GENDER DIFFERENCES IN LIFE EXPECTANCY IN THE EU*

Prof. Pavle Sicherl, PhD, SICENTER (Socio-economic Indicators Center), Ljubljana
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Povzetek

Pričakovana življenjska doba ob rojstvu kot eden od najbolj pomembnih kazalcev blaginje je v vseh državah EU daljša za ženske kot moške. Občutek neenakosti pa je lahko zelo različen glede na to, katere statistične mere uporabljamo. Tako znaša statična odstotkovna razlika za povprečje EU v letu 2010 manj kot 8 % (kar se zdi malo), medtem ko časovna distanca znaša 27 let (kar daje povsem drugačen občutek o velikosti razlik). Časovne serije kazalcev lahko torej primerjamo v dveh dimenzijah: statični razliki in časovni distanci (kjer primerjamo razliko v času, ko sta obe enoti dosegli enako raven kazalca). Članek prikazuje dodatne vidike problema merjenja razlik med spoloma v pričakovani življenjski dobi v dinamičnem kontekstu in s tem dodatne podlage za analizo in odločanje. V širšem okviru torej omenjeni problem ocenjuje kot dolgoročni fenomen, ki hkrati statistično kaže izjemno velike razlike med opazovanimi državami.

Pričakovana življenjska doba za ženske presega moško za najmanj 3,7 let na Nizozemskem in največ 11,2 leti v Litvi; razlika znaša med 5 % in 16 % vrednosti moške dobe. S-časovna-distanca prikazuje bistveno večjo stopnjo razlike med spoloma kot statične mere. Časovni zaostanek v tem, kdaj so moški dosegli enako raven kazalca kot ženske, se giblje za države EU med 16 in več kot 50 let. Ne samo da se slika dejanskega stanja s pomočjo časovne distance bistveno razlikuje od tiste na osnovi statičnih mer; razlike med državami so tudi nepričakovano velike, kar pomeni veliko kompleksnost pri bodoči razlagi teh razlik.

Statistična analiza obsega obdobje 1960–2011 za vse države EU in 269 NUTS2 regij v letu 2010, temu so dodane še primerjave s povprečjem 10 najboljših držav v svetu po spolu (kot mednarodni mejnik dosežkov). Tudi časovni seriji povprečij za te države kažeta podobna razmerja med spoloma: absolutna razlika je okoli pet let, odstotkovna 6,4 %, časovna distanca znaša 27 let. Z izjemo treh držav pri ženskah in dveh pri moških države EU ne dosegajo mednarodnega mejnika dosežkov, največja časovna zaostajanja pri ženskah dosežejo celo 34 let, pri moških pa več kot 50 let, kar je dodaten dokaz velikih razlik v pričakovani življenjski dobi znotraj EU. Na regionalnem nivoju je razpon med spoloma za analiziranih 269 NUTS2 regij med 2,3 in 10,9 let, z mediano 5,5 let (ta je enaka kot za 3118 okrožij v ZDA).

Statistična analiza prikazuje realno stanje v dodatni perspektivi in predstavlja izhodišče za nadaljnje kompleksne raziskave (na podlagi medicinskih, družbenih, ekonomskih in okoljskih dejavnikov) o vzrokih za razlike v pričakovani življenjski dobi med spoloma in izredno velike razlike med državami v tem pogledu.

***Ključne besede**: pričakovana življenjska doba, razlike med spoloma, S-časovna-distanca, razlike med državami EU in NUTS2 regijami*

Abstract

In all EU countries the female life expectancy is higher than that of males but the perception of degree of gender disparity in life expectancy may be very different depending on the statistical measures used. The static difference for the EU27 average in 2010 was less than 8 percent (which may appear to be small) while the time distance was 27 years (which gives a very different perception of the magnitude of the gap). Thus the major conclusion is that the gender disparity in life expectancy is clearly a long-standing phenomenon, with astonishing differences between countries.

Female life expectancy exceeds that of males in a range from 3.7 years for the Netherlands to 11.2 years for Lithuania; it varies from around 5% to 16% of the male life expectancy. S-time-distance shows a much higher degree of gender disparity than the static measures; the time delay ranges from 16 years to more than 50 years. Statistical analysis covers the period 1960-2011 for all EU27 countries and for 269 NUTS2 regions in 2010, with added comparison to the international frontier of the average of the 10 best countries in the world. The ranges in life expectancy between EU countries are large, for females about 8 years and for males about 12 years. The time gap behind the respective international frontiers is up to 34 years for females and up to more than 50 years for males. This statistical analysis presents the reality with new eyes, and represents an input for further large systematic research project(s) including medical, social, and economic factors.

***Key words**: life expectancy at birth, gender disparities, S-time-distance, distances between EU countries and NUTS2 regions*

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1. Introduction

Gender inequalities are a major social, economic, and political issue over a broad spectrum of activities. In this article we shall concentrate on gender disparities in life expectancy in the European Union, with two main aims. Firstly, life expectancy is a major indicator in the subjective evaluation of well-being, and thus also an important element in the evaluation of gender inequality. Furthermore, in the very diverse situation surrounding gender inequality in different concerns around the world, female life expectancy at birth is higher than that for males for 99.5 percent of the world population. Secondly, this article contributes some novel methodological tools that can be usefully applied for other indicators in analysing gender and other disparities.

The statistical picture of gender disparities is presented by using three descriptive measures (absolute and relative static measures as well as the S-time-distance measure as a special family of time distance measures defined for the level of the indicator). Expressed in time units, the time distance approach is easy to understand and provides a useful complement to existing methods, providing new insights from existing data.

This novel perspective will be used to complement the usual static measures in describing the gender disparities in life expectancy between EU countries and for the NUTS2 regions. This will be extended to show the situation in the EU against the international frontier of the average for the best countries in the world as well as by using S-time-step as a complementary measure of dynamics of this indicator.

2. Methodology: Time distance measure as an additional perspective in measuring disparities

The perceptions of well-being and societal progress are subjective, and the resulting decisions and actions are influenced not just by the availability of statistical data and indicators, but also by *measures that are used in the measurement, analysis, presentation, and semantics of discussing these issues* as indispensable elements to form these perceptions.

The descriptive statistical measures describing disparities are predominantly static. The present state-of-the-art does not realise that, in addition to a static comparison, there exists in principle a theoretically equally universal measure of difference (distance) in time when a given level of the variable is attained by the two compared time series. Here we shall very briefly repeat the definitions.

The statistical measure **S-time-distance** measures the distance (proximity) in time between the points in time when the two series compared reach a specified level of the indicator X. S-time-distance for a given level of X_L is defined as:

$$S_{ij}(X_L) = \Delta t\,(X_L) = t_i(X_L) - t_j(X_L) \qquad (1)$$

The **S-time-step** measures the time elapsed between two levels of a time-series, providing an alternative description of its growth rate, measuring the growth of a series by using the inverse relation to the conventional ΔX/Δt growth rate metrics. S-time-step is expressed in units of time and is defined as:

$$S_i(\Delta X_L) = [t_i(X_L+\Delta X) - t_i(X_L)]/\Delta X \qquad (2)$$

Further information on the time distance methodology and applications are available in numerous earlier publications such as IB Revija (Sicherl, 1999), Social Indicators Research (Sicherl, 2007), in the paper published by the OECD Statistics Directorate (Sicherl, 2011), and most extensively in the book (Sicherl, 2012).

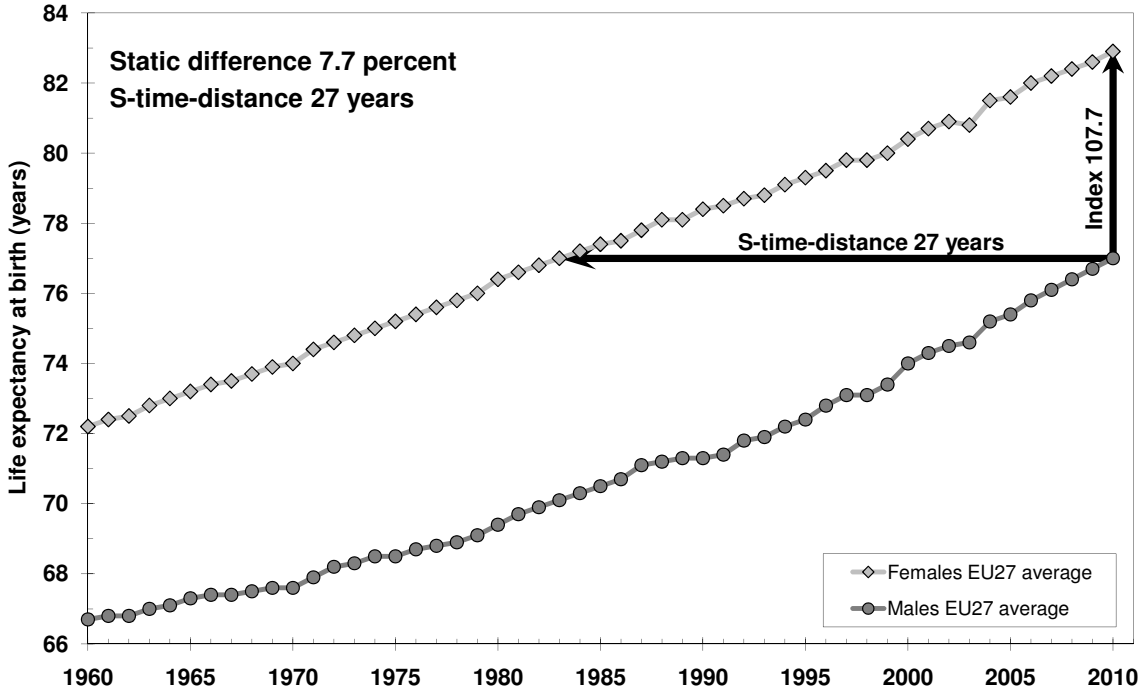
Static measures of disparity require no further explanation. Time distance methodology is well positioned to complement them as one of the appropriate tools for the task of measuring disparity. It provides two novel generic descriptive statistical measures to measure one of the dimensions of these disparities. The time distance approach brings about two persuasive advantages for extensive practical use. Expressed in time units, it is intuitively understood by policymakers, professionals, managers, media, and the general public, thus facilitating their subjective perception about their position in society and in the world in this additional dimension. Another technical and presentational advantage is that time and time distance are comparable across variables, fields of concern, and units of comparison. This makes it an excellent analytical, presentation, and communication tool[1].

Gender disparity – static distance and time distance

As stated, time series can be compared in two dimensions. In this section we use female life expectancy in the EU countries to present the example of how the time distance method can describe additional insights of development in the indicator over several decades (1960-2011) depending on data availability.

[1] In this article we are using the time distance methodology for benchmarking disparities between genders as well as between countries and regions. S-time-distance method has been in the papers mentioned above systematically introduced both as a concept and as a quantifiable measure in statistical and comparative analysis. Granger finds the concept a useful addition to the present state-of-the-art. "As Sicherl (1973, 1993) proposes … observed time distance is a dynamic measure of temporal disparity between the two series intuitively clear, readily measurable, and in transparent units." (Granger and Jeon, 1997)

Figure 1: **Gender disparities in life expectancy at birth, EU27 average in 2010: static index and time distance**



Source: Own calculations based on Eurostat (2006, 2013).

In Figure 1 we take the example of gender disparities in life expectancy at birth for EU27 aggregates. One way is to compare time series at the given point in time, i.e. in our case the static gap in life expectancy between women and men in 2010. The absolute difference amounted to 5.9 years; the index was 107.7. Another dimension of the degree of disparity is taking into consideration the distance in years when men and women reached the same reference level of the variable; in our case the life expectancy for men in 2010 was already reached by women in 1983: S-time-distance amounted to 27 years.

Figure 1 illustrates these two dimensions of gender disparities in life expectancy. It shows that perceptions of the size of this gap can be very different depending on the statistical measure used. Here the static difference between two lines in 2010 is less than 8 percent (which may appear to be small) while the time distance is 27 years (which gives a very different perception of the magnitude of the gap). The perception of well-being and of the degree of disparity is subjective. For a realistic evaluation of the situation we need both measures[2]. Different people will give different subjective weights to the static and time distance dimension of disparity and they might be also very different for different indicators.

There are several possibilities for the calculation of S-time-distances with various degrees of approximations. One of these methodological possibilities is to start with a time matrix visualisation of the selected indicator over many units and over time. The intention is to complement rather than replace the existing mostly static measures to provide a broader dynamic analytical framework. Sicherl (2011: 9) explains the correspondence between the conventional table format for time-series data, and the complementary presentation based on the time distance approach. It refers to three types of comparisons: the level of the indicators, their dynamics, and comparisons of levels relative to a benchmark.

The first complementary presentation refers to the initial data for indicators (see example in Figure 2). For a presentation of levels the conventional table format for time-series data is transformed into a time matrix, which has a table-graph format. The identifiers in the level-time matrix are units and selected levels of indicator, while the corresponding times are in the main body of the table. Calculating these times by interpolations may pose a small problem of the degree of accuracy compared to the original data, but it offers additional understanding about the time dimension of disparities and a good summary overview. For instance, the time series of female life expectancy for the period 1960-2011

[2] Sicherl (2011: 25–28) discusses the concept of 'overall degree of disparity', arguing that disparities in society depend not only on static measures of inequality but also on time-distances in the relevant dimension. It is defined as proximity in the indicator space as well as proximity in time, which has the potential to bring new additional understanding for numerous issues in economics, management, research, and statistics. Further discussion on the inter-temporal aspect of wellbeing will be available in Sicherl (in press).

Figure 2: **Time matrix for female (F) life expectancy for EU27 countries**

Level	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Inter. frontier F								1954	1958	1964	1970	1974	1978	1982	1987	1992	1998	2003	2008	
EU27 F								1964	1970	1974	1979	1983	1988	1994	1999	2003	2006	2010		
France F									1962	1966	1970	1974	1978	1983	1986	1989	1994	2003	2005	2009
Spain F								1963	1967	1971	1974	1977	1979	1981	1986	1991	1996	2000	2005	2009
Italy F								1963	1967	1970	1974	1978	1982	1986	1989	1993	1997	2003	2006	2010
Portugal F	1961	1962	1964	1969	1971	1974	1975	1976	1978	1980	1984	1987	1991	1996	2000	2003	2006	2010	2011	
Sweden F										1960	1965	1970	1976	1980	1988	1993	2000	2006		
Finland F								1962	1966	1970	1973	1977	1980	1990	1994	1998	2003	2006		
Austria F								1964	1972	1976	1979	1984	1987	1990	1995	1999	2004	2007		
Cyprus F								1973	1975	1976	1978	1980	1986	1992	2000	2005	2006	2008		
Luxembourg F								1970	1972	1976	1981	1984	1987	1992	1997	2003	2006	2008		
Slovenia F							1964	1971	1973	1983	1985	1988	1994	1996	2000	2005	2007	2010		
Germany F							1961	1963	1972	1976	1979	1983	1987	1991	1996	1999	2005	2010		
Belgium F								1960	1969	1973	1977	1981	1984	1988	1993	2000	2005	2010		
Netherlands F											1966	1972	1975	1979	1987	2003	2006	2010		
Ireland F							1961	1967	1973	1979	1982	1987	1991	1999	2001	2003	2006	2011		
Greece F								1960	1964	1969	1972	1977	1983	1988	1994	2001	2007	2011		
United Kingdom F									1962	1970	1978	1983	1987	1993	1999	2004	2008	2011		
Malta F						1965	1973	1980	1981	1984	1986	1989	1991	1994	2000	2004	2006	2011		
Denmark F										1964	1970	1976	1995	1999	2004	2008				
Estonia F								1994	1995	1996	1999	2002	2005	2007	2009	2010				
Czech Republic F								1962	1980	1987	1991	1995	1998	2004	2006	2011				
Poland F						1963	1965	1967	1972	1984	1994	1997	2000	2004	2008	2011				
Slovakia F								1965	1975	1985	1992	1998	2004	2008						
Lithuania F							1961	1962	1964	1995	1996	2006	2008	2010						
Hungary F						1963	1968	1981	1993	1996	2000	2004	2007							
Latvia F								1995	1996	1998	2004	2007	2009							
Romania F			1961	1962	1969	1973	1987	1996	1999	2003	2006	2007	2011							
Bulgaria F							1963	1969	1997	2000	2003	2008								

Note: International frontier F represents the unweighted average of the best 10 countries in the world for female life expectancy for each five-years average in UN (2011).
Source: Own calculation based on data from Eurostat (2006, 2013); for International frontier data from UN (2011).

in the extended Eurostat table amounts to about 1260 entries, while the entries in the time matrix in Figure 2 are condensed to about 300 entries. This is a great advantage for presentation and understanding; Figure 2 can serve also as a first-level visualisation that usefully complements the details in the original database.

There is a problem with the current Eurostat database for life expectancy (Eurostat, 2013) since for a number of countries it does not contain the time series from 1960 as it does for other countries. This makes it difficult to analyse developments over a longer period of time. For such countries we have complemented the data with the earlier data published by Eurostat (2006).

The second complementary presentation refers to comparison of levels. The usual index values by years (benchmark=100) is complemented by the S-time-distance measure in years from the benchmark (– time lead, + time lag from benchmark) in Figure 3. The third complementary presentation refers to dynamics and comparison of dynamics. Table of growth rates or indices of dynamics are complemented with the table of S-time-step in Figure 4, which represents the time needed to achieve the next level of the selected indicator value.

It is easy to explain the relationship between Figures 2, 3, and 4. From the level-time matrix in Figure 2 we can derive two statistical measures, expressed in

standardized units of time: S-time-distance and S-time-step. S-time-distances in Figure 3 for selected levels of X_L are arrived at by subtracting the respective times for a given unit and the times for the benchmark unit in the level-time matrix in Figure 2 (in this case the benchmark is the trend for international frontier, i.e. the average of the top 10 performers in life expectancy according to data in UN (2011) for the respective gender). Subtracting the respective times for consecutive levels of the variable in the series for each unit in the time matrix in Figure 2, we obtain S-time-step in Figure 4, a possible measure of the dynamic characteristics of a series.

There is a wealth of information and of possible comparisons in the tables not discussed here. At a glance one can see that even in the EU27 there are substantial differences in female life expectancy between Member States. While in France female life expectancy approached 86 years, in Romania and Bulgaria it was around 78 years, a difference of around 8 years. Comparing the EU27 and international frontier rows in Figure 2 one can immediately see that for given levels of female life expectancy, they were attained earlier by the average of the 10 best countries in the world forming the international frontier than for the EU27 average.

The detailed calculation of time distances for EU27 and all individual countries are in Figure 3. At the level of female life expectancy of 84 years only 3 EU countries – France, Spain, and Italy – were ahead of the international frontier average, being 3 years ahead. Fourteen EU

Figure 3: **S-time-distance lag in years behind international frontier for females (F)**

Level	73	74	75	76	77	78	79	80	81	82	83	84
Inter. frontier F	0	0	0	0	0	0	0	0	0	0	0	0
EU27 F	10	12	10	10	9	10	12	12	11	8	8	
France F		4	3	1	0	1	1	-1	-3	-4	0	-3
Spain F	9	9	7	5	3	1	0	-1	-1	-2	-2	-3
Italy F	8	9	7	5	4	5	4	2	1	-1	1	-3
Portugal F	22	20	17	14	13	14	14	13	11	8	7	3
Sweden F			-3	-5	-4	-2	-2	1	1	2	3	
Finland F	8	8	6	4	3	2	8	7	6	5	3	
Austria F	9	14	12	10	10	9	8	8	7	6	4	
Cyprus F	19	17	13	9	6	8	10	13	13	8	5	
Luxembourg F	16	14	13	11	10	10	11	10	11	8	5	
Slovenia F	17	15	19	16	14	17	14	13	13	9	7	
Germany F	9	14	12	10	9	9	10	9	7	7	7	
Belgium F	6	11	9	7	7	6	6	6	8	7	7	
Netherlands F				-4	-2	-2	-3	0	11	8	7	
Ireland F	13	15	15	12	13	14	18	14	11	8	8	
Greece F	6	7	5	3	3	5	6	7	9	9	8	
United Kingdom F		4	6	9	9	9	12	12	11	10	8	
Malta F	26	23	20	17	15	14	12	13	11	8	8	
Denmark F			0	1	2	18	17	17	16			
Estonia F	40	37	32	30	28	27	26	22	18			
Czech Republic F	8	22	23	22	21	20	22	19	18			
Poland F	13	14	20	24	23	22	22	21	18			
Slovakia F	11	17	21	22	24	26	26					
Lithuania F	8	6	31	27	32	31	29					
Hungary F	27	35	32	30	30	30						
Latvia F	40	38	35	34	33	31						
Romania F	42	41	39	36	33	33						
Bulgaria F	15	39	36	34	34							

Time lead Time lag

Source: Own calculation based on Figure 2.

Figure 4: **S-time-step (years): Time needed to achieve the next level of life expectancy for females (F)**

Level	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Inter. frontier F									3.6	5.7	5.9	4.5	3.6	4.1	5.2	5.5	5.6	4.7	5.6	
EU27 F									6.0	4.0	5.0	4.0	4.7	6.0	5.3	4.3	2.7	4.3		
France F										4.3	4.3	4.0	4.0	4.6	3.3	3.1	4.2	9.6	2.0	3.8
Spain F									3.8	3.8	3.6	2.5	2.0	2.5	4.9	5.1	4.7	4.2	5.1	3.9
Italy F									3.8	3.9	4.0	4.0	3.7	3.5	2.9	4.5	3.9	6.2	2.5	4.3
Portugal F		0.6	2.2	4.8	2.2	2.3	1.4	1.5	1.8	2.2	3.2	3.0	5.0	4.5	3.6	3.8	2.3	4.5	0.8	
Sweden F											4.3	5.0	6.5	4.0	8.0	5.1	6.9	5.5		
Finland F									4.0	4.0	3.3	3.3	3.3	10.0	3.6	4.4	5.2	2.7		
Austria F									8.0	4.0	3.3	4.5	3.0	3.6	4.6	4.3	4.8	2.8		
Cyprus F									1.5	1.5	1.9	1.9	5.8	5.8	7.9	5.6	0.8	2.0		
Luxembourg F									1.9	4.5	4.2	3.7	2.8	5.3	4.6	6.1	3.2	1.6		
Slovenia F								6.7	2.5	9.7	2.0	3.0	6.3	1.7	4.2	4.9	1.9	2.8		
Germany F								2.8	8.3	4.3	3.0	4.0	3.6	4.8	4.2	3.4	6.0	5.0		
Belgium F									8.3	4.5	3.7	4.0	3.3	3.5	5.8	6.7	5.3	4.8		
Netherlands F												6.0	3.6	3.6	7.6	16.5	3.0	4.0		
Ireland F								6.3	6.1	6.0	2.8	4.9	4.7	8.0	1.8	2.2	2.4	4.7		
Greece F									4.0	4.6	3.3	4.7	6.0	4.6	6.8	6.6	6.4	3.3		
United Kingdom F										7.7	8.3	4.5	4.1	6.2	6.0	4.5	4.5	2.6		
Malta F							8.0	7.2	1.1	2.5	2.5	2.5	2.5	2.5	6.0	3.8	2.8	4.5		
Denmark F											6.4	5.8	19.1	3.7	4.5	4.5				
Estonia F									0.7	0.8	3.4	3.0	2.7	2.6	1.4	1.7				
Czech Republic F									17.9	6.5	4.9	3.9	2.3	6.0	2.7	4.2				
Poland F							2.0	2.9	4.4	12.2	9.6	3.4	3.0	3.5	4.5	2.8				
Slovakia F									9.8	10.0	7.0	6.0	6.0	4.0						
Lithuania F								1.3	2.0	30.8	1.4	9.8	2.4	1.9						
Hungary F							5.3	13.0	11.8	3.0	3.8	3.9	3.8							
Latvia F									0.8	2.8	5.3	3.9	1.6							
Romania F				0.8	7.4	3.6	14.0	9.4	2.1	4.5	2.6	1.7	3.3							
Bulgaria F								6.7	27.9	2.8	3.3	4.7								

Source: Own calculation based on Figure 2.

countries lagged behind the international frontier from 3 to 8 years, another 11 countries lagged from 16 years in Denmark to 34 years in Bulgaria.

More detailed estimates of the dynamics used by the S-time-step measure are presented in Figure 4. The values of S-time-step show the number of years needed in the past to reach the next consecutive level of female life expectancy. The average value of S-time-step in the row for EU27 is 4.6 years, i.e. in the past nearly 5 years were needed for an increase of 1 year of life expectancy. Portugal shows the highest dynamics of countries with data from 1960.

This section examined the potential possibilities of the time distance method to provide additional insights into analysis of female life expectancy in the EU by looking at the disparities between countries in the time distance perspective and the S-time-step as a measure of dynamics complementary to the growth rate measure.

3. Time matrix combining female and male life expectancy and the corresponding differences between countries and genders

Figure 5 shows how the time matrix visualisation can at a glance provide comparisons across gender within a group as well as comparisons of levels of either female or male life expectancy among different units used in the figure. The combination of time matrix for female expectancy in Figure 2 and the corresponding male

time matrix can be arranged in several ways. Figure 5 illustrates two possibilities depending on the analytical priority.

If one would be concerned predominantly with gender differences within countries, the arrangement in the upper part of Figure 5 for EU27 averages for female and male values (or between the values for the international frontier) would allow easier observation of gender disparities directly. It is easy to observe that the female time series have reached much higher values than those for males. Only for the span of life expectancy between 73 and 77 years are values for both genders available, and for these values the rounded S-time-distances amount accordingly to 33, 30, 30, 28, and 27 years of lag of male life expectancy behind female life expectancy (i.e. these levels for males been achieved by females so many years earlier).

Except for the first four rows, Figure 5 is arranged in a different way: the time matrix is sorted by the value of life expectancy. This means that by appropriate comparisons we may observe the disparities between countries and between genders at the same time. To reiterate, the time matrix condenses information of combined time series of female and male life expectancy for the period of more than 50 years (1960-2011), which in the Eurostat extended database amounts to more than 2500 entries; in this time matrix it is condensed to a much smaller number of entries (less than 600). This presents a first level visualisation that usefully complements the details in the original database by showing the easily understandable summary overview.

Female life expectancy is higher than that of males in all EU countries (easily observed if we arranged the rows for EU27 F and EU27 M). This tendency is so strong that the first 21 positions in Figure 5 ordered by the value of life expectancy are that of female life expectancy. Only in six countries (Slovakia, Lithuania, Hungary, Latvia, Romania, and Bulgaria) was the female life expectancy mixed with the male life expectancy among some above average EU countries.

The time matrix format with the table-graph characteristics allows at the same time two types of comparisons between countries and genders. First, visually one can observe over the period approximate levels achieved as well as dynamics in terms of the number of steps in life expectancy achieved (depending on the data available). Second, from the values of times in the time matrix further measures can be calculated, i.e. S-time-distances between genders and countries, on the one hand, and S-time-steps as additional measure of dynamics, on the other. Out of a very large number of possible comparisons in Figure 5 only a small number of available comparisons can be commented on here.

The gaps in life expectancy in the EU are large. One can observe that the differences between EU countries in male life expectancy are even larger than those for females (which are about 8 years). The value for Italy reached 80 years, while those for Latvia and Lithuania are about 68 years, which shows a gap for males of about 12 years.

The overall gender gap is smaller, at around 6 years for the EU27 average. However, Table 1 shows that the country differences in gender disparity in life expectancy are very varied, from about 4 years to 11 years in favour of females. These are the most obvious absolute differences. From Figure 5 we can derive two more analytical illustrations, Figures 6 and 7.

Figure 6 deals with disparities between countries compared to the benchmark international frontier of 10 best countries in the world, separately for females and males. The EU27 average is clearly below the international frontier over the analysed period, and the S-time-distance lag is now at about 8 years for females and about 9 years for males. The distinction between genders is that the trend in S-time-distance behind the international frontier for males has been declining from 24 years to 9 years.

Comparing each country to the international frontier for each gender provides a large amount of information. For females at the end of the analysed period, three EU countries were ahead of the international frontier for females: Spain, France and Italy showed a time lead of about 3 years. At lower levels Sweden and Netherlands were also ahead of the international frontier, with their lag now at 3 and 7 years. Following the three countries with a time lead, there are 14 countries with a time lag up to 8 years, and at the end of the list Hungary, Latvia, Romania, and Bulgaria showed a time lag of 30 to 34 years behind the international frontier for females. Comparing EU countries to the EU27 average would produce a similar order of disparity within the EU, and only the values of S-time-distance would be numerically lower by, very roughly, 10 years if the values were calculated from the EU average. For women the results have also been discussed already in connection with Figure 3. Several countries have decreased the time delay over the period: Portugal, Cyprus, Luxembourg, Slovenia, Malta, and Estonia.

The gaps in time behind the international frontier have been even larger for males. Only Sweden, over the whole period, and Italy at the end, are ahead of the frontier for males by 2 years and one year (earlier, in some years Cyprus, the Netherlands and Greece were above that level). These countries and Spain are close to the frontier; 10 other countries have S-time-distance of 10 years or less, for 5 countries the lag is between 30 to 40 years, and for Bulgaria 44 years, Latvia and Lithuania more than 50 years.

However, notwithstanding the wide gap behind the international frontier for males, many countries have

Figure 5: **Time matrix containing both female (F) and male (M) life expectances for EU countries**

Level	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Inter. frontier F														1954	1958	1964	1970	1974	1978	1982	1987	1992	1998	2003	2008	
Inter. frontier M										1955	1964	1973	1977	1982	1987	1992	1997	2001	2004	2009						
EU27 F														1964	1970	1974	1979	1983	1988	1994	1999	2003	2006	2010		
EU27 M								1963	1971	1979	1983	1987	1993	1997	2000	2004	2007	2010								
France F															1962	1966	1970	1974	1978	1983	1986	1989	1994	2003	2005	2009
Spain F														1963	1967	1971	1974	1977	1979	1981	1986	1991	1996	2000	2005	2009
Italy F														1963	1967	1970	1974	1978	1982	1986	1989	1993	1997	2003	2006	2010
Portugal F							1961	1962	1964	1969	1971	1974	1975	1976	1978	1980	1984	1987	1991	1996	2000	2003	2006	2010	2011	
Sweden F																1960	1965	1970	1976	1980	1988	1993	2000	2006		
Finland F														1962	1966	1970	1973	1977	1980	1990	1994	1998	2003	2006		
Austria F														1964	1972	1976	1979	1984	1987	1990	1995	1999	2004	2007		
Cyprus F														1973	1975	1976	1978	1980	1986	1992	2000	2005	2006	2008		
Luxembourg F														1970	1972	1976	1981	1984	1987	1992	1997	2003	2006	2008		
Slovenia F													1964	1971	1973	1983	1985	1988	1994	1996	2000	2005	2007	2010		
Germany F													1961	1963	1972	1976	1979	1983	1987	1991	1996	1999	2005	2010		
Belgium F														1960	1969	1973	1977	1981	1984	1988	1993	2000	2005	2010		
Netherlands F																	1966	1972	1975	1979	1987	2003	2006	2010		
Ireland F													1961	1967	1973	1979	1982	1987	1991	1999	2001	2003	2006	2011		
Greece F														1960	1964	1969	1972	1977	1983	1988	1994	2001	2007	2011		
United Kingdom F															1962	1970	1978	1983	1987	1993	1999	2004	2008	2011		
Malta F												1965	1973	1980	1981	1984	1986	1989	1991	1994	2000	2004	2006	2011		
Denmark F																1964	1970	1976	1995	1999	2004	2008				
Estonia F														1994	1995	1996	1999	2002	2005	2007	2009	2010				
Czech Republic F														1962	1980	1987	1991	1995	1998	2004	2006	2011				
Poland F												1963	1965	1967	1972	1984	1994	1997	2000	2004	2008	2011				
Italy M									1964	1970	1976	1981	1984	1987	1992	1995	1998	2001	2005	2008	2011					
Sweden M													1972	1981	1986	1991	1994	1999	2003	2007						
Slovakia F														1965	1975	1985	1992	1998	2004	2008						
Cyprus M											1973	1975	1977	1982	1989	1998	2001	2005	2007	2010						
Spain M									1963	1969	1973	1977	1979	1983	1993	1997	2000	2004	2007	2010						
Netherlands M												1972	1977	1984	1993	1997	2002	2004	2007	2010						
Lithuania F													1961	1962	1964	1995	1996	2006	2008	2010						
Malta M								1963	1980	1981	1983	1986	1988	1991	1993	1998	2000	2006	2009	2010						
United Kingdom M									1961	1972	1979	1983	1986	1991	1995	1999	2002	2005	2008	2011						
Hungary F												1963	1968	1981	1993	1996	2000	2004	2007							
France M								1961	1967	1973	1979	1984	1987	1991	1995	1999	2003	2005	2009							
Latvia F														1995	1996	1998	2004	2007	2009							
Ireland M										1973	1980	1986	1990	1996	2000	2002	2003	2005	2009							
Greece M									1960	1961	1964	1969	1973	1980	1987	1996	2001	2006	2009							
Germany M								1961	1973	1977	1981	1984	1990	1994	1997	2000	2003	2006	2010							
Luxembourg M								1974	1977	1982	1985	1988	1992	1995	1998	2003	2004	2007	2010							
Austria M								1972	1976	1980	1984	1986	1989	1994	1997	1999	2003	2006	2010							
Romania F									1961	1962	1969	1973	1987	1996	1999	2003	2006	2007	2011							
Bulgaria F													1963	1969	1997	2000	2003	2008								
Belgium M								1960	1971	1976	1980	1984	1987	1993	1996	2002	2004	2008								
Denmark M												1976	1989	1996	1998	2003	2005	2009								
Finland M							1965	1972	1976	1979	1982	1990	1993	1996	2000	2003	2007	2010								
Portugal M	1961	1962	1966	1969	1971	1976	1977	1978	1980	1983	1986	1993	1997	2000	2003	2005	2007	2010								
Slovenia M						1970	1972	1983	1985	1988	1994	1996	2000	2004	2005	2007	2009									
Czech Republic M							1969	1980	1991	1993	1995	1998	2003	2005	2008											
Poland M						1963	1991	1993	1996	1999	2001	2007	2010													
Slovakia M								1991	1993	1999	2003	2008	2011													
Hungary M						1994	1996	1999	2001	2006	2008	2011														
Estonia M		1994	1995	1996	1998	2002	2003	2005	2008	2008	2009	2011														
Romania M						1962	1998	1999	2004	2006	2010	2011														
Bulgaria M								1997	1999	2005	2009															
Latvia M	1995	1995	1996	1996	1998	2002	2007	2008	2009																	
Lithuania M				1995	1996	2007	2008	2009	2010																	

Females Males

Note: International frontier F (females) and international frontier M (males) represent the unweighted average of the best 10 countries in the world for life expectancy for each five-years average in UN (2011) for the respective gender.
Source: Own calculation based on data from Eurostat (2006, 2013); for International frontier UN (2011).

Figure 6: **S-time-distances (in years) for female (F) and male (M) life expectancy for EU countries from the respective international frontier**

Level	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
Inter. frontier F					0	0	0	0	0	0	0	0	0	0	0	0
Inter. frontier M	0	0	0	0	0	0	0	0	0	0	0					
EU27 F					10	12	10	10	9	10	12	12	11	8	8	
EU27 M	24	18	14	16	14	13	11	10	9							
France F						4	3	1	0	1	1	**-1**	**-3**	**-4**	0	**-3**
Spain F					9	9	7	5	3	1	**0**	**-1**	**-1**	**-2**	**-2**	**-3**
Italy F					8	9	7	5	4	5	4	2	1	**-1**	1	**-3**
Portugal F					22	20	17	14	13	14	14	13	11	8	7	3
Sweden F							**-3**	**-5**	**-4**	**-2**	**-2**	1	1	2	3	
Finland F					8	8	6	4	3	2	8	7	6	5	3	
Austria F					9	14	12	10	10	9	8	8	7	6	4	
Cyprus F					19	17	13	9	6	8	10	13	13	8	5	
Luxembourg F					16	14	13	11	10	10	11	10	11	8	5	
Slovenia F					17	15	19	16	14	17	14	13	13	9	7	
Germany F					9	14	12	10	9	9	10	9	7	7	7	
Belgium F					6	11	9	7	7	6	6	6	8	7	7	
Netherlands F								**-4**	**-2**	**-2**	**-3**	**0**	11	8	7	
Ireland F					13	15	15	12	13	14	18	14	11	8	8	
Greece F					6	7	5	3	3	5	6	7	9	9	8	
United Kingdom F						4	6	9	9	9	12	12	11	10	8	
Malta F					26	23	20	17	15	14	12	13	11	8	8	
Denmark F							0	1	2	18	17	17	16			
Estonia F					40	37	32	30	28	27	26	22	18			
Czech Republic F					8	22	23	22	21	20	22	19	18			
Poland F					13	14	20	24	23	22	22	21	18			
Italy M	15	12	9	7	5	4	3	1	**0**	1	**-1**					
Sweden M				**-5**	**-2**	**-1**	**-1**	**-3**	**-2**	**-1**	**-2**					
Slovakia F					11	17	21	22	24	26	26					
Cyprus M		9	2	**0**	**0**	1	6	4	5	3	1					
Spain M	14	9	4	2	1	5	4	3	3	3	1					
Netherlands M			**-1**	**-1**	1	6	4	5	4	3	1					
Lithuania F					8	6	31	27	32	31	29					
Malta M	26	19	13	11	8	6	6	3	5	5	2					
United Kingdom M	17	14	10	9	8	8	7	5	4	4	2					
Hungary F					27	35	32	30	30	30						
France M	18	15	11	9	9	8	6	6	5	5						
Latvia F					40	38	35	34	33	31						
Ireland M	18	16	14	12	13	13	9	6	4	5						
Greece M	6	**0**	**-4**	**-4**	**-2**	**0**	3	4	5	5						
Germany M	22	17	11	13	11	10	7	6	5	6						
Luxembourg M	27	20	15	15	13	11	11	7	7	6						
Austria M	25	20	13	12	11	9	7	6	5	6						
Romania F					42	41	39	36	33	33						
Bulgaria F					15	39	36	34	34							
Belgium M	21	16	11	10	11	9	9	7	8							
Denmark M			3	12	13	11	11	8	9							
Finland M	24	17	17	15	13	12	10	10	10							
Portugal M	28	22	20	19	17	15	13	10	10							
Slovenia M	33	30	23	22	21	18	15	12								
Czech Republic M	38	31	25	26	23	20										
Poland M	44	37	34	32												
Slovakia M	44	39	36	33												
Hungary M	51	44	38													
Estonia M	53	45	38													
Romania M	51	45	38													
Bulgaria M	50	44														
Latvia M																
Lithuania M																

Females | Males | **Females bold: - time lead** | **Males bold: - time lead**

Source: Own calculation based on Figure 5.

over the analysed period decreased the time delay, as could be anticipated in the decrease for the EU27 average. Italy has come from a delay of 15 years to -1 year. Cyprus, Spain, Malta, and the United Kingdom have joined the Netherlands to form a group that is not more than two years behind the male frontier.

Similar trends for males have been experienced by France, Ireland, Germany, Luxembourg, Austria, Belgium, Portugal, and Slovenia, which have decreased the delay to a range between 5 and 12 years. All EU countries below them have also decreased time lags behind the international frontier. Yet six countries were still lagging from 38 to more than 50 years, which is more than the lowest for females at 34 years.

As we see, for the indicator life expectancy at birth, years (time units) are used in four measures: 1. The indicator itself, 2. Static difference between genders, 3. S-time-distance of time lead or time delay between units and benchmark (such as the international frontier, average for EU27, male against female, etc.). 4. S-time-step of time spent between the two next levels of the indicator as an additional measure of dynamics. If, for instance, the methodology were used for employment ratio, the time units would be used only for S-time-distance and S-time-step.

Figure 7 deals with another application of S-time-distance - time lag for males behind females in life expectancy for a given level of the indicator. The time

Figure 7: **S-time-distance (years): Time lag for males (M) behind females in life expectancy**

Level	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Inter. frontier M								28	29	29	27	27	27	27	
EU27 M								33	30	30	28	27			
France M									33	32	33	31	31		
Spain M								20	26	26	26	27	28	28	
Italy M								24	25	25	24	22	23	22	22
Portugal M	15	16	16	14	15	20	22	23	24	25	24	24			
Sweden M										31	29	29	27	27	
Finland M								34	34	33	34	34			
Austria M								30	25	24	24	22	24		
Cyprus M								9	14	22	22	25	21	18	
Luxembourg M								25	27	27	23	23	23		
Slovenia M							35	33	32	24	24				
Germany M							30	30	25	24	24	23	23		
Belgium M								33	28	29	27	28			
Netherlands M											36	33	31	31	
Ireland M							29	29	27	23	22	18	18		
Greece M								20	23	27	29	29	26		
United Kingdom M									33	29	24	22	21	18	
Malta M						21	15	11	12	15	14	17	18	17	
Denmark M										39	35	33			
Estonia M															
Czech Republic M								43	28						
Poland M						45	45								
Slovakia M															
Lithuania M															
Hungary M						48									
Latvia M															
Romania M			42	44	40	38									
Bulgaria M															

Source: Own calculation based on data from Figure 5.

matrix in Figure 5 can be arranged in a way that for each country the line for females is followed by the line for males and the times in the matrix are than subtracted for each country separately. These results are very important for the general conclusion that the time distance perspective indicates that in the past the gender difference in life expectancy has been very large and quite stable.

Both for the averages for the international frontier and for the EU27 average it is shown that the time delay was at about 27 years; the relationship is very persistent and it changes very slowly. Broadly speaking, at the lower end of the table there are 10 countries with S-time-distance delay of more than 30 years; for five of them (Estonia, Slovakia, Lithuania, Latvia, and Bulgaria) there was no possibility to calculate the delay. For these 5 countries we can estimate that the time delay of male behind female life expectancy is more than 50 years, i.e. more than half a century.

This may in some instances be a question of shorter time series, but this does not in any way change the overall conclusion that the time distance method significantly showed the large time distance perspective of the degree of disparity between female and male life expectancy, which is not taken into account in the standard static analysis of disparities.

4. Gender disparities in life expectancy in EU countries and at NUTS2 regional levels

Differences in gender disparity between EU27 countries

The advantage of women in terms of life expectancy is confirmed for the EU at the country and regional levels. For all EU27 countries the higher life expectancy at birth

Table 1: **Female-male disparity in life expectancy at birth for EU27 countries**

Country	Difference between female and male life expectancy (years) in 2011	Gender difference as a percentage of male life expectancy	S-time-distance: Time lag for males behind females in life expectancy	World rank for females 2005-2010	World rank for males 2005-2010	Difference in ranks (females minus males)
Netherlands	3.7	4.7%	30	23	13	10
Cyprus	3.8	4.8%	17	38	25	13
Sweden	3.9	4.9%	26	11	6	5
United Kingdom	4	5.1%	18	31	18	13
Denmark	4.1	5.3%	23	41	32	9
Malta	4.3	5.5%	18	35	31	4
Ireland	4.5	5.7%	16	25	19	6
Greece	4.6	5.9%	26	26	23	3
Germany	4.8	6.1%	23	22	22	0
Italy	5.2	6.5%	22	5	7	-2
Luxembourg	5.1	6.5%	22	29	26	3
Belgium	5.4	6.9%	27	21	24	-3
Austria	5.6	7.2%	24	12	17	-5
Spain	6	7.6%	28	6	21	-15
Portugal	6.4	8.2%	20	30	38	-8
Finland	6.5	8.4%	33	16	33	-17
Czech Republic	6.3	8.4%	25	42	47	-5
Slovenia	6.5	8.5%	23	28	41	-13
France	6.9	8.8%	29	2	16	-14
Bulgaria	7.1	10.0%	> 50	83	105	-22
Romania	7.2	10.1%	38	73	98	-25
Slovakia	7.5	10.4%	> 50	54	84	-30
Hungary	7.5	10.5%	48	61	100	-39
Poland	8.5	11.7%	44	45	79	-34
Estonia	10.1	14.2%	> 50	51	110	-59
Latvia	10.2	14.9%	> 50	62	115	-53
Lithuania	11.2	16.4%	> 50	66	124	-58
EU27	5.8	7.5%	26			

Source: Own calculation based on data from Eurostat (2006, 2013); for world ranks UN (2011).

for women is confirmed for the period for all available data for countries in the period 1960–2011. In 2011 it varied from 3.7 years for the Netherlands to 11.2 years for Lithuania. If we compare the gender disparity with the absolute level of male life expectancy it is shown that it varies from around 5% to 16% of male life expectancy. In other words, for EU27 women are expected to live 7.5% longer than men; in eight countries even more than 10%, in Lithuania even more than 16%.

The method of calculating S-time-distances here is slightly different from that earlier using the time matrix. The level of male life expectancy for 2011 is the starting point, and it is calculated at what time in the time series for females this value has been reached. The differences between the two procedures are small and do not affect the general conclusions. The third column in Table 1 shows the time lag for males behind females for life expectancy at birth. S-time-distance shows a much higher degree of gender disparity than the static measures; the time delay ranges from 16 years to more than 50 years (that female value after 1960 was never as low as the 2011 level of male life expectancy).

What is clear is that there are astonishing differences in gender life expectancy between EU countries. To examine this we calculated ranks separately for females and males against the world list of 196 countries from data in UN (2011) and the respective differences between the two ranks. There are only 10 countries for which the difference in the ranking is lower than 10. In the world context Italy stands out from the EU countries as it is ranked 5 for females and 7 for males, in both cases in the 10 best countries. France is placed at 2 for females, but at 16 for males; Spain showed a similar difference, being placed 6 for females and 21 for males, for Sweden this is reversed, at 11 for females and 6 for males.

Surprisingly high differences in ranking are found in the last 8 countries in the table, indicating that the world ranks for male life expectancy are much worse than that for females. For Estonia, Latvia and Lithuania the difference between the two rankings favour females by more than 50 ranks; e.g. Estonia occupies rank 51 for female and 110 for male life expectancy. The position of women in society over a long period, history and also the lifestyle of men might be influencing these differences in the rankings. A contrasting case is that of the United Kingdom, with a difference in rankings in the opposite direction, where the females ranking is 31 and that of males 18.

Differences in gender disparity at NUTS2 regional levels

Disparities in life expectancy in EU27 can also be analysed at the regional level. Similar conclusions were drawn when data were also analysed for 2010 for NUTS1 and NUTS2 regional levels. For the first, gender disparity in life expectancy ranged from 3.8 to 10.9 years, and the median value was 5.9 years; for the second it ranged from 2.3 to 10.9 years of life, with a median value of 5.5 years. The median value for 3118 US counties for female-male disparity in 2007 was also 5.5 years. The results for 2007 showed that in all of the 3118 US counties, female life expectancy was higher than that of male life expectancy (Kulkarni et al., 2011).

Figure 8 shows the frequency distribution of the number of NUTS2 regions in 2010 by the levels of life expectancy. It is remarkable that no country in that year showed a highest level for males that was higher or equal to the lowest level for females (with the exception of the United Kingdom, for which we therefore introduced two separate rows for genders). But for the UK, too, in all NUTS2 regions the female life expectancy was higher than that of males.

Looking at Italy as an example yielding more details for regions in individual countries Figure 9 compares static and time distance deviations from the country average of total life expectancy. It is clear that all values of female life expectancy are higher and ahead of total life expectancy, and that the static percentage differences ranging from -5% to 5% show a much smaller deviation from the average than S-time-distance, which ranges from about -15 years of time lead to about 15 years of time lag behind the average.

In analysing the very large gender differences in life expectancy between the EU27 countries, some obvious possible explanatory factors such as the Global Gender Gap Index of the World Economic Forum (Hausmann, Tyson, Zahidi, 2011), women's voting rights (UNDP, 2007), or real adjusted gross disposable income of households per capita (Eurostat, 2012b) did not show a high degree of association. Much more complex research is needed to take into account very different factors.

Figure 10 shows S-time-distances for NUTS2 regions in 2010 for female life expectancy against the trend of the female international frontier. Of the 269 NUTS2 regions, half of them lagged 7.3 years or more behind. Of 55 NUTS2 regions that showed a time lead in 2010, 51 of these regions were from the three countries that are ahead in Figure 6 (France, Spain, and Italy), while the rest were two regions in Austria and one in Greece and Finland.

5. Conclusions

Gender disparities in life expectancy in the European Union are examined, since life expectancy is a major indicator of well-being and thus also an important element in the evaluation of gender inequality. These statistical results provide food for thought in terms of further, more complex analysis of the reasons why

Figure 8: **Frequency distribution of number of NUTS2 regions in 2010 by levels of life expectancy**

LEXP level	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Spain										1	2	4	8	3	1	1	1	5	6	5	1
Italy												2	9	9	1		2	4	12	3	
France								1	2	4	7	9	2	1	1	1	3	10	10	1	
Greece										1		10		2	1	5	5	1	1		
Finland									1	1	2				1		4		1		
Austria										1	4	2	2			1	4	4			
Germany									1	6	11	12	7			20	15	2			
United Kingdom F													1	2	9	9	14	2			
United Kingdom M									1	3	9	7	8	9							
Slovenia									1		1					1		1			
Belgium								1	2	1	1	4	2		2	2	6	1			
Sweden												1	7			1	6	1			
Netherlands											1	5	6			5	7				
Portugal					1	1				2	3	1	1		1	1	3				
Ireland												2					2				
Cyprus													1				1				
Luxembourg											1						1				
Malta													1				1				
Czech Republic						2		2	3	1			1	3	3	1					
Denmark										2	2	1		1	3	1					
Poland				1	8	3	4						2	7	6	1					
Estonia				1										1							
Slovakia					2	1	1					1	2	1							
Hungary		1	1	3	1	1					1	5	1								
Romania			4	3		1				1	5	1	1								
Bulgaria			3	2	1					3	1	2									
Latvia		1										1									
Lithuania	1											1									

Females Males

Source: Own calculation based on data from Eurostat (2012a).

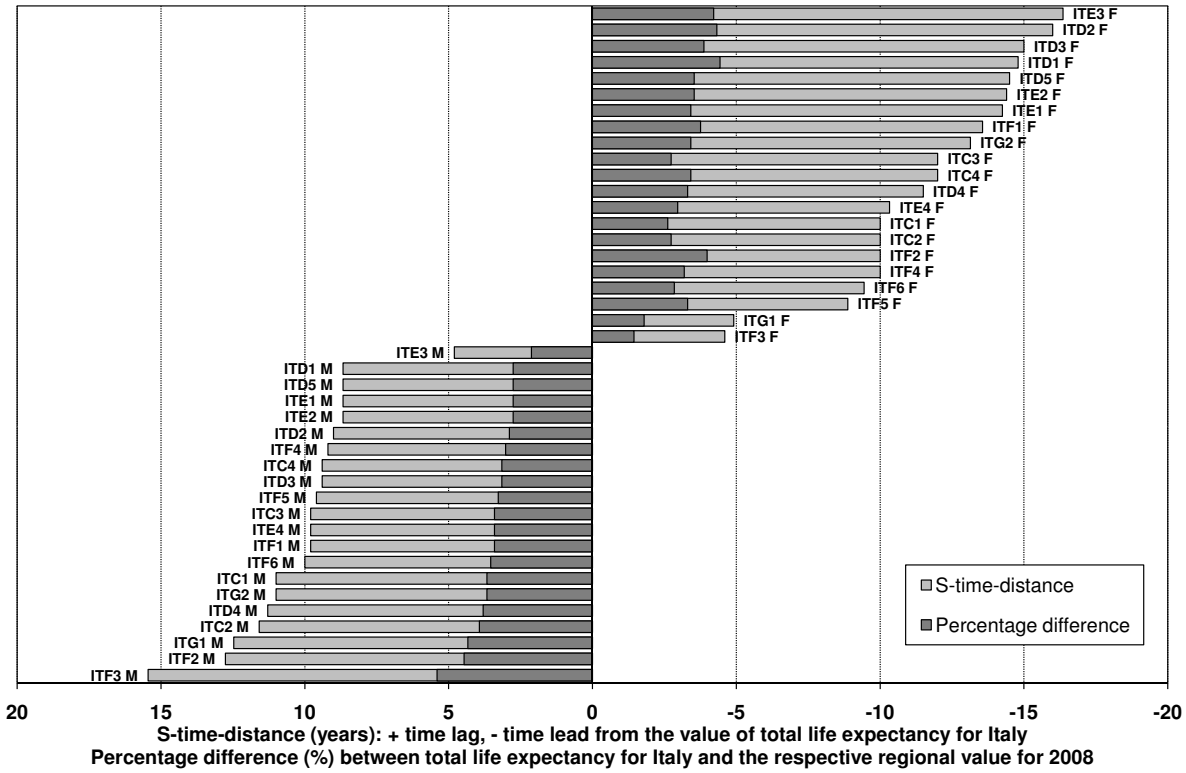
the gender disparity in life expectancy is so much in favour of women, thereby standing out against so many domains where the gender disparity in many countries leans in the other direction.

In all EU countries female life expectancy is higher than that of males, but the perception of degree of gender disparity in life expectancy may be very different depending on the statistical measures used. The static difference for the EU27 average in 2010 was less than 8 percent (which may appear to be small) while the time distance was 27 years (which gives a very different perception of the magnitude of the gap). Thus the major conclusion is that the gender disparity in life expectancy is clearly a long-standing phenomenon, with astonishing differences between countries.

The time distance approach opens up the possibility for simultaneous two-dimensional comparisons of time series data in two specified dimensions: vertically (standard measures of static difference) as well as horizontally (Sicherl time distance), providing a new dimension of analysis for a variety of problems. The application of novel methodological tools can be usefully applied to other indicators in analysing gender and other disparities. Statistical analysis covers the period 1960-2011 for all EU27 countries and for NUTS2 regions in the year 2010, with added comparison to the international frontier of the average of the 10 best countries in the world.

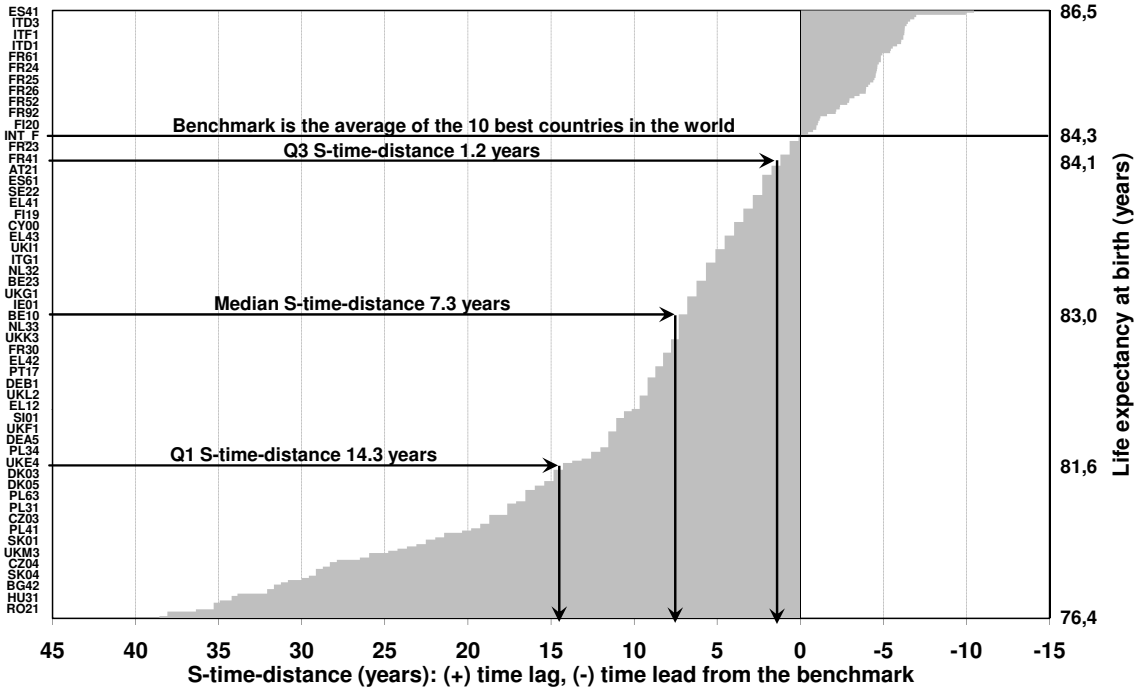
Section 2 applies the methodology to the time series of female life expectancy for the period 1960-2011. In

Figure 9: **Static and time distance deviations in 2008 for gender values (F – females, M – males) of NUTS2 Italian regions from the trend of country average of total life expectancy**



Source: Own calculation based on data from Eurostat (2012a); for Italy total life expectancy data from Eurostat (2013).

Figure 10: **Values of female life expectancy for NUTS2 regions in 2010 compared to the time when such level was attained in the average trend for the 10 best countries in the world**



Notes: Because of the high number of regions included, on the vertical axis only every fifth region code is shown (while values for all regions are displayed).
Source: Calculation based on Eurostat data (2012a); for International frontier data from UN (2011).

the extended Eurostat time series table, data amount to about 1260 entries, while the entries in the time matrix in Figure 2 are condensed to about 300 entries. This is a great advantage for presentation and understanding and is also a first-level visualisation tool. At a glance one can see that even in EU27, there are substantial differences in female life expectancy between the member countries. Beyond that, the time matrix enables one way of estimating two statistical measures, S-time-distance and S-time-step.

In Section 3 Figure 5 shows how the time matrix visualisation can at a glance provide comparisons across gender within a group as well as comparisons of levels of either female or male life expectancy among different units. The gaps in life expectancy in the EU are large. One can observe that the differences between EU countries in male life expectancy of about 12 years are even greater than that for females by about 8 years. Examining the degree of disparity against the benchmark of the international frontier S-time-distance (- time lead, + time lag) shows how many years earlier or later a given country reached the same level of life expectancy as the international frontier in Figure 6. The time gap of EU countries behind the respective international frontiers is up to 34 years for females and up to more than 50 years for males.

Figure 7 concentrates on the major issue of gender disparities in life expectancy, presenting time distances between male and female life expectancy for all EU countries and the international frontier over the whole analysed period, and showing the extensive gender disparities. Looking at the position in 2011 in Table 1, female life expectancy exceeds males in a range from 3.7 years for the Netherlands to 11.2 years for Lithuania; it varies from around 5% to 16% of male life expectancy. The corresponding S-time-distance shows a much higher degree of gender disparity than the static measures; the time delay ranges from 16 years to more than 50 years. As in the EU27 average, the gender disparity between time series of the respective international frontiers shows an absolute difference of about 5 years, 6.4%, and time delay of 27 years. At the regional level the range of gender difference for the analysed 269 NUTS2 regions is between 2.3 and 10.9 years with a median value of 5.5 years, which is the same as for 3118 USA counties.

One line of factors contributing to such a dominant statistical fact of higher female than male life expectancy is the possible difference in our genes. An example of such studies is research into the tendency for females to outlive males in different species in the animal kingdom (Monash University, 2012). In addition to economic, social, and environmental factors there are important differences in lifestyle and time use. This statistical analysis presents reality with new eyes, and offers an input for further large systematic research projects.

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