The spread of human capital in the former Soviet Union area in a comparative perspective: Exploring a new dataset

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Abstract

To date, the rise and fall of the (former) USSR has triggered a lot of research much of which has focussed on the accumulation of physical capital, growth, and consumption. Recently, also the accumulation of human capital has increasingly been incorporated in this picture. However, few datasets exist that cover this crucial variable for this vast area. Therefore, our main objective is to make available a new dataset that contains human capital related time series for the USSR (and the Newly Independent States (NIS) after its dissolution), constructed mostly on an annual basis. These data are drawn together from various primary sources, available datasets and secondary literature where our focus was on constructing a dataset as consistent as possible. It is our hope that, by supplying these data in electronic format, it will significantly advance quantitative economic history research on Russia and all over the former Soviet Union area (FSU) and will inspire further research in various new fields relating to intellectual production.

The data presented in this paper follow after the discussion of the information value of the primary sources utilised, and the various problems that arose when linking and splicing the data from various sources. After constructing series of human capital indicators we perform a time-series and spatial analysis in order to identify the long-term trends of education penetration and of the human capital development in the FSU area with a strong emphasis on inequality issues between the NIS. Applying these results in a simple growth accounting framework provides us with some preliminary insights on the role of human capital in economic development in the FSU area.

Keywords: human capital, education, economic development, socialism, USSR, Russia

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1. Introduction

It is undisputed that human capital plays an important role in economic growth and human development. It is seen as indicative of long run growth, reduction in corruption, participation in decision making, etc (e.g. Lucas, 1988; Romer, 1990; Perotti, 1996; Alesina & Perotti, 1996). However, especially for the former socialist countries, very little information on this variable is available. Recently, some papers on long run development of human capital and growth have appeared dealing with China and Eastern Europe (e.g. Foldvari and Van Leeuwen, 2005; 209; Van Leeuwen & Foldvari, 2011a,b; Van Leeuwen, Van Leeuwen-Li, & Foldvari 2011), but research on how it affects economic development in these countries is still in its infancy.

This is especially true for the former Soviet Union area (FSU)[1] where the standard datasets do hardly ever include human capital. For example, the dataset 'Soviet Economic Statistical Series' constructed by the Slavic Research Center at Hokkaido University, is primarily focused on external trade while Easterly & Fisher (2001) do not include human capital as a monetary measure. Even the big international datasets from Cohen & Soto (2007) and Morrisson & Murtin (2009) do not include estimates for the USSR (although Morrisson and Murtin in their paper do make some guesstimates).

Therefore, in Section 2 we construct a new and consistent dataset on human capital and related measures for the USSR and the Newly Independent States after its dissolution. We have constructed the data series of various human capital indicators (both in natural- and monetary units), basically on an annual basis stretching back in most cases to 1920s, and in some instances even to the 19th century Russian Empire. To this dataset we add population (which is a crucial variable in many human capital estimates) in age-cohort breakdown, as well as comparable macroeconomic indicators like GDP, fixed (physical) capital stock, size of the general government expenditures, and the total wage bill. These data are drawn from various primary and secondary sources (including available datasets and literature) where our focus lay in constructing a dataset as clear, transparent, and consistent as possible. Section 3 discusses the construction of the human capital indicators as well as their spread throughout the FSU area, while Section 4 deals with economic development and spatial growth of human capital in the FSU comparing it with China. We end with a brief conclusion.

2. Primary and secondary sources, description, and data discussion

2.1 General description of the sources

The starting point in constructing the dataset consisted of the official statistics, available datasets and the research literature based on them (Table 1).

The official statistical data are easiest to reach. Indeed, as pointed out in Davis & Wheatcroft (1994) as well as in other literature starting at least from Gerschenkron (1947), the Soviet official series contain the information that at least was not intentionally falsified in a straightforward way as the government statistical offices preferred either to not to publish the unpleasant data or to adjust the methodology to let the resulting figures look better.

[1] 'The former Soviet Union' (the FSU or ex-USSR) is the mostly common term used hereinafter for all time periods and for all territorial coverage of both the Russian Empire, Soviet states after its fall, the USSR and the Newly Independent States after its collapse. The terms 'USSR' or 'Soviet Union' are used for the period of 1922-1991 only when this state existed within its actual borders. The term 'Newly Independent States' refers to multiple of existing states on the territory of the former USSR, both to the period after its dissolution and to the period when they were the Soviet republics, basically within their current borders. 'Russia' refers to the territory basically within the borders of the contemporary Russian Federation, in various periods.

Table 1
Basic human capital related indicators for the FSU area available in the dataset.

Category	Indicator	Period	Basic Sources and Literature	Notes
Human capital (self-sufficient proxies)	Literacy	ca. 1250-2010	SRSO[a], HSE IDEM (2011), Mironov (1985, 1991, 1994, 2003)	Except the NIS other than Russia for 1990-2010.
	Age heaping	1897-2010		Calculated based on distribution of 1-year cohorts of population at age 23-62.
	Average years of education	1897-2002	Russian Empire Statistical Office (Troinitskii, N.A., ed., 1905), SRSO, UNSD (2012), HSE IDEM (2011), Poliakov, ed. (1992, 1999, 2007)	Calculated based on inputs.
	Educational enrolment	ca. 1800-2010	SRSO[a], CIS Stat[b] Johnson (1950)	
	Government expenditure on education	1923-2010	Soviet and Russian Ministries of Finance, SRSO[a], UIS UNESCO (2012), SU–HSE (2005, 2007, 2010a, 2010b), De Witt (1961), Noah (1966), Plotnikov (1954), Subbotina (1965)	
	Book production	1913-2010	SRSO[a]	Except the NIS other than Russia for 1990-2010.
Human capital (proxy with differentials)	Wages	1985-2010	SRSO[a], CIS Stat[b]	
		1935-1984	SRSO[a], Chapman (1963), Zaleski (1980)	
		1923-1934	SRSO[a]	For the entire USSR and for urban sector basically.
		1913-1922	Soviet Statistical Office, Krumin, ed. (1923, 1924)	
Population	Total persons	1885-2010	Andreev et al. (1993, 1998), Gel'fand (1992), Maddison (2010), Volkov (1930)	
	Male/Female	1897-2010	UNSD (2012), HSE IDEM (2011), Poliakov, ed. (1992, 1999, 2007)	
Size of the economy	GNP/GDP	1885-2010	Becker (1969), Bergson (1961), Gregory (1982), Easterly & Fischer (2001), Harrison (1998), Maddison (2010), Markevich & Harrison (2011), Ponomarenko (2002), Steinberg (1990)	
	NMP	1928-1990	Khanin (1991), Steinberg (1990)	For the entire USSR.
Fixed (physical) capital	Stock	1928-2010	Easterly & Fischer (2001), Moorsteen & Powell (1966), CIS Stat[b], Marquetti & Foley (2011)	Gross stock, until ca. 1990 includes residential property.
	Annual investment	1928-2010	World Bank (2011), Bergson (1961), Moorsteen & Powell (1966), Steinberg (1990)	
Prices	GNP/GDP deflator	1886-2010	World Bank (2011), Becker (1969), Bergson (1961), Steinberg (1990)	
	Consumer price index	1886-2010	SRSO[a], World Bank (2011), Chapman (1963), Gregory (1982)	

Notes:
[a] Soviet and Russian Statistical Offices – respectively of the USSR and Russia.
[b] Interstate Statistical Committee of the Commonwealth of Independent States.

The basic official publication used for this study is the statistical yearbook "The national economy of the USSR". In addition, the USSR statistical office also published topical volumes like "Labour", "Construction of culture", "Culture, education and science", "Women and children",

since end 1950s normally once per decade. We used some official volumes (e.g. "Labour in the USSR" of 1975 and 1983 editions) which were not available to the scholars at the time of their publication but have been disclosed after the Soviet Union collapsed.

Besides these publications, the government financial office (Ministry of Finance since 1946) published the national budget execution reports on a 5-yearly basis since 1962 (providing annual historical data for the latest 5-year period and back to 1940 with 10- and 5-year intervals). Such publications had not been regular before. In the late 1980s they launched such reporting on an annual basis. The financial office also published topical volumes on educational-, cultural services-, and research expenditures twice (in 1939 and 1958).

2.2. Population size, literacy and numeracy

The population data were obtained from the published census data. There were 9 comparable censuses in the FSU: 1897, 1920, 1926, 1937, 1939, 1959, 1970, 1979 and 1989. We have assured that the data from HSE IDEM (2011) comply with those from the published census volumes with some minor exceptions. The discrepancies within the data for 1897, 1926, 1937 (most of all) and 1939 censuses are, however, not considered to be significant.

In all the FSU censuses, literacy was defined as an ability to read at least one language. Hence, writing skills were not taken into account at all. In our opinion, conventional measurement based on direct questions left much room for reading proficiency criteria also to be eased, especially since literacy was a politically sensitive topic.

Innumeracy (age heaping) is measured as the excess of people reporting their ages ending on multiples of -5 and -0 (i.e. 25, 30, 35 etc). This measure is then converted into the ABCC index, proposed by A'Hearn et al. (2009), which captures the percentage of persons correctly reporting their ages. Availability of the census data on 1-year age cohorts for male and female population at age 23-62 allows calculating their levels of numeracy, which is probably less upward-biased than literacy.

2.3. Educational attainment and enrolment

Our third educational variable (besides age heaping and literacy) concerns educational attainment. We express educational attainment and enrolment for the male, female and total population separately in 6 ISCED levels to which the national systems of the Russian Empire (less), the Soviet Union and the NIS after its dissolution (more) generally fit.

Following the previous cross-country datasets on educational attainment (Barro & Lee, 2010; Cohen and &, 2007) and the age structure of the FSU published data on censuses we chose as our balanced solution to select 5-year intervals for our age groups starting with 10 years and completing with 70+ years.

In most cases we assign to each education level those durations of education that were normatively prescribed as of the census date. This lead to a slight overestimation of educational attainment in 1970 and 1979 when significant part of the population obtained their reported lower secondary education at the time when its duration was 7 years (instead of 8 years later) while the proportion of people who obtained only primary education under older rules (duration was reduced from 4 to 3 years) was evidently less. In earlier years the actual duration of schooling tended to be shorter than the normatively prescribed one. To take this into account we use the evidence from Allen (2003) and Mironov (1991, 1994). We tried as much as possible to take into account those changes in duration of various schooling levels that took effect over time. However, the period prior 1930s could be subject to some revisions in this respect.

For incomplete levels of education as reported in the census, we assign the average value of the nearby completed ones.[2] We assign the average duration of our detailed categories to a census-

[2] E.g., 8 years of 'complete lower secondary' and 10 of 'complete upper secondary' result in 9 for 'incomplete upper secondary'.

based broad education-level group.[3]

The major problem in operating with the Soviet-era enrolment series is their lack of full coverage of various types of educational establishments, especially as regards primary and secondary schools (ISCED 1-3 levels). We use both series on total enrolment and available incomplete series on education levels to estimate the complete ones, predominantly for the inter-war period (1920/21-1940/41 school years).

Persons with correspondence education in ISCED 5 level were included starting from 1939. In 1960s part-timers reached almost a half of all the ISCED 5 education enrolment and up to 20% of the ISCED 4 enrolment. Though the period of correspondence study was 0.5-1 years longer it evidently failed to compensate the lack of learning time for part-time students relative to full-time ones.

We also pay attention to some special cases. The first case was pre-tertiary education institutions that operated in 1922-1940 as 'faculties for workers' ('rabfaki') that generally provided evening classes allowing socially active people to get eligibility for entering tertiary education institutions without taking full-time secondary school course. We assign the ISCED 3 to these institutions. Another special case were the various institutions of lower vocational education. We assume that the average level of general education for their graduates was ISCED 1 in 1920-1940s, ISCED 2 in 1950-1960s and ISCED 3 in 1970-1980s.

The gender composition of students is presented much worse in the official publications primarily due to later start of the coverage (1927/28 for most series) and larger intervals between the data points (10-15 years maximum as regards primary and secondary schools, 3-5 years for the higher levels). Our approximations for post-secondary non-tertiary and tertiary education are thought to have better fit to reality than those for lower levels, due to availability of more intermediate data points.

We use the resulting enrolment data combined with the attainment data from the censuses to estimate educational attainment in years between censuses (see Section 3).

2.4. Financial data on human capital expenditures

One way to valuate human capital is to estimate expenditure on education (creating a cost-based measure of human capital – see Section 3). However, to do so we require estimates on government expenditure on education. The USSR National government consolidated budget included all levels of the state finances. To estimate expenditures for education proper we often use broader category 'enlightenment', which in the Soviet official financial reporting also included cultural services and, in certain periods, research.

The expenditures for education proper consisted of two major groups: general education ('obshchee obrazovanie, vospitanie') and vocational education ('podgotovka kadrov'). The former generally included kindergartens (ISCED 0), schools of various types for general education for both children and adults (ISCED 1-3) as well as homes for orphan children, additional after-classes services, certain types of courses for children moral upbringing; while the latter encompassed vocational non-tertiary and tertiary education, and adult training. There was no division of the general education financing between the levels (most often they were in the same school and the same teachers could give classes to both ISCED 2 and 3 pupils). Like in the case of enrolment, we assigned some special-case education institutions to the recipients of the respective level of financing.

The official expenditure figures included both current (for wages, scholarships and stipends, books etc.) and capital (for construction and renovation, equipment purchase and repairs). The latter accounted for about 8-10% of overall expenditures on educational, cultural services and research.

The official publications provided not only the government expenditures from the budget but also from various institutional sources (that were basically under the government control). They also captured the part of private expenditures that was union republican budget revenues as tuition

[3] E.g., 8 years of 'complete lower secondary' and 9 of 'incomplete upper secondary' result in 8.5 for 'people with lower secondary education'.

fees in upper secondary school grades, vocational non-tertiary and tertiary education (introduced in 1940 and abolished in 1956).

The educational financial data are much better represented for the entire USSR than for its republics. Therefore we use the former to estimate the latter when it is necessary. Our approach is to estimate the share of a republic in total expenditures and then to calculate absolute numbers. Logarithmic transformation is sometimes used for periods of high inflation (end 1920s-1930s, 1990s).

For the Soviet era we allocate the USSR central government budget between the republics. The size of consolidated budget of a particular republic is chosen as a single criterion to define its weight among the others in expenditures of the USSR central government.

We make allowance for the border changes in 1929 when Tajikistan split off from Uzbekistan and in 1936 when Kazakhstan and Kyrgyzstan split off from Russia becoming republics of the USSR.

2.5. Book production

Book production is often thought to be indicative of the level of literacy (Baten & Van Zanden, 2008), or the accumulation of existing knowledge (Eisenstein, 1979). The number of copies may be considered as a proxy for human capital quantity while number of titles may proxy its quality.

However they fail to capture the quantity of information and we have no data on text volume in the books published for an extended period. The evidence provided in Mironov (2003) suggests that the share of brochures was significantly higher in the FSU than in other countries. Official publications and propaganda texts are also included into the Soviet-era book statistics while in other countries they are normally omitted.

Another feature of the book production indicators is that they are sensitive to unfavourable changes in macroeconomic environment that accompany wars and economic crises. These indicators have a more rapid and more significant response to such shocks than enrolment and education expenditures.

Nevertheless, books may be considered a relatively reliable predictor of human capital before the ICT revolution (until 1990s in the FSU). Hence, both variables are included in our dataset within current country borders.

2.6. Labour market (employment and wages)

In order to valuate human capital, i.e. to determine how much a certain amount of schooling is worth, one needs information on the labour market and especially how an increase in education may increase the average wage.

The Soviet labour market was strictly regulated throughout the whole period. However, except for the period of mass compulsory labour during (and some time before, and after) WWII, a typical Soviet worker had substantial freedom of choice as to what education to obtain and what occupation to choose. Moreover, the available evidence suggests that many of the formal restrictions effectively were not obstacles to a high degree of social mobility. That applied less to wage setting though. In the centrally-planned Soviet economy wage proportions were defined and set by the government. However, in our opinion, they were set to address shortage or abundance of particular skills and therefore essentially affect their supply and demand.

We use gross wages[4] for blue- and white-collar workers on the observation that they were representative for wage development in general. The Soviet ruling elite considered industrial sector as the key one in the national economy. That is why the relationship between the wages of blue- and white-collar industrial workers may be considered as the core of the overall income distribution

[4] Some data on blue- and white-collar workers were omitted in the sources. We estimate them based on total employment and average wage in the state-owned sector. In some cases (mainly for 1920s) we use time-series retropolation.

and, since, as a reliable proxy for human capital private returns. Our assumption is that the visible and non-visible (i.e. not reflected in official data) income relation was the same for the blue- and white-collar industrial workers in any particular year.

Our gross average wage figures include various types of monetary and in-kind remuneration of employees. However they do not include the cost of subsidies for various social services consumed by them as non-marketable remuneration. The major weak point of the average wage official data is that they are upward-biased (especially from 1930s to 1960s) because of statisticians' preference for the industrial sector in terms of employment, while agricultural wages were significantly lower. Scarce official data appear from 1940 on employment and wages in collective agricultural enterprises for the USSR so that direct calculation of unbiased average wage becomes possible but only for selected years. For the FSU republics except Russia we have unbiased average wage data only from mid-1980s. To address this problem we use a retropolation correcting for the change in urban/rural population ratio. These corrected average wage series allow us to calculate an income-based human capital measure in Section 3.

2.7. National accounts (GDP, fixed capital) and their price indices

Obviously, any analysis of human capital is severely limited if we cannot calculate its relationship with per capita income and fixed capital. However, initially, the structure of the national income of the former USSR was quite different from that in most Western economies.

Epistemologically, the Soviet official Net Material Product (**NMP**) concept was based on the belief that no new value added may be created outside sectors of material production. Therefore, the official national income figures omitted most of services until mid-1980s. For that reason we take the **GDP (GNP)** estimations from the literature but also use the series of both NMP and GDP in current prices for their cross-check. We additionally verify estimations of the USSR GNP by the monetary indicators, like size of the general government expenditures and total wage bill, expressed in current prices. We have chosen to splice those series that had generally the same concepts and close values in time points to be linked together.

Our **gross fixed capital stock** estimation (in current prices) is based on gross fixed capital to GNP (at factor cost) ratio derived from Easterly & Fischer (2001) assuming this relationship, regardless of its monetary expression, is correct for any particular year. Like annual gross fixed investment, the accumulated stock values did not include those in livestock, inventories but did include those in residential housing, capital repairs in construction and installation services.

The principal difference in the FSU economic growth rates assessments arises from application of different measurements of inflation, both the indicators and their size. Therefore finding an appropriate price index to evaluate the FSU human capital in monetary units is rather a complicated but very important issue.

Our preferable inflation indicator is **GDP deflator** as the most comprehensive price index that covers an entire economy. However we use consumer price indices for its construction and cross-check.

A problem in using the Soviet official statistics that estimated 'real' growth rates with earlier years as base (1913 or 1926/27) was identified in Gerschenkron (1947). The so-called 'Gerschenkron effect' is the upward bias in output indices weighted by base-year prices during a process of industrialisation. This bias is caused by underestimation of inflation which is calculated employing Paasche index. The underlying negative correlation between the quantity and price of certain goods leads to an overrepresentation of goods that were scarce and costly in the base year compared to the situation later. The longer period we take to create an index, the more aggravated the problem can become. On the other hand, if we take a later year as base for a price index and calculate inflation employing Laspeyres index this will result in a reverse effect: the more we go back from the later base year, the more we tend to overestimate inflation. After deriving the price indices with different year base (1928, 1937, 1950, 1958, 1964, 1973, 1982) we address the so called 'Gerschenkron effect' by making our synthetic deflator where weights (e.g. of 1928 and 1937) are to change when they approach or diverge from the respective year base.

To test our Chained Deflator Index (CDI) for its relevancy we apply it to the 1928 average wage as of the Soviet official sources. The assumptions are the following: 1) inflated 1928 wage should be close to actual one in a particular year; 2) the difference between them would indicate to changes in people's material well-being from 1928; 3) as the latter's dynamics has more or less reliable empirical evidence the difference between actual and theoretical wages could provide a good guidance in testing various deflator estimates. We also compare our CDI testing outcomes with those for basic price indices derived from estimations of the USSR GNP in various prices in Bergson (1961). The outcomes (Table 2a) generally confirm our assumptions and better fit of our CDI comparing to previous price indices for the period prior 1950.

To additionally check the relevancy of our CDI we construct our index of average wage to GDP (GNP) per capita (AW/GDPpc) with 1928 as the benchmark, effectively index of wage bill to GDP ratio. Its dynamics (Table 2b) also generally fits the trends reported in empirical literature (e.g., Chapman, 1963; Mironov, 2004).

Table 2.
Monetary economic indicators with application of our Chained Deflator Index.
a) Average wage.

Year	Actual average monthly wage[a]	What average monthly wage should have 1928 PPP[a]				Actual vs theoretical average monthly wage			
		at 1928 weights deflator	*at 1937 weights deflator*	*at 1950 weights deflator*	***at our chain deflator***	*at 1928 weights deflator*	*at 1937 weights deflator*	*at 1950 weights deflator*	***at our chain deflator***
1928	5,86	5,86	5,86	5,86	**5,86**				
1929	6,67	6,68	7,10	7,10	**6,73**	0%	-6%	-6%	**-1%**
1930	7,80	7,63	8,60	8,61	**7,78**	2%	-9%	-9%	**0%**
1931	9,39	8,70	10,42	10,45	**9,07**	8%	-10%	-10%	**4%**
1932	11,89	9,93	12,63	12,67	**10,63**	20%	-6%	-6%	**12%**
1933	13,05	11,33	15,31	15,36	**12,54**	15%	-15%	-15%	**4%**
1934	15,48	12,92	18,55	18,63	**14,91**	20%	-17%	-17%	**4%**
1935	18,91	14,74	22,48	22,59	**17,83**	28%	-16%	-16%	**6%**
1936	20,70	16,82	27,23	27,39	**21,46**	23%	-24%	-24%	**-4%**
1937	25,32	19,19	33,00	33,22	**26,01**	32%	-23%	-24%	**-3%**
1938	28,89		36,13	36,78	**28,49**		-20%	-21%	**1%**
1939	30,31		39,54	40,72	**31,24**		-23%	-26%	**-3%**
1940	33,10		43,29	45,08	**34,29**		-24%	-27%	**-3%**
1941			44,59	46,88	**35,43**				
1942			45,93	48,76	**36,63**				
1943			47,31	50,71	**37,89**				
1944			48,73	52,73	**39,24**				
1945	43,90		54,81	58,70	**43,85**		-20%	-25%	**0%**
1946	47,50		61,65	65,33	**48,97**		-23%	-27%	**-3%**
1947	56,93		69,34	72,72	**54,64**		-18%	-22%	**4%**
1948	60,23		78,00	80,95	**60,91**		-23%	-26%	**-1%**
1949	62,04		82,44	85,25	**64,17**		-25%	-27%	**-3%**
1950	64,20		73,24	75,42	**56,77**		-12%	-15%	**13%**
1951	65,60		70,74	73,02	**54,96**		-7%	-10%	**19%**
1952	66,90		68,48	70,93	**53,39**		-2%	-6%	**25%**
1953	67,90		65,85	67,88	**51,10**		3%	0%	**33%**
1954	70,60		65,55	66,72	**50,22**		8%	6%	**41%**
1955	71,50		64,07	65,90	**49,61**		12%	8%	**44%**

Note:
[a] Basically in urban sector of the national economy (excluding agricultural non-state enterprises) in rubles of 1961 denomination, current prices; based on official data.

b) Average wage to GDP per capita (wage bill to GDP ratio).

Year	Real GDP per capita change to 1928 level[a] *Maddison GDP*	Average wage to GDP per capita (AW/GDPpc) change to 1928 level[b] *our CDI and Maddison GDP*	Average wage to GNP per capita (AW/GDPpc) change to 1928 level[c] *Bergson GNP*	Average wage to GNP per capita (AW/GDPpc) change to 1928 level[d] *our GNP*	White/blue-collar wage differential in industry change to 1928 level
1928					
1929	1%	**-2%**		-2%	-2%
1930	6%	**-5%**		-8%	11%
1931	7%	**-3%**		-11%	9%
1932	5%	**7%**		-11%	26%
1933	9%	**-5%**		-22%	39%
1934	19%	**-13%**		-30%	29%
1935	36%	**-22%**		-33%	3%
1936	45%	**-34%**		-41%	-4%
1937	57%	**-38%**	-47%	-43%	-15%
1938	57%	**-35%**		-35%	-7%
1939	63%	**-41%**		-38%	-9%
1940	56%	**-38%**		-43%	-14%
1941					-4%
1942					6%
1943					6%
1944					6%
1945					6%
1946	40%	**-31%**		-47%	-6%
1947	55%	**-33%**		-44%	-22%
1948	75%	**-44%**	-51%	-47%	-30%
1949	91%	**-50%**	-56%	-53%	-35%
1950	107%	**-45%**	-54%	-51%	-40%
1951	105%	**-42%**	-55%	-52%	-44%
1952	114%	**-42%**	-56%	-52%	-47%
1953	120%	**-40%**	-55%	-52%	-48%
1954	127%	**-38%**	-55%	-52%	-48%
1955	142%	**-40%**	-57%	-54%	-45%

Notes:

[a] Calculation based on Maddison (2010).

[b] Calculation based on official data on wages, our CDI and Maddison (2010) data on real GDP per capita.

[c] Calculation based on official data on wages, Bergson (1961) data on GNP and Andreev et at (1993) data on total population.

[d] Calculation based on official data on wages, our data on GNP in current prices and Andreev et at (1993) data on total population.

We also calculate our CDIs using the methods described above for subsequent years where it was possible: for 1958-1964 using the GNP data from Becker (1969), 1973-1982 using the GNP data from Steinberg (1990).

Comparing the resulting real GDP growth rates with those derived from Maddison (2010) for the USSR (1928-1990), we find a discrepancy. The discrepancy might arise from different deflator base. Maddison could deflate the GDP with retail price indices that evidently exceeded the entire GDP deflators about twice in 1930-1940s. Maddison could also ignore the data that demonstrated deflation in 1950-1955 and overall price stability in 1956-1958, which is identified by us.

3. Methods of human capital evaluation and their application to the FSU case

The above data are used to calculate human capital indicators. Such natural indicators like book production numbers and volumes, literacy, numeracy, and average years of education are surely not human capital proper but rather its proxies. However, in our case they may well be used to verify the monetary indicators or to go back in time where input monetary data are too scarce. Yet, for more recent periods, especially when literacy and numeracy reached 100% and thus did not reflect any more changes in educational attainment of a society, it became necessary and possible to calculate a monetary indicator of human capital. This can either be done by using a cost- or income-based measure.

The most basic natural indicator is book production. Looking at this variable, one may notice a decline in book titles in the USSR in 1960-1980s (Table 3), despite growth in number of book copies. Our explanation considers this observation as indirect evidence of a deterioration in human capital quality in the USSR. The 1990s economic collapse contributed much to the further decline, both in number of titles and number of copies. However, the number of book titles not merely recovered in Russia, but is at historical high at present (902.0 per million inhabitants in 2009). This suggests that diversity of knowledge flows, even leaving electronic media aside, may have gotten a boost under open market system. The evidence that book printing (number of copies) in Russia has not recovered may be explained in the way that electronic publishing (Internet most, CD/DVDs too) is replacing the printed press.

Table 3
Book titles per million persons in Europe and the FSU.

	FSU	Total Europe (without FSU)
1920s	219.2	
1930s	239.0	
1940s	161.3	321.9
1950s	269.2	343.2
1960s	335.2	430.4
1970s	327.8	570.6
1980s	292.2	702.9
1990s	190.8	751.7

Source: Plopeanu et al. (2012); own calculations

Another evidence of this is that the number of translated Western titles went up. Indeed, as can be seen in Table 4, the number of translations went up quite considerably, largely because more Western European books were translated into Slavic languages (see also Abramitzky & Sin, 2010).

Table 4
Number of book titles translated in Europe per million persons.

	Translations within Europe
1980	22.10
1985	26.37
1990	27.38
1995	45.20
2000	45.24
2005	53.92

Source: Plopeanu et al. (2012)

Of course, if book production were purely an indicator of literacy, its effect on economic growth should decline when adult literacy approaches 100%. This is also true for the percentage persons reporting their correct age (ABCC index or age heaping). The results (Table 5) show that

literacy rose after numeracy. However, in both cases, after 1950 there was almost full literacy and numeracy which hardly changed in the later part of the twentieth century.

Table 5
Literacy and age heaping in the FSU.

	Literacy	Age heaping (ABCC index)
1897		79.4
1920	44.1	
1926	54.7	85.2
1939	87.4	96.8
1959	98.4	97.7
1970	99.7	99.7
1979	99.8	99.8
1989	99.8	100.0

Clearly, even though literacy and numeracy reached its zenith in the 1950s, human capital formation did not. After all, if almost everyone is literate, or can count, still people may acquire more formal schooling. This is often captured by the average years of education. We use the method as proposed by Foldvari & Van Leeuwen (2009). They basically use census data by level of education as described in the previous section. The in-between years were calculated using the Barro & Lee (2001) perpetual inventory method. However, this results in a bias: when calculating backwards, one will overestimate average years of education and when forward estimating one will underestimate it with an equal amount. Therefore, they propose to calculate each number back and forward and take an average. This estimate seems plausible. If we compare it with the only available series for all Soviet republics from Barro & Lee (2010), we get an error to signal variance ratio of 56% for our series versus 270% in the Barro & Lee series (as it follows from our test results in Table 6).[5]

Table 6
Reliability ratio of average years of education in the former USSR area (based on panel least squares).

	Dependent variable: Barro & Lee (2010) average years of education		**Dependent variable: average years of education (our series)**	
	coefficient	*t-value*	*coefficient*	*t-value*
constant	2.323	1.083	5.578	6.487
average years of education (our data)	0.640	2.239		
average years of education (Barro & Lee, 2010)			0.270	2.239
	time and region dummies		*time and region dummies*	
No. Obs	41		41	
R^2	0.981		0.993	

Yet, calculating average years of education still does not capture all important aspects of human capital properly. After all, measuring human capital in terms of average years of education is similar to calculating physical capital in terms of number of machines: their heterogeneity makes it

[5] If series x and y are both unbiased estimators of a latent variable s, that is: $y = s + \varepsilon$ and $x = s + \eta$ then the limit of the OLS estimator of β_1 in the equation: $y = \beta_0 + \beta_1 x + u$ will be $\frac{Cov(x,y)}{Var(x)} = \frac{\sigma_s^2}{\sigma_s^2 + \sigma_\eta^2}$. From this we can estimate which of the two proxies x and y has lower error to signal ratio.

impossible to aggregating them by simple addition. Therefore, it is important to valuate human capital. This can be done using the cost- and the income-based measure.

In calculating the cost-based measure, we follow Judson (2002), updated by Van Leeuwen & Foldvari (2008b). As suggested by Judson (2002), the cost-based human capital indicator is similar to the measurement of physical capital stock. Her method allows to calculate the per capita (or per worker) stock of human capital at the replacement value of a single year of education. By multiplying it by average years of education, we arrive at the total accumulated stock of human capital per capita at its replacement cost, as proposed by Van Leeuwen & Földvári (2008b):

$$h_t = S_t \sum_j d_{jt} a_{jt}$$

where h_t denotes the average human capital stock per worker in year t, S_t is the average years of formal education in year t, d_{jt} is the public expenditure on education per level j in year t (per student enrolled), a_{jt} denotes the share of the labour force (population at the age of 15+ in the FSU case) in year t with a certain level of education.

This method does not include foregone wages and non-government spending on education largely because these data are unavailable for many countries and adding them would make these series incomparable with other countries. However, it is based on the key component of schooling costs, which normally defines their dynamics. And the above-mentioned shortcoming can be remedied in principle by adding private expenditure and foregone earnings.

Using the income-based measure, we follow Foldvari & Van Leeuwen (2011b) and calculate the expected future wage flow presumably arising from education. Human capital is then treated in parallel with investments: the price of an asset, like a bond or a stock, will tend to be the present value of all expected future flows of income from it. Since, the present value of the future expected labour income of a worker, assuming continuous time and his/her retirement age at 65, can be expressed as:

$$\bar{h} = \int_{t=0}^{65-\bar{x}} \bar{w} e^{(g-q)t} dt = \frac{\bar{w}}{g-q}\left(e^{(g-q)(65-\bar{x})} - 1\right)$$

where $\bar{h}$ is per worker stock of human capital in monetary units, $\bar{w}$ is actual average wage, $\bar{x}$ is the average age in the population, g is constant rate of expected real wage growth and q is the discount factor. We assume that q-p=0.02, as people expect their utility resulting from higher wages will increase with time, in line with Dagum & Slottje (2000) at micro-level. To arrive at a republic- or country-wide stock of human capital we should substitute average wage ($\bar{w}$) with the total labour income (total wage bill). Alternatively, we can multiply per worker stock of human capital by the respective number of workers in the labour force.

This measure is not affected by intra-country wage differentials. However, if we assume that earnings of unschooled workers were the same among the FSU republics in a particular year then their difference in average wages would display the rewards for schooling. Including future earnings of unschooled allows us to capture not only private but also social returns to education if their wages increase due to investments into education made by other individuals or the state.

Notably, in the FSU the fluctuations of the human capital income-based measure tend to move reversely with those of white/blue-collar wage differential in industry (see Fig. 1). This highlights the pattern where positive social returns to education are gained in much at the expense of private ones. Although similar trends may be observed in more developed countries with market economy, the wage compression in the FSU appeared to be rather sharp and astonishing in 1910s (even before the Bolshevik Revolution) and particularly reinforced in mid-1940s – early 1980s.

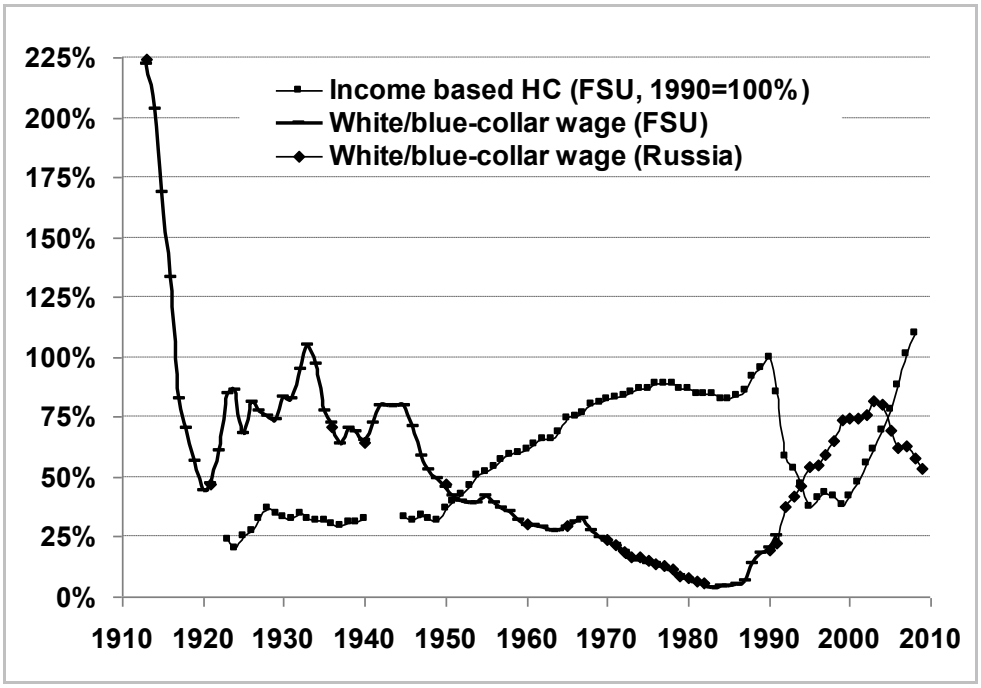

Fig. 1. Income-based human capital and white/blue-collar wage differential in the FSU (1910s-2000s).

The result of various human capital measurement results is given in below Table 7. Basically all series move about in the same direction, while the income-based measure is strongly influenced by abrupt real wage dynamics, especially in 1990s. However, it has been recovered at least by 2008. One more special thing to note is that, when corrected for the urban/rural population change, income-based human capital in the FSU is slightly lower in the 1920s and slightly higher in the 1970-2000s. However, we expect that this change will be bigger in countries with a larger agricultural sector.

Table 7
Human capital in the FSU.

	Average years of education[a]	**Cost based**[b] *1990 GK dollars*	**Income based**[c] *1990 GK dollars*	**Income based**[d] *1990 GK dollars*
1924	1.6	128	36,390	
1940	3.5	1,510	59,014	60,189
1959	5.1	3,140	109,859	116,956
1970	6.4	5,180	150,004	156,555
1979	8.1	8,580	157,371	166,264
1989	9.8	11,673	174,014	190,593
2000			74,805	80,085
2008			198,433	212,439

Notes:
[a] Population at the age of 10+.
[b] Per capita (population at the age of 15+) stock calculated based on education expenditures data for the entire FSU.
[c] Per worker stock calculated based on average wage data for public (basically urban) sector of the FSU economy (1924), average wage data for the entire FSU (1940-1989) and average wage data for the NIS (2000-2008).
[d] Per worker stock calculated based on average wage data for the FSU republics (NIS), corrected for their change in urban/rural population ratio and weighted by their labour force.

4. The spread of human capital in the FSU in a comparative perspective

The development of human capital in the USSR has been quite remarkable in an international perspective. Comparing with China, both countries started with a low cost-based on human capital measure. However, where China started from almost the absolute 0-level, the USSR already had quite a human capital base in the 1920s. In that respect they more represented Europe (see Fig. 2). In addition, it witnessed a fast growth by catching up to Europe in average years of education (but probably not in cost- or income-based human capital).

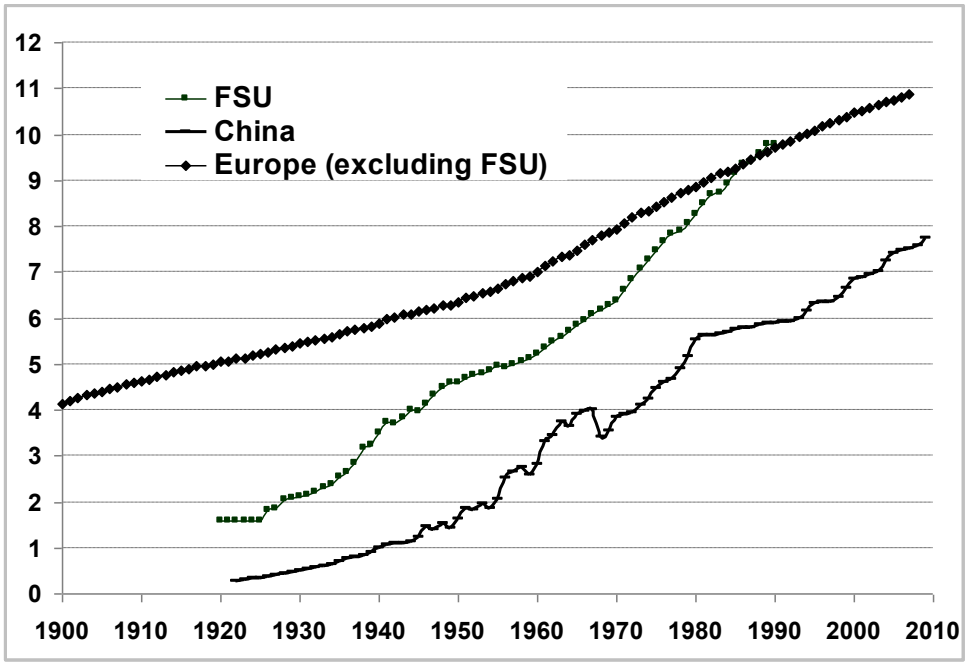

Fig. 2. Average years of education in Europe, China and the FSU.
Source: Van Leeuwen & Foldvari (2011a); Van Leeuwen, Van Leeuwen-Li & Foldvari (2011); own calculations

Indeed, looking at Fig. 3, we note that the human capital in China in recent years grows much faster than it did in the USSR in the most part of the twentieth century.

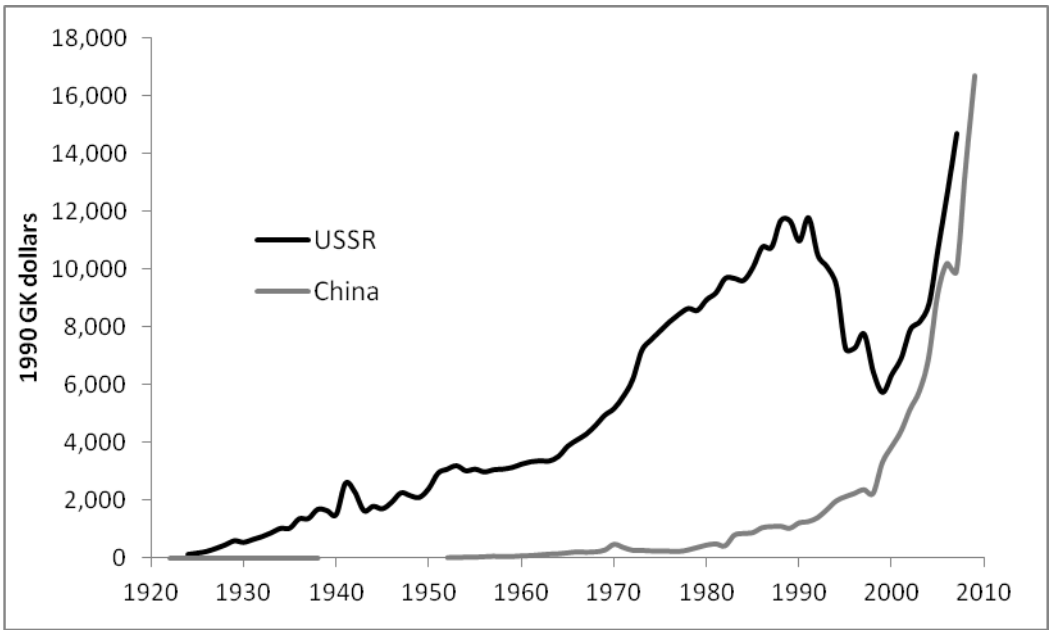

Fig. 3. Cost-based human capital per capita in China and the FSU (1990 GK dollars).

Possibly, the faster development of the USSR in the early twentieth century is one of the reasons it outperformed China during that period. Indeed, human capital played a very important role. This period of fast growth of human- and physical capital is also the period with the highest negative TFP growth (Table 8). As pointed out by Van Leeuwen, Van Leeuwen-Li & Foldvari (2011), in China this was largely caused by a reduction in technical efficiency of the factors of production: the continuous increase in human- and physical capital reduced the returns, while general technical change kept increasing. In the later part of the century, when the growth of the factors of production slowed down, technical inefficiency did not decline so much anymore, and TFP grew increasingly positive since it became largely driven by general technical development. However, this apparently did not work for the USSR since economic growth continued to be low. Only after the fall of socialism and deep decline in 1990s economic growth recovered in end 1990s - 2000s. The basic argument is that technical inefficiency reduced, which allowed for more TFP growth. Given our previous discussions, this may be caused either by integration of human capital (lagging provinces and countries grow harder in terms of human capital), because market economies have more efficient allocation of capital, or because general technical development became faster, possibly because more knowledge came available via the West.

Table 8
GDP, factors of production, and TFP change.

	Factor share of human capital (HC)[a]	**Factor share of physical capital (FC)**	**Growth of GDP**	**Growth of HC[a]**	**Growth of FC**	**TFP growth**
			FSU			
1920-1940	40%	60%	6%	18%	8%	**-6%**
1950-1966	40%	60%	4%	4%	10%	**-4%**
1966-1977	40%	60%	3%	7%	5%	**-3%**
1978-1993	40%	60%	1%	2%	3%	**-2%**
1994-2006	40%	60%	3%	7%	7%	**-4%**
			China			
1920-1940	53%	47%	0.1%	10.7%	-16%[b]	**-13%**
1950-1966	53%	47%	2%	16%	7%	**-10%**
1966-1977	44%	56%	2%	1%	5%	**-1%**
1978-1993	54%	46%	6%	12%	9%	**-5%**
1994-2006	54%	46%	8%	15%	11%	**-5%**

Note:
[a] cost-based measure.
[b] Growth of capital stock in China prior to 1950 taken from Wu (2012). Used with special permission from the author.

For China, this growth was largely caused by a reduction in technical inefficiency paired with increased general technical growth. The provinces, however, remained as divided in terms of human capital as they had been in the 1920s.

Despite the evidence is limited at this moment, this process was similar for the USSR. If we compare different FSU republics (see Table 9), we see that factors of production kept growing in all of them, notwithstanding their level of economic development. Of course this did vary by human capital indicator, so the republics could change their positions. Whereas human capital inequality across republics in terms of age heaping went down (unsurprisingly since numeracy went up), inequality in books per capita went up considerably. While Central Asian and, to some extent, Transcaucasian republics advanced in average years of education Russia appeared to be the loser in its relative position as regards both the latter indicator and the two monetary (cost- and income-

based) human capital measures. However, as regards the cost- and income-based measures, inequality remains about equal, suggesting there is no catch up and investment in human capital remains constant, irrespective of its level. This is similar as was noticed in China, where rich provinces witnessed equal (or even faster) growth of human capital, irrespective of its level of income. This increased technical inefficiency (i.e. a lower return to capital).

Table 9
Human capital indicators in the FSU.

			Age heaping	Books (no. titles per mln people)	Average years of education	Cost based HC	Income based HC (average wage)[b]	Income based HC (average wage, corrected for urban/rural change)[c]
1939[a]	USSR		97%	227.8	3.2	1,649	91,028	78,849
	of which	Armenia	94%	530.2	3.3	1,634	87,801	62,850
		Azerbaijan	91%	351.4	3.3	1,856	97,572	79,019
		Belarus	97%	147.2	3.2	1,298	46,024	37,177
		Georgia	89%	400.1	3.7	1,930	101,569	79,604
		Kazakhstan	97%	102.3	3.0	2,517	160,026	116,635
		Kyrgyzstan	95%	240.1	2.7	1,730	70,585	53,756
		Russia	98%	297.1	3.2	1,931	103,703	78,597
		Tajikistan	87%	190.1	2.7	1,563	96,092	71,794
		Turkmenistan	92%	231.8	2.9	2,483	72,451	71,376
		Ukraine	99%	152.7	3.4	1,083	62,387	53,466
		Uzbekistan	90%	160.8	2.8	1,111	85,693	70,944
	Gini		**1.0**	**14.3**	**2.2**	**10.5**	**16.4**	**13.6**
1989	USSR		100%	268.5	9.8	11,673	207,249	220,514
	of which	Armenia	100%	301.6	10.6	19,319	244,799	244,799
		Azerbaijan	99%	171.0	10.7	14,473	265,226	265,226
		Belarus	100%	292.6	9.5	15,313	171,115	171,115
		Estonia	100%	1317.7	9.9	25,581	305,000	305,000
		Georgia	98%	365.1	10.6	20,909	277,042	277,042
		Kazakhstan	100%	118.9	9.9	17,157	380,867	380,867
		Kyrgyzstan	100%	236.2	9.9	14,804	185,140	185,140
		Latvia	99%	722.5	10.0	21,980	266,977	248,099
		Lithuania	100%	729.6	9.4	21,565	259,269	259,269
		Moldova	99%	339.3	9.1	15,994	193,895	193,895
		Russia	100%	313.0	9.8	12,189	217,170	217,336
		Tajikistan	100%	169.0	9.6	12,381	211,575	211,575
		Turkmenistan	100%	185.0	9.9	12,840	150,904	150,904
		Ukraine	100%	164.1	9.7	12,336	98,279	172,760
		Uzbekistan	100%	116.6	10.0	11,320	233,786	233,786
	Gini		**0.0**	**20.8**	**1.1**	**14.1**	**15.4**	**13.0**

Notes:
[a] 1940 for income-based measures.
[b] Per worker stock; for the FSU republics calculated based on average wage data for public (basically urban) sector of their economies; for the USSR calculated based on weighted average for its republics (by their labour force).
[c] Per worker stock calculated based on average wage data for the FSU republics (NIS), corrected for their change in urban/rural population ratio and weighted by their labour force.

5. Conclusion

In this paper, we construct a new dataset on human capital and related indicators for the former USSR area, most of them between ca. 1920 and 2000. This fills a gap in the literature since so far very few estimates of this vast area have been made available.

We use official statistics, combined with more recently available information and secondary literature. Combing all information we arrive at consistent estimates of literacy, book production (no. titles and total book output), average years of education, and cost- and income-based human capital measures. In addition, we add information on physical capital, GDP, and labour force.

We find that the USSR and its republics increased its human capital fast in the most part of the twentieth century. However, very little integration took place among the republics. Also some of the indicators provide evidence on deterioration in human capital spending level and its quality during late Soviet era. This most likely caused increased technical inefficiency, leading to a reduction in TFP growth. The same situation occurred in China. However, whereas China managed to keep technical inefficiency relatively moderate and, in addition, managed to increase general technology, in the former USSR area we do so far not find much evidence for a similar development. Just a few promising signs of the recovery appeared in 2000s.

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