The 100-year family

Longevity 15
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Motivation

- Demographic models focus on individuals, not families
- Kinship webs are a guide to inequalities, support systems and mortality risk
- Family structures are changing and with ever wider range of types and mutual support systems
- This has an actuarial element to the extent it affects pensions and other financial instruments and the development of new products

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Examples of important changes affecting families

- Increased longevity and improving parity between men and women
- Much reduced infant mortality leading to fewer children and smaller family sizes
- Total fertility rates per woman now below replacement e.g. postponement of first birth by ~ 10 years since 1950
- Concept of a family is changing e.g. more single parent and step families, and fewer 3-generational families
- Reducing household size with more people than ever living alone especially in old age

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Examples of specific research questions

- How does family size and age vary as a result of the changes occurring in the long term?
- Does increased longevity off-set falling birth rates in terms of family size?
- What is the effect of China's one-child policy on family size and average age?
- How is age of inheritance impacted by increased longevity?
- What is the effect of delayed child birth on care provision and looking after older family members?

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Approach

Basic steps

1. Design a typical family based on gender, number and dates of births
2. Apply life table mortality to each member
3. Adjust for different family types or events such as death, divorce (“what if scenarios”)
4. Output KPIs (size, average age, dependency ratios etc.) and charts
4. Create and compare other scenarios

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Defining a basic family

- What is meant by a family?
- Blood ties (biological connection)
- Nuclear family (couple + 2 children)
- Household (cohabiting, not cohabiting)
- Other (any unit built around person(s) of interest with biological, economic, or social ties)?

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Concept of a focal woman

A focal woman is:

- used for defining family ties and membership (e.g. parents and grandparents, partner, siblings, children)
- someone who has caring responsibilities for her own children, her children's children and her parents as they grow old etc.
- acts a reference point for measuring family change, in this case over a 100-year time interval

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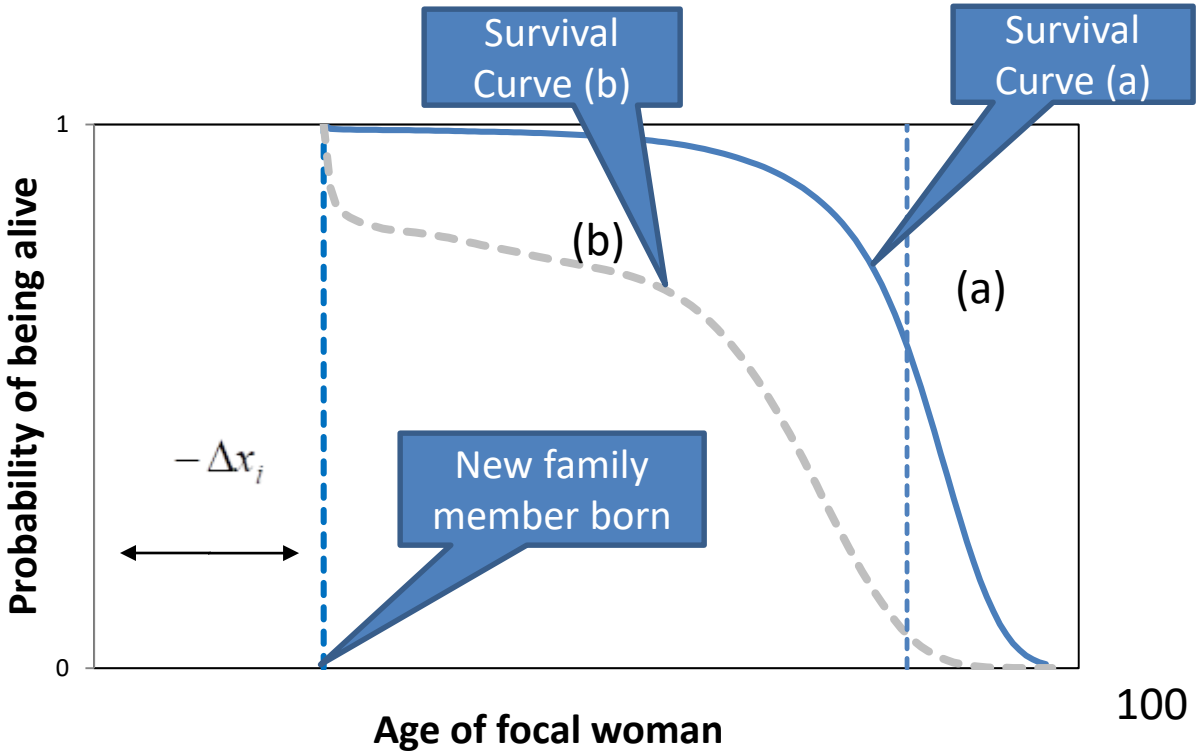
Data and notation used

In 1850 a woman needed four children for at least one to survive to age 70. Today it is only slightly more than one



- Mortality is based on cohort ONS life tables 1840 to 2066 by gender
- Family members are assigned to the cohort based on their year of birth to determine their survival in which $-\Delta x_i$ equals the age displacement of a person born after focal woman

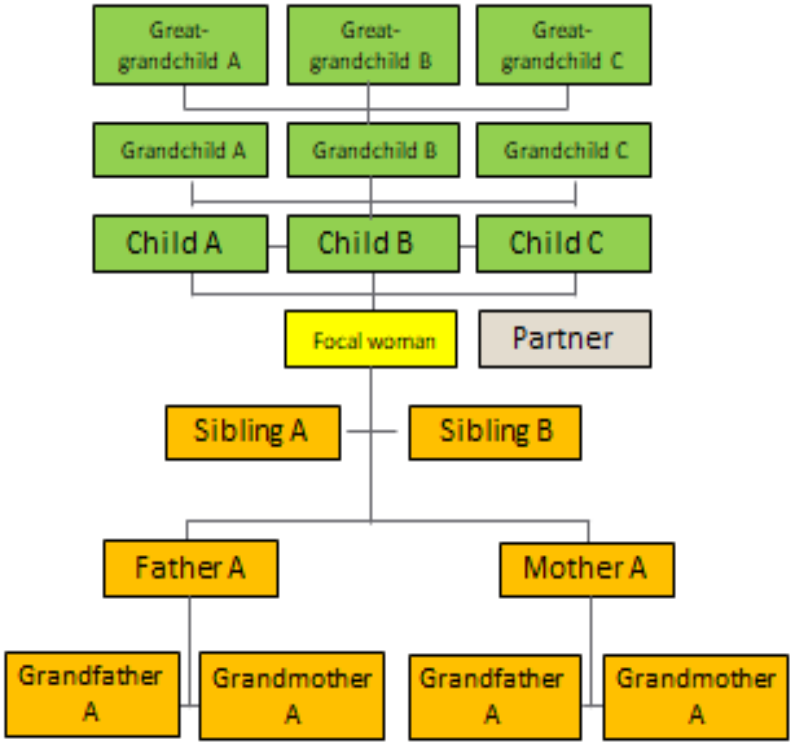
Key: (a) Survival curve for person born today; (b) 100 years ago

Example of the Schubert family – things were different then!

No.	Name	Birthday	Age at death (yrs)
1	Franz Ignaz Vietz	12.04.1783	0.0
2	Ignaz Franz	08.03.1785	59.7
3	Elisabeth	01.03.1786	2.4
4	Karl	23.04.1787	0.7
5	Franziska Magdalena	06.06.1788	0.2
6	Franziska Magdalena	05.07.1789	2.5
7	Franz Karl	10.08.1790	0.1
8	Anna Karolina	11.07.1791	0.0
9	Petrus	29.06.1792	0.5
10	Josef	16.09.1793	5.1
11	Ferdinand Lukas	18.10.1794	64.3
12	Franz Karl	05.11.1795	59.4
13	Franz Peter	31.01.1797	31.8
14	Aloisia Magdalena	17.12.1799	0.0
15	Maria Theresia	17.09.1801	76.9

Franz Schubert the Austrian composer was born in 1797and died in 1828, aged 31.8 yrs. His parents, Franz and Elisabeth, were married in 1785 one year after their first child was born in 1783. They subsequently had a further 14 children born between 1785 and 1801. Of the 15 children, 7 did not survive their first year, 3 died before their 6th birthday, and 5 survived to adulthood. The composer himself died aged 31.8 years and died of typhus. His mother died aged 56 and his father died aged 67 having fathered a further five children with his second wife!

Principal social and economic ties based on focal woman



Example of a family structure as defined by the principal social, biological and economic ties as seen from the perspective of a focal woman

Key:

- Focal woman
- Partner
- Current and earlier generations
- Future generations

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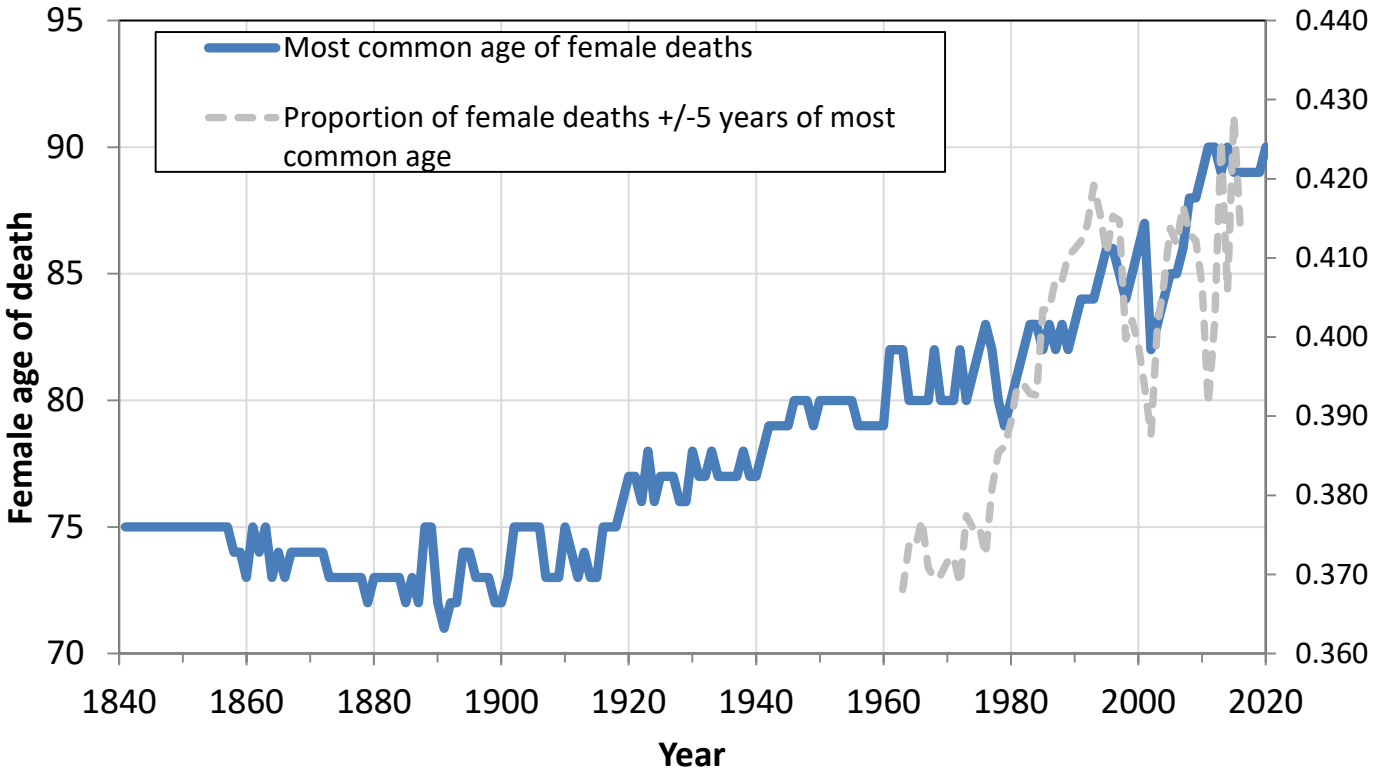
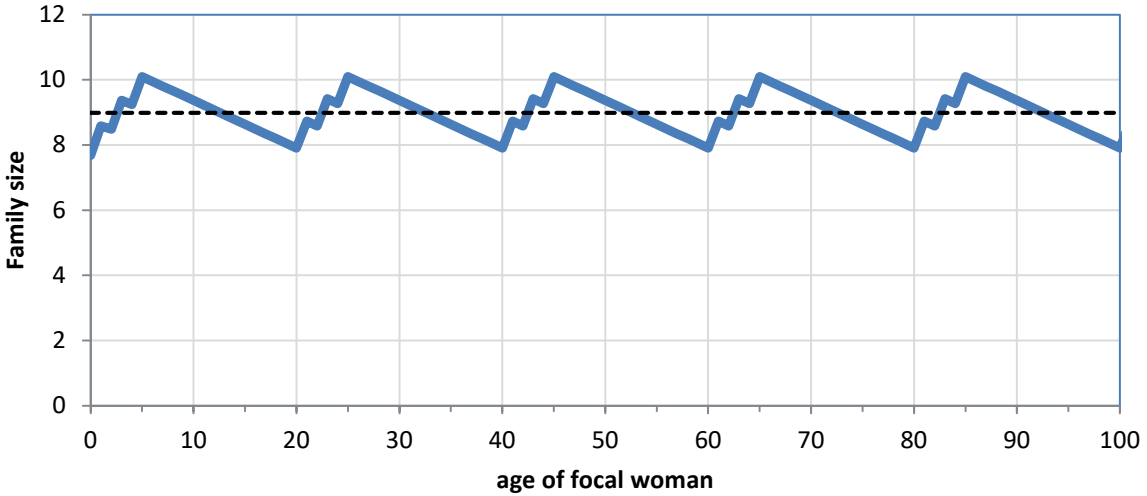
Changes in the lifespans of focal women



Women are increasingly living longer. Before 1920, 70 to 75 was the most common age of death. Today it is 89 years. The chart uses life tables up to 1963 and actual deaths thereafter. It shows that deaths are increasingly clustering around the modal age with 42% of deaths in 2019 occurring between 84 and 94 years. Age and amount of inheritance are also affected.

Repeating patterns
or examples of what to expect

Case (a): The 100-year sustainable family



Typical steady state based on fixed number and spacing of births and constant life expectancy viz 3 children from age 20 with 2-year gap and life expectancy of 60.

Average family size of 9 (min 8 and max 10); average age 33 at age 0 and 33 after 100 years. Conclusion: Even a sustainable family varies in size over time

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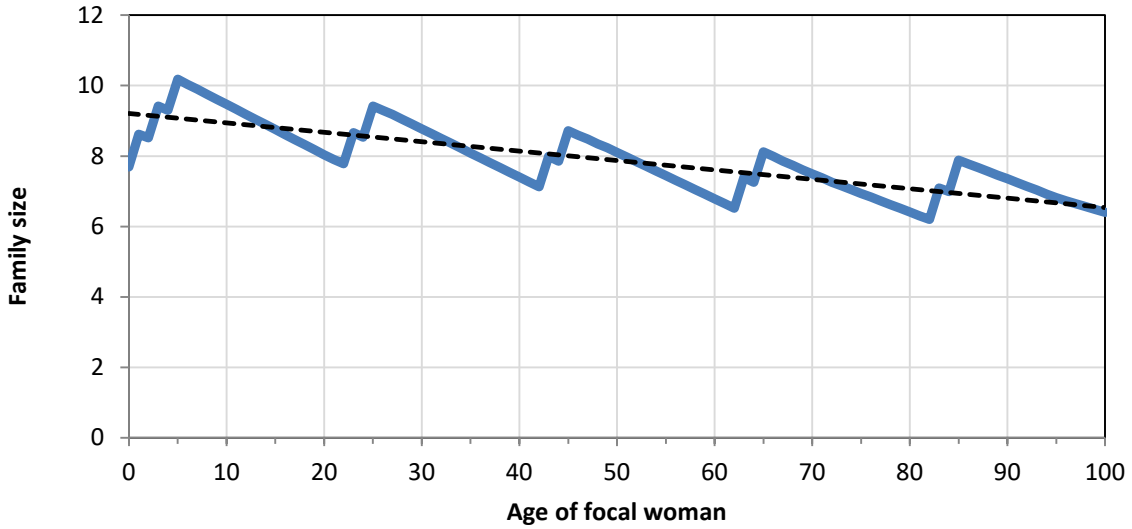
Repeating patterns
or examples of what to expect

Case (b)

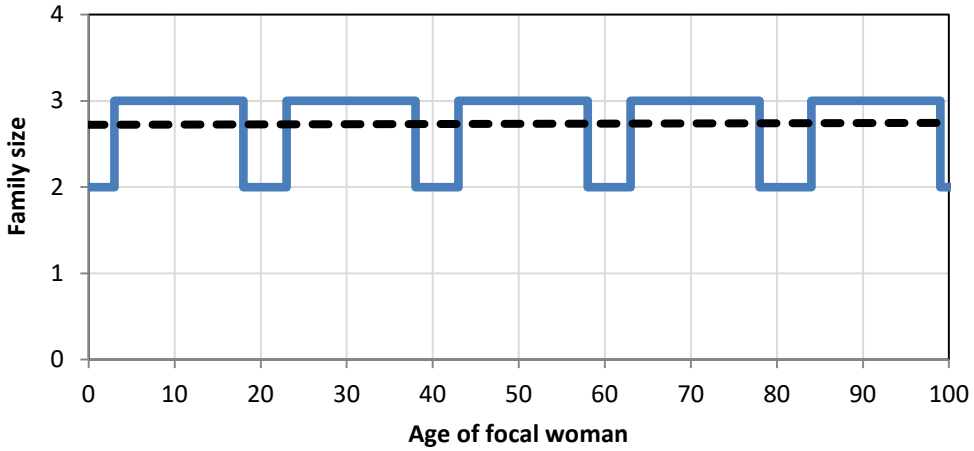


Family downsizes from 3 to 2 children. First birth is at age 22 with a two year gap while life expectancy increases from 60 to 80 years after 100 years elapsed

Conclusion: Increased life expectancy does not offset a falling birth rate causing average age to increase and family size to fall

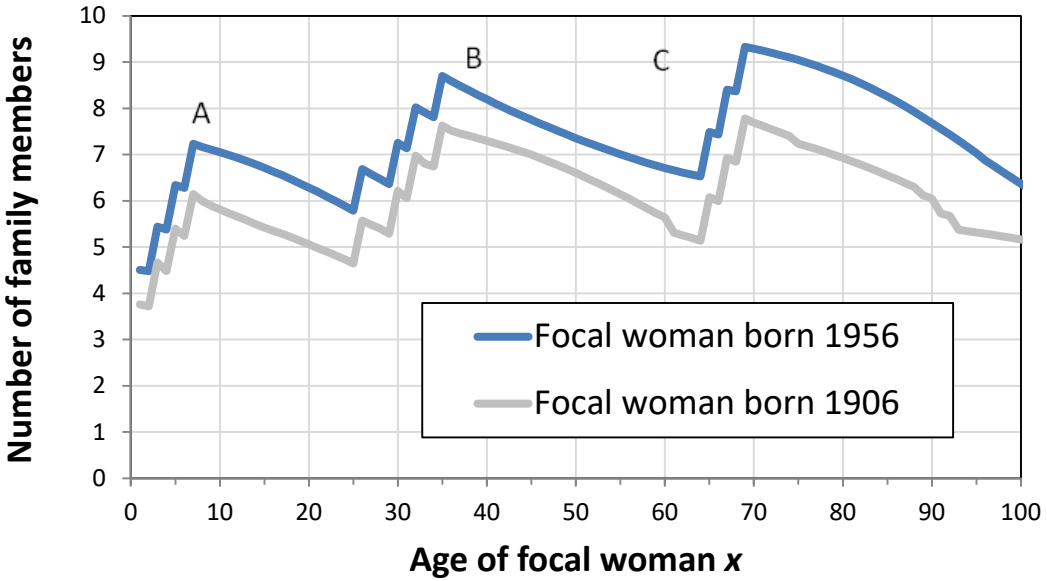
Repeating patterns
or examples of what to expect

Case (c): Fixed life spans



With a constant birth rate, a higher life expectancy increases family size and average age. If the ratio of life expectancy to the birth gap is an integer then family size does not vary. This example shows a fixed life span of 55 years with a birth interval of 20 years a fluctuating family size of 2 to 3 members.
Conclusion: Constant size is a theoretical possibility but not constant age

Examples based on two reference years 50 years apart using cohort life expectancy



Example of two women born in 1906 and 1956 with two sets of grandparents born around 1900, parents born in 1920, three younger siblings, and an older partner showing longevity gap based on different cohorts.

Key: (A) own siblings, parents and grandparents (peak age 8), (B) own children and partner (peak age 37), (C) grandchildren

Examples of summary indicators

Examples of family summary measures include:

- Family size by age of focal woman
- Average age by age of focal woman
- Person years lived
- Dependency ratio of older family member to working age adults
- Total dependency ratio based on both younger and older members

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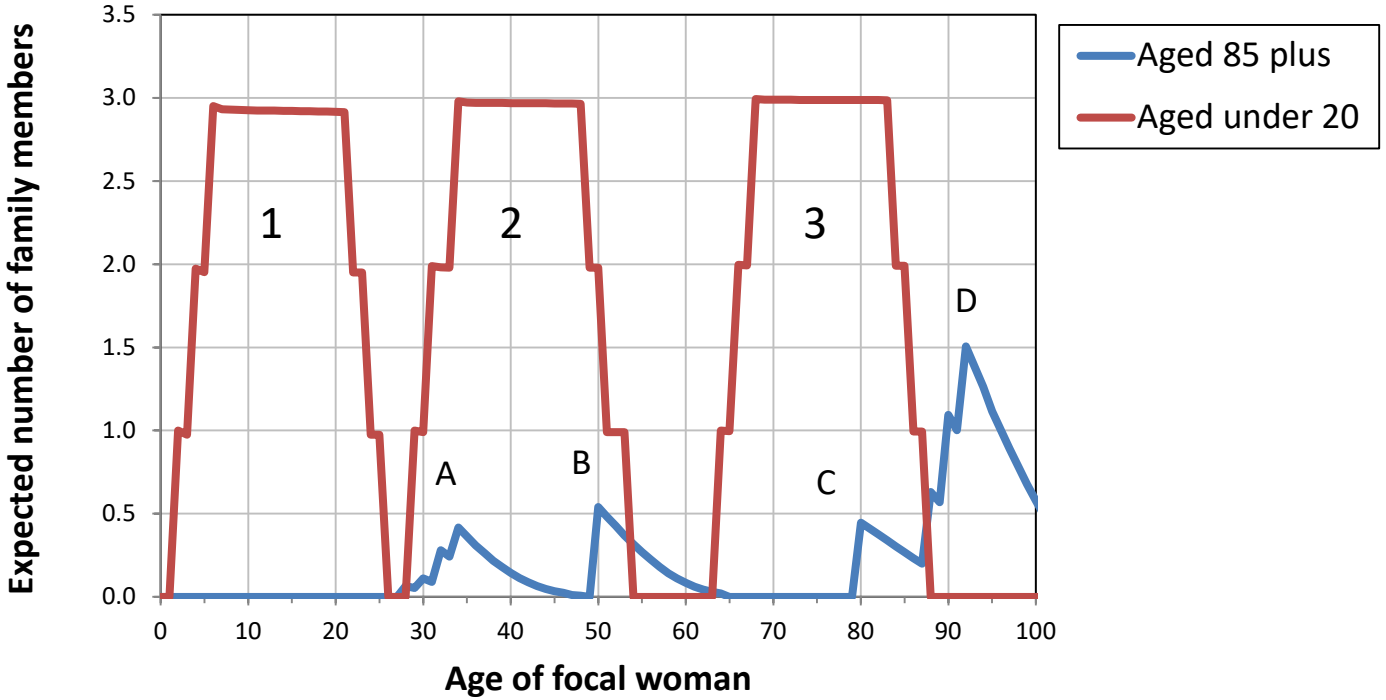
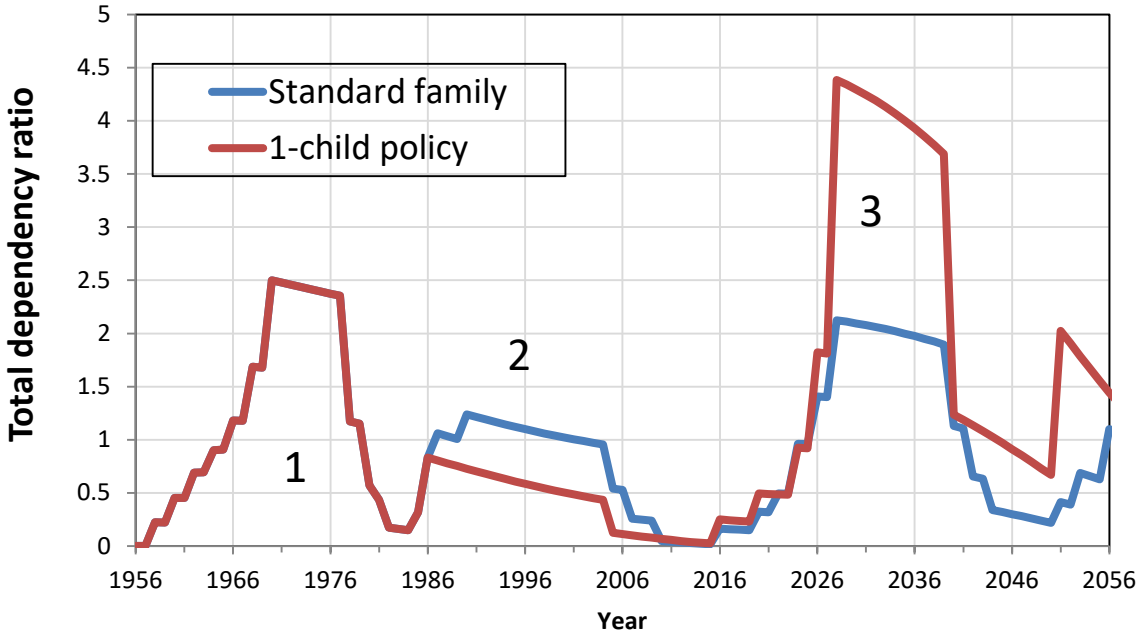
Refinements to basic model - separation by age group



Example showing three generations of younger family members aged 0-20 and older family members aged 85+ based on focal woman born 1956

Key to 85+: (A) grandparents, (B) own parents, (C) partner and (D) siblings

Example of structural imbalance based on Chinese one-child only policy



Ratio of young and old family members to working age adults in a standard family (blue) and under the one-child only policy introduced in 1979 (and abandoned in 2013). Though it works initially, by the third generation the imbalance is overwhelming. (Based on focal woman born in 1956.)

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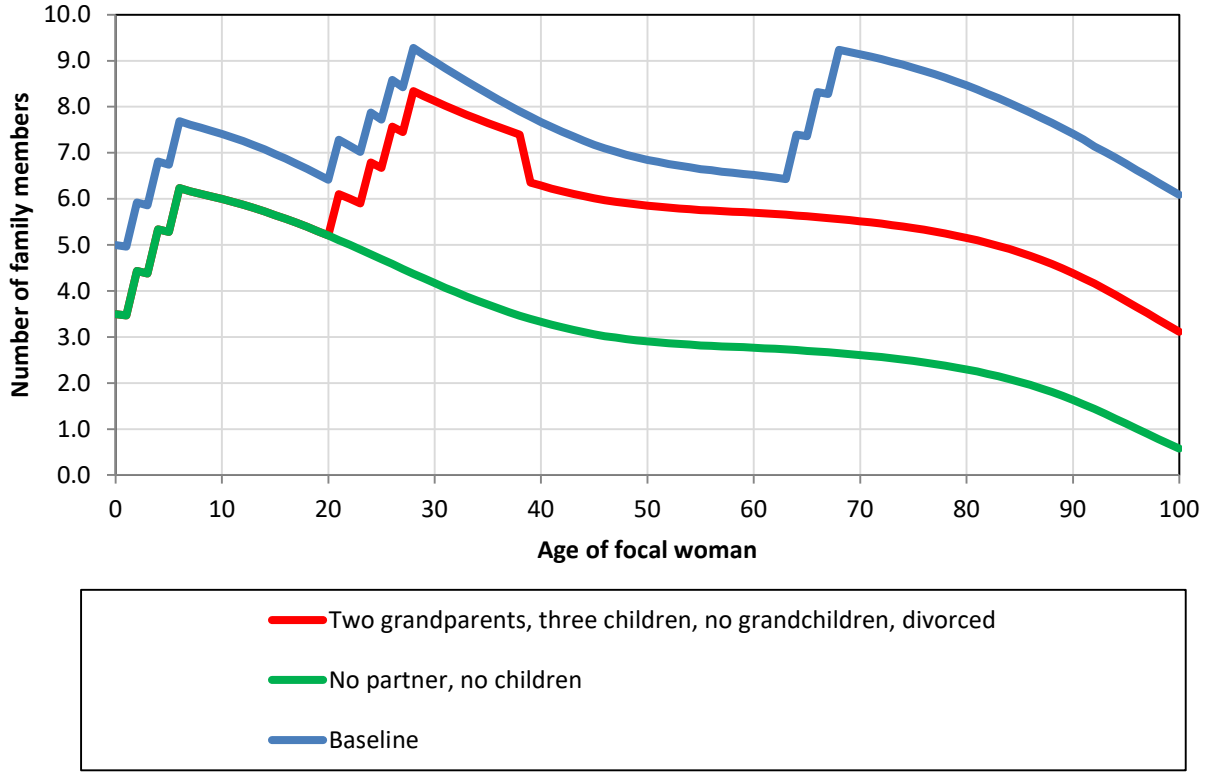
Average family pool based on three different scenarios A, B and C



The effect of death of partner and no grandchildren or a childless woman on the size of family pool compared with previous example of woman with three children and three grandchildren

Concept of a sandwich generation and its quantification

- Delayed births and increased longevity affect the timing and amount of care provided i.e. children, elderly parents, or partner and the burden of caring
- A family carer or focal woman could theoretically be responsible for her children, parents and partner at the same time but how likely is it and how does it arise?
- This can be quantified for different cases showing the concentration of care responsibilities over the life cycle and the compression of caring into short time windows

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Sandwich example

- Case (a): No overlap

Focal woman vital details

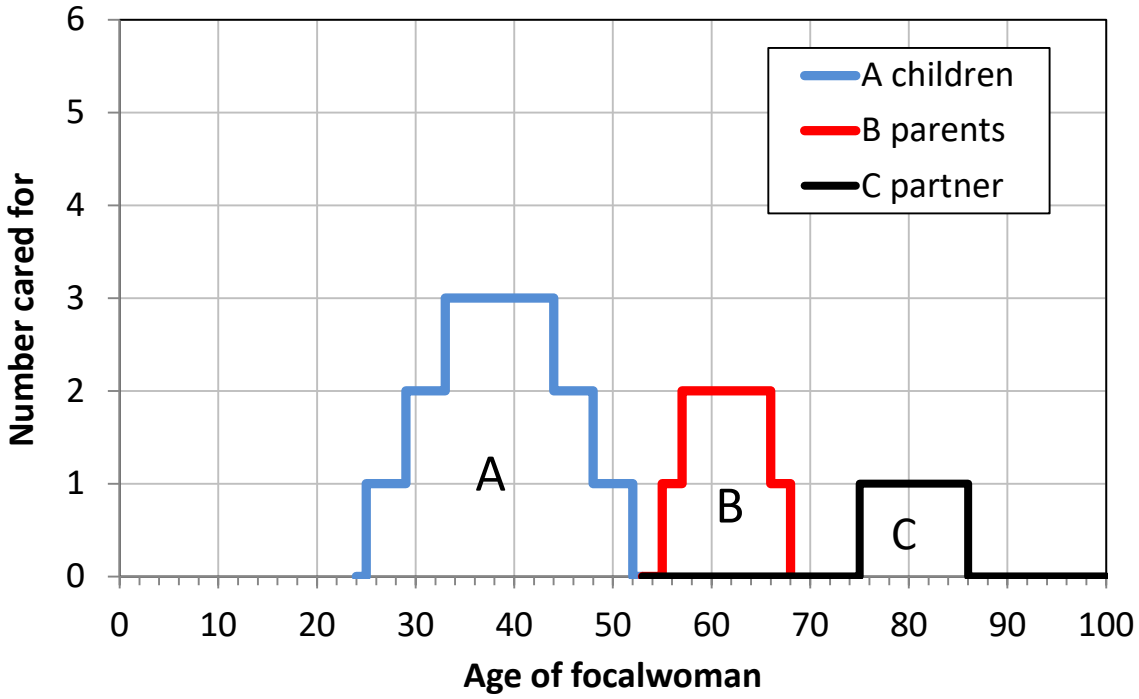
Year of birth	Year of death	Year of marriage	Age at death	Marriage age	Length of marriage	Age of father at birth	Age of mother at birth	Marriage age of partner
1956	2046	1984	90	28	56	26	24	34

Family accounts

Family member	Year of birth	Age difference with focal woman	Year of death	Age of focal woman at death of family member	Threshold age for child adulthood	Focal woman's age at child adulthood	Age at which family member care required	Age of focal woman at caring age
Father	1930	-26	2020	64	n.a.	n.a.	80	54
Mother	1932	-24	2022	66	n.a.	n.a.	80	56
Partner	1950	-6	2040	84	n.a.	n.a.	80	74
Child 1	1980	24	2070	RIP	18	42	80	RIP
Child 2	1984	28	2074	RIP	18	46	80	RIP
Child 3	1988	32	2078	RIP	18	50	80	RIP

Tables showing base information including focal woman's vital details and those of family members . For this illustration it is assumed that child care is from 0-18 and older person's care starts at age 80

Care years provided by age of focal woman and family size: Case (a) no overlap



Carers age	Age at start of care	Age at end of care	Number of care giving years
Father	54	64	10
Mother	56	66	10
Partner	74	84	10
Child 1	24	42	18
Child 2	28	46	18
Child 3	32	50	18

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Sandwich example

Case (b) with overlap

Focal woman vital details

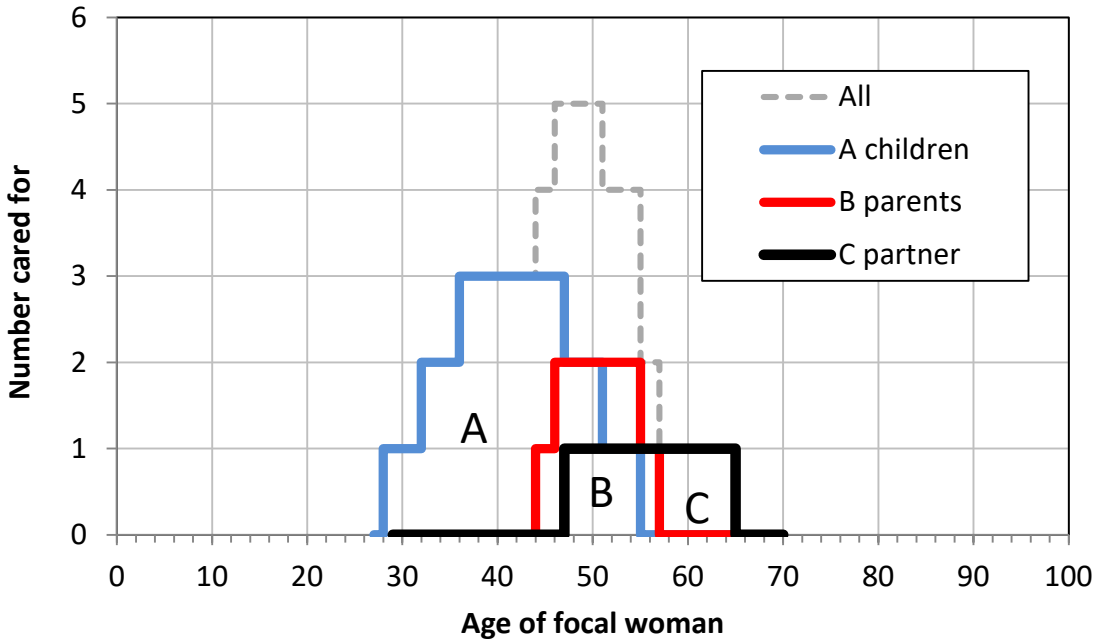
Year of birth	Year of death	Year of marriage	Age at death	Marriage age	Length of marriage	Age of father at birth	Age of mother at birth	Age of partner at marriage
1956	2046	1980	90	24	40	36	34	40

Family accounts

Family member	Year of birth	Age difference with focal woman	Year of death	Age of focal woman at death of family member	Threshold age for child adulthood	Focal woman's age at child adulthood	Age at which family member care required	Age of focal woman at caring age
Father	1920	-36	2010	54	n.a.	n.a.	80	44
Mother	1922	-34	2012	56	n.a.	n.a.	80	46
Partner	1940	-16	2020	64	n.a.	n.a.	63	47
Child 1	1984	28	2070	RIP	18	46	80	RIP
Child 2	1988	32	2074	RIP	18	50	80	RIP
Child 3	1992	36	2078	RIP	18	54	80	RIP

Key: RIP, assumed dead

Care years provided by age of focal woman and family size: Case (b) with overlap



•**Care years given to named family members**

Sandwich years	Own parents/ children	Own parents/ partner	Partner/ children	Parents, partner and children	Any sandwich (yrs)
Start age (A)	44	47	47	47	44
End age (B)	54	56	54	54	56
Duration (B-A)	10	9	7	7	12

Conclusions

- This research is concerned with how demographic trends at a macro level have impacted on families
- It is driven by the observation that actuaries and demographers work with data on individuals and tend to ignore families
- By ignoring the family dimension actuaries might overlook risk factors that affect products based on individuals but also the possibility of developing new products at a family level
- However other applications of these concepts in family and care planning and also the financial aspects appear promising. Genealogists may also be interested in the concepts.

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