

Can Depreciation of Human Capital Explain Recent Trends in the Returns to Education?

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Returns to Education World Bank Workshop, 2020

1 Motivation

- Stylized fact about Human Capital in Russia
- Time Trend in Returns to Education in Russia

2 Depreciation of Human Capital in Russia

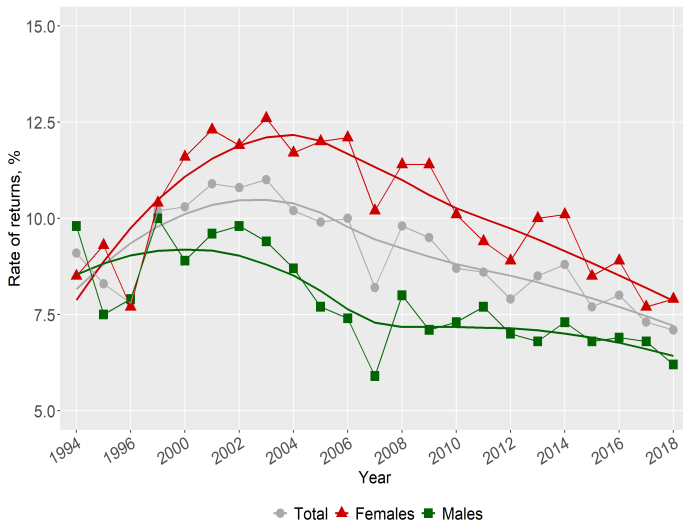
- Analytical Treatment of Depreciation
- Estimation Results
- Arrazola's Non-Linear Least Squares Approach
- Estimation Results

3 Further Exploration of Depreciation

- Depreciation and the Gender Dimension
- Depreciation and Occupational Routineness

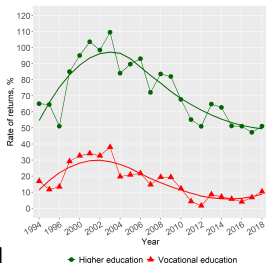
Motivation

Rates of Overall and Gender-wise Returns to Education in 1994-2018



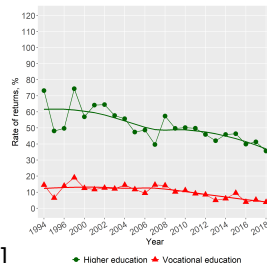
Results on Returns to Education in Russia

Co-movement of Vocational Education and Higher Education by Gender



[Females]

- Returns for males are almost flat.
- Returns for females show a *concave* pattern.



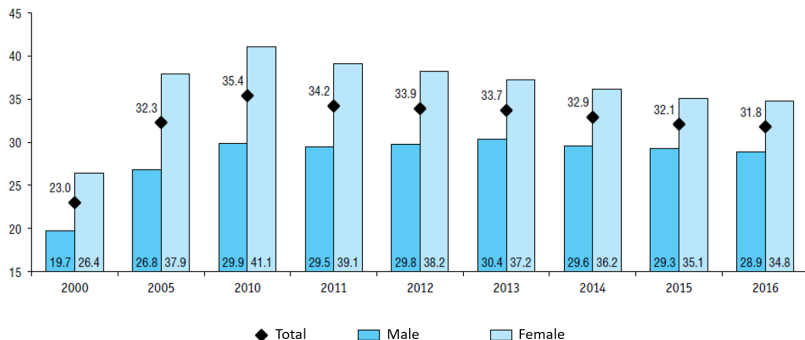
[Males]

Motivation

Peak in Enrollment in University Education (HSE Yearbook)

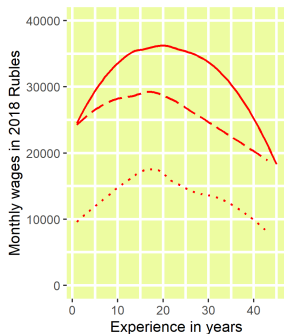
Proportion of the Number of Students in Higher Education
to the Number of Population Aged 17-25

Percentages



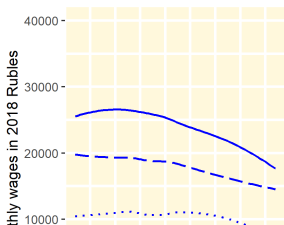
Depreciation of Human Capital in Russia

Neuman-Weiss Vintage Effects by Education Levels



[Higher Education]

[Vocational]



Depreciation of Human Capital in Russia

Analytical Treatment of Depreciation

Two kinds of depreciation or *loss of productive potential of human capital* (neuman_091._1995):

- **External depreciation** ("obsolescence" or "vintage effect"): due to an overall upgrading of technology or the operation of other market forces that lowers the value of education or training obtained in a previous period.
- **Internal depreciation:** due to deterioration of physical and mental abilities of an individual due to the progression of a person's age.

Depreciation of Human Capital in Russia

Murillo Methods

- **murillo_172._2006** implemented a variation of the **neuman_091._1995** model with a focus on empirical implementation to Spain.
- In a nutshell, the model can be expressed as follows:

$$\log(W) = \alpha + \beta_1 S + \pi_1 TS + \beta_2 T + \pi_2 T^2 \quad (1)$$

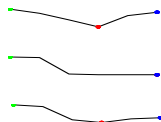
where T is years of experience, S is years of schooling, α , β_1 , β_1 , π_1 , π_2 are regression coefficients.

- The depreciation rate during T years applied to schooling can be computed as $\pi_1 S$ and the depreciation rate applied to experience as $2\pi_2 T$.

Depreciation of Human Capital in Russia

Initial Results for the Depreciation Rate (DR) by Years

Statistic		1994	1998	2003	2006	2012	2018
1	Experience, mean	21.41	22.32	22.20	22.24	22.52	22.52
2	Education, mean	12.70	12.69	12.79	12.79	12.95	13.27
3	DR Experience, %	1.87	1.55	1.04	0.50	1.37	1.63
4	DR Education, %	2.80	2.71	0.11	0.00	0.00	0.00
5	DR Human Capital, %	4.67	4.26	1.15	0.50	1.37	1.63



Depreciation of Human Capital in Russia

Non-Linear Least Squares Estimates: Whole Sample

- **arrazola_132b._2005** developed an alternative *Non-Linear Least Squares* approach on the issue of human capital depreciation.

Parameter	1994	1998	2003	2006	2012	2018	
Human Capital Depreciation: Whole Sample	0.0246 (0.0052)	0.0208 (0.0043)	0.0093 (0.0050)	-0.0040 (0.0058)	0.0369 (0.0043)	0.0459 (0.0051)	
Human Capital Depreciation: Female Sample	0.0275 (0.0060)	0.0260 (0.0042)	0.0156 (0.0038)	0.0065 (0.0044)	0.0197 (0.0036)	0.0249 (0.0036)	
Human Capital Depreciation: Male Sample	0.0261 (0.0067)	0.0168 (0.0059)	-0.0020 (0.0082)	0.0015 (0.0095)	0.0595 (0.0063)	0.0511 (0.0069)	

- The sparklines indicate a similar roughly **U-shaped pattern** for depreciation as reported for Murillo's estimations, with depreciation of human capital first declining and then increasing again.
- This supports the narrative that the observed increase and then decrease in returns to education in the Russia may be explained through the effect of depreciation.

Further Exploration of Depreciation

Depreciation and the Gender Dimension

- The Neuman and Weiss model provides an estimation of the depreciation rate for human capital, but by itself is unable to identify how much of that depreciation is *external* or *internal*.
- Examining differences in depreciation rate by the **segregation classification** helps solve this problem based on a conjecture.
- The conjecture is that *external depreciation* would have a greater affect by **industry sector**, as technological change would propagate more rapidly through a sector rather than through **occupations**, which are dispersed across sectors.
- Occupation is related to education and changes in education propagate slower. Industries include heterogeneous education groups, while occupations are more homogeneous, and hence market changes affect industries quicker.

Further Exploration of Depreciation

Average Human Capital Depreciation Rates (DR) by Female- and Male-dominated Industries and Occupations, RLMS 2018

Statistic		Female-dominated industries	Male-dominated industries	Female-dominated occupations	Male-dominated occupations
1	Experience, mean	23.45	22.97	21.67	23.48
2	Education, mean	14.06	13.01	13.67	12.67
3	DR Experience, %	0.89	1.82	1.55	1.40
4	DR Education, %	0.00	0.00	0.00	0.00
5	DR Human Capital, %	0.89	1.82	1.55	1.40

- DR is higher for male-dominated **industries** (e.g., engineering and technology-oriented sectors) compared to the female-dominated ones (e.g., administration, services, and education).
- But DR does not appear to vary across male-dominated (e.g., science and engineering professionals, stationary plant, and machine operators) and female-dominated (e.g., personal care workers, teaching professionals, sales workers) **occupational groupings**.
- This means that internal depreciation is the same for all individuals, but external depreciation is greater in male-dominated industries.

Further Exploration of Depreciation

Depreciation and Occupational Routineness

- In light of a discussion about computers and robots taking over routine-oriented jobs, we compare DR between **jobs and sectors** using 2 measures (**mihaylov_152._2019**):
 - **Net Routine Task Intensity**, showing vulnerability to automation of tasks performed as part of a job.
 - **Gross Non-Routiness Measure**, reflecting the opposite characteristic.
- These measures are based on the textual analysis of jobs description in the ISCO-08 classification.

Further Exploration of Depreciation

Average Human Capital Depreciation Rates (DR) by Routineness Classification, RLMS 2018

Statistic		High	Low	Medium	High	Low	Medium
		Net Routine Task Intensity			Gross Non-Routiness Measure		
2	Experience, mean	21.44	22.79	22.76	22.94	22.22	22.05
3	Education, mean	12.86	13.67	12.8	13.66	12.76	13.02
4	DR Experience, %	1.8	1.5	1.64	1.62	1.73	1.48
5	DR Education, %	0	0	0	0	0	0
6	DR Human Capital, %	1.8	1.5	1.64	1.62	1.73	1.48

- DR explained by experience does not differ substantially between people with jobs with varying routine task intensity.
- The same outcome also applies to workers varying in the degree of non-routine content at their jobs.
- This means both external and internal depreciation types are the same across occupational groups generated on the basis of routineness intensity.

- Benefits to society from human capital investment also depends on what happens to human capital after the schooling period.
- Human capital depreciation in the Russian Federation may have strong effect on returns to education, which in turn drive people's decisions for further education.

- Policy to reduce **internal depreciation** includes incentives to individuals and firms to invest in on-the-job training and reskilling.
- Policy to reduce **external depreciation** would focus on curriculum/content of education: creativity and problem-solving skills; learning how to learn.