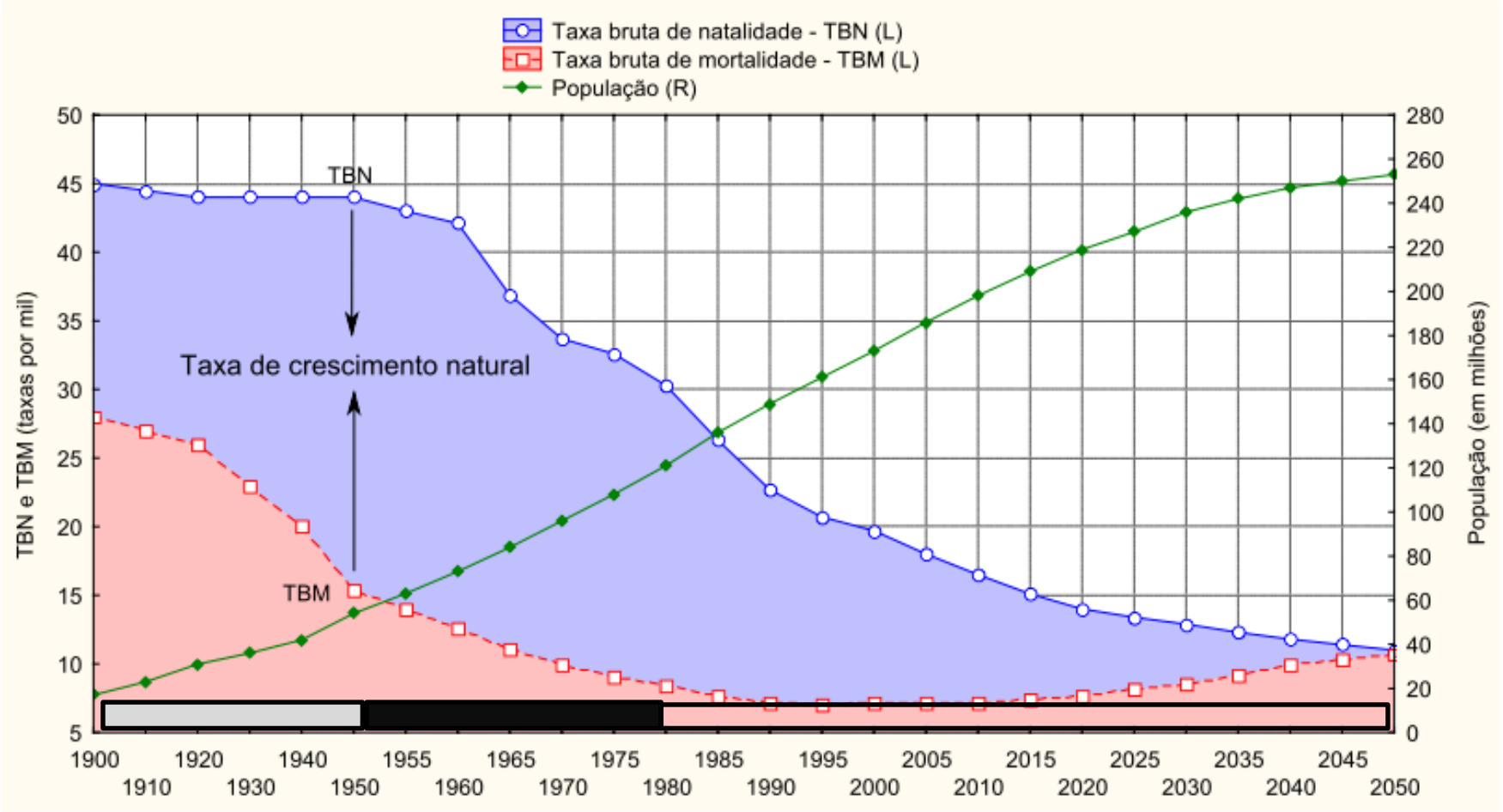

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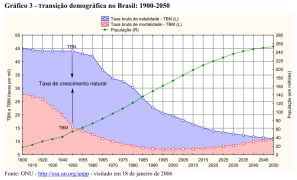
Demographic Transition



Brazil

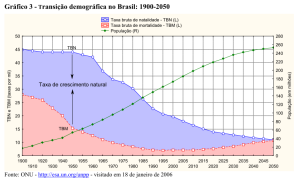
Consequence of the transition ➔ changes in the population age structure:

- Pop is no more predominantly young AND It begins a progressive **aging** process

- the fall in **Fecundity** rates reduces the percentage of the young part of the population → Age Structural Transition (**AST**) process:
  - changes in the size of the various age cohorts and modifies the proportional weight of the various age groups in the population as a whole.

- Changes in the **pattern of infant mortality and life expectancy at birth**

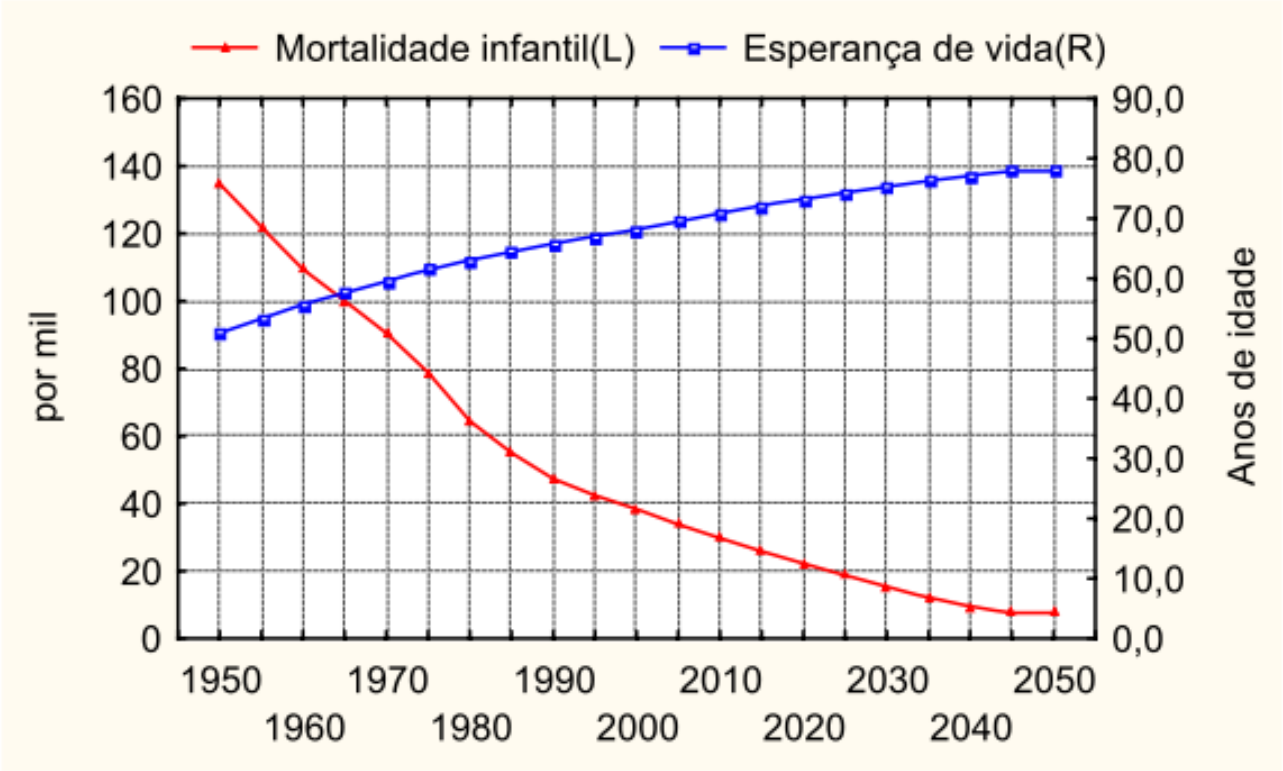
Demographic Transition



Brazil

Gráfico 5: Taxas de mortalidade infantil (por mil) e esperança de vida ao nascer (em anos)

Brasil: 1950-2050



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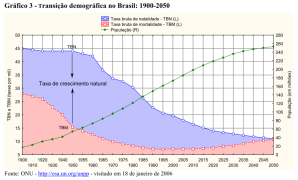


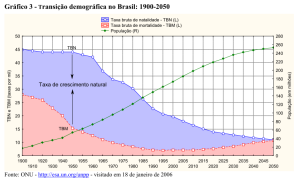
Impact on the Brazilian age structure:

- Increase of the **working age population** which could favor the economic and social development of the country.

- This phenomenon caused by the changes in the population dynamics is, in a synthetic way, called "**demographic bonus**", "**window of opportunity**“

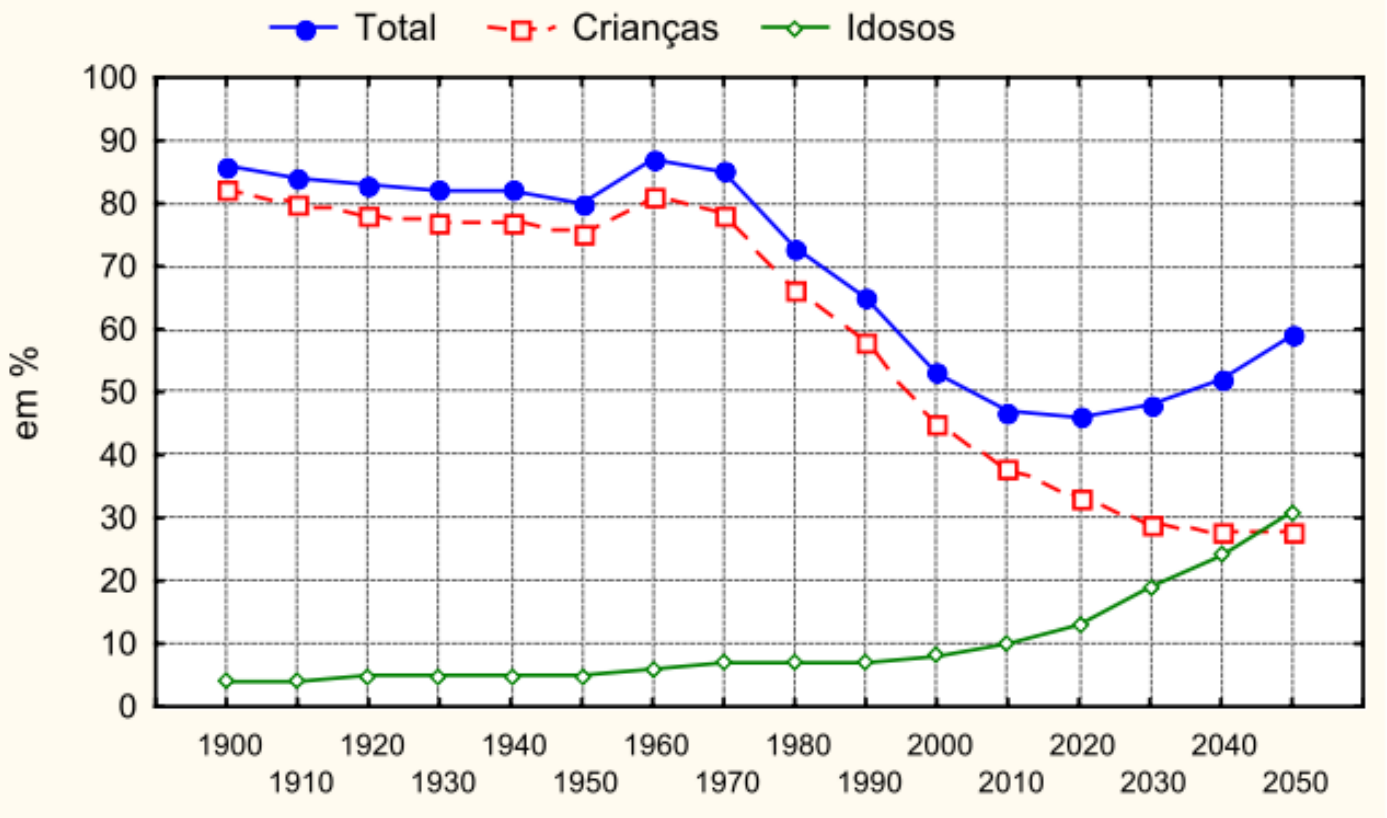
- Reduction in the relative weight of children (0-14y) and increasing, firstly, the weight of adults (15-64y) - population of active age (PIA) and, in a later period, the weight of the elderly (> 65y) . Dependents = children and the elderly

Demographic Transition

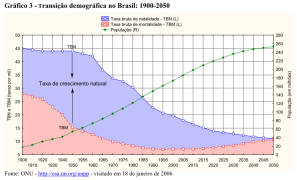


Impact on the Brazilian age structure:

Gráfico 6: Taxas de dependência demográfica no Brasil – crianças e jovens de 0-14 anos e idosos de 65anos e mais (1900-2050)



Demographic Transition



It can be said that:

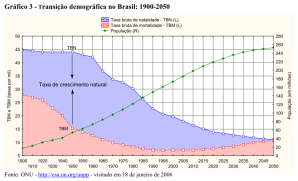
the "economic burden" of **demographic dependence** will be much **smaller** in the first half of the twenty-first century than at any other time in Brazilian history.

These changes have potentially a **positive effect** on per capita income:

- If the output per worker is considered fixed and labor force participation rates, the simple increase of the PIA - due to the composition effect - will **raise GDP** per capita.
- However, the macroeconomic effect of this phenomenon, called "demographic bonus", is not automatic.

It is a "window of opportunity" that requires adequate **economic policies** so that population potential can be put at the service of economic development and the well-being of the population.

Demographic Transition



"...existem configurações institucionais e estruturais que possibilitam, para um dado país, a uma determinada época, um aproveitamento maior das condições sociais e econômicas criadas pela nova estrutura etária.

Se essas configurações, que emergem como uma "construção social" e não como um dado espontâneo da evolução econômica, não forem estabelecidas, o bônus demográfico converte-se em ônus demográfico."

Alves & Bruno (2006)

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Article discussion

1. Summary

2. Important subjects

3. Caveats

Population TFT (The Economist)
https://www.youtube.com/watch?v=0CNC_VJ11CM

Population x CC (The Gardian)
https://www.youtube.com/watch?v=SxbprYyjyyU

UN Population Division

- World Population Prospects 2017 (https://esa.un.org/unpd/wpp/)