Why Are Women's and Men's Work Lives Converging?

Demography, Human Capital Investments and Lifetime Earnings

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Abstract

This paper investigates the observed trends in demographic patterns of increases in life expectancy and decreases in birth rates alongside increases in returns to human capital investment, increases in real earnings and expected lifetime earnings for men and women as potential explanations for the increased convergence of women's and men's work lives.

Employing annual U.S. Census Annual Demographic Files and demographic data from Vital Statistics from 1964 through 2013, we estimate long-run relationships between actual life expectancy or actual birth rates, human capital investments and actual and expected labor market outcomes for men and women. Findings suggest a long-run relationship for all these variables for women while for men, changes in birth rates do not matter.

The long-run relationships are overall more convincing for women than men: Shocks to demography, human capital investments and real hourly earnings have permanent effects on women's lifetime earnings while for men only one type of shock - a change in the return to college - has a long-run impact on lifetime earnings.

Keywords: life expectancy, lifetime earnings, human capital investment, VECM

JEL classification: J3, J16, J24, N3, C22

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1. Introduction

One of the most notable trends of the last half-century has been women's increased labor force attachment, changes in attitudes towards female labor force participation and earnings (Goldin 2014; Fernández, 2013). While these trends have certainly been duly noted, measured, and analyzed, most recent papers have not taken a longer time span approach to this topic and also have not focused on the lifetime dimension of labor force participation decisions, human capital investments and lifetime earnings. In particular, earlier research did not have the data available to analyze these dimensions over a fifty-year time horizon. The longer time span that we use in this paper allows us to test whether changing demography, in particular increases in lifespan as well as changing family formation patterns, can explain much of these trends both through encouraging greater investments in human capital, and through direct effects on labor force attachment.

In this paper, we use 50 years of US Census Annual Demographic Files to track the changes in US women's and men's lifetime earnings. We calculate lifetime real earnings to consider what the lifetime payoff is for labor market participation, and show that these numbers have shown increased convergence over the fifty years from 1964 to 2013. For women, lifetime earnings have risen both because of higher hourly earnings rates and because of higher lifetime hours worked, both because of extended years of labor force participation and because of more hours worked per year of participation. We then consider what forces could have affected this measure.

We then consider the relationships that may have driven the increased amounts of lifetime work and earnings for women, both absolutely and relative to men. Figure 1 gives a schematic diagram of our hypothesized relationships. Changes in technology (i.e., external shocks to the demographic-economic social system) can affect outcomes through two main pathways: 1) effects on demographics (e.g., changes in medical technology that increase life expectancy and/or make family planning easier), where we differentiate between effects on life expectancy and effects on family structure; 2) effects on household productivity, where while it is also of course quite likely that nonmarket productivity has increased, we focus on market productivity effects (e.g., changes in work techniques such as labor-saving devices) that have both increased labor productivity, particularly for skilled labor, and possibly shifted the relative productivity of women's to men's labor.[1] We argue that as technology has increased productivity, this will have increased the returns to investments in human capital of both earnings and work experience, thus raising earnings and thus (assuming income effects do not outweigh substitution effects) increasing hours of lifetime work. In addition, through the demographic pathway, both genders both have higher payoffs to investment in human capital through having more years in which to utilize it, and also then increase their hours of lifetime work (in part due to the need to accumulate more deferred earnings for retirement). The lowered fertility rate has a similar effect of raising payoffs for women as they can now spend more time in the market, but would be expected to have less effect on men (or have the effect of reducing their labor through the income effect in households of women's higher earnings).

We contribute new insights to the literature on gender differences in work patterns on several dimensions. First, we employ individual-level data from the CPS over a long time-span of 50 years and estimate returns to experience and college, real hourly earnings and expected lifetime outcomes from this dataset. Other papers employing a time-series approach to studying gender differences in work patterns have used aggregated annual data series which has made it impossible for them to calculate the marginal returns to human capital investment (McNown and Rajbhandary 2003). Second, we collect and utilize the actual demographic patterns on life expectancy (as well as fertility and birth rates, and also marriage and divorce rates for additional consideration of demographic factors). Other studies have neglected inclusion of information on life expectancy, favoring instead a narrower focus on fertility trends, thus missing one of the most important trends over the past century or more in human demography (Salamaliki et al. 2013; McNown and Rajbhandary 2003; Hondroyiannis and Papapetrou 2002).

Thus we track both the changing amounts of human capital—measured in terms of education and potential work experience, and the changing returns to human capital—measured in terms of the returns to college education and to an additional midcareer year of work experienced, the latter calculated through estimation of comparable hourly earnings equations at each point in time. In addition, we consider how the demographic factors of

[1] For literature on these various shocks see Greenwood et al (2005), Guinnane (2011), Jones et al. (2003).

longer lives (using national vital statistics report life tables to calculate expected longevity) and changes in marriage, divorce, and childbirth rates have impacted these lifetime work values over this time span (again, both directly, and indirectly through increasing human capital investments).

While this paper addresses themes of long-held interest in the area of the economics of gender, its focus on lifetime work patterns notably differentiates it from other contributions in this area. The most comparable recent paper to ours is Mulligan and Rubenstein (2008), which focuses on increased within-gender inequality as the main driver of overall increases in women's work. In contrast to Mulligan and Rubenstein's paper and other recent papers (e.g. Autor et al. 2008) that focus on the importance of differential returns to skill, we emphasize factors that have increased work for all women and argue for their primacy in explaining the overall pattern of gender convergence. Thus we shift the analytical focus back to considering demographic factors as the main driver of current work pattern trends. In addition, we focus on increased life expectancy as a main potential avenue for change, while earlier papers in this vein have mainly focused on reduced birth rates. We argue that longer life expectancies have led to fundamental changes in how both women and men approach paid work and that this avenue is at least as important in explaining changing work patterns over the past fifty years as drops in the birth rate.

Regarding the subsequent layout of the paper: Section 2 explains the data and empirical methodology. Section 3 displays and discusses our empirical results, and Section 4 concludes.

2. Data and Empirical Methodology

For this paper we employ data from the U.S. Census Annual Demographic Files and demographic data from Vital Statistics from 1964 through 2013.

From the CPS data returns to 15 years of experience and returns to college graduation were calculated based on a Mincerian regression framework by gender. The current analysis is based on OLS regressions and further extension to this paper will include the Heckman selection corrected estimates of returns.[2] We have selected 15 years of experience and college graduation as the most significant changes over time and by gender have occurred on these two dimensions in terms of returns. Real hourly earnings for men and women are calculated from the CPS with the base year 2013.

At each point in time, we calculate expected values for lifetime earnings, considering both the probability of survival to each age and the probability of working at each age conditional on survival, and multiplying those by the actual average earnings experienced by each gender-age cohort.

From the Vital Statistics data on actual life expectancy at birth for women and men separately and the birth rate, the number of births per 1,000 people in the population, are obtained for the period.

Looking at the data over time for our key variables of interest, life expectancy at birth, birth rates, return to 15 years of experience and return to college, hourly earnings and expected lifetime earnings for both men and women, several distinct patterns for the actual demographic data, the estimated data and the expected calculations emerge, which we discuss in the following in detail.

Figure 2 shows that actual life expectancy for women has increased steadily over time from the mid-1960s to 2012 while at the same time birth rates have declined (Figure 3, for men and women). This is consistent with decreasing fertility rates over the period, a further demographic trend.

[2] For a detailed discussion on the variable selection and specification, see Jacobsen et al. *forthcoming*.

The estimated marginal returns to 15 years of experience for women over this 50 year period has increased (Figure 4) and also steady increasing returns to college completion for women, especially from mid 1980s onwards (Figure 5). While returns to college increase for women, Figure 6 also depicts an increase in real hourly earnings for women. Over the entire 50 year period under consideration, we also find that our calculated expected lifetime earnings increases steadily over time for women.

All in all, steady increases in life expectancy and decreases in birth rates or fertility are the actual demographic trends. The returns to human capital, through college and experience levels, are also increasing over time alongside increases in earnings. At the same time expected lifetime earnings are increasing also for women.

Some of these trends can be also observed for men: Men also experienced strong increases in life expectancy at birth like the women (Figure 8). This general demographic trend in increases in life expectancy at birth and birth rates extends to both men and women and can probably be accounted for some of the medical advances and fertility transitions (Guinnane 2011). However, the marginal returns to 15 years of experience and college for men are not as clearly increasing over time as for women (Figure 9 and Figure 10). At the same time real hourly earnings and expected lifetime earnings do not exhibit a clear increasing trend (Figure 11 and Figure 12).

While the female actual and expected variables of interest exhibit clear trends, this is not the case for the male variables. Looking at the summary statistics, Table 1, these variables have very different means and standard deviation by gender. For instance, women have higher life expectancy at birth than men. Also women have higher returns to college graduation than men. Reversely, men on average have higher returns to 15 years of experience, real hourly earnings and expected lifetime earnings. From the beginning of the period, 1964, to the later years, 2012, large increases in life expectancy at birth and large decreases for birth rates occurred. Returns to experience and returns to college for both genders showed large increases. Real hourly earnings and also expected lifetime earnings increases are found, when comparing the two end points of the time-series data can be observed between the two dates.

Given these differences in the trends over time and also the summary statistics, we will employ time-series analysis to our data for both women and men separately.

Each of our data series are tested for whether they are stationary or non-stationary, a pre-condition for testing for cointegration (Johansen 1988, 1991, 1995).

For each gender separately four models are tested for cointegration:

Model 1 contains life expectancy at birth, returns to 15 years of experience, real hourly earnings and expected lifetime earnings.

Model 2 is the birth rate, returns to 15 years of experience, real hourly earnings and expected lifetime earnings.

Model 3 is life expectancy at birth, returns to college, real hourly earnings and expected lifetime earnings.

Model 4 contains the birth rate, returns to college, real hourly earnings and expected lifetime earnings.

If these tests for cointegration hold, then vector error correction models are estimated to determine the long-run relationship and also the adjustment process (Johansen 1988, 1991, 1995). Thereafter, shocks of innovation to our demographic and economic variables and their effect on expected lifetime earnings are tested with impulse response functions.

3. Results

From the initial visual inspection of the data, clear increases over time in actual life expectancy at birth and clear decreases in birth rates for men and women are visible. In terms of estimated returns to human capital, real labor market earnings, and expected lifetime earnings the increasing trends for women seem larger than for men. To test whether the time series are stationary or non-stationary, Table 2 shows the results for women from the Augmented Dickey-Fuller tests (ADF), the Phillips-Peron (PP) test and the Dickey-Fuller test for a unit root in which the series has been transformed by a generalized least-squares regression (DF-GLS).[3] . The data series are presented in levels and first-differences. For the five variables of interest in levels life expectancy at birth, birth rate, returns to 15 years of experience, returns to college, real hourly earnings and expected lifetime earnings these test across the broad indicate that the Null Hypothesis for all three test is non-stationary.[4] For these variables in levels we cannot reject the Null Hypothesis of non-stationarity.

Once first-differences are applied to these series, we can reject non-stationarity and this indicates that our data series for women all appear to be I(1) processes. This confirms the visual inspection results of the data in the previous section.

In Table 3 levels and first-differences of the data series for men are presented. Here, the findings for the levels of the data for life expectancy, returns to 15 years of experience, returns to college, real hourly earnings and expected lifetime earnings are that across the board these series appear to be non-stationary. Testing these data in first-differences indicates that also for men the process underlying the series appear to be I(1) processes. From the initial data inspection this was not as obvious as for the female data series.

As all our variables for women and men are integrated of the same order, one can proceed to investigate the relationship between these variables for women and men separately. If one were to run a regression with these variables, a concern that the relationship found is a spurious one, so we must first consider whether cointegration exists for these sets of variables.

[3] The Kwiatkowski-Phillips-Schmidt-Shin tests (KPSS) for stationarity are presented in Annex 1 for women and men separately. The null hypothesis for this test is stationary.
[4] The only series that is not specifically for women is the birth rate.

In order to estimate a vector error correction model (VECM), we first perform a cointegration analysis for women and men separately. We investigate several models for women and men separately, which will follow the theoretical models described in the previous section regarding variable choice.

Table 4 provides lag-order selection statistics for the VECM with the Akaike Information Criterion (AIC) for the separate models. In Table 5 the statistics for the Johansen test for cointegration indicate the number of cointegrating equations in a vector error-correction model (VECM). The results indicate that for all the models for women a cointegrating relationship exists, albeit of differing rank order and therefore different number of cointegrating equations, supporting the notion of a long-run relationship between these different variables for women. Contrary to this, for the models for men it is found that in the cases of Model 2 and Model 4, which include the actual birth rate, no cointegration relationship exists, as the Johansen test indicates a rank of 0 to be significant. Hence, there is no support for a long-run relationship between the actual birth rate, returns to 15 years of experience or returns to college, real hourly earnings and expected lifetime earnings for men while there is for women.

For both genders we find support for a cointegrating relationship between actual life expectancy, returns to 15 years of experience or returns to college, real hourly earnings and expected lifetime earnings.

In Table 6 the results of VECMs for the different female models and for the two male models are presented. The table reports results from the estimates of the parameters in the cointegrating equation.

For women the coefficient on hourly earnings and expected lifetime earnings are significant in all four models. This suggests that the actual earnings and expected earnings enter in a statistically significant way into a cointegrating vector. In Model 2, where actual birth rates, returns to experience are added in addition to these, also returns to 15 years of experience are significant.

For men hourly earnings and expected lifetime earnings are significant in Model 3, which also includes actual life expectancy and estimated returns to college graduation. This indicates that these variables enter significantly into a cointegrating vector.

To test-evaluate the cointegrating equations, the prediction of the cointegration equations for in sample values are plotted over time (see Annex 1) for the four models for women and the two models for men. Overall, the aim is for the predicted cointegration equation to appear more stationary than non-stationary. For Model 1, Model 2 and Model 3 for women this seems to be case while not for Model 4 for women. For the male VECMs Model 1 does not appear to be non-stationary, but Model 3 does.

In order to understand the effect of shocks on the dynamic paths of all the variables in our model, we also estimate impulse response functions. In particular, we are interested to see whether shocks to demographic variables, such as life expectancy at birth and birth rates, to economic variables, such as marginal returns to experience or to college and real hourly earnings, have a transitory or permanent effect on expected labor market outcomes. In Figures 13-18 orthogonalized impulse response functions are depicted.

In Figure 13 the impulse response functions for Model 1 for women display the different shocks such a one standard deviation shock to actual life expectancy, returns to 15 years of experience and real hourly earnings and effect on expected lifetime labor market outcomes represented by expected lifetime earnings. Shocks to life expectancy and hourly earnings have a small permanent effect while the shock to return to experience seem to be closer to zero and seem to die out over time more than in the two other cases.

In Figure 14 the shocks to birth rates, returns to experience and hourly earnings all have a permanent effect on expected earnings. However, the effect of hourly earnings on expected earnings is the strongest in the short-run and long-run than the other shocks.

For women shocks to life expectancy and to returns to college seem to have the strongest permanent effect on expected earnings (Figure 15). The effect of a shock on hourly earnings has a strong short and medium run effect but then tapers off to around zero in the long run. The impulse response functions for Model 4 for women indicate strong permanent effects of shocks to the birth rate, return to college and hourly earnings (Figure 16).

For men the impulse response functions for Model 1 are not convincing; they oscillate around and do not exhibit a clear effect (Figure 17). In Model 3 the effects of shocks are permanent on expected lifetime earnings for men, in particular a shock to return to college has a long-run effect on expected earnings.

While we will need to perform additional robustness checks on these results to see if they hold up under various changes to our variable definitions and model specifications, the basic results are in keeping with our underlying theoretical structure whereby technological (or other shocks) are transmitted through various pathways, both demographic and production-related, to have measurable effects on the outcome of lifetime earnings profiles.

Figures

Figure 1: Hypothesized relationships between variables

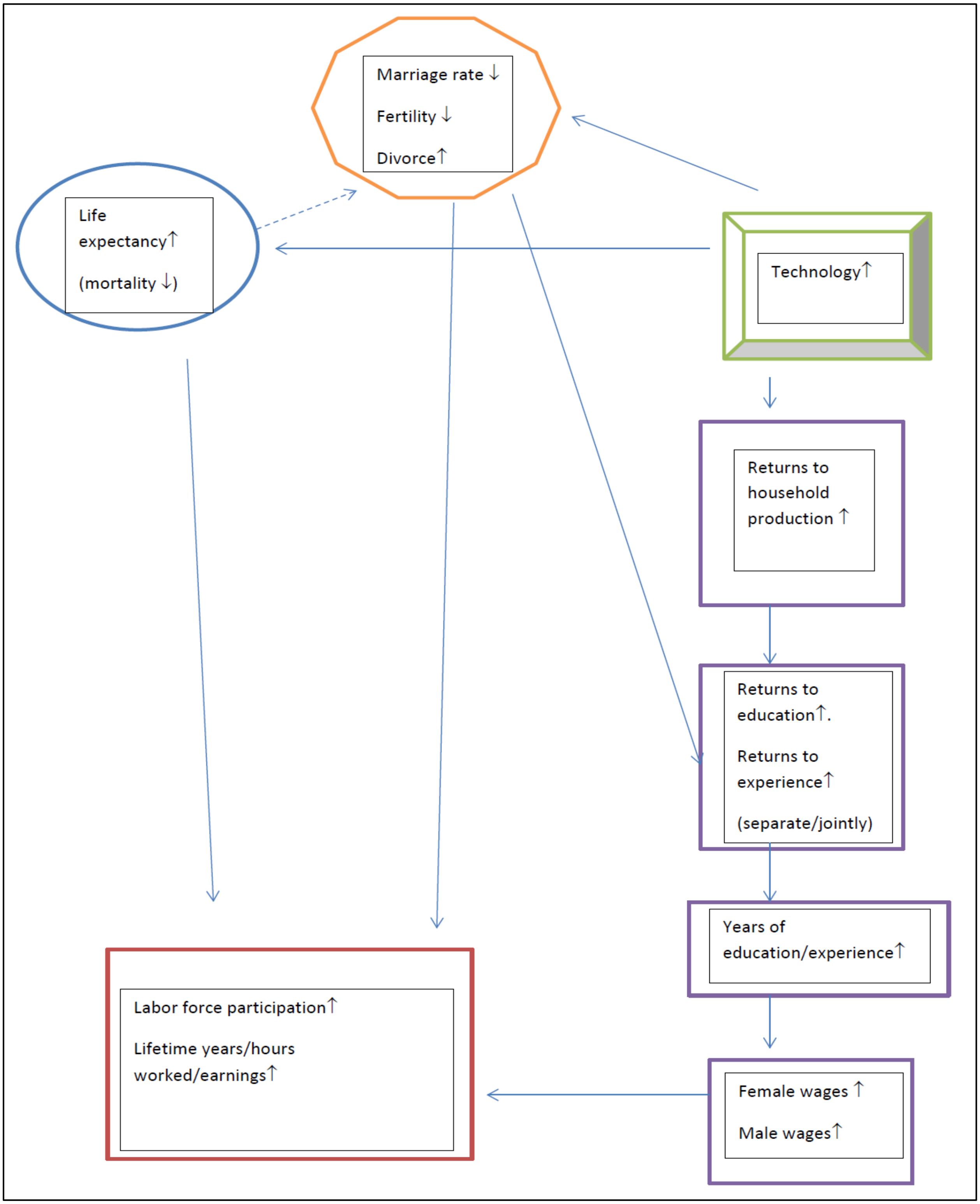
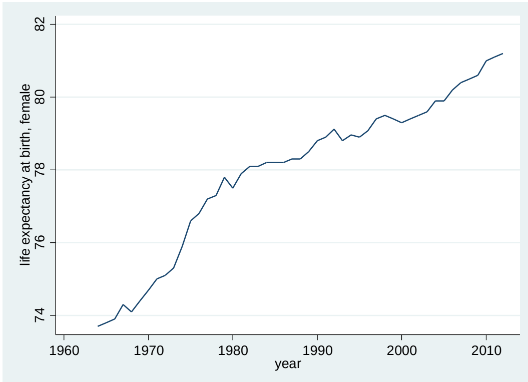


Figure 2: Life expectancy at birth, female; Figure 3: Birth rate, female and male



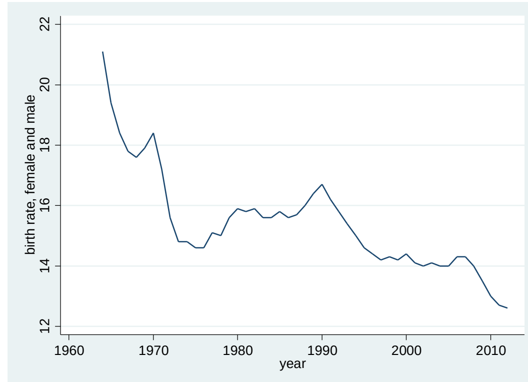
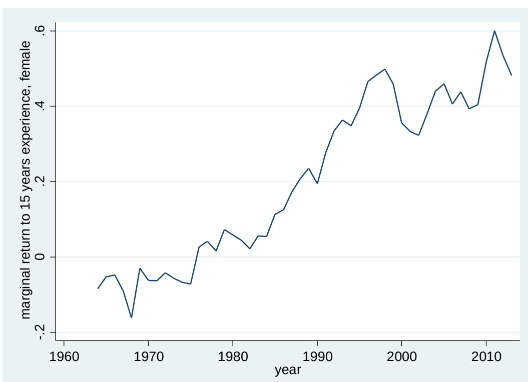


Figure 4: Return to 15 years of exp.,female; Figure 5: Return to college, female



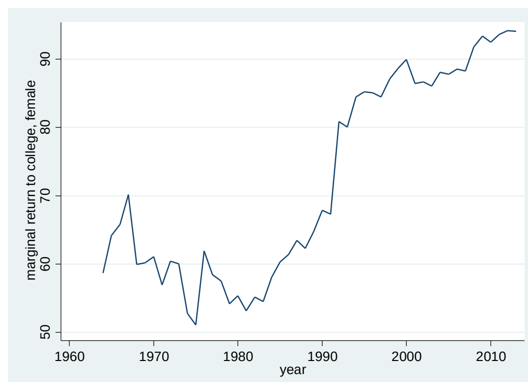
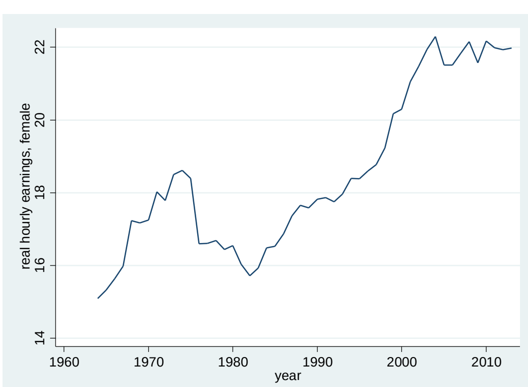


Figure 6: Real hourly earnings, female; Figure 7: Expected lifetime earnings, female



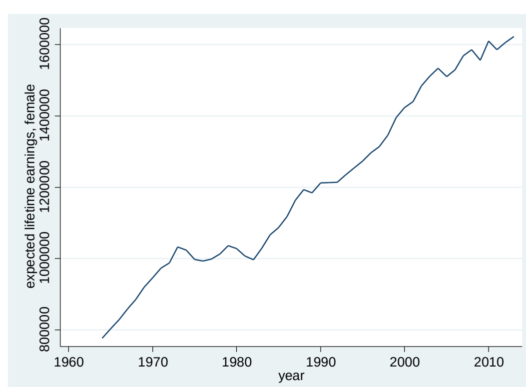
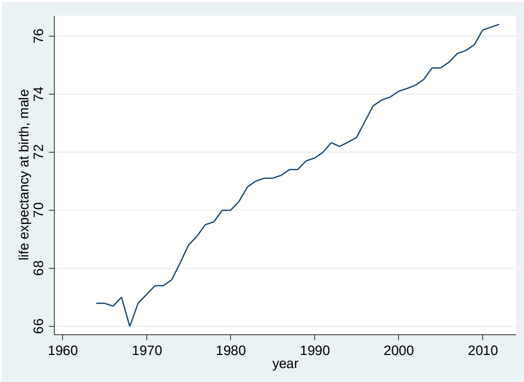


Figure 8: Life expectancy at birth, male; Figure 9: Return to 15 years of experience, male



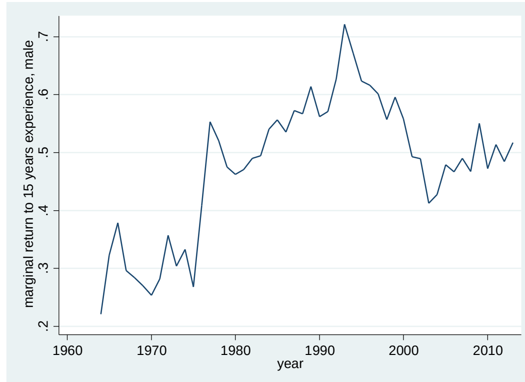
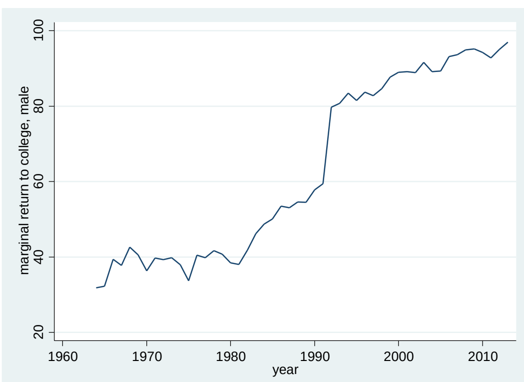


Figure 10: Return to college graduation, male; Figure 11: Real hourly earnings, male



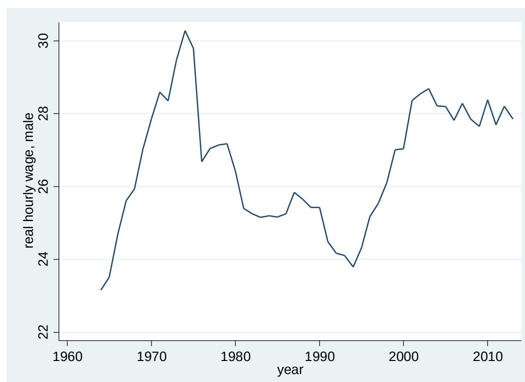


Figure 12: Expected lifetime earnings, male

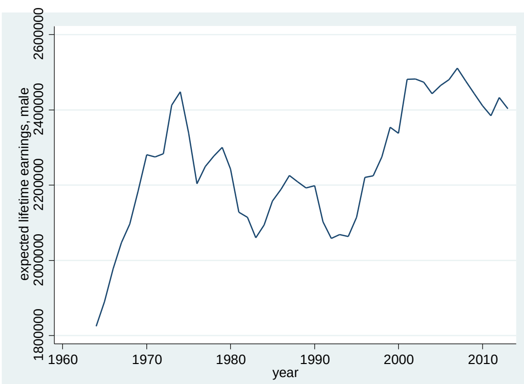


Figure 17: Impulse Response Function Model 1, male: Life Expectancy, Returns to 15 Years of Experience, Hourly Earnings, Expected Lifetime Earnings

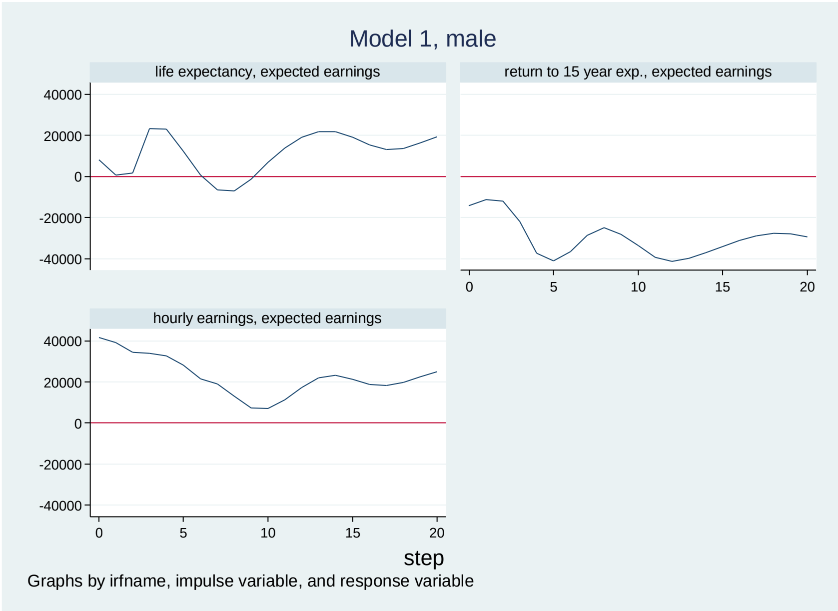


Figure 18: Impulse Response Function Model 3, male: Life Expectancy, Returns to College, Hourly Earnings, Expected Lifetime Earnings

Tables

Table 1: Descriptive Summary Statistics

Descriptive Summary Statistics, 1964-2013

Variable	Obs	Mean	Std. Dev.	Min	Max	1964	2012
Female							
life expectancy at birth	49	77.973	2.144	73.7	81.2	73.7	81.2
birth rate 1/	49	15.429	1.700	12.6	21.1	21.1	12.6
returns to 15 years experience	50	0.206	0.221	-0.162	0.600	-0.084	0.536
returns to college	50	72.288	14.814	51.064	94.172	58.667	94.172
real hourly earnings	50	18.533	2.240	15.088	22.291	15.088	21.931
expected lifetime earnings 2/	50	1205.519	252.1542	776.9085	1622.444	776.909	1605.69
Male							
life expectancy at birth	49	71.425	3.070	66	76.4	66.8	76.4
returns to 15 years experience	50	0.476	0.120	0.221	0.721	0.221	0.485
returns to college	50	63.349	23.907	31.824	96.984	31.824	94.993
real hourly earnings	50	26.601	1.742	23.162	30.276	23.162	28.206
expected lifetime earnings 2/	50	2252.169	166.986	1824.511	2511.304	1824.511	2432.945

Note: 1/ both female and male. 2/ In 1000s.

Table 2: Unit Root Tests, female

	Augmented Dickey-Fuller		Phillips-Perron		DF-GLS	
Variables	no trend	with trend	no trend	with trend	no trend	with trend
female						
life expectancy at birth	-1.943	-1.658	-1.782	-1.539	0.922	-1.194
Δlife expectancy at birth	-3.812	-4.085	-7.013	-7.268	-3.744	-3.985
birth rate, both male/female	-1.69	-2.864	-3.313	-3.752	0.012	-2.074
Δbirth rate, both male/female	-4.7	-4.621	-4.729	-4.582	-1.792	-3.09
returns to 15 years experience	-0.8	-3.018	-0.856	-2.776	-0.125	-2.877
Δreturns to 15 years experience	-5.56	-5.478	-6.458	-6.383	-5.559	-5.335
returns to college	-0.06	-2.048	-0.359	-1.881	0.307	-1.677
Δreturns to college	-5.355	-5.53	-8.44	-8.529	-3.464	-4.403
real hourly earnings	-0.768	-1.574	-0.77	-1.531	0.166	-1.609
Δreal hourly earnings	-4.211	-4.165	-6.273	-6.204	-4.222	-4.235
expected lifetime earnings	-0.344	-1.817	-0.436	-1.755	1.292	-1.854
Δexpected lifetime earnings	-4.37	-4.318	-6.213	-6.145	-4.211	-4.348

Note: Critical values at 1, 5, 10 percent: without trend -3.6, -2.9, -2.6; with trend -4.2, -3.5, -3.2 (ADF, PPERRON)
For DF-GLS: without trend -2.6,-2.3 and -2.0; with trend -3.8, -3.2 and -2.9. Lag 1 included.

Table 3: Unit Root Tests, male

	Augmented Dickey-Fuller		Phillips-Perron		DF-GLS	
Variables	no trend	with trend	no trend	with trend	no trend	with trend
male						
life expectancy at birth	-0.033	-2.451	0.072	-2.862	1.466	-2.221
Δlife expectancy at birth	-5.038	-4.947	-8.067	-7.978	-4.043	-4.736
returns to 15 years experience	-1.816	-1.73	-2.356	-2.149	-0.869	-1.623
Δreturns to 15 years experience	-5.886	-5.847	-7.575	-7.533	-2.926	-4.672
returns to college	-0.419	-1.701	-0.395	-1.831	0.609	-1.627
Δreturns to college	-4.406	-4.372	-7.394	-7.315	-4.43	-4.498
real hourly earnings	-2.341	-2.245	-2.192	-2.066	-1.287	-1.841
Δreal hourly earnings	-4.111	-4.057	-5.524	-5.515	-4.042	-4.089
expected lifetime earnings	-2.517	-2.605	-2.549	-2.393	-0.963	-2.088
Δexpected lifetime earnings	-4.374	-4.361	-4.957	-4.983	-3.779	-4.258

Note: Critical values at 1, 5, 10 percent: without trend -3.6, -2.9, -2.6; with trend -4.2, -3.5, -3.2

For DF-GLS: without trend -2.6,-2.3 and -2.0; with trend -3.8, -3.2 and -2.9. Lag 1 included.

Table 4: Selection-order criteria

Selection-order criteria, AIC						
	LL	LR	df	p	AIC	lag
Female						
Model 1	-418.178	428.64*	16	0.000	19.4746*	1
Model 2	-419.606	55.15*	16	0.000	20.9603*	3
Model 3	-604.175	443.78	16	0.000	27.7411*	1
Model 4	-608.732	37.732*	16	0.002	29.3659*	3
Male						
Model 1	-440.495	38.269*	16	0.001	22.5998*	4
Model 2	-486.653	49.604	16	0.000	23.229*	2
Model 3	-683.246	417.54	16	0.000	31.2554*	1
Model 4	-683.752	42.526	16	0.000	31.989*	2

Note: Significant AIC values are reported here. The optimal lag is selected accordingly.

Table 5: Johansen test for cointegration

Johansen Test for Cointegration						
	Rank	parms	LL	eigenvalue	trace statistic	significant
Female						
Model 1	1	15	-453.342	0.515	33.188	1 percent
Model 2	1	47	-442.207	0.453	34.332	1 percent
Model 3	2	20	-644.627	0.374	17.165	5 percent
Model 4	2	52	-626.024	0.373	19.613	1 percent
Male						
Model 1	3	71	-431.043	0.350	2.052	5 percent
Model 2	0	24	-525.149		50.364	1 percent
Model 3	2	20	-728.756	0.343	17.370	5 percent
Model 4	0	24	-733.712		51.198	1 percent

Table 6: Vector error-correction models

Vector error-correction models															
	equ.	life expectancy		birth rate		return 15 year exp.		return college		hourly earnings		expected earnings		constant	trend
		coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.	coef.	s.e.		
female															
Model 1	1	1		…	…	1.460	1.405	…	…	1.924	0.287	-0.037	0.007	-76.999	0.219
Model 2	1	…	…	1		5.876	3.222	…	…	3.497	0.857	-0.085	0.022	-1.589	0.993
Model 3	1	1		…	…	…	…	0		1.306	0.247	-0.020	0.006	-79.621	0.031
	2	0.000		…	…	…	…	1		-38.344	6.115	0.878	0.157	-131.86	-11.043
Model 4	1	…	…	1		…	…	0		-20.444	6.804	0.386	0.171	-20.831	-3.228
	2	…	…	0		…	…	1		-1403.92	420.031	27.657	10.543	-1202.71	-252.787
male															
Model 1	1	1		…	…	0		…	…	0		-0.0002	0.001	-66.742	-0.212
	2	0.000		…	…	1		…	…	0		0.0009	0.000	-2.188	-0.012
	3	-0.000		…	…	0		…	…	1		-0.014	0.000	3.051	0.074
Model 3	1	1		…	…	…	…	0		0.892	0.254	-0.012	0 .003	-63.941	-0.154
	2	0		…	…	…	…	1		-7.870	3.697	0.088	0.048	1.280	-2.150