Male-Female life expectancy differences in 21 developing countries, 1990-2006"

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Abstract

The research scope of the given thesis is the impact of the development of the country on the Male:Female Life Expectancy Difference. The research is based on the data across 21 developing countries within 1990 – 2006. During this analysis *no direct impact* of the socio-economic development indicators on the Life Expectancy Difference between males and females is determined. *The indirect effect of these factors on the Life Expectancy Difference is assessed*, which is due to their correlation with the circulatory system diseases as well as infectious and parasitic diseases directly affecting M:F LED. The conclusion is that in the short term factors, describing the level of development of the state, decrease LED between males and females in the developing countries indirectly, still in long run term the situation may change.

Keywords: life expectancy, male:female life expectancy difference, direct/indirect impact, development of a country.

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I love you, guys … ☺

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Introduction

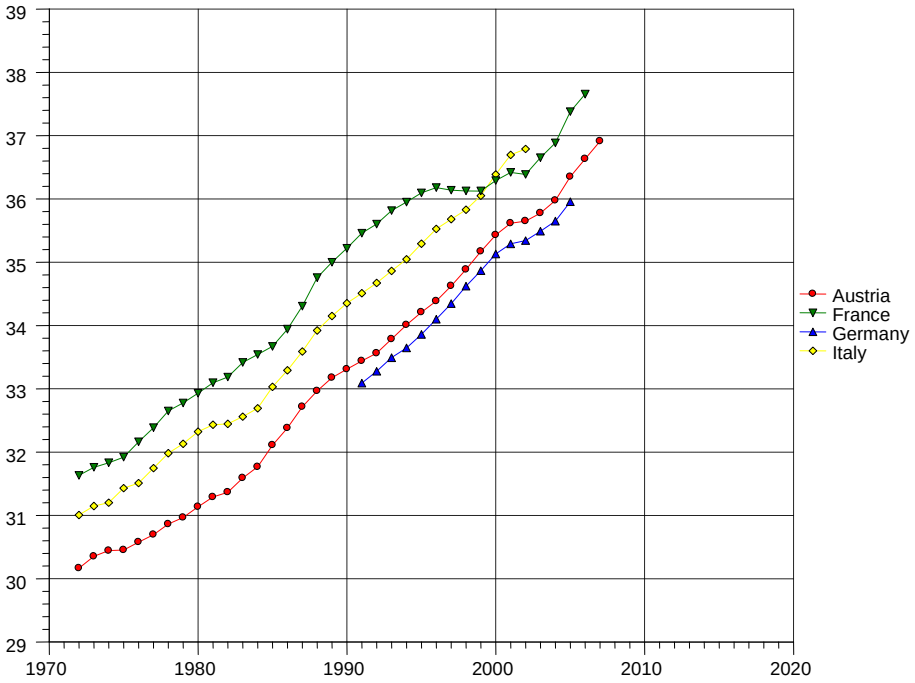
The scope of the study of the given thesis is Life Expectancy Difference between males and females (M:F LED) across countries, which has been of great importance for decades. The reasons of this question being of such significance nowadays are discussed below. Today in the era of globalization and integration of developed countries, each state puts all its efforts in improvement of the political, economical and social situation in the region. The development of the certain countries depends, along with other factors, on the educated labor force available. At the same time amount of educated labor force is in positive relation with the number of economically active population, which in some cases is affected by the health status of the population of the given country. Therefore, development of the particular country is in high correlation with heath status of the individuals participating in the labor market of the given state. Consequently, many countries, especially developing ones, pursue a Demographic Policy, intended to increase the life expectancy (LE) of the population, as LE indicates the overall health of a country (Matt Rosenberg, 2005).

An interesting trend is observed throughout years, concerning dissimilarity in the change of male and female LE. Due to a number of reasons, some of which are still not identified, females have higher LE than males. This matter has been a theme of number of discussions in several sources for years. For instance, according to the data provided in the international brief by W. Kingkade (1997) in Russia in 1990 LE of females was higher than for males and they lived from nine to ten years longer; or for instance, M. Rosenberg (2010) mentioned that today in the North America this difference varies from four to six years, while in Russia the difference now is more than 13 years. In some resources the explanation of this difference in LE is that females are physically more enduring than males. Males' body is

constructed in a way of their being inferior to females in their stamina. In other sources, it is said that the reason males have shorter LE than females is that males face more difficulties in their daily work, they are more stress exposed, they smoke more and consume alcohol in a bigger amount, which results in decreasing their LE in comparison to females' LE.

In order to examine the life expectancy difference between males and females, the data provided by WHO project is used. The data from this source indicates that people in the developed countries have LE with an increasing trend, while in developing ones LE of population is mostly decreasing. This situation is quite logic for the following reasons. People living in more developed countries face less stress and consume better goods and services, including health care services. The difference in LE between developed and developing countries are clearly shown in the figures below. Figure 1 describes the LE at the age of 45+ for four randomly chosen developed countries: Austria, France, Germany and Italy, for 16 years. It is clearly seen that the LE is strongly increasing, which is true for all developed countries.

Figure 1. LE trend for the age group of 45+ in four Developed countries, 1990 – 2006



Created by WHO, Data for All

On the other hand, graphs presented in Figure 2, which describes the LE at the age of 45 for three developing countries, namely Kazakhstan, Republic of Moldova and Ukraine, illustrate strictly decreasing life expectancy. This pattern can be observed in most underdeveloped states.

Figure 2. LE trend for the age group of 45+ in three developing countries, 1990 –2006.

Created by WHO, Data for All project

The research area given work covers is the M:F LED in the developing countries. *The main purpose of this study is to determine how the underdevelopment of the country affects the M:F LED; what the factors influencing this difference in developing countries are; how the gap between LE of both sexes changes in accordance with the change of socio-economic factors.* In order to give competent and reliable answers to the questions putted forward, the econometric analysis describing the impact of characteristics of the development, which are named below, is presented in this work. The research area covers 21 developing countries for 16 years beginning from 1990, which is post transition period for the most of the countries included to the sample. Indicators, used to proximate the stage of the development a certain country attained, are real GDP (pop per capita), Human Development Index (HDI) and percentage of the Urbanization of population. Initially, an increase in real GDP, HDI and percentage of urbanization of the population are supposed to entail decrease in LED. On the other hand, number of other variables, such as Gini index, difference in participation between male and female labor force are expected to have an opposite impact on the M:F LED, to be

exact if augmentation in the one of the latter factors is observed, this definitely increases the gap between LE of both sexes.

An interesting finding in my research is that, even if there is *no way to derive any conclusion about the direct effect of the above stated variables on M:F LED, an indirect effect of some of them is found*. In order to investigate this oblique impact I include to my research area three kinds of diseases, namely circulatory system diseases, infectious and parasitic diseases along with lugs, trachea and bronchus cancer, which are described in details later. Not surprisingly, some of these diseases do have *significant* influence on the M:F LED. Later, it is determined that these diseases are affected by socio-economic indicators and this consequently entails an indirect effect of the development indicators of the certain state on the M:F LED.

This research is based on the econometric approach with an estimation process including three methods: Pooled OLS, Fixed Effects and First Order Differences. On the first steps a simple model consisting of basic variables, which are GDP, Gini Index and HDI is built. Furthermore, the initial model is extended, by including more variables to the regression, which are expected to have a high probability of diminishing the gap between male and female LE. By doing so, the number of unobservable factors in the error term is decreased, resulting in obtaining more accurate and precise estimators.

The thesis consists of four chapters. The first one is Literature review, which summarizes earlier papers on the topics relative to the one of my research. A number of studies concerning LE as such, Mortality Rate (MR), which is in close correlation with LE and which is of the same importance; the life expectance ratio (LER) along with mortality rate ratio (MRT) between males and females are gathered in this part of the given work. The

second chapter, named Data analysis, includes the description of the data used in the given study, sources from which the data is obtained as well as brief discussions on the subject of trends in LE and outlier countries. The third chapter is Empirical modeling, where the models and their descriptions are given, estimation methods are shown and argumentations of the reasons of applying each method are provided. The forth chapter, Discussion of the Results, presents the final estimations results and their interpretations. Finally, Conclusion summarizes the main findings of my research and suggests the possible ways of eliminating the gap between LE of men and women.

Literature Review

Life expectancy (LE) is a concept that has been of a great interest for various scientists. There have been number of works devoted to the explanation of the life expectancy using various methods. The earliest studies about this issue were done in 1970-1980 by a number of researchers, such as P. Watson, D. Kruger and R. Nesse, C. Dolea, E. Nolte and M. Mckee, etc.

One of such works is written by David A. Swanson (1989), in which he studies LE using regression methods. This analysis was state-based and the author used the data of 1980 for 50 states. In his work the author examines whether regression approach may be used during life expectancy analysis. According to him the coefficients of the regression model are quite accurate and provide good estimation results, suggesting this method being quite appropriate while estimating LE.

A similar study was done by Frank T. Denton, Christine H. Feaver and Byron G. Spencer (2005), in order to assess whether econometrics is good in explaining LE. The authors use stochastic forecasting and time series analysis by regressing lagged mortality rate in year *(t-1)* and *(t-2)* on mortality rate in year *t* to predict LE. To this end they use the data of "annual age-sex mortality rates for 75 time periods" (p.204). What they manage to determine during given research is that "econometrics should feel comfortable" in estimating LE (p.226). The indirect result which can be obtained from the paper is that the correlation between the mortality rates and life expectancy is high for both males and females; nevertheless the level of correlation might differ along age groups.

At this point I would like to switch from works concerning LE forecasting to *studies assessing the influence of various socio-economic factors on LE* and mortality rate (MR).

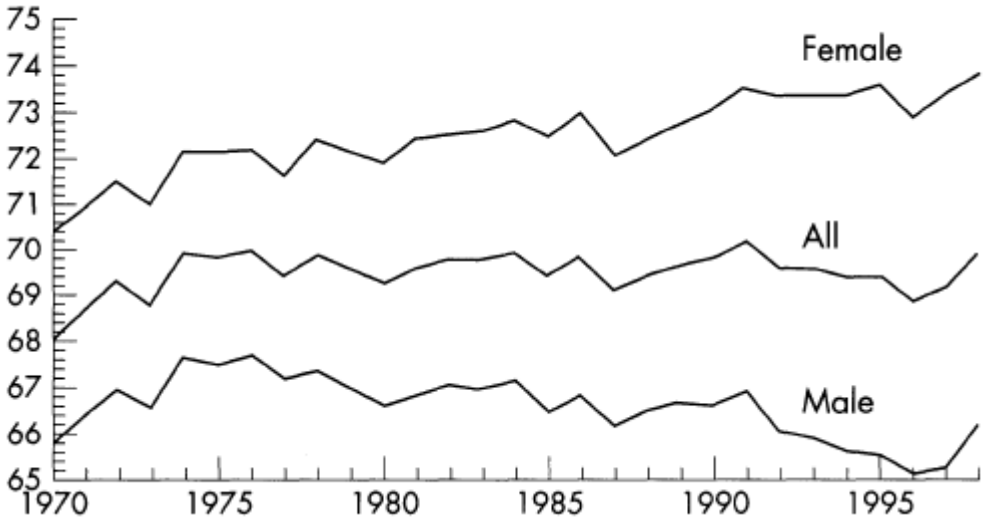
Some of such researches examine the change in LE from various causes of death. For instance, in his work A. T. Flegg studied the impact of income inequality, illiteracy and medical care on infant mortality in underdeveloped countries. The author examined the impact of the abovementioned parameters on the infant mortality rate, using the two staged OLS method. According to him income distribution and mothers' education level has significant impact on the infant mortality rate. Flegg concludes that unequal income redistribution and low level of females' education prevents reduction in infant mortality rates (Flegg, 1982). Furthermore, the LE change depending on life style and amount of calories consumed was studied by Vijayendra Rao. In compliance with this study, which was conducted for 51 countries, if factors like income distribution, consumption of medical services and literacy are controlled for, in those countries, where consumption of meat and poultry is higher the LE after age five is lower than in countries preferring vegetables in their diet (Rao, 1989). Other causes of decrease in LE are HIV and AIDS. This issue was studied by Eric Neumayer. In his research, which included 187 countries, the author concludes that these illnesses have a significant negative impact on the LE (Neumayer, 2004).

LE is indicator performing information about the expected years of the life for the given age group and its estimation is based on the data describing *mortality rate (MR)*. Hence, while discussing LE and LER, one should note that it is closely related to MR and *Mortality Rate Ratio (MRR)*. Correspondingly, in many studies these indicators are examined together or explanations concerning one of them are implemented to illustrate the tendency in another one. On the other hand, the question of LER and MRR between males and females has been of high significance for years as well, the importance of which is explained by the presence of necessity in stable demographic development. Below a brief summarization of a few papers about the given fields of LE related studies is provided. Even if in the given works the authors

mostly use MR indicator, the fact that they investigate the difference in health status between males and females make these studies of particular interest in concern with my research. However, in my work *I use the Life Expectancy indicator at the age of 45+ as a proxy for health status of the population*, due to the fact that the last one describes health status of population more precisely and is discharged from the influence of the factors which are beyond the research area of the given thesis.

C. Dolea, E. Nolte and M. Mckee (2002) analyzed the change in LE in Romania after the transition period. In their research the authors studied the impact of various types of diseases, external and other kinds of causes on males and females death rates. During estimation they decomposed life expectancy by age and causes of death using "routine data on mortality" for 1990, 1996, 1998 years and compared the death rates caused by above stated causes for different age groups. The result of the given study is that the life expectancy at birth for both males and females decreased from 1990 to 1996. They assessed that the rate of decrease in LE for males is higher than for female, consequently the LE gap between two genders increased during the research period. The results are illustrated in the figure below.

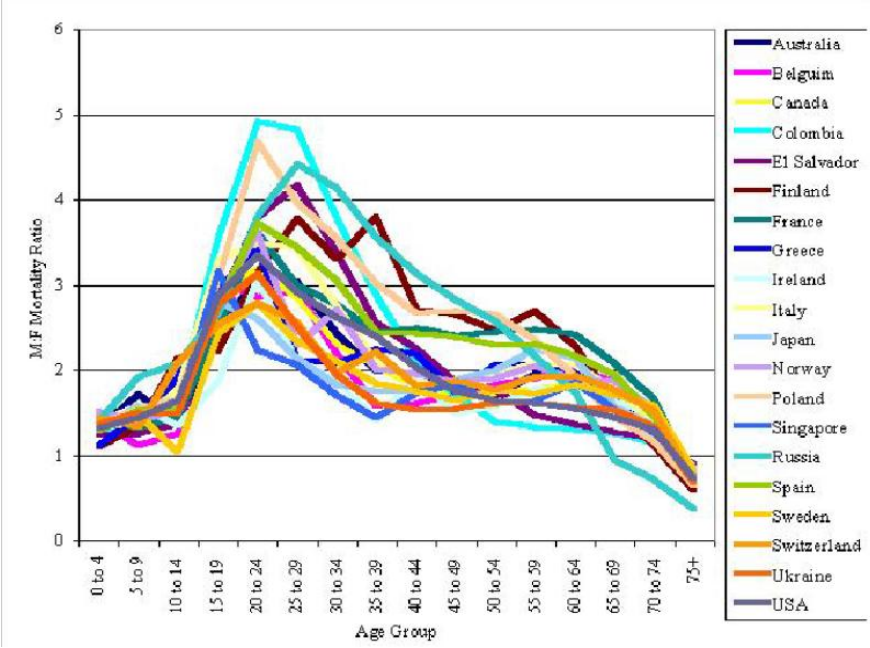
Figure 3. LE trends in Romania, 1970 – 1998



C. Dolea, E. Nolte and M. Mckee, 2002, "Changing LE in Romania after the transition"

One more study on this topic is "Sexual selection and the Male:Female Ratio" by Daniel Kruger and Randolph M. Nesse (2004). In their paper Kruger and Nesse compare female and male LE by quantifying and graphically examining the mortality ratio between genders. According to them, males have higher MR than females. The authors discuss two kinds of causes of mortality: external and internal ones. External death causes includes environmental aspects, such as homicide, suicide and those which result directly from behavior and include such indicators as smoking, consuming alcohol and other kind of manifestation of risky life-style. In contrast, internal death causes are mostly related to any kind of illness. The results of analysis show that MR for males is significantly higher than those for females, especially entailed by the external causes and at the age of an early adulthood. Internal causes increases MR for males as well, still the age group now is different and the preponderance is observed for the males in the middle age group and beyond it (see figure 4).

Figure 4. Male:Female MR in 2000 by age in 20 countries.



Daniel Kruger and Randolph M. Nesse, 2004, "Sexual selection and the Male:Female Ratio"

The authors conclude that "being male is now the single largest demographic risk factor for early mortality in developed countries" (p.80). Another interesting conclusion the authors arrive at is that the difference between sexes based MR in the recent years decreases, for the reason females and males smoking habits converge little by little. They conclude that the possibility to decrease males MR to MR of females would decrease males MR by one third. They suggest that to this end "complex interactions of sex, behavior and culture" should be considered as they forestall a simple solution (p.82).

The most related paper to the present research field is written by the same authors, Kruger, Nesse (2007), in which they analyze the MR of representatives of both sexes for 14 Eastern European and 12 Western European countries for pre-transition period and post-transition periods. They discuss the issue of influence of the economic transition to Male:Female MR. During their research they study countries experienced economic transition

period and conclude that these countries face much difficulties in various economic and political spheres than others. As a result, the decrease in employment, wages and other indicators of economic development is observed, as well as the level of political stability falls. The obvious outcome is that the individuals face with a number of socio-economic problems, their social status is exposed to decline; hence their life becomes more stressful. This outcome clearly has a negative impact on MR, especially on MR of males, which is higher than MR of females. What is interesting to note is that transition has higher impact on people of middle age, who has already established their life styles, has their regular job and stable wage. The reason of this situation is that these people do loss the stability of their life and in most cases cannot adapt to a new system. As a result they experience higher stress and higher mortality rate. The reason males M:F MR increases is that males tend to compete for obtaining various resources, social status and attracting mates, than females, what is stipulated by their nature. As a result, on the one hand competition increases the level of death from external causes, on the other hand increased stress increases the internal causes of death and this flows out to the high MR, especially for males.

One more study placing emphasis to a given issue as well "Explaining rising mortality among men in Eastern Europe" by Peggy Watson (1995). According to her "it is East European men, rather than women, who are dying more frequently at younger ages" (p. 923). In her work the author attempts to find out the explanation of this process. She considers various causes of death such as environmental pollution, standards of living, a number of life-style habits, etc. What she manages to determine is that the psychosocial factors have a negative impact on men health in East Europe. Furthermore, the author claims that frustrations of state socialism have a negative impact on health of individuals as whole, particularly on males. Watson says that "It points to the effort which has gone into making a

'normal' life, the way this effort has been centered on the household and has made use of informal ties to get round an unresponsive institutional system" (p. 932).

Table below combines brief information about all abovementioned papers.

Table 2. Summary of the papers discussed above.

Study	Sample	Method	Results
Swanson, 1989	50 countries, 1980	Regression	The coefficients of the regression model are quite accurate and provide good estimation results
Denton, Feaver and Spencer, 2005	Annual age-sex group mortality rates for 75 year period, 1926 – 2000	Stochastic forecasting and time series analysis by regressing lagged mortality rate in year *(t-1)* and *(t-2)* on mortality rate in year t	"Econometrics should feel comfortable" in estimating LE; the correlation between the mortality rates and LE is high for males and females
Flegg, 1982	46 undeveloped countries, 1968 – 1972	Two staged OLS method	Unequal income redistribution and low level of female education prevents reduction in infant mortality rates
Rao, 1989	51 countries, 1980	Two staged OLS method	LE in those countries, where consumption of meat and poultry is higher the LE is lower after age 5
Neumayer, 2004	187 countries, from 1955 onward	β-convergence	HIV/AIDS have a significant negative impact on the LE
Dolea, Notle, Mckee, 2002	"routine data on mortality" for Romania, 1990, 1996, 1998	Decomposition of life expectancy by age and causes; comparison of the death rates	The life expectancy at birth of males and females decreased from 1990 to 1996; the LE gap between two genders increased
Kruger, Nesse, 2004	20 countries, across past 70 years in 5 countries	Quantitative description, comparison and graphical analysis	MR for males is significantly higher than those for females
Kruger, Nesse, 2007	14 eastern European countries, 12 western European countries, 1985-1989, 1990-1994,	Quantitative description, comparison and graphical analysis	Transition has a negative impact on MR, especially on MR of males

Watson, 1995	1995- 1999 13 western European countries, 1970-1990	Quantitative description, comparison and graphical analysis	Frustrations of state socialism has a negative impact on health of individuals as whole, particularly on males

In my work I try to combine the best features of these approaches and study the M:F life expectancy difference. To this end, I use socio-economic indicators along with diseases and base my estimation on the econometric analysis, providing results which are well-founded and more accurate. The reason of using LE ratio is that this indicator gives more precise description of health status of individuals for various age groups.

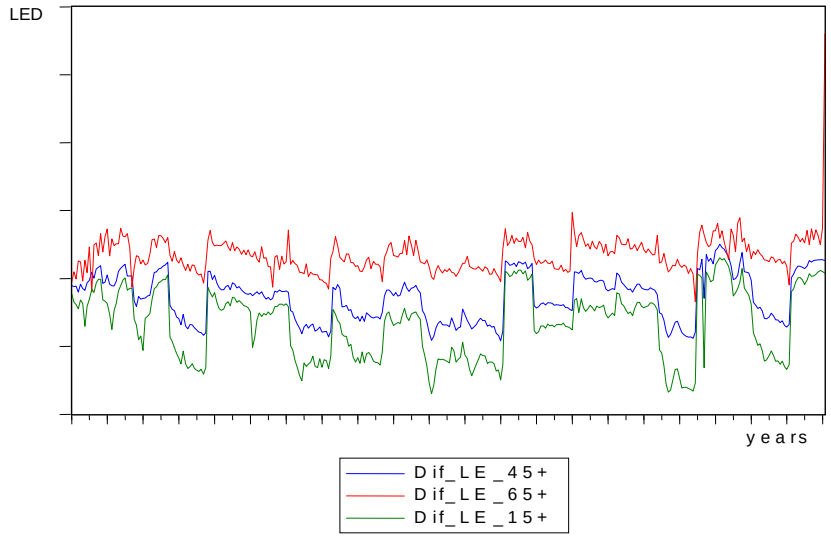
Data Analysis

Data for this research is obtained from several sources. The main database I turn to several times is *WHO project: Data For All*. In this data store information about heath describing variables along with some development indicators is provided. Here the data about *three groups of diseases affecting LED* is presented, which are:

- Circulatory system diseases;
- Lungs, trachea and bronchus cancer;
- Infectious and parasitic diseases.

To estimate the health status I apply data on age and sex based LE. It should be emphasized, that during analyzing data on LE, the fact of LE trend being the same for all three age groups: 15+, 45+ and 65+ is observed (see figure 5). In addition, in comparison with 15+ and 65+ age groups, LE at the age of 45+ is less affected by the factors which are beyond of the scope of the present research. Therefore I formulate my study only for the age group 45+, which has M:F LED in between the rest two groups and with some stipulation the results of this research can be applicable to them as well.

Figure 5. Age based LED for 15+, 45+, 65+



Further, I use information about *some socio-economic indicators*, namely real GDP (PPP per capital), percentage of Urban Population and Human Development Index (HDI) from WHO project. The second source of data on similar parameter of the development of the country is *Word Bank Database (WBD) Global Development Indicators project*, performing data on Gini index, which provides information about income redistribution across families within a country. The different project of the same source, i.e. *Gender Statistics project* of the WBD, provides data about labor force participation by sexes in absolute terms.

It has to be noted that not all variables used during research process are provided directly in the either of the named resources. For instance, there is no implicit information about LED as such, what is given is LE at the age of 45+ for males and females separately. In order to estimate LED between genders, I use a simple mathematical method and subtract female LE from male LE, to put it in a formula:

$$LED^{45+} = LE_M^{45+} - LE_F^{45+},$$

where LED^{45+} describes the LED, which is a subject of an interest in this work, LE_M^{45+} and LE_F^{45+} are LE of males and females correspondingly.

Applying the same logic as for LED, I use subtraction to find out the difference in the labor force participation between males and females, i.e. in the model specified in the next chapter

$$L\_F\_D = L\_F\_M - L\_F\_F,$$

where L_F_D is one of the regressors, L_F_M and L_F_F are absolute labor force participation rate of males and females accordingly.

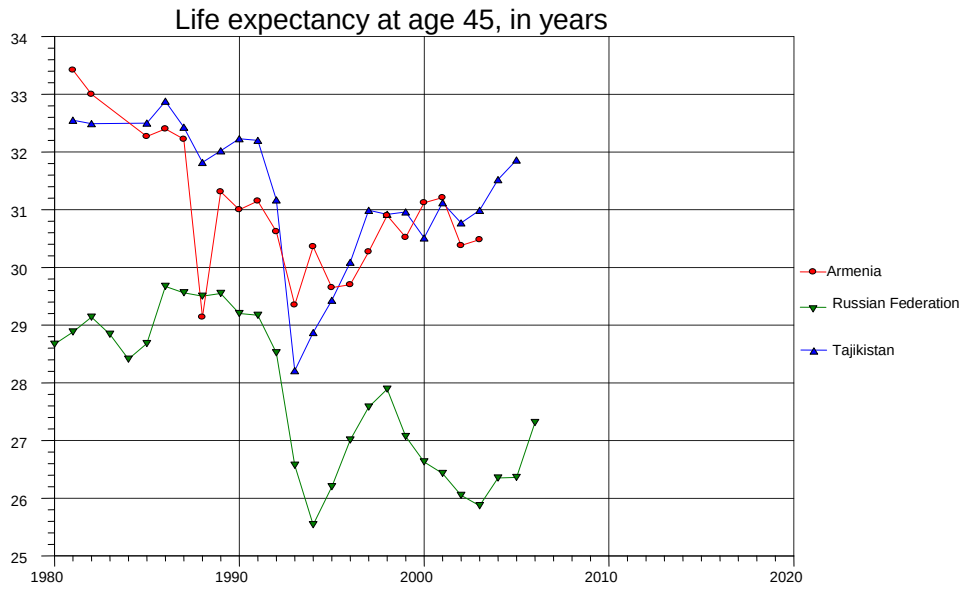
Brief statistical description of the abovementioned variables is given in the table below.

Table 3. Statistical description of the model parameters.

Name	Description	Mean	St. Deviation	Number of Observations
DIF_LE_45	The difference between LE of the males and females at the age group of 45+	-6.36	1.74	338
Real GDP	Real GDP (ppp per capita)	5210.12	3474.97	314
HDI	Human Development Index	0.77	0.056	169
Gini Index	Income Redistribution Index	33.73	5.45	294
Urbn_pop	Percentage of Urban Population	56.80	13.28	271
L_f_d	Difference in Labor Force participation between males and females	9.42	57.44	338
Circs_D_M	Circulatory System Diseases among males	802.71	158.30	335
Inf_par_M	Infectious and Parasitic Diseases among males	29.53	20.00	334
Cancer_M	Lung, Trachea and Bronchus Cancer among males	63.95	26.41	335

At this point it is worth mentioning, that in spite of decreasing LED in most countries there are *breakdown points* within the analyzed period of time in some countries, when LE for both genders sharply declines and then gradually converges to its initial position (see figure 6).

Figure 6. Breakdown points in LE at the age group of 45+ for three developing countries.



Created by WHO, Data for All project

The reasons of such breakdown points vary across countries and time periods. They can include political and economical instability factors as well as natural cataclysms. Sharp decrease in LE for both genders in Armenia in 1988 is a good example for the latter case. The probable reason of that demographic crisis was an earthquake, which took place in on 10th December, 1988 and entailed big human and material losses for Soviet Armenia (BBC News, 1988). In general, a breakdown points are observed in the most of CIS countries, in some

cases they are sharper in some smoother, nevertheless they are presented in LE trend of each member state of the CIS. The reason is the fact, that after reintegration of the Soviet Union most of them faced national or international wars, which definitely had a negative impact on the LE of the population in each country. One of the brightest examples is the case with Tajikistan in 1993, when LE of the population sharply diminished. The reason of this decrease might be the Civil War which took place after the collapse of the Soviet Union. In the period described the national revenue, standards of living, education, healthcare services and other socio-economic facilities became of the poor quality. Gradually, this and other kinds of problems occurring in the country poured out to mass protest entailing the military conflict, which left a mark on LE of the population of Tajikistan (M. Toshmuhammadov, 2004).

One more observation is that LE for both sexes in Russian Federation (RF) is significantly lower than LE in the rest CIS countries. The possible reasons might be the demographic crisis in RF lasting for several years, which is a result of low fertility as a consequence of economic instability on the one hand, and high alcohol and tobacco consumption on the other hand.

Another interesting aspect is the different trend in male LE in Azerbaijan in comparison with the LE trends of males of the rest developing countries presented in this work. According to the data obtained from the WHO database, LE of males as well as LE of females in the given 20 developing countries is strictly decreasing, still as it is stated above, the situation is not similar in Azerbaijan. What is observed in a given country is that LE of males is strongly increasing, LE of females is decreasing though. This strange pattern seems to be really interesting to study. Unfortunately, the lack of the necessary data prevents the possibility of conducting a detailed research. However, this unusual pattern might be explained by the fact that at the beginning of the 1990s Azerbaijan was engaged in an

aggressive military conflict, which surely had an impact on the male LE, decreasing it far below average LE in Azerbaijan. Nevertheless, after the agreement on cease-fire was signed and aggressive military operations calmed down, the male LE started to converge to its normal state.

The data I use in this thesis includes information about *21 developing countries* (see table 4) for time period of *1990 – 2006*, which is post-transition period for most of these countries. For some of these countries data is not given sequentially as it is missed for some years, which means that I during writing process I deal with unbalanced panel data (see Wooldridge, 2002).

Table 4. 21 developing countries included to the model.

Countries	
1. Albania	12. Luthiana
2. Armenia	13. Poland
3. Azerbaijan	14. Republic of Moldova
4. Belarus	15. Romania
5. Bosnia-Hercogovina	16. Russian Federation
6. Bulgaria	17. Tajikistan
7. Croatia	18. Macedonia
8. Georgia	19. Turkmenistan
9. Kazakhstan	20. Ukraine
10. Kyrgyzstan	21. Uzbekistan
11. Latvia	

World Bank, July 2008

Modeling

As mentioned above the main assumption of this thesis is that M:F LED depends on the stage of the development a certain country attained. The case is that the development of the country stimulates the increase in LE of males through the fact of better work and more stable life conditions, fewer stress is experienced along with the products and services of higher quality provided. On the other hand, as the development process of the country occurs, the balance between female and male participation in the socio-economical and political life of the country stabilizes. This means that females experience approximately the same level of stress and preserve the same kind and frequency of activities as males do. The expected consequence of this smoothing is that LE of females gradually approaches the LE of males and hence LED between sexes diminishes.

In order to support this idea by empirical evidence, I turn to econometric analysis and use some advanced panel data methods, which are discussed below. During estimation process I use *Pooled OLS Method, Fixed Effects Method and First Differences Method*. I start the work with a simple model including three main development indexes, namely real GDP (PPP per capita), Gini Index and Human Development Index (HDI):

$$Led^{45+}_{i,t} = \beta^{1}_{i,t} * GDP_{i,t} + \beta^{2}_{i,t} * Gini\_Index_{i,t} + \beta^{3}_{i,t} * HDI_{i,t} + \alpha_{*}\upsilon_{i} + \omega_{i,t} \quad (1)$$

where $\omega_{i,t}$ includes other unobserved factors, *i* denotes country specific cross-section, *t* – time periods for which the data is available. Special attention should be paid to the $\upsilon_i * \alpha$ term. Here υ_i consists of constant term and country specific effects, which may or may not be observed. In the case, when country specific effects do not exist and there is only constant error term, which can easily be included to ω_i, Pooled OLS can be implemented, providing

consistent and efficient estimates for the given regression model. Nevertheless, if the situation is such, that country specific effects do exist, still there is no way to estimate these effects Fixed Effect Method is worth to use in order to obtain unbiased and consistent estimators (W. Greene, 2002). Another opportunity to eliminated country specific fixed effect is to apply First Differences Method. The latter method should be used, when there is serial correlation among the unobservable terms across time period. In such a case subtraction excludes correlation among ω_i and first differences estimators will be efficient and consistent (Wooldridge, 2003).

I expect GDP and HDI to have a negative impact on the LED. An increase in GDP should lead to the expansion of the standards of living, working conditions, etc. Hence, on the one hand, it is expected to have a positive impact on the LE of the population in a certain country. On the other hand, more companies and enterprises have possibility to function, thus larger amount of labor force participation is required and higher ratio of females are involved to the creation of GDP. This approximates their male-female life styles and their LE approaches the same critical value. The result of this processes taking place is the decrease in LED between the genders. The same logic can be applied to HDI, with the conclusion that countries with higher HDI are more developed and can provide population inhabiting that country with better quality of services, products and consequently better living conditions. Therefore, M:F LED decreases, when the upward trend is observed in the HDI.

Coming to Gini Index, one should expect it to increase the difference between male and female LE. The idea is following. It is of common knowledge, that the higher Gini Index the higher inequality in wealth distribution in a country (The World Factbook). The evident outcome is that families with lower income can afford fewer goods and services, experience higher stress and consequently LE decreases. Higher decline in male LE than in female LE is

expected, for the reason they are exposed to higher stress and weaker health status than females, which results in increase of the LE gap between sexes.

In order to get more accurate results and to decrease the error term, I do the following model modifications. To begin with, as far as correlation index between GDP and HDP is revealed to be close to 1 (see table 5), what prevents the efficient estimation and results in overestimating of the coefficients, *HDI is excluded from the equation (1)*. The reason of leaving GDP in the model, while dropping HDI, is that there is no enough data on HDI to continue further extensive estimations and, on the other hand, GDP in most similar analyses is considered to be a good proxy for the development of the country given the data shortage.

Table 5. Correlation coefficients of the variables of the model (1).

Variables	LED^{45+}	GDP	Gini Index	HDI
LED^{45+}	1.00	-0.59	-0.02	-0.58
GDP	-0.59	1.00	0.002	0.9
Gini Index	-0.02	0.002	1.00	-0.1
HDI	-0.58	0.9	-0.1	1.00

Even if this is the case, the high correlation between GDP and HDI provides the basis to state that these variables have a similar impact on LED, suggesting that all aforecited discussion concerning the effect of the HDI on LED still holds true.

Further, *I add more variables describing the socio-economic situation in the given country*. Among them there is Percentage of Urban Population Ratio (Urbn_Pop) and Labor Force Difference (L_F_D) between males and females. As far as most of the developing countries faced (some of them are still experiencing) a certain periods of the political

instability, which surely leaves a mark on the LE trends, including Political Stability (PS) indicator to the model, along with the described variables would be of a great value. Unfortunately, lack of the data on PS prevents including this factor to the regression.

After abovementioned modifications are done, the model takes the following form.

$$Led^{45+}_{i,t} = \beta^{1}_{i,t} * GDP_{i,t} + \beta^{2}_{i,t} * Gini\_Index_{i,t} + \beta^{3}_{i,t} * Urbn\_Pop + \beta^{4}_{i,t} * L\_F\_D + \upsilon_i * \alpha + \omega_{i,t} \quad (2)$$

For the reasons similar to the ones provided for GDP and HDI, Percentage of Urban Population is also expected to smooth the difference between genders by decreasing LED, whereas difference in Labor Force Participation has an opposite effect. The idea is that increase in L_F_D, occurs when there are more men and less women participating in labor market. Consequently, increasing working stress of males, possibility of road accidents and other factors negatively affect their LE, while having no impact on for females. Hence LED in this case is obviously has an augmentative trend.

The second type of variable, having an impact on the LED, is those describing possible causes of mortality. These variables have an impact on the LE of both sexes, for most of them it is true that male LE is more sensitive to these diseases than females LE though. Their causing high level of mortality affects LE by decreasing it and as far as males are physically more inclined to such kinds of diseases their LE declines with a rate higher than female LE, entailing increase in M:F LED. The model describing this relationship is as following:

$$Led^{45+}_{i,t} = \alpha^{1}_{i,t} * circ\_d\_M + \alpha^{2}_{i,t} * cancer\_M + \alpha^{3}_{i,t} * Inf\_par\_M + \upsilon_i * \alpha + \omega_{i,t} \quad (3)$$

As it is seen from the final regression, the diseases included in to the regression model are divided into three main groups. The first one is disease of the circulatory system, which

are more typical for males. The fact that males suffer from this type more frequently than females is stipulated by the higher level of stress experienced and intensive daily life. The second type of diseases increasing LED is the cancer of the lung, bronchus and trachea, which is also more characteristic for men. The explanation is that men consume more tobacco and the ratio of males smoking is much higher that the ratio of females, the obvious consequence is higher frequency of the lung, bronchus and trachea cancer cases among males. As a result their LE decreases, what results in increase in LED. Finally, the last group of diseases influencing the difference in LE between genders is infectious and parasitic ones, which have the same tendency as well as distribution between males and females. Hence the impact of the given group of mortality causes on the LED is the same as the impact of the previous two groups. For the reason, LE of males is more sensitive to these diseases, the data on these variables only for males is included to the last model, which should provide better results.

Results

In this chapter the result, obtained from the estimation of the models described in the previous section, are presented. Due to the fact that not all of the results are found to be significant, the discussion of the impact of those ones only is included to the given analysis, which do have a significant influence on the LED.

Model 1. *All variables of the model (1) failed to meet the significance criteria on the either of the significance levels, using Pooled OLS Method*. The reason for having no significant impact can be, on the one hand, a country specific effect, which is not observed for data shortage or estimation limitations. In order to control for this unobservable, I implement Fixed Effects and First Differences Methods. What transpires is that, *while using Fixed Effects Method the only indicator of the development, which has an impact on the LED is Gini Index.* According to this estimation results, as was expected, an increase in Gini index by 1 point, which indicates inequality in income distribution among families, leads to increase in M:F LED by 0.04 years at the 5% significance level (t-statistics = 1.96). Nevertheless, *while using First Differences Method the significance of this variable as well as all the rest does not hold anymore*, entailing impossibility of deriving any conclusion about the impact by any of the given regressors on the LED. In order to determine which method provides reliable results first order serial correlation in the error term using Durbin-Watson statistics is tested for (William E. Griffiths, R. Carter Hill, and Guay C. Lim, 2008). Given the fact that First Difference Method provides Durbin-Watson statistics equal to 1.88, which is close enough to 2, the same indicator is much lower (=0.7) while applying Fixed Effects Method, the conclusion of First Differences Method being more preferable can be induced. On the other hand, as it was discussed above, high correlation between GDP and HDI may result in

insignificance and inefficiency of the estimators of this model. In order to eliminate this shortage of the given model, as well as to decrease the unobservable term, I switch to the next model.

Model 2. Eliminating HDI and adding new variables to the initial model results in obtaining more informative and efficient coefficients. *While using Pooled OLS Method the significant impact of DGP, the Percentage of the Urbanization of Population and Difference in Labor Force participation on the M:F LED is observed*. Moreover, GDP and L_F_D perform the expected impact on the LED, which was described in the discussion above. Pursuant to results of the present estimation increase in GDP diminishes LED between males and females very slightly, per 0.0001 year (t-statistics = -1.92) and the estimator is significant at the 5% significance level. The rest two variables provide more factual results, performing well at the 1% significance level. Regression shows that positive change in the Percentage of Urban Population by 1% increases the M:F LED by 0.07 years (t-statistics = -3.5). The obtained result is different from the one, which was expected. The possible explanation is that increasing urban population diminishes amount of the health care services per individual; overpopulation in the cities, resulting in higher rate of infectious and parasitic diseases, heavy traffic and increasing number of accidents, entails decreasing LE. As far as men are more exposed to experience the negative consequences of the change in socio-economic environment the M:F LED increases accordingly. On the other hand, country specific effects which are not considered may serve as a ground for this outcome. Similar to percentage of urbanization of population, increasing gap between male and female participation in labor market have a small, still positive impact on the difference in their LE, by increasing it by 0.003 years (t-statistics = -3.5). Nevertheless, Gini Index provides no significant results, and no evidence about its impact can be presented in this case. Even though the results of the Pooled OLS appear to be logic and well performing in this case, the issue of unobserved cross

country specific effects leading to biased and inefficient estimators is still present. Thus, the same model is estimated once more using Fixed Effect and First Differences Methods. Although the estimators of *the Fixed Effect Method all appear to be insignificant*, evolving impossibility of any kind of inference, *First Order Differences Method determines significance of Gini Index and Urbanization of the Population* at 5% significance level. Hence, if an increase by 1% in urbanization level of population is observed, the decrease in M:F LED by 0.03 years (t-statistics = -2.14) should be expected. Such an outcome may be entailed by easier access to the health care services as well as better living conditions, entailing higher LE, particularly for males. The estimator of Gini Index present expected results once more, indicating that increase in the inequality in the income distribution by 1 point augment M:F LED by 0.015 (t-statistics = 1.88). Considering the first order autocorrelation, with the Durbin-Watson statistics being far below 2, while implementing Fixed Effects Method, and above 2, during the First Differences method application, it will be appropriate to consider results obtained from these estimations to be inefficient and uninformative.

Model 3. In this model the same approach as in the previous two is used to estimate the effect of such diseases as circulatory system diseases; lungs, trachea, bronchus cancer and infectious and parasitic diseases on the M:F LED. Before proceeding to discussion of the results, the following fact, which arises as a consequence of including to the model male specific indicators, should be emphasized. While interpreting the results in this model, one should consider the following refinement of the mathematical relationship between regressors and regressants of the equations. M:F LED is estimated as difference between LE of males (LE_M) and females (LE_F), i.e. M:F LED = LE_M – LE_F. Thus any kind of decrease in LE_M or increase of LE_F results in diminishing of M:F LED (M:F LED↓= LE_M↓–

LE_F↑). However, it is important to consider the signs of the variables in this particular situation. In the most cases, LE of males is less than LE of females (LE_M < LE_F), this implies that the difference between LE of males and females is negative (M:F LED < 0). As a result, it is required to divide the coefficient of each regressor by -1, in order to get reasonable interpretation of the estimation variables for the M:F LED. While using *Pooled OLS Method highly significant impact (1% significance level) of diseases, namely cancer and circulatory system diseases, on the given difference is identified*. Lung, trachea and bronchus cancer increases M:F LED by 0.05 year (t-statistics = -8.08), circulatory system diseases have smaller impact at the rate of 0.03 year increase (t-statistics = -3.04). Further, as in each of the aforecited models, the cross country fixed effect should be controlled for. In this purpose the Fixed Effects and First Differences Methods estimations are performed. The results indicate *highly significant positive impact of circulatory system diseases as well as infectious and parasitic diseases of males on LED* at the 1% and 5% significance levels accordingly, *while applying Fixed Effects Method*. Reverse is true, *if First Differences Method is implemented, i.e. the significance level of circulatory system diseases in this case is 5% along with 1% for parasitic and infectious diseases*. The results of the Fixed Effects Method indicate that increase in a number of males suffering from infectious or parasitic disease causes increase in M:F LED per 0.02 year (t-statistics = -2.35), while if the case is circulatory system disease the augmentation is only 0.002 year (t-statistics = -2.84). First Differences estimation displays an increase in M:F LED per 0.014 year (t-statistics = -4.13) in the infectious and parasitic diseases cases increase among men and 0.001 year (t-statistics = -2.32) rise if the increase is observed in the number of circulatory system diseases among males. Once more Durbin-Watson statistics testing for first order serial correlation among unobservable terms supports the efficiency of the First Differences Method, showing the statistics close to 2, suggesting absence of serial correlation, while it indicates positive serial correlation when Fixed Effects

Method is used. However, Durbin-Watson statistics is not informative in terms of higher order serial correlation. In order to check for it, correlogram of residuals, which describes autocorrelation among residuals, is built. According to the results of this test the given model does not suffer from the serial correlation, due to small correlation coefficients, for instance the second lag has coefficient 0.11, the third one 0.06 and the higher the lag the lower are coefficients in the correlogram. Eventually, the initial conclusion concerning the First Differences performing efficient and reliable estimators holds true.

Table 6. The statistically significant estimators of the models (1), (2), (3).

Independent Variables	**Dependent Variable**		
Model 1.	Pooled OLS	Fixed Effects	First Differences
GDP			
Gini Indec		0.04**	
		(0.19)	
HDI			
Durbin-Watson statistics		0.74	1.87
Observations	149	149	87
Model 2.	Pooled OLS	Fixed Effects	First Differences
GDP	0.0001**		
	(0.00006)		
Gini Index			0.015**
			(0.008)
Urbn_Pop	0.07***		-0.03**
	(0.02)		(0.01)

L_F_Dif	0.003*** (0.001)		
Durbin-Watson statistics	0.18	0.76	2.96
Observations	234	234	194
Model 3.	Pooled OLS	Fixed Effects	First Differences
Cancer_M	-0.05*** (0.01)		
Inf_par_M		-0.02** (0.01)	-0.014*** (0.003)
Circs_M	-0.003*** (0.001)	-0.002*** (0.001)	-0.0010** (0.0004)
Durbin-Watson Statistics	0.02	0.75	2.34
Observations	334	334	311

*** Statistically significant at 1% significance level

** at 5% significance level

* at 10% significance level

Standard errors are given in the parenthesis

Conclusion

In the present work the impact of the development of the country on the M:F LED is analyzed. The research is based on the country specific development indicators with application of econometric models and estimation method.

The results of the given study reveal no direct significant impact of the either of development indicators on the LED between males and females throughout the changes in models and methods during the research. Hence, there is no basis to make any kind of conclusions about the direct consistent effect of these variables on the M:F LED. This result can be explained by the fact that the development indicators used during estimation process are not informative enough about country specific effects for the short period of time within which the survey is carried out. However, *their accumulative impact is displayed in the diseases, which are the included in the final model* (see table 7).

Table 7. The impact of the development indicators on diseases by groups.

Independent Variables	**Dependent Variable**		
Circs_D	Pooled OLS	Fixed Effects	First Differences
GDP	-0.02**	-0.02***	-0.02***
	(0.01)	(0.01)	(0.003)
Gini Indec			
Urb_Pop	0.06***		
	(0.22)		
L_F_Dif	-0.26***		0.04**
	(0.09)		(0.02)

Durbin-Watson statistics	0.15	0.53	2.7
Observations	231	231	191
Inf_par_D	Pooled OLS	Fixed Effects	First Differences
GDP	-0.001**		-0.001***
	(0.001)		(0.0004)
Gini Indec	0.75**	-0.65**	-0.32*
	(0.38)	(0.28)	(0.18)
Urb_Pop			-0.3*
			(0.18)
L_F_Dif			
Durbin-Watson statistics	0.18	0.69	1.6
Observations	231	231	191

*** statistically significant at 1% significance level

** at 5% significance level

* at 10% significance level

Standard Errors are given in parentages

The negative influence, for instance, of the GDP on circulatory system diseases accumulated for years, results in decrease of the LED between males and females through the correlation between given disease and the difference between LE of males and females, which was determined in the previous chapter. Even if at the first glance a direct effect was expected, it is not determined, which is due to the stage of the development a certain country has attained. As far as, the object of the research is developing countries, even if the increase in GDP entails relatively better service conditions, providing better health care services and thus decreasing number of the diseases discussed earlier, it is not high enough to perform a direct effect on M:F LED.

The possible ways of solution of the emerged situation is to pursue a policy intended to improve the health care services, by increasing the governmental spending on health care as well as extend utilization of the health insurances in order to prevent self-treatment and increase diseases prevention measures. In the countries with heavy traffic provide better public transport services, which decreases the number of accidents and stress on the one hand, and improves the environment conditions on the other hand, which have an impact on the health status of the population as well could be another possible solution. The measures preventing pollution of the environment, such as arrangement of green spaces, transferring heavy industries to the less populated territories, are also important to the end of decreasing M:F LED.

At the end, it is important to note that above stated results are valid in short term, suggesting that initial expectations about direct influence of development indicators of the country on LED may be actual in long term period given more observations are available and data of better quality is provided. In other words, development indicators may perform significant positive influence on the M:F LED in longer term. This supposition provides basis for future researches, which will rely on a longer time period and wider data base, including information about such parameters as political stability, mentality of local population, and indicators on leisure preference and willingness to work, as well as environmental factors, which are not observed in this work due to a data shortage.

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