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Actuarial Sciences

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4. Fertility

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Outline

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Changes in fertility

Social changes and familiy structure

Throughout the 20th century, several social transformations contributed to a shift in family structures, moving from horizontal to vertical arrangements in many societies.

- Vertical families consist of multiple generations living together (e.g., grandparents and great-grandparents). The term "vertical" reflects their structure in a family tree.
- Horizontal families extend across the same generation, including aunts, uncles, and cousins living together.

Changes in fertility

More vertical families

Here are some key social changes that played a role in this shift:

- 1. Industrialization and Urbanization: The shift from agrarian to industrialized societies, along with urban expansion, led to smaller living spaces and increased mobility, making extended family arrangements less practical.
- 2. Economic Changes and Social Mobility: Changes in economic structures, increased social mobility, and the pursuit of independence encouraged the rise of nuclear families over extended ones.

Changes in fertility

More vertical families

- **3. Changes in Cultural Norms:** Changing cultural values, which began to emphasize individualism and personal autonomy, led couples to form separate households rather than living with extended family members.
- 4. Technological Advances and Social Welfare: Technological progress and the development of social welfare programs reduced the need for extended family support, allowing greater independence among family members, including the elderly.

Changes in fertility

What is behind the size reduction of families?

Why families have become smaller has been subject of a lot of social and economic research.

- Of course, the Demographic Transition (DT) describes the shift in developed countries from high to low mortality and fertility rates, but does not explain the underlying causes. It accounts for changes in family size due to improved living conditions and reduced infant mortality.
- Recent trends: While the DT provides a framework, additional factors are now at play. These include cultural shifts, economic changes, and evolving social norms that further contribute to the decline in family size.

Changes in fertility

What is behind the size reduction of families?

In modern times, besides low mortality rates, we've seen **specially low fertility rates,** raising questions about the underlying causes.

- The effort to explain that fertility behavior led to a new theoretical element in demography: the Second Demographic Transition (SDT).
  - Concretely, the SDT tries to explain the behavior of families in the post-transitional Europe[a] as well as other societies with specially low fertility rates.
  - Among developed countries at the end of the 20th century, only the US had fertility rates large enough to guarantee the generational replacement in the mid and long term.

[a] Post-transitional societies in the context of the SDT are those that have already experienced the first demographic transition (late 19th to mid-20th century) and then entered the phase of low fertility rates and family behavior changes in the second half of the 20th century.

Changes in fertility

What is behind the size reduction of families?

- "*The second demographic transition entails "sustained sub-replacement fertility, a multitude of living arrangements other than marriage, the disconnection between marriage and procreation, and no stationary population (Lesthaeghe and Surkyn 2008, pp.82; Lesthaeghe 2010, pp. 211; Lesthaeghe 2014, pp 18112). The primary driver of these trends is the cultural shift toward postmodern attitudes and norms (i.e., those stressing individuality and self-actualization) (van de Kaa 2001).* [a]"

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[a]- Lesthaeghe R, Surkyn J. When history moves on: The foundations and diffusion of a second demographic transition. Ideational perspectives on international family change. 2008:81–118.

- Lesthaeghe R. The Unfolding Story of the Second Demographic Transition. Population and Development Review. 2010;36:211–51.

- Lesthaeghe R. The second demographic transition: A concise overview of its development. Proceedings of the National Academy of Sciences. 2014 201420441.

- van de Kaa DJ. Postmodern Fertility Preferences: From Changing Value Orientation to New Behavior. Population and Development Review. 2001;27:290–331.

Changes in fertility

An unpredicted output

The observed fertility levels in developed countries today were not anticipated according to the Demographic Transition (DT). This recent phenomenon indicates the presence of new societal conditions.

- According to **van de Kaa (1987)**[a][b], there has been a series of sequential events that have led to the current low fertility levels.
  - Notorious **change of legal marriage to cohabitation.**
    - e.g., van de Kaa estimated that about 40% of people in Western Europe will never get married.
  - A change in the **way of thinking about family.**

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[a] Dirk Jan van de Kaa is a Dutch demographer. From 1970 to 1987 he was the first director of the Netherlands Interdisciplinary Demographic Institute. From 1987 to 1995 he was director and rector of the Netherlands Institute for Advanced Study.

[b] van de Kaa DJ. Europe's second demographic transition. Washington, D.C: Population Reference Bureau; 1987.

Changes in fertility

Changing the values scale

A key factor in explaining this shift is the changing role of the family in people's lives:

- The focus has shifted from prioritizing children to prioritizing the adult couple.
- Children are now seen as a way to "enhance" the parents' lives, with even child-free living becoming a valid option for personal fulfillment.
- During the first Demographic Transition (DT), societies were child-centered, with altruism serving as the core motivation in family life.

Changes in fertility

Individualism on the scene

In contrast, in the SDT, social motivation is **individualism**

- Norms and attitudes emphasizing rights and development of individuals became more important.
- Children are not the essential variable in future plans, but now one of several possibilities.
- During the first TD, people planned their future with a "family" vision.
- In the SDT, it is a combination of **familism, consumerism, careerism, hedonism and other lifestyles.**

Changes in fertility

Individualism on the scene

Lesthaeghe 's concept of the Second Demographic Transition highlights a shift toward individualism and diverse lifestyles, which also reflects broader societal changes.

- To understand these shifts, we can look at two key axes: Survival vs. Self-Expression Values, and Traditional vs. Secular-Rational Values.
- These axes help explain how countries prioritize security, autonomy, and modernity, influencing fertility and family dynamics.

Changes in fertility

Cultural dimensions of values

In the context of cultural and social analysis, sociologists Inglehart and Welzel identify two key dimensions of cross-cultural value variation: Traditional vs. Secular-Rational values, and Survival vs. Self-Expression values.

Changes in fertility

Values

- Traditional Values: Focus on religion, national pride, respect for authority, and family. Found in societies where religion and tradition play a central role in life.
- Secular-Rational Values: Emphasize rationality, autonomy, tolerance, and environmental concerns. Common in societies where religion is less central, and individual freedoms and democracy are prioritized.

Changes in fertility

Values

- Survival Values: Focus on physical and economic security, with an emphasis on material well-being and stability. These societies prioritize basic needs like security and employment.
- Self-Expression Values: Emphasize autonomy, freedom of expression, and diversity. These societies promote individual rights, gender equality, and democratic participation.

Changes in fertility

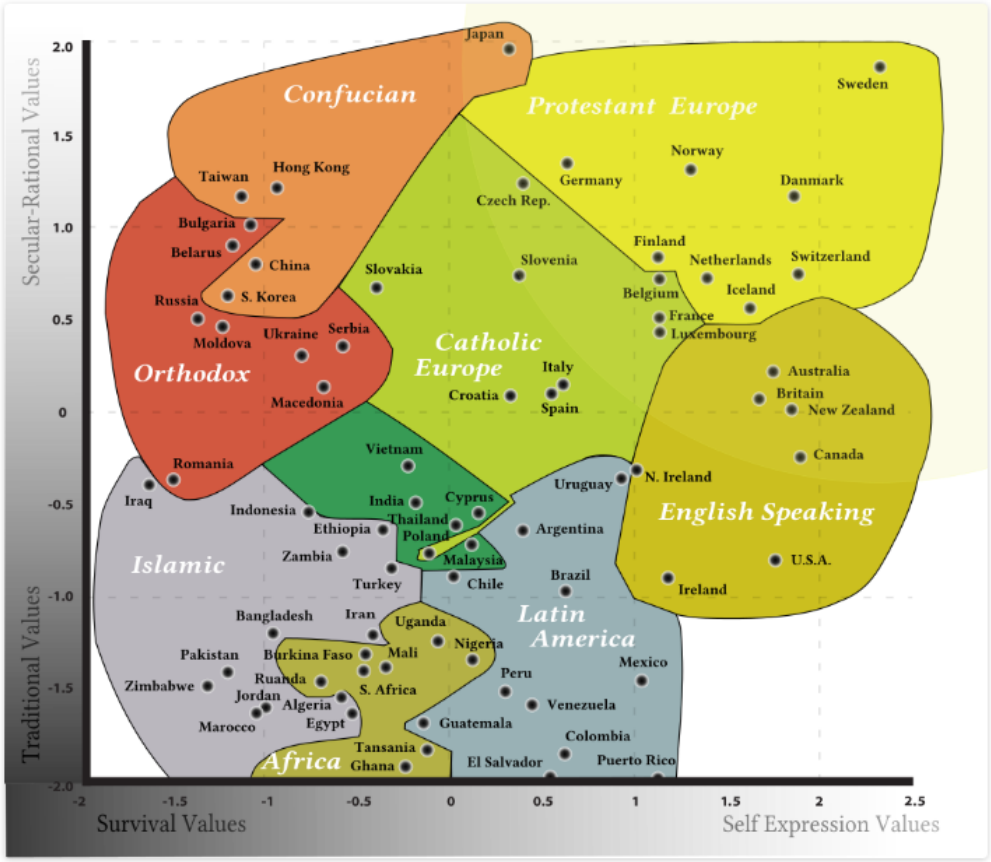

Figure: Countries according to axis Survival Values - Self Expression Values, and Traditional - Secular-Rational Values. Taken form Erik Gandini's documentary *The Swedish Theory of Love* (2016).

Outline

From Social Theory to Demographic Metrics

Fertility vs Fecundity

Having explored the social and cultural dimensions influencing fertility patterns, it's time to shift focus to how we measure this phenomenon. Understanding the decline in fertility and changes in family structures requires practical, quantitative tools. Next, we'll delve into demographic analysis, where various measures and indices help us assess fertility trends more precisely.

Introducing concepts

Fertility vs Fecundity

In demography, the term "**fertility**" is related with the number of live births a woman has had. On the other hand, "**fecundity**" is just the physiological ability to bear children. In short, fecund is the opposite of sterile.

- (*) **WARNING!** In French, Spanish and related languages, the demographic meaning of "fecund" and "fertile" are ***reversed.***
  - Fertiliy is "fécondité" in French and "fecundidad" in Spanish.
  - Fecundity is "fertilité" in French and "fertilitidad" in Spanish.

Introducing concepts

Interesting facts

Theoretically, the maximum number of children a woman can have is around 15 to 16, if she starts childbearing soon after menarche, which typically occurs between ages 10 and 14 (with variations between developed and less developed countries).

- Now, assuming a reproductive span from 15 to 49 years, an average pregnancy lasting just under nine months, and an interval of about 18 months between births, a woman could give birth approximately every 2.2 years, reaching this potential maximum (Bongaarts, 1978). This represents the upper limit of reproduction for a population.

Introducing concepts

Interesting facts

While this is a theoretical limit, real-world cases can sometimes exceed expectations.

According to the Guinness World Records, the most prolific mother in recorded history was an 18th-century Russian woman who gave birth to a total of 69 children. Despite having only 27 pregnancies, she experienced multiple births, including 16 pairs of twins, seven sets of triplets, and four sets of quadruplets.

Introducing concepts

Hutterites as a benchmark

Looking at more typical cases, the highest recorded average fertility rate for any known population is about 10 births per woman.

- This has been observed among the Hutterites, an ethnoreligious group whose communal lifestyle and social structure have historically encouraged large families.
- The Hutterites, like the Amish and Mennonites, trace their roots to the Radical Reformation of the early 16th century.
- The Hutterite community stands out for its high fertility rates, making it a unique subject for studying fertility patterns.

Introducing concepts

Natural Fertility

Populations like the Hutterites, in which there are no control over births, are said to have **natural fertility**.

- That type of fertility is essentially a biological phenomenon. However, it may change between populations due to social customs, such as age at marriage, breast feeding and weaning practices.

Introducing concepts

Human fertility: **females are key**

Fertility is a complex and essential aspect of human life, involving reproductive processes that require the contributions of both sexes. However, when we delve into the study of fertility, **it's often framed through the lens of female biology.** This focus is due to women's direct role in pregnancy and childbirth, which are central to fertility outcomes.

Introducing concepts

Childbearing ages

From a quantitative perspective, when studying fertility as a demographic phenomenon, it's essential to define specific age ranges in order to measure and analyze the data.

- Based on empirical observations, most births occur between the ages of 15 and 50, with about 98% of all births falling within this range. Therefore, in demographic fertility analysis, this age range is commonly used as a reference for assessment.

Introducing concepts

Non-constant (calendar) fertility

Now, even within the female population of childbearing age, fertility is not constant and tends to vary with age, partly due to changes in fecundity, but also influenced by other factors, but particularly:

- 1. Sexual activity
- 2. Contraceptive use, which can significantly affect the probabilities of procreation.

Introducing concepts

In or out of wedlock: Does it matter?

Sexuality is often socially regulated and has been shaped within certain social structures. As a matter of fact, fertility rates tend to differ noticeably between women in stable unions or marriage and those who are not. For this reason, fertility studies are generally more accurate when considering births based on relationship status—whether within marriage or cohabitation.

Introducing concepts

More factors on the scene

In addition, not all women are at the same risk of childbearing, even if they fall within childbearing age. Therefore, fertility studies often begin by dividing the female population into subgroups based on characteristics that may influence their exposure to the risk of procreation. Some key factors include:

- 1. Age
- 2. Marital status[a]
- 3. Parity (the cumulative number of live births)

Once these subgroups are identified, researchers analyze how their behaviors, in combination with the broader population composition, contribute to an overall (aggregate) fertility measure.

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[a] Within married couples, the duration of the marriage can also be an important factor. Over time, sexual activity within the couple may decrease, which in turn affects fertility rates.

Introducing concepts

Curling the loop?...

There is one more concept: Fecundability.

- **Fecundability** is just the physiological ability to conceive[a]
  - It's the statistical probability of conceiving per menstrual cycle.
  - This is important to take into account in the statistical modelling of the process of family building and estimation of effectiveness of family planning programmes.

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[a] We can translate this to Spanish as "*Fertibilidad: una medida de cuán fertil es un individuo*".

Introducing concepts

Women fecundability by age

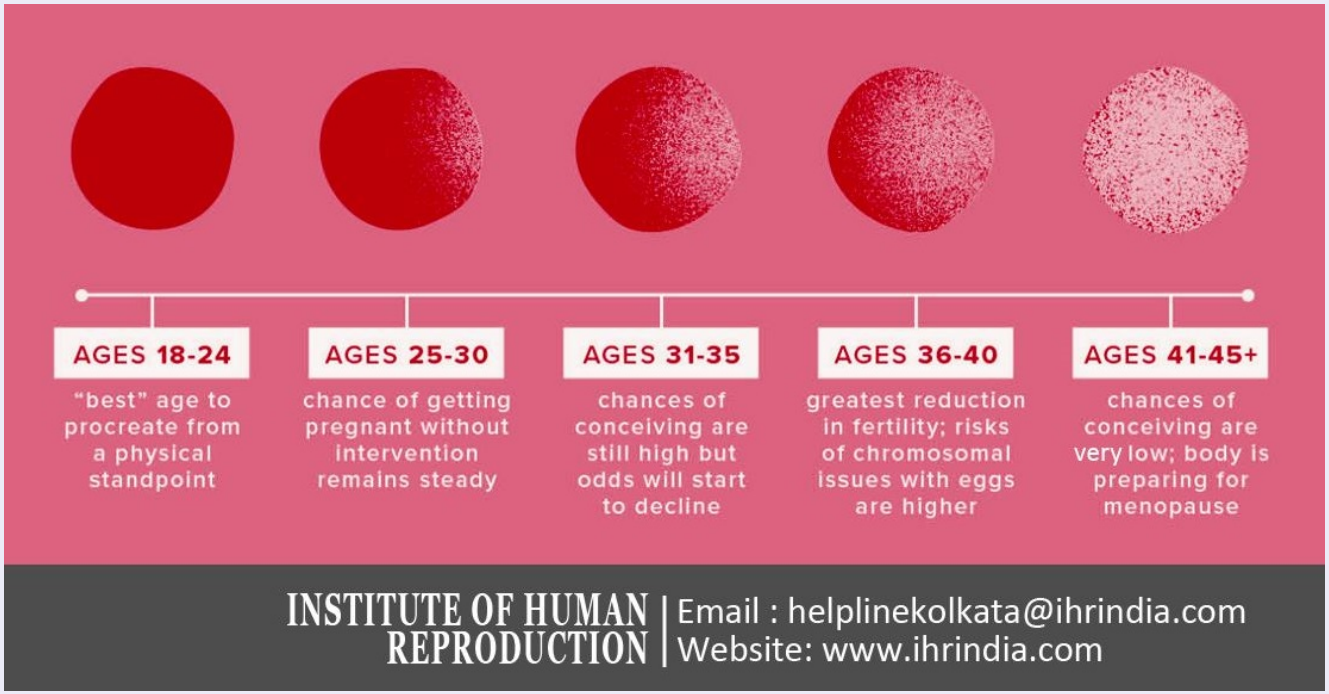

Figure: 1. Female fecundability timeline.

Introducing concepts

Women fecundability

"Generally speaking, historical data point to a slow decline in fecundity until after the age of 35 years. For example, compared to women aged 20–24 years, fertility is reduced by 31% in women aged 35–39 years" (Menken et al., 1986)[a].

[a] Menken J, Trussell J and Larsen U (1986) Age and infertility. Science 233, 1389–1394.

Introducing concepts

Women fecundability

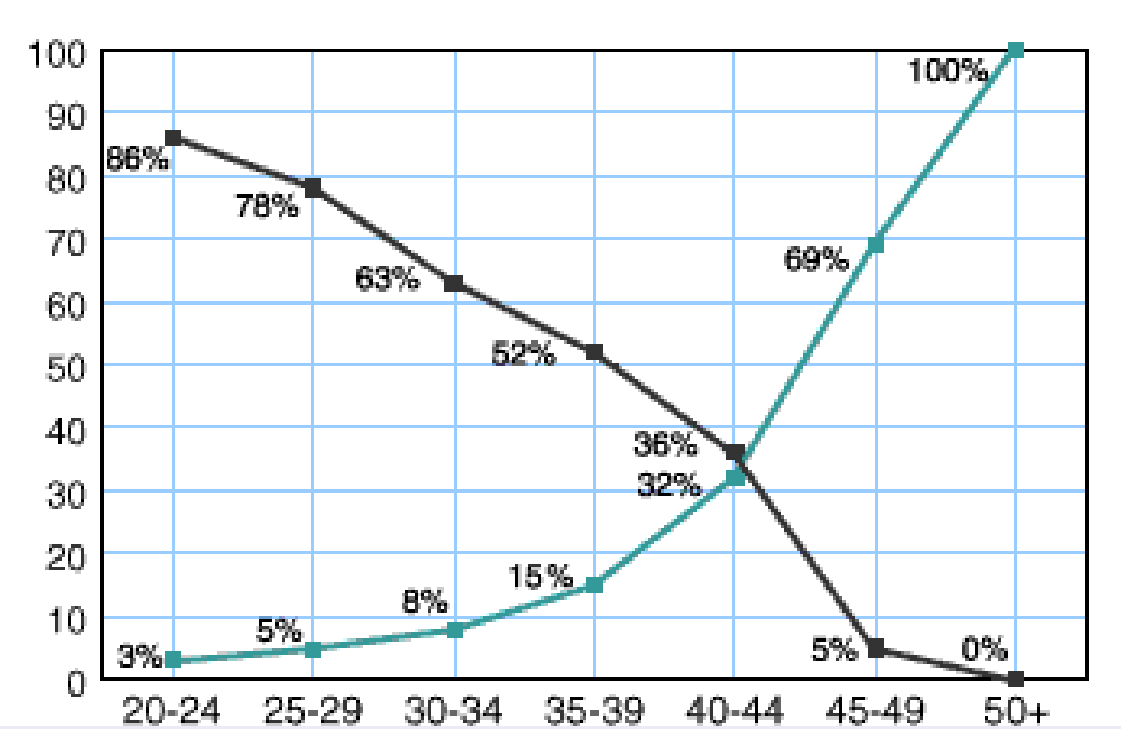

Figure: 2. Likelihood of getting pregnant (black); Likelihood of infecundity (blue).

Introducing concepts

Period and cohort fertility analysis

There are basically two ways for studying fertility: **period** and **cohort** analysis

- **Cohort analysis** tracks the reproductive history of women born or married in the same year, following them over time.
- By comparing different cohorts (e.g., women born in 1900, 1925, and 1959), we can observe real generational differences in fertility trends.
  - **This reveals real changes in fertility tendencies by generations.**

Introducing concepts

That's nice, but...

In practice, it is difficult to have complete data sets for performing a cohort analysis.

- So, it is quite more common to perform a **period fertility analysis.**
  - A period fertility analysis looks cross-sectionally; i.e., births occurring during a specified period, like a year.
  - For example: analyzing fertitlity in 2019 means considering fertility of women between 15 and 49 years of age that year.
  - Thus, we analyze quite different generations at the same time: from those that were born just 15 years ago to those who were born almost 50 years ago!

Introducing concepts

Lexis diagram: cohort and period fertility analysis

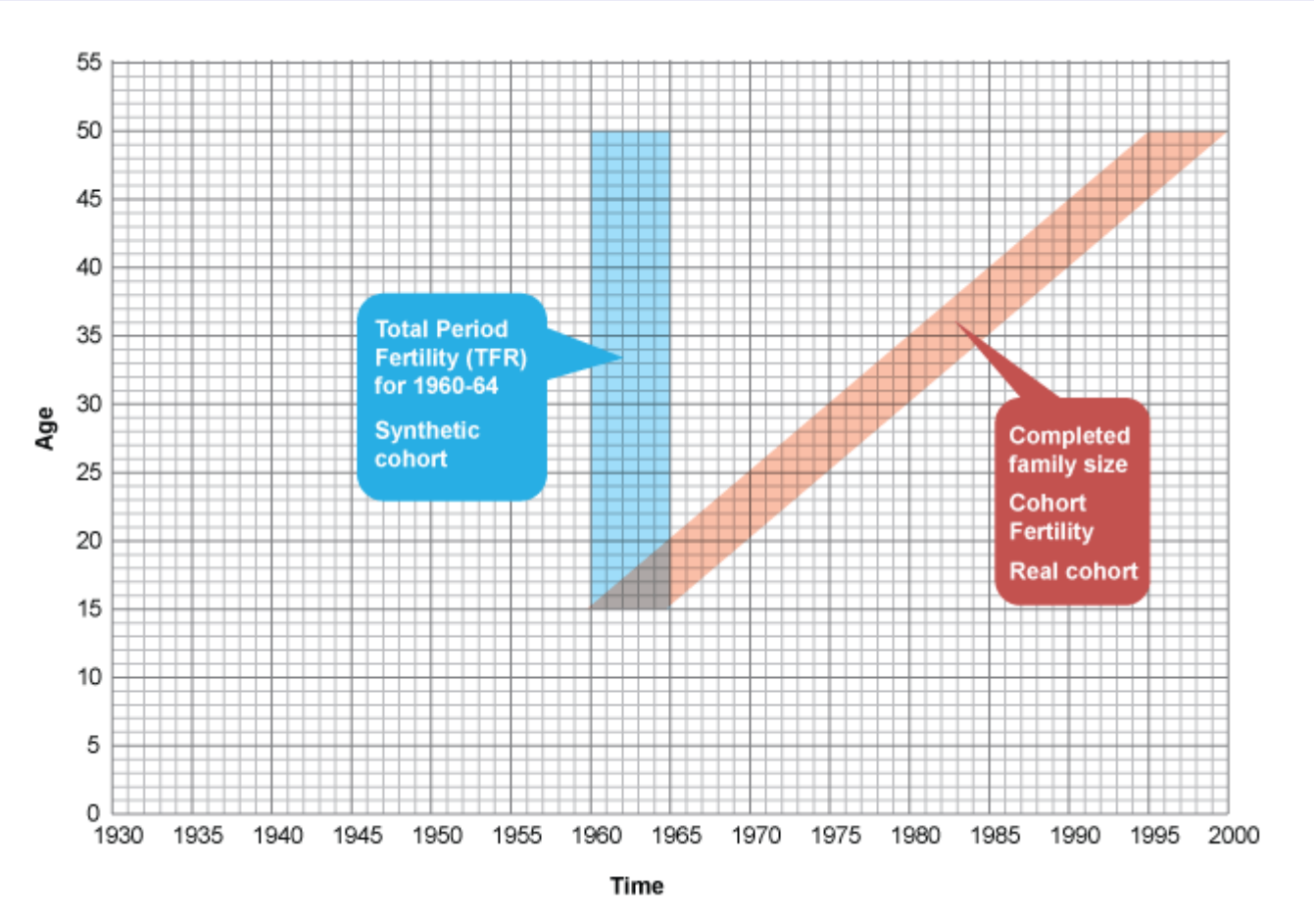

Figure: 3. Lexis diagram. Cohort and period fertility.

Introducing concepts

Period analysis

Because of the latter, period analysis is typically simpler to do than cohort analysis.

- It is indeed more frequently used.
- In period analysis, we suppose that a cohort of women is passing by their childbearing ages according to the current fertility.