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# Regional Life Expectancy in Russia 1996-2019 – A Preston Curve and Convergence Clubs

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## Abstract
Russian regional life expectancy at birth is shown to improve 1996-2019 using the average life expectancy as well as by gender with the extremely high gender gap decreasing. Life expectancy at the traditional retirement age also increases using a broad measure of economic development (Human Development Index) but not with a narrow measure (per capita real GRP). Regional female life expectancy except for a few outlier regions such as Moscow city converges over time while regional male life expectancy forms two convergence clubs with one converging at a much higher speed than the other indicating that the extremely low male life expectancy in Russia is more heterogeneous than female life expectancy.
**Key Words:** Russian regions; Life expectancy; Preston curve; Convergence clubs.

## 1. Introduction
Life expectancy (LE) performance in Russia's regions is perhaps more pertinent than ever before as the dual shocks of the pandemic and Ukrainian war have reduced resources to improve LE while military recruitment could worsen the already large male/female LE gap (hereafter "LE gap") that has long characterized Russian mortality. In 2018, the government listed as one development goal the achievement of LE at birth of 78 years by 2024 and 80 years by 2030 (Shartova *et al.*, 2021) with such a goal sometimes contained within a vague "increase the population" decree (Rybakovskii, 2022) now in doubt. While average LE can now be examined prior to the pandemic across many years (1996-2019) and regions (79), we can also examine male and female LE separately as well as the gap between them plus LE at retirement age. Over time, improved development should result in LE trending upward and the gap closing as while female LE might continue to increase, male LE is far too low and would be expected to rise faster than female LE if development is having a positive impact on health unlike the Soviet era where unusually male LE fell during peacetime until the mid-1980s (Zhuravskaya *et al.*, 2024). How LE is impacted by economic variables is surprisingly understudied even in Russia (Rotova, 2020). At least one study cites the need to look at divergence/convergence effects across time and space to better understand the LE experience since the 1990s (Timonin *et al.*, 2017). The relationship between LE and income has been studied for many decades with one popular method being a Preston curve that illustrates the slowing improvement of LE as income increases on a logarithmic curve with several applications to Russia and the Soviet Union found in the literature (e.g., Shkolnikov *et al.* (2001)). How the Preston curve shifts can be examined using Herfindahl concentration levels and income distribution with the latter seen as one of many shift factors for the Preston curve with greater dispersion usually found to be lowering LE. Unlike previous studies, we apply the Preston curve to the LE average, by gender and the gap in years plus LE for seniors. Further, unlike any literature we could find, we examine divergence/convergence of LE without any a priori grouping of regions (e.g., Bartoll and Mari-Dell'Olmo (2016)) using the logt test econometric method of Phillips and Sul (2007;2009), that avoids technical issues such as cointegration as well.

Section two summarizes the literature. Section three outlines the data and descriptive LE statistics. Section four describes the method and section five discusses the results. Section six concludes.

## 2. The Literature
While the Preston curve is decades old, there is also a small literature on health production functions using LE as the dependent variable which is summarized in Halicioglu (2011). Purely descriptive studies of LE differences across regions that go into details about why LE remains so low in some regions and the idea of regional clubs is mentioned (e.g., Rimashevskaia *et al.* (2012)) but not analyzed econometrically. The LE production and Preston

equations are quite similar so we use the Preston curve with literature on that method in the $20^{th}$ century summarized by Rodgers (2002) and Preston (2007). For Russia, a summary of much of the LE literature and a Preston curve analysis across regions 2005-2015 has recently been done (Shkolnikov *et al.*, 2019). They point out that Russia has been an exception to the usual Preston results in that during some of the Soviet era (1965-1984) LE declined though income and wealth increased. In the 1990s there was a return to the more usually found lower LE when income and wealth declined across regions (Shkolnikov *et al.*, 2001). Since 2000, LE and income/wealth both increase for Russia overall too which suggests the entire transition era 1996-2019 follows the typical Preston curve relationship. Moscow and St. Petersburg remain outliers with mortality reductions there likely to cause divergence in cross-regional LE rates, but when omitted from the sample most of the other regions show converging LE rates 2003-2014 (Timonin *et al.*, 2017). Rather than rerunning regressions with the two largest cities omitted from the sample, we examine the issue of LE convergence in more detail by descriptively looking at sigma convergence and econometrically examining the possibility of LE convergence clubs over time using a logt test which we believe has not been done for Russian LE ever.

## 3. Data and Descriptive Statistics

Regional LE at birth is available from Rosstat for all years in the transition era for both genders. To facilitate the use of other control variables, we begin the sample period at 1996 and end just before the pandemic in 2019 with the impact of the pandemic and Ukraine war left for further research. We divide the sample period into three subperiods 1996-2007, 2008-2012 and 2013-2019 with the last subperiod the only one with seniors LE data available. By seniors we mean life expectancy at the traditional retirement age of 55 for women and 60 for men. By traditional, we mean that since the 1950s when Khruschev lowered the retirement age for women from 60 to 55 in 1956 as part of a broader ideological effort to increase women's "social protection" and to quickly show that female labor force participation rate was as high as that of men. The reform allowed grandmothers to participate more in childcare, which was officially viewed as a woman's primary responsibility. The younger age for women than men though the former live much longer became by the 1990s an important factor for improving women's lifetime earnings (Ogloblin, 1999). In June 2018, Putin announced the plan to increase the retirement age for women from 55 to 63 and men from 60 to 65. In July 2019, following widespread protests and a fall in his popularity, he amended the plan to reduce the raising of the retirement age for women from 63 to 60 years. Starting in January 2019, the retirement age is increasing by one year each year, from 60 to 65 for men and from 55 to 60 for women. Due to data availability we only examine senior LE over time and regions with the traditional ages.

The average, female and male LE means all increase across the subperiods (Table 1). Also male LE variance is about twice female LE variance in any subperiod. Though skewness is within normal bounds (-2,2), female LE skewness is always negative while male LE skewness is always positive. Average LE skewness is negative in the first two subperiods but positive in the last one. Female LE kurtosis is higher than male LE kurtosis suggesting outliers are more likely with female LE. The mean LE gap decreases by a year across each subperiod showing improved LE over time. Senior male LE has much higher variance and skewness than senior female LE with the LE gap for seniors being 10 years.

For control variables (Table 2), we use several data series from Sohag *et al.* (2023) kindly provided by the authors with details of their formation and sourcing left to their work. The data include a standard Theil index of economic diversification based on 20 economic groups classified by their Russian classification categories. We use the "extensive margin" Theil index from their study as it reflects the diversification among regions. It is equal to zero if all economic groups are represented in a region and has a value as high as 2.9 with many fewer groups. They also construct a standard Herfindal Index (HHI) which varies from 0 to 1 with a lower number representing a more diversified regional economy. As the Theil index and HHI are positively correlated (0.38), we use both in the regression to fully control for economic diversity of a region. We also use their natural log of per capita real Gross Regional Product (pcGRP) series as well. The Russian statistical service (Rosstat) also provides a regional Human Development Index (HDI) based on the standard United Nations methodology. HDI is a broader measure of a region's economic development than per capita GRP which is sometime criticized as being too narrow to represent the standard of living. pcGRP is uncorrelated with all LE variables, HDI and HHI. HHI is also uncorrelated with all LE variables and HDI.[1] Regional HDI data are unavailable 1996-1998 but do exist for the more aggregate Federal Districts. During the three-year period, the Federal Districts all had a HDI value near 0.7 so we assume this value for these three years across all regions given the lack of data and chaotic economy of the mid-1990s. HDI is highly and positively correlated with average LE as well as gender specific LE and, as a higher development level would suggest, is highly and negatively correlated with the LE gap between women and men.

## 4. Methods

We apply a standard OLS Preston curve from the literature including a trend and regional fixed effect. Russia has always been an exception to the regular Preston curve result of "d" being positive (Shkolnikov *et al.*, 2019).

$LE_{it} = a_{it} + b_t + c_i + dLn(GRP_{it}) + Z_{it} + \varepsilon_{it}$ (1)

We expand from a simple Preston curve by examining not just the average LE as the dependent variable, but also use the female LE, male LE, or LE gender gap as the dependent variable with LE at birth and LE for seniors too. We control for a region's economic complexity by including in the Z shift factors the Theil and HHI indices. Finally, we allow for the pcGRP being too narrow a measure of economic development but substituting HDI for pcGRP in a second series of regressions. All regressions are run with robust error term to correct for the well-known heteroscedasticity of Russian regions.[2]

Though Russia's Preston curve has been unusual in the past, we hypothesize that relatively higher levels of development (pcGRP or HDI) will improve LE so "d" should be positive overall and with either gender, but negative with the LE gap. The trend term should be positive as over time advances in health knowledge and technology should improve LE. As the Theil and HHI indices rise, the economy is less diverse but in the Russian case this could mean a concentration on oil and gas wealth, so we treat these two variables as control variables with an uncertain sign. Importantly, we could find no prior work with the Preston curve for Russia that addressed the mix of economic activity in a region when looking at economic development.

Sigma convergence is easily examined using the coefficient of variation across regions with all four of the LE variables with convergence defined as a lower coefficient of variation result over time. Then we use the nonlinear time-varying econometric (Phillips and Sul, 2007) "log t test" method that permits multiple equilibria or clubs of regions that might not be detected with just using the coefficient of variation and allows for testing of β-convergence over a long period of time. The Phillips and Sul (PS) method is superior in that it can detect clubs and test convergence simultaneously while also not being constrained to be linear. Different time paths and individual heterogeneity of states are also allowed making it more flexible than prior methods with no requirement that the time series be cointegrated (Bartkowska and Riedl, 2012).

Following the PS method descriptions of Zhang *et al.* (2019) closely and leaving details to Du (2017), the four LE variables (average, female only, male only, female/male gap) are decomposed. For each variable, the panel is denoted as $X_{it}$ where i = {1, . . ., N=79} and t = {1, . . ., 24} with t being years in the sample 1996 to 2019. The natural log of $X_{it}$ ($Ln(X_{it})$) is decomposed into:

$$Ln(X_{it}) = (c_i + \beta_i \varepsilon_{it} L(t)^{-1} t^{-a})\mu_t \qquad (2)$$

where $\mu_t$ represents the common stochastic trend, $c_i$ is fixed, $\varepsilon_{it}$ is iid (0,1) across *i* but weakly dependent and stationary over t. L(t) is the slowly increasing varying function with L(t) going to ∞ as *t* goes to ∞. L(t) is assumed to be log(t) and a is the decay rate which gives the method its name "log t test." A standard Hodrick-Prescott filter is used to separate the trend and cyclical components. If β is less than zero then the absolute convergence hypothesis is rejected and in a next step, conditional or club convergence using the β value can be done. Importantly, if we reject that all regions converge, this does not necessarily mean they diverge as there may be multiple equilibria or club convergence.

Testing for club convergence uses an iterative algorithm described in Phillips and Sul (2007) with significance at the 5% level. To do the test, the data must be stacked based on a final value for each region which is the 2019 LE value. This year represents the last year before the pandemic with the impact of the pandemic left for another paper. A club can contain any number of regions from two to N-1 members with the membership number variable k. The size of the club is determined by the estimated t-statistic of β. As long as the estimated t-statistic is greater than -1.65 a region joins a club. When two regions meet this threshold, the process continues to add regions in the order they were stacked. When a region no longer meets this threshold the first club is formed. That last region then begins the process again toward forming a second club. If no club can be formed the regions are diverging not converging. If an initial set of clubs is found, a log *t* test is done for all pairs of clubs to see if clubs can be further merged to jointly meet the convergence hypothesis using Von Lyncker and Thoennessen (2017) algorithm. The result is a final number of clubs that cannot be further merged which also evaluates the stability of the initial set of clubs. We will only discuss the final club results though the initial club results are available upon request.

## 5. Results

Using four dependent variables – LE at birth average and for each gender plus the LE gap – the trend term is statistically significant and positive for the first three and negative for the LE gap which is expected if LE is increasing over time and male health is narrowing the large gap with female health as well (Table 3). The simple Preston curve result of higher economic development raising the LE is also found using either HDI or pcGRP as a measure of development. Using the Theil measure of economic diversity, LE by gender, average and the gap is higher with a more diverse economy across the regressions though the negative sign is not always statistically significant. Using pcGRP, the HHI is positive but insignificant for average LE and by gender but matching the Theil results is significant and negative for the LE gap. When HDI is used, the HHI result is similar to the Theil results thereby providing robust evidence that higher LE by gender and average is found in a region with a more economically diverse economy. All equations have a regional fixed effect and reasonable overall fit (R-squared).

Looking at LE at retirement age, the trend term is again statistically significant and positive for average LE and both genders' LE but is no longer significant for the LE gap indicating over time any improvements in male LE at retirement age have been matched by improvements in female LE at retirement age (Table 4). Economic development represented by pcGRP becomes insignificant and even with a negative sign suggesting a region's development does not give a standard Preston curve result including with the LE gap. However, when pcGRP is replaced by the broader HDI index, the Preston curve hypothesis is nicely supported with a decline in the LE gap when development is relatively higher. The Theil index is negative and significant for average LE and both genders' LE indicating a regionally diverse economy improves both LE at birth and retirement age using either pcGRP or HDI. The Theil index now has no statistically significant impact on the LE gap. The HHI results are quite different using pcGRP versus HDI for economic development. With pcGRP in the equation, a less diverse regional economy improves senior LE average and for both genders plus decreases the senior LE gap. Using HDI in place of pcGRP, the HHI index is insignificant except with the LE gap where it behaves as in the pcGRP equation. The overall fit of all equations with a much smaller sample is good.

The coefficient of variation (not shown in a table, but available upon request) across the 24 years exhibits no evidence of sigma /divergence convergence for either gender LE or only a slight convergence for average LE suggesting regional LE increases over 24 years but regions with relatively low LE are not improving their health faster than leading regions – the LE distribution is fairly constant. However, a descriptive look at overall convergence could miss convergence clubs and multiple equilibria, so the PS results are more important. While a log t test for all regions indicates no convergence in the panel (Table 5, part A), two convergence clubs form after decomposing the variable with most regions in a weakly converging club with a mean LE of 67.5 over time and space. A second club with regions scattered across Russia do converge and have a lower LE of 66.6. The six remaining regions with do not converge and constitute an outlier group. Female LE like average LE appears not to converge with an initial log t test (Table 5, Part B). Once clubs considered, female LE is more homogenous with almost all regions weakly converging at a mean LE of 73.5 in one club though female LE has more outliers than male LE. Just six regions with a much lower mean female LE (71.8) exhibit no convergence with all but Moscow city and Ingushetia being in the Far East. Female LE except for these six regions indicates regions with relatively low female LE improve faster than regions with relatively high female LE.

Male LE (Table 5, Part C) like the prior two results indicates no convergence at first. However, clubs are found to be similar to the average LE results. Fifty-seven regions are in a weakly converging club with a mean male LE of 61.6. Eighteen regions strongly converge with a mean LE of 60.3. This second club like the second club with average LE converges at a much faster speed than the other club with most of the regions in it suggesting both LE average and male LE are much more heterogenous than female LE which really has one club only. Like the prior results, four regions with a mean of 60.3 do not converge and are the same regions found in this group with average LE and female LE. Finally, the LE gap like the others appears initially not to converge, but then, unlike the other three LE variables, four convergence clubs are found with no clear exclusive Federal District within Russia containing a club's members (Table 5, Part D). Further, these clubs are all converging at a similar speed so unlike average and male LE. Three regions with a much lower mean LE gap (7.94) do not converge including Moscow City.

# 6. Conclusions

The Preston curve hypothesis of higher economic development leading to higher LE is using either pcGRP or HDI to measure development supported for Russian regional LE average and by gender. Unlike the last three decades of the Soviet era described in Shkolnikov *et al.* (2019), LE rose as income rose across regions. Further even as pcGRP growth stagnated after 2010, LE continued to increase partly because advances in cardiovascular health (Timonin *et al.*, 2017) both for LE at birth and for seniors. The unusually large gender LE gap compared to other countries narrows across regions as economic development increases which is also a positive sign for Russian regional health levels. The economic diversity of a region improves LE average and by gender but the LE gap is relatively narrower with less economic diversity in a region. Therefore a region dominated by the oil/gas sector such as Tyumen, for example, would improve LE and see the LE gap narrow relative to a more diverse region such as Rostov Oblast. Senior LE which we were unable to find any empirical literature on does improve if economic development includes measures of health and education (HDI) and not just production (pcGRP) reflecting that a high share of GDP in Russia is from extractive industrial sectors. While a less economically diverse regional economy reduces the LE gap using either a Theil or HHI diversity index, the average LE and gender LE results are mixed with one diversity measure's results the opposite of the other. Average and gender specific senior LE is improving with the gap narrowing also only when a broad measure of economic development is considered.

While an initial look at LE convergence suggests a stagnation in LE regional distribution over time, an econometric test yields two LE convergence clubs for average LE indicating a group of regions scattered across Russia lags behind a larger group where development is helping relatively low LE regions catch up to relatively high LE regions with a few regions such as Ingushetia outliers that do not converge at all. Female LE is more homogenous in that almost all regions are in a single club and converge. Male LE is similar to average LE with more than one club. The LE gap having four clubs plus a small group that does not converge indicates significant heterogeneity in closing the large female/male LE gap in Russia which is quite large compared to other countries. Male life expectancy does improve over time but not to where the relatively low male LE regions improve more than others. The results here provide a base to examine the impact of the pandemic and Ukrainian war on the level, growth and speed of convergence of LE across Russia by gender and for the LE gap as well.

Further research beyond the scope of this paper includes extending the analysis to include the COVID years and the Ukrainian war 2020-2024 as data become available. Linking the LE results to unemployment rates as has been done in a regional panel of non-Russia Europe (Bartoll and Mari-Dell'Olmo, 2016). Such links can help understand if the regions where military recruitment and mobilization are relatively high (Solanko, 2024) are also regions where LE was already relatively low meaning the continual need for troops could create new LE clubs as high mortality disproportionally impacts high LE regions. LE club analysis can then be included in examining whether some regions are so badly impacted by the Ukrainian war that the mortality there has lowered the LE significantly below where it otherwise would be leading to erosion of support for the war (Duvanova *et al.*, 2023). These clubs can also be linked to the economic growth and population shrinkage before the Ukrainian war (Batunova and Perucca, 2020) and during with hundreds of thousands believed to have emigrated since Feb. 2022.

**Notes:**

1. Sohag et al. (2023) use several other Theil indices to look at diversification but these are highly correlated with HHI so are not used here.
2. Specifically, the vce(hc3) option in Stata17 (2024) software's linear regression which yields conservative confidence intervals.

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**Table-1.** Life Expectancy Descriptive Statistics

| | 1996-2007 | | | | 2008-2012 | | | | 2013-2019 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. At Birth | Mean | Var. | Skew. | Kurtosis | Mean | Var. | Skew. | Kurtosis | Mean | Var. | Skew. | Kurtosis |
| LeFem | 71.6 | 6.64 | -0.96 | 5.65 | 73.9 | 6.81 | -1.087 | 6.02 | 76.1 | 6.33 | -0.85 | 7.55 |
| LeMale | 58.7 | 10.1 | 0.45 | 4.41 | 61.9 | 10.6 | 0.58 | 4.26 | 65.4 | 11.33 | 0.72 | 5.64 |
| LeAvg | 65.1 | 7.83 | -0.15 | 4.43 | 67.9 | 8.19 | -0.11 | 4.29 | 70.8 | 8.34 | 0.11 | 5.92 |
| Le Gap | 12.9 | 2.16 | -0.8 | 4.85 | 12 | 2.03 | -1.34 | 5.89 | 10.8 | 1.95 | -1.34 | 6.15 |
| | 2013-2019 | | | | | | | | | | | |
| 2. Seniors | Mean | Var. | Skew. | Kurtosis | | | | | | | | |
| LeFem | 25.5 | 1.64 | 0.62 | 9.16 | | | | | | | | |
| LeMale | 15.7 | 2.54 | 2.33 | 10.9 | | | | | | | | |
| LeAvg | 20.6 | 1.94 | 1.76 | 10.2 | | | | | | | | |
| Le Gap | 9.8 | 0.61 | -1.56 | 5.8 | | | | | | | | |

**Table-2.** Descriptive Statistics for Control Variables

| (n=1896) | | | | |
|---|---|---|---|---|
| Variable | Mean | Std. | Min | Max |
| HHI | 0.36 | 0.23 | 0.04 | 1.00 |
| Theil | 0.65 | 0.62 | 0.01 | 4.57 |
| ln(pcGRP) | 12.198 | 1.915 | 9.273 | 19.830 |
| HDI | 0.79 | 0.06 | 0.58 | 0.96 |

**Table-3.** Russian Regions 1996-2019 Panel Preston Curve Results (N=1896)

| **A. LE from birth, pcGRP=Econ.Dev.** | | | **B. LE from birth, HDI=Econ.Dev.** | | |
|---|---|---|---|---|---|
| 1. Average LE | | | 1. Average LE | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***-632.602 | -33.27 | Constant | ***-315.987 | -7.28 |
| Trend | ***0.348 | 37.17 | Trend | ***0.184 | 8.14 |
| RegDum | ***-0.0426 | -15.79 | RegDum | ***-0.04 | -14.47 |
| HerfIndex | 0.381 | 1.3 | HerfIndex | *-0.558 | -1.69 |
| Theil | ***-0.583 | -2.89 | Theil | -0.29 | -1.42 |
| Ln(pcGRP) | ***0.214 | 6.61 | HDI | ***19.45 | 6.92 |
| Rsq | 0.47 | | Rsq | 0.48 | |
| 2. Female LE | | | 2. Female LE | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***-494.203 | -30.91 | Constant | ***-199.513 | -5.21 |
| Trend | ***0.283 | 35.91 | Trend | ***0.13 | 6.49 |
| RegDum | ***-0.046 | -19.9 | RegDum | ***-0.043 | -18.78 |
| HerfIndex | 0.24 | 0.97 | HerfIndex | **-0.71 | -2.5 |
| Theil | ***-0.818 | -4.62 | Theil | ***-0.52 | -2.87 |
| Ln(pcGRP) | ***0.145 | 5.23 | HDI | ***18.703 | 7.44 |
| Rsq | 0.49 | | Rsq | 0.51 | |
| 3. Male LE | | | 3. Male LE | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***-771.0 | -33.85 | Constant | ***-432.461 | -8.57 |
| Trend | ***0.414 | 36.85 | Trend | ***0.239 | 9.09 |
| RegDum | ***-0.04 | -12.35 | RegDum | ***-0.036 | -11.02 |
| HerfIndex | 0.53 | 1.48 | HerfIndex | -0.41 | -1.04 |
| Theil | -0.35 | -1.51 | Theil | -0.06 | -0.26 |
| Ln(pcGRP) | ***0.282 | 7.39 | HDI | ***20.196 | 6.23 |
| Rsq | 0.45 | | Rsq | 0.45 | |
| 4. LE Gap | | | 4. LE Gap | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***276.796 | 27.33 | Constant | ***232.947 | 10.58 |
| Trend | ***-0.131 | -26.14 | Trend | ***-0.109 | -9.51 |
| RegDum | ***-0.006 | -4.38 | RegDum | ***-0.007 | -4.9 |
| HerfIndex | *-0.292 | -1.72 | HerfIndex | *-0.304 | -1.78 |
| Theil | ***-0.47 | -5.86 | Theil | ***-0.46 | -5.83 |
| Ln(pcGRP) | ***-0.137 | -8.22 | HDI | -1.49 | -1.05 |
| Rsq | 0.31 | | Rsq | 0.29 | |
| Note: ***-1%, **-5%, *-10% | | | | | |

**Table-4.** Russian Regions 2013-2019 Panel Preston Curve Results (N=553),

| Senior LE (age 55 for women, 60 for men) | | | | | |
|---|---|---|---|---|---|
| **A. Senior LE, pcGRP=Econ.Dev.** | | | **B. Senior LE, HDI=Econ.Dev.** | | |
| 1. Average LE | | | 1.Average LE | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***-350.413 | -6.26 | Constant | ***-367.49 | -6.59 |
| Trend | ***0.185 | 6.64 | Trend | ***0.189 | 6.87 |
| RegDum | ***-0.014 | -6.18 | RegDum | ***-0.013 | -6.96 |
| HerfIndex | **0.819 | 2.43 | HerfIndex | 0.21 | 0.77 |
| Theil | ***-0.555 | -4.51 | Theil | ***-0.379 | -3.15 |
| Ln(pcGRP) | -0.13 | -0.95 | HDI | ***8.068 | 3.88 |
| Rsq | 0.20 | | Rsq | 0.23 | |
| 2. Female LE | | | 2. Female LE | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***-369.736 | -7.59 | Constant | ***-378.902 | -7.77 |
| Trend | ***0.198 | 8.15 | Trend | ***0.198 | 8.23 |
| RegDum | ***-0.016 | -8.03 | RegDum | ***-0.016 | -9.24 |
| HerfIndex | *0.553 | 1.72 | HerfIndex | -0.09 | -0.35 |
| Theil | ***-0.557 | -4.5 | Theil | ***-0.388 | -3.14 |
| Ln(pcGRP) | -0.19 | -1.44 | HDI | ***6.903 | 3.86 |
| Rsq | 0.29 | | Rsq | 0.31 | |
| 3. Male LE | | | 3. Male LE | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | ***-331.089 | -4.95 | Constant | ***-356.078 | -5.34 |
| Trend | ***0.173 | 5.19 | Trend | ***0.181 | 5.47 |
| RegDum | ***-0.011 | -4.43 | RegDum | ***-0.01 | -4.76 |
| HerfIndex | ***1.084 | 2.85 | HerfIndex | 0.50 | 1.57 |
| Theil | ***-0.554 | -4.15 | Theil | ***-0.37 | -2.94 |
| Ln(pcGRP) | -0.06 | -0.39 | HDI | ***9.233 | 3.63 |
| Rsq | 0.13 | | Rsq | 0.16 | |
| 4. LE Gap | | | 4. LE Gap | | |
| | Coeff. | T-stat. | | Coeff. | T-stat. |
| Constant | -38.65 | -1.14 | Constant | -22.82 | -0.65 |
| Trend | 0.03 | 1.49 | Trend | 0.02 | 1.01 |
| RegDum | ***-0.005 | -3.95 | RegDum | ***-0.006 | -5.07 |
| HerfIndex | **-0.532 | -2.58 | HerfIndex | ***-0.591 | -3.23 |
| Theil | 0.00 | -0.04 | Theil | -0.02 | -0.27 |
| Ln(pcGRP) | -0.14 | -1.42 | HDI | *-2.331 | -1.66 |
| Rsq | 0.09 | | Rsq | 0.09 | |
| Note: ***-1%, **-5%, *-10% | | | | | |

**Table-5.** LE Convergence Using "logt test" and Four Measures of LE

| **Full Sample (79 regions, 24 years)** | | | | |
|---|---|---|---|---|
| **A. Average Life Expectancy** | | | | |
| | Beta Coef. | t-stat. | Mean | Median |
| All regions | ***-0.488 | -10.915 | | |
| Club 1 (59) All other regions | -0.05 | -0.73 | 67.5 | 67.5 |
| Club 2 (14) Kursk, Oryol, Bashkortostan, Orenburg, Kurgan, Chelyabinsk, Altai, Irkutsk, Novosibirsk, Omsk, Kamchatka, Primorskiy, Amur, Sakhalin | **0.22 | 2.6 | 66.6 | 66.6 |
| Group (no convg) (6) Ingushetia, N.Ossetia-Alania, Stavropol, Magadan, Jewish autonom., Chukotka | ***-1.04 | -30.6 | 67.20351 | 67.3 |
| **B. Female Life Expectancy** | | | | |
| | Beta Coef. | t-stat. | Mean | Median |
| All regions | ***-0.42 | -9 | | |
| Club 1 (73) All other regions | 0.04 | 0.62 | 73.5 | 73.6 |
| Club 2 (no convg) (6) Moscow City, Ingushetia, Kamchatka, Magadan, Jewish autonom., Chukotka | ***-1.05 | -35.4 | 71.8 | 70.8 |

**Table 5 cont.**

| **C. Male Life Expectancy** | | | | |
|---|---|---|---|---|
| | Beta Coef. | t-stat. | Mean | Median |
| All regions | ***-0.48 | -10.13 | | |
| Club 1 (57) All other regions | -0.05 | -0.65 | 61.6 | 61.4 |
| Club 2 (18) Kursk, Oryol, Komi, Bashkortostan, Chuvash, Orenburg, Kurgan, Sverdlovsk, Chelyabinsk, Altai, Krasnoyarsk, Irkutsk, Novosibirsk, Omsk, Kamchatka, Amur, Primorskiy Krai, Sakhalin | ***0.23 | 3.17 | 60.5 | 60.3 |
| Club 3 (no convg) (4) Ingushetia, Magadan, Jewish autonom., Chukotka | ***-1.13 | -35.77 | 60.3 | 57.3 |

**Table 5 cont.**

| **D. Life Expectancy Gap** | | | | |
|---|---|---|---|---|
| | Beta Coef. | t-stat. | Mean | Median |
| All regions | ***-1.34 | -88.92 | | |
| Club 1 (55) All other regions | ***0.38 | 3.59 | 12.6 | 12.6 |
| Club 2 (13) Belgorod, Ivanovo, Kostroma, Leningrad, Adygea, North Ossetia-Aliana, Astrakhan, Volgograd, Mordovia, Saratov, Tyumen, Buryatia, Primorskiy Krai | ***0.36 | 4.16 | 11.95 | 12 |
| Club 3 (6) Moscow Oblast, Kaliningrad, Karachay-cherkess, Krasnodar, Stavropol, Rostov | ***0.41 | 3.42 | 11.03 | 11.0 |
| Club 4 (2) Saint Petersburg, Kabardino-Balkar | ***1.18 | 7.85 | 10.37 | 10.45 |
| Club 5 (no convg) (3) Moscow City, Dagestan, Ingushetia | ***-1.61 | -28.13 | 7.94 | 7.75 |