Central planning, economic growth: a theoretical and empirical application on the USSR and Central Europe ca. 1920-2000

Peter Foldvari , Bas van Leeuwen and Dmitry Didenko

Abstract

On the one hand, many studies argue that physical capital accumulation drove economic growth in the early socialist period. Other studies, however, have argued that the physical/human capital ratio was negatively related to economic growth implying that fast growth of physical capital may lead to lower economic growth. In this paper we show theoretically and empirically that the physical to human capital ratio must be (slightly) higher than in the West. Applying regression analysis, we find that the effect of the physical to human capital is highly positive and significant during the socialist period. This effect is even bigger when we use NMP instead of GDP, once more confirming the logic behind the socialist growth model. Only after the fall of socialism the effect of the physical to human capital ratio turned negative. The same pattern can be found for Austria, having a positive (but less high) effect of the physical/human capital ratio in the 1950s-1970s, and a negative relation afterwards. This suggest that growth patterns were similar albeit more pronounced in the socialist countries.

1. Introduction

The economic transition in the countries with centrally planned economy (those identified themselves as socialist and those were often referred to in a political slang as the 'Eastern bloc') has triggered many studies in its underlying sources of growth. Many of those make use of some sort of growth accounting framework in which they decompose GDP growth in physical (or fixed) capital, sometimes human capital, and some sort of residual factor, TFP, which is supposed to capture technological change. These studies, however, find that technical change was limited (and declining) during the socialist period when growth was mainly driven by physical capital accumulation (Kaplan (1968); Bergson (1978 [1971], pp. 166-168; Kontorovich 2001, 687). Indeed, Bob Allen (2003) even simulated that without the massive capital accumulation of the 1930s, the USSR would have been worse off in the 1960s. This follows logically from a simple AK model as the Solow model (Solow 1956; 1957). Here an increase in physical capital stock will increase the growth of per capita GDP.

However, the problem with such a framework is that actual economic growth in the 'Eastern Block' turned out to be lower than in the Western world: whereas many of the Central and Eastern European countries had been at par with the West in the 1920s, in the

1980s they lagged substantially behind in terms of per capita GDP. This would be consistent with studies finding that, when physical capital/ human capital ratio grows, per capita GDP growth decreases (e.g. Erk, Altan Cabuk, Ates 1998; Duczynski 2002; 2003).

These different views are less surprising when looking at it from a policy perspective. Whereas the former centrally planned countries measured their income in Net Material Product, loosely described as the sum of material production, the West calculated GDP which also included immaterial production like services. In order for NMP to grow, the socialist governments should maximize material production. Since material goods can be used either in consumption or to create more material goods, the economic policy priority was thus defined in the way that even among material goods the output of fixed capital investment needs (means of production) should outperform that of consumer goods. However, in the West, where government rather focussed on maximizing consumption, the immaterial sector also took a large share of GDP. Hence, if Western GDP was converted into NMP (roughly the service sector being subtracted), the West turned out poorly in economic development compared to the socialist countries. From a socialist point of view, it was thus logical to maximize material output.

In this paper we analyze economic development in Eastern Europe and the USSR from the socialist policy perspective. In Section 2 we start by looking at the data. We find that most socialist countries knew a sharply rising physical-human capital ratio combined with lowering economic growth in terms of GDP. In Section 3 we explain this by a one sector model in which the government can either prefer to maximize material output or consumption (or a combination of both). This model is an exogenous growth model, meaning the long-run (balanced growth) effect is zero. In Section 4 we, however, empirically study the effects of physical-and human capital on growth. We end with a brief conclusion.

2. Data

This paper requires data on both physical[1] -and human capital as well as GDP per capita and its socialist equivalent, Net Material Product per capita. Data on human-and physical capital as well as GDP for the socialist countries are being extended quite rapidly these past years. GDP estimates for Central Europe and the USSR are taken from Maddison (2007) and, in the case of the Republics of the USSR, extended by Didenko et al (2011) based on the World Bank (2011).[2] Physical capital is taken from Van Leeuwen and Foldvari (2010) and Didenko et al (2011) based on Easterly and Fisher (2001). The income based human capital measure is taken from Didenko et al (2011). For comparison we also added a cost-based human capital measure for the USSR taken from Didenko et al (2011).[3] Finally, the Net Material Product is

[1] This refers to the gross fixed capital stock.

[2] Didenko et al (2011) used GNP/cap., which they assumed comparable to GDP/cap, based on Bergson (1961), Becker (1969), Steinberg (1990).

[3] For this analysis, the cost based analysis is the most appropriate. Not only does it compare better with the cost-based valuation of fixed capital, but also it remains the question if we can have income based capital stock estimates for socialist economies as generally there was no market for fixed capital under socialism while there was a quasi-market for human capital.

taken from Didenko et al. (2011) which in its turn was based on the official figures from 1958 and Khanin (1991) for the earlier period in current prices.

The results are reported in below Table. The most interesting feature is that there

Table 1: Per capita GDP, human-and physical capital in socialist Eastern Europe in 1990 GK dollars

		1930s				1980s				2000s			
		GDP/cap	K/cap	H/cap (cost based)	H/cap (income based)	GDP/cap	K/cap	H/cap (cost based)	H/cap (income based)	GDP/cap	K/cap	H/cap (cost based)	H/cap (income based)
USSR		1,787	1,547	1,649	59,014	6,753	30,646	10,127	156,974	6,013			132,629
of which	Armenia			1,729	69,778	5,434		17,176	159,511	7,768			210,663
	Azerbaidjan			2,289	76,283	4,942		14,024	180,897	4,168			234,079
	Belarus			1,144	36,001	5,554		11,087	111,903	8,969			227,321
	Estonia					10,630		24,108	241,084	16,065			348,400
	Georgia			2,771	80,619	9,355		25,010	206,002	4,484			149,397
	Kazakhstan			6,184	124,682	8,104		21,994	290,587	7,996			117,524
	Kirghizia			1,660	55,465	3,184		11,706	121,716	2,439			142,370
	Latvia					9,278		19,188	184,751	11,374			295,028
	Lithuania					8,538		21,032	166,740	8,736			200,579
	Moldova					5,679		13,915	130,171	3,095			102,092
	Russia			1,790	81,527	7,308		10,624	171,960	6,943			130,011
	Tajikistan			1,771	74,597	3,214		12,117	139,842	1,228			42,019
	Turkmenistan			2,352	56,071	3,614		10,593	115,713	3,137			114,976
	Ukraine			1,048	48,403	5,585		10,574	116,864	3,893			78,334
	Uzbekistan			1,558	67,374	4,124		13,461	155,995	4,151			186,990
Austria		3,221	4,135		87,274	14,753	30,683		419,171	21,435	43,278		485,662
Bulgaria		1,443	1,264		75,396	6,281	9,224		124,955	6,424	8,853		79,627
Czechoslovakia		2,662	2,981		109,313	8,329	15,770		176,107	9,897	14,188		233,175
Germany		4,206	4,275		64,571	15,044	31,165		401,016	19,291	25,813		553,817
Hungary		2,473	2,241		57,475	6,648	10,919		188,916	8,182	13,863		210,450
Poland		1,775	3,319		28,179	5,617	14,342		146,800	7,974	11,588		243,855
Romania		1,191				4,101	8,037		138,182	3,566	6,854		103,524

seems to be little change in per capita GDP ranking over time. Indeed, Germany, Austria, the Baltic states and Czechoslovakia were as much in the top ranks in 2000 as they had been in the 1930s. The same can be found true for the physical capital stock. In the income based human capital stock we find some sort of reversal though: whereas before the War it was Czechoslovakia that topped the list, after the War their places were taken in by Germany, Austria and the Baltic states. Unfortunately we do not have comparable cost-based human capital data for Eastern Europe, but the limited data that we have available in Table 1 show a similar pattern with Kazakhstan and Georgia dominating before the War and the Baltic states making a recovery thereafter. A possible reason may be the USSR central government

equalizing policy that was targeted to allow the low-developed national periphery catch up the European Russia regions in terms of education spread.

These results can also be plotted in maps. In map 1a and 1b we can see per capita GDP in 1937 and 1990. Since we only had GDP/cap for the USSR as a whole we decided to plot this as being "Russia" (though bearing in mind that in 1937 Russia was better off than the USSR as a whole while in 1990 it approximately had the USSR average level) because the other regions might have had considerably different per capita incomes. As one can see, both before and after the War Austria and Germany were in

Map 1a: GDP/cap in 1937 (USSR=Russia, current borders) (1990 GK dollars)

Map 1b: GDP/cap in 1990 (1990 GK dollars)

the lead together with Czechoslovakia. However, Russia made quite a recovery after the War.

Maps 2a and b show similar data for the gross stock of physical capital. Even though, just as in per capita GDP, Germany and Austria remain the leading economies, Russia made up quite some ground in capital formation. For human capital (we reported the income based variant here since we have most data on income based measures of human capital) the situation is different. Map 3a and b show that it was especially Czechoslovakia and Kazakhstan that did well in the 1930s. Even though that remaind the case throughout the century, in the 1990s Austria, Germany and the Baltic states had gained top positions also in this ranking.

Map 2a: Physical capital per capita in 1937 (USSR=Russia, current borders) (1990 GK dollars)

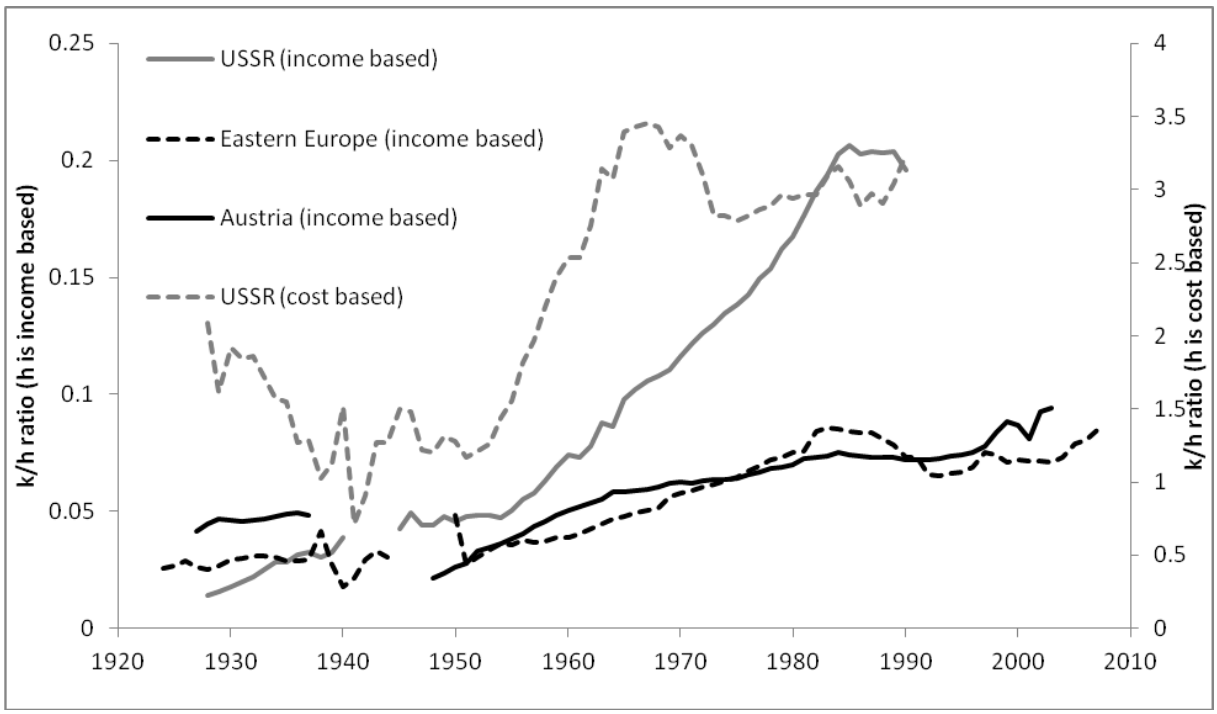
Map 2b: Physical capital per capita in 1990 (USSR=Russia, current borders) (1990 GK dollars)

Map 3a: Income based human capital per capita in 1937 (USSR=Russia, current borders) (1990 GK dollars)

Map 3b: Income based human capital per capita in 1990 (1990 GK dollars)

In sum, whereas GDP/cap and physical capital/cap rankings were quite persistent over time, this was less true for human capital. Physical capital accumulation was especially rapid in the USSR and, to a lesser extent, in Eastern Europe while human capital accumulation was especially rapid in Germany and Austria and the Baltic states. This suggests that the physical/human capital ratio is likely to rise more (or decline less) in Eastern Europe and especially the former USSR than in Western countries. This feature is plotted in Figure 1 where we show the physical-human capital ratio for Eastern Europe and the USSR. We can clearly see that this ratio grows much faster in the USSR. While this ratio does grow faster in

Figure 1: Physical to human capital ratio in socialist Eastern Europe and the USSR



Eastern Europe until the 1980s, its growth is clearly less than in the USSR. Also we find a decline of this ratio in the 1990s when physical capital became valued closer to its actual market price. Another important point to note from above Figure is that the cost-based human capital indicator seems to move quite well together with the income based measure with the

exception of the pre-1940 period. Nevertheless it is clear that both the cost-and income measures show a far faster growth in physical-human capital ratio in the USSR than elsewhere.

3. The model

The finding is that the rank in terms of GDP per capita remained the same while the physical-human capital ratio increased considerably in Eastern Europe, but especially in the USSR, even though not unexpected, warrants further analysis given that several studies, as argued in the introduction, find a negative relation between physical-human capital ratio and economic growth. How can we explain this development in Eastern Europe and the USSR?

The most likely explanation lies in the different role of the state played in economic development in state-socialist countries and market economies, and, as a result, the difference in preferences of the social planner. In state-socialism, initially the government takes full control of the resources and also makes the majority of allocation decisions. As such, we can use the government's priorities as those of the "social planner". In a market economy, however, decisions regarding the allocation of resources are made by private agents as they make decisions about the size and allocation of their savings and consumption. But the decisive factor is not the role of the state. Even if the state has a large redistributive power (in a mixed-economy or in a welfare state) as long as its primary concern is welfare maximization in the long-run (which can be simply modelled as a maximization of the discounted sum of present and future consumption), the final outcome should, at least theoretically, not be different than from a society where private agents make all decisions. State-socialist governments, however, were influenced by the Marxian theory of economic development, that, based on Adam Smith's view on productive and unproductive labor, put an emphasis on the distinction between material and immaterial production, the later is simply not even included the Material Product System (MPS), a system of national account widely used in state-socialist countries until the 1980s and the People's Republic of China until 1993.

Even though we are going to present a formalized model, the main results and mechanisms can be summarized in a quite succinct way. A state-socialist regime, once following a Marxist-influenced economic policy, had a tendency to value material production above immaterial production, the latter being simply important as much as it was indispensable to consumption. Since material goods are very likely to be produced in a more physical capital intensive way than immaterial goods, this leads to a higher ratio of physical to human capital along the optimal growth path of the economy. This has consequences on the performance of the economy as well, but the conclusion strongly depends on the way of measurement: in terms of GDP per capita growth (SNA), since the social returns to fixed capital are likely to be lower than that of human capital (as it is usually found in the empirical literature) the same amount of resources spent on increasing physical rather than human

capital leads to a lower rate of economic growth. It turns out, if one measures performance within the MPS, the planned economy should produce a faster growth and outperform other economies. This necessarily comes at the price of reduced consumption, however (both tangible and intangible goods). Once a state-socialist regime, probably thanks to growing social tensions arising from low consumption of intangible goods, starts to put more emphasis on their production relative to material output, its physical to human capital ratio should necessarily decline.

The optimization problem that we discuss below is basically the same as in that Barro and Sala-i-Martin (2004, Chapter 5). We start with following Ellman (1973) in that the government makes the decisions like some sort of social planner and has a combination of per capita consumption (c) and per capita material production (qm) in its utility function, which it seeks to maximize:

$$V(t, q_t^M, c_t) = \int_0^\infty e^{-\rho t} \left(a \ln q_t^m + b \ln c_t \right) \quad (1)$$

,where ρ is the discount factor.

Even though, as argued by Ellman, the socialist government largely focuses on material production, it may also have consumption in its utility function in order to prevent hunger or political instability. The constants a and b reflect the preferences of the planner, which indicates how much the government values each of the two components.

The factor accumulation is governed by the following equations, where we assumed the same rate of depreciation in all sectors and for both types of capital. The super and subscripts *m* and *i* denote the two sectors (material and immaterial). *k* and *h* denote physical and human capital respectively. δ and *n* are the rate of depreciation and the growth rate of labour force.

$$\dot{k}_m = I_k^m - (\delta + n) k_m \quad (2)$$

$$\dot{k}_i = I_k^i - (\delta + n) k_i \quad (3)$$

$$\dot{h}_m = I_h^m - (\delta + n) h_m \quad (4)$$

$$\dot{h}_i = I_h^i - (\delta + n) h_i \quad (5)$$

The products are either produced as material or immaterial goods, or, in terms of investment, income is either consumed or invested in *k* or *h*:

$$y_t = c_t + I_k^m + I_h^m + I_k^i + I_h^i = k_m^\beta h_m^{1-\beta} + k_i^\gamma h_i^{1-\gamma} \quad (6)$$

Consumption consists of material and immaterial goods which require a different mix of the

two capitals to be produced:

$$q_t^m = k_t^{\beta} h_t^{1-\beta} \quad q_t^i = k_t^{\gamma} h_t^{1-\gamma} \tag{7}$$

In equation 7 we can assume that $\beta>\gamma$, that is, material goods are produced more physical capital intensively than immaterial goods.

Consumption is seen as a composite of the two types of goods and they are assumed to be imperfect substitutes. This is modelled as if consumption equalled a Cobb-Douglas type utility function.

$$c_t = \left(q_t^m\right)^{\alpha} \left(q_t^i\right)^{1-\alpha} \tag{8}$$

, where α is simply the elasticity between material and immaterial consumption.

Now we can write the following Hamiltonian:

$$H = e^{-\rho t}\left(a \ln q_t^m + b \ln c_t\right) + \lambda_1(q_t^m + q_t^i - c_t - I_h^m - I_k^i - I_h^i - (\delta + n)k_m) +$$
$$+\lambda_2(I_k^i - (\delta + n)k_i) + \lambda_3(I_h^m - (\delta + n)h_m) + \lambda_4(I_h^i - (\delta + n)h_i) \tag{9}$$

The first order conditions require:

$$H_c = e^{-\rho t}\frac{b}{c_t} - \lambda_1 = 0 \tag{10}$$

$$H_{I_k^i} = -\lambda_1 + \lambda_2 = 0 \; H_{I_h^m} = -\lambda_1 + \lambda_3 = 0 \; H_{I_h^i} = -\lambda_1 + \lambda_4 = 0 \tag{11}$$

$$\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda \tag{12}$$

The additional conditions of an optimal path are:

$$H_{k_m} = \frac{e^{-\rho t}\beta(a + \alpha b + \lambda q_t^m e^{\rho t})}{k_m} - \lambda(\delta + n) = -\dot{\lambda} \tag{13}$$

$$H_{k_i} = \frac{e^{-\rho t}\gamma(b(1-\alpha) + \lambda q_t^i e^{\rho t})}{k_i} - \lambda(\delta + n) = -\dot{\lambda} \tag{14}$$

$$H_{h_m} = \frac{e^{-\rho t}(1-\beta)(a + \alpha b + \lambda q_t^m e^{\rho t})}{h_m} - \lambda(\delta + n) = -\dot{\lambda}$$

$$H_{h_i} = \frac{e^{-\rho t}(1-\gamma)(b(1-\alpha) + \lambda q_t^i e^{\rho t})}{h_i} - \lambda(\delta + n) = -\dot{\lambda} \tag{15}$$

Where we already incorporated our finding that the shadow-prices λ1-λ4 are equal along the optimal path. Making above expressions equal for the same sectors lead to the following physical to human capital ratios within each sectors:

$$\frac{k_m}{h_m} = \frac{\beta}{1-\beta} \quad (16)$$

$$\frac{k_i}{h_i} = \frac{\gamma}{1-\gamma} \quad (17)$$

Since:

$$\frac{\dot{c}}{c} = \frac{e^{-\rho t}\beta(a+\alpha b+\lambda q_t^m e^{\rho t})}{k_m \lambda} - (\rho+\delta+n) = \frac{\beta(a+\alpha b)c_t}{k_m b} + \left(\frac{1-\beta}{\beta}\right)^{1-\beta} e^{\rho t} - (\rho+\delta+n) \quad (18)$$

$$\frac{\dot{c}}{c} = \frac{e^{-\rho t}\gamma(b(1-\alpha)+\lambda q_t^i e^{\rho t})}{k_i \lambda} - (\rho+\delta+n) = \frac{\gamma(1-\alpha)c_t}{k_i} + \left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} e^{\rho t} - (\rho+\delta+n) \quad (19)$$

where we made use of that:

$$q_t^m = \left(\frac{1-\beta}{\beta}\right)^{1-\beta} k_m \text{ and } q_t^i = \left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} k_i \quad (20)$$

In this model there is no endogenous growth, and we did not introduce any exogenous productivity factors. As such, we know that once the steady state is achieved, both per capita income and consumption will be constant. This level is for the immaterial and material goods:

$$c_t = \left[\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta} e^{\rho t}\right]\frac{bk_m}{\beta(a+\alpha b)} \quad (21)$$

$$c_t = \left(\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} e^{\rho t}\right)\frac{k_i}{\gamma(1-\alpha)} \quad (22)$$

so the steady state ratio of the physical capital in the two sectors is:

$$\frac{k_m}{k_i} = \frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta} e^{\rho t}} \frac{\beta(a+\alpha b)}{b\gamma(1-\alpha)} \quad (23)$$

The same for human capital is:

$$\frac{h_m}{h_i}=\left[\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma}e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta}e^{\rho t}}\right]\frac{(1-\beta)(a+\alpha b)}{b(1-\gamma)(1-\alpha)} \quad (24)$$

In order to arrive to the economy-wide ratios of physical to human capital, we need to express the total amount of physical and human capital in the economy:

$$k_t=k_m+k_i=\left(1+\left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma}e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta}e^{\rho t}}\right)\frac{\beta(a+\alpha b)}{b\gamma(1-\alpha)}\right)k_i \quad (25)$$

Doing the same for human capital yields:

$$h_t=h_m+h_i=\left[1+\left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma}e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta}e^{\rho t}}\right)\frac{(1-\beta)(a+\alpha b)}{b(1-\gamma)(1-\alpha)}\right]h_i \quad (26)$$

We can now simply divide above equations and arrive at the physical- to human capital ratio:

$$\frac{k_t}{h_t}=\frac{\frac{\gamma}{1-\gamma}+\left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma}e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta}e^{\rho t}}\right)\frac{\beta(a+\alpha b)}{b(1-\gamma)(1-\alpha)}}{1+\left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma}e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta}e^{\rho t}}\right)\frac{(1-\beta)(a+\alpha b)}{b(1-\gamma)(1-\alpha)}} \quad (27)$$

This is a general formula when a planner derives utility both from consumption and material production. In the extreme case, when a>0 and b=0, that is the planner does not assign any value to consumption, investment will only be in the material production and

$$\frac{k_t}{h_t}=\frac{\beta}{1-\beta} \quad (28)$$

Since usually β<0.5, this means that k/h<1.

In the other extreme case, when a=0, we have the case where consumption is all important (which will be approximately the case for capitalist/post-socialist countries), b cancels out and we get:

$$\frac{k_t}{h_t} = \frac{\frac{\gamma}{1-\gamma} + \left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta} e^{\rho t}} \right) \frac{\beta\alpha}{(1-\gamma)(1-\alpha)}}{1+\left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta} e^{\rho t}} \right) \frac{(1-\beta)\alpha}{(1-\gamma)(1-\alpha)}} = \frac{\frac{\gamma}{1-\gamma}+z\beta}{1+z(1-\beta)} = \frac{\frac{\gamma}{1-\gamma}+z\beta}{1+z-z\beta} \quad (29)$$

with: $z = \left(\frac{\rho+\delta+n-\left(\frac{1-\gamma}{\gamma}\right)^{1-\gamma} e^{\rho t}}{\rho+\delta+n-\left(\frac{1-\beta}{\beta}\right)^{1-\beta} e^{\rho t}} \right) \frac{\alpha}{(1-\gamma)(1-\alpha)} > 0$ and if β>γ , z>1. (30)

if α=β=θ, that is if both material and immaterial goods were produced with the same factor intensity:

$$\frac{k_t}{h_t} = \frac{\frac{\theta}{1-\theta} + \frac{\theta(a+\alpha b)}{b(1-\theta)(1-\alpha)}}{1+\frac{a+\alpha b}{b(1-\alpha)}} \quad (30)$$

if a=0:

$$\frac{k_t}{h_t} = \frac{\theta}{1-\theta} \quad (31)$$

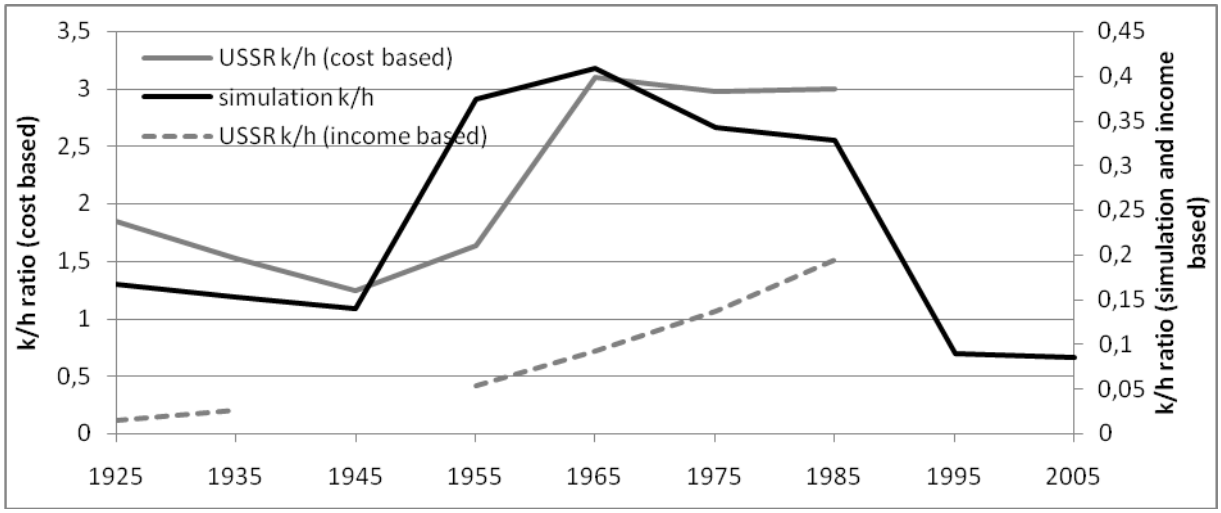
Which is the same result that Barro and Sala-i-Martin (2004, Chapter 5) obtained.

In sum, we can set the coefficients of above model in such a way that they resemble socialist and capitalist policy. The model will then return the approximate physical/human capital ratio in both economies. We assume that during the 1920s, 1930s[4] and after the 1980s

[4] Of course this varied by country. In the USSR, even though it was Stalin who proclaimed the aim of making the collective farmers prosperous while the government was setting their wage rate in such a way they were about 3 times lower than for industrial blue-collar workers. Much other evidence suggests that the consumption of the latter worsened as well in 1930s. Allen (2003) recognized the trend to overall welfare level improvement largely due to migration from rural to urban sector. However HC was more heavily invested then than FC was, resulting in a *de facto* decline of the physical-human capital ratio.

the planner had only consumption in its utility. During socialist times, however, there was a preference for material production. The result is given in below graph. We have to stress that above model incorporate human capital as direct expenditure into the model for which the closest empirical equivalent is the cost based measure (see Judson 2003 or van Leeuwen and Földvári 2008). The income based measures reflect private returns to human capital so even though these may not deviate from the cost based measurement for a very long period, it is much less appropriate to test the model.

Figure 2: Simulated and actual physical to human capital ratio in the USSR



Notes: Assumptions: rho=0.02; delta=0.07; n=0.01; 1920-1940: a=1; b=3; alpha=0.6; beta=0.3; gamma=0.2. 1950s: a=2; b=1; alpha=0.6; beta=0.4, gamma=0.2; 1960s: a=3; b=1; alpha=0.6; beta=0,.4, gamma=0.2; 1970s and 1980s: a=2; b=1; alpha=0.6; beta=0.4, gamma=0.2; 1990s and 2000s: a=1; b=2; alpha=0.5; beta=0.3, gamma=0.2.

As a cost based estimate is currently only available for the USSR and its Republics for the CEE countries we need to rely largely on income based measures. Hence, in Figure 1 we plot both the cost-and income based measure for the USSR. Indeed, the income based factor is much higher than the cost based method, which only includes government expenditure and excludes private expenditure (roughly 45% of total expenditure in the USSR) as well as foregone wages.

4. Effects on economic growth

In principle, faster growth of physical capital per capita can lead in one sector growth models to faster economic growth. Hence, we expect to find that an increase in the k/.h ratio leads to a higher level of per capita GDP. This is the case because in our model in the long run growth must be zero (at least based on capital accumulation) hence, the level of k/h must have effect on the level of per capita income, but not on its growth rate.

From our model, it follows that, during the socialist period, we expect the effect of the k/h ratio to be bigger than in the non-socialist periods, i.e. after ca. 1990 (or in Eastern Europe before ca. 1950). The reason is that the material sector, which was stimulated during socialism as pointed out in Section 3, was also the most physical capital intensive. Therefore, an increase in the k/h ratio must have increased the level of per capita GDP more in socialist economies than during non-socialist period which were characterised by higher levels of the non-material sector taking other things equal. Our second hypothesis is that, when including Net Material Product instead of per capita GDP, the effect of the K.H ratio will go up. This follows logically from the fact that the Material Product consist of material production with a high physical capital ratio. This model also predicts that the NMP growth rates also faded though not so much as those of the GNP.

The results are reported in Table 2 below. We find that the k/h ratio has a positive effect on per capita GDP and NMP as expected. However, looking at Eastern Europe, it becomes clear that this effect is biggest for the socialist period, i.e. between 1950 and 1990

Table 2: instrumental variable regression with k/h ratio

	dependent variable: log of per capita GDP/ NMP						
	Eastern Europe			**USSR**		**Austria**	
	ln(GDP/cap)	**ln(GDP/cap)**	**ln(GDP/cap)**	**ln(GDP/cap)**	**ln(NMP/cap)**	**ln(GDP/cap)**	**ln(GDP/cap)**
	1920-1940	**1950-1990**	**1990-2010**	**1950-1990**	**1950-1990**	**1950-1990**	**1990-2010**
constant	NA	NA	NA	36.85	-2.97	-35.24	-40.13
				-2.58	(-0.20)	(-9.68)	(-1.97)
year				-0.013	0.005	0.024	0.025
				(-1.90)	(0.64)	(13.61)	(2.56)
ln(k/h ratio)	0.145	0.838	-0.192	0.867	1.001	0.680	-0.256
	(1.62)	(18.5)	(-1.19)	(5.35)	(6.36)	(7.70)	(-0.62)
Cragg-Donald Wald F statistic (p-value)	NA	NA	NA	29.452	29.452	219.834	0.523
Hansen J statistic (p-value)	0.977	0.01	0.19	0.389	0.549	0.389	0.436
N	43	185	93	35	35	37	14

Note: Eastern Europe: excluding Austria; fixed effects; z-statistic in parentheses

with a value of 0.84. For the USSR we included both the GDP/cap and the Net Material Product per capita. The results suggest that the effect of the k/h ratio during socialism were almost equal in the USSR as in Eastern Europe. However, when including the NMP, we find that this effect goes up, thus confirming our second hypothesis. Finally, we also included Austria. We found that, during the 1950-1990 period, the effect was slightly lower than that of

the socialist countries. However, after 1990, even though we have too little data to make a firm commitment, it looks that, just as in Eastern Europe, the effect of the k/h ratio turns insignificant.

5. Conclusion

Two stories go round concerning centrally planned economies. On the one hand it is claimed that initially they experienced fast economic development due to strong capital accumulation while, on the other hand, it is argued that their growth rates declined due to a rising physical-human capital ratio.

In this paper we addressed this issue by analyzing the growth model during the socialist period. We developed a model in which the government either has preferences for consumption or material production, or a combination. Since the socialist governments in general had a preference for material production (Ellman, 1973) our model shows that the k/h ratio increases strongly. Only after ca. 1990 and, for Eastern Europe before the 1940s, we find a slower growth of the k/h ratio. This latter is understandable from the perspective of capitalist growth which focuses more on the immaterial sector which developed at a more advanced stage of economic development and which was characterised by a lower physical capital intensity. In addition, investment in capitalist world is only appreciated as long as it maximizes long-run consumption.

Given the model used, an increase in the k/h ratio cannot effect long run growth. Any increase in either the growth of physical -or human capital can only have a temporary effect on the growth of per capita income. Therefore, we estimate a model in which the k/h ratio affects the level of per capita income. Following our model, we expect that during socialism the effect of the k/h ratio on per capita income was higher than both before or after socialism. In other words, a faster increase of physical -as compared to human capital increases per capita income. The reason is that during socialism the government focussed on material production, which had a higher intensity of physical capital. Indeed, we find that during the socialist period, the effect is highest. This is even exacerbated when including NMP as an indicator of per capita production: we find that the effect of an increasing k/h ratio for the USSR is close to 1.

These findings suggest that economic theory is an important driver of economic development. Clearly, in Eastern Europe, and especially in the former USSR, the increase of physical to human capital was based on economic models that were stimulating economic development. This becomes even clearer when using NMP, being a different (more material production oriented) measure of per capita production. Only when human capital intensive (and physical capital extensive) sectors were on the rise, an increase in the physical- human capital ratio became negative and insignificant. The fact that this applies both to capitalist and (former) socialist countries again implies that the choice for a centrally planned economy at the start of the twentieth century may not have been so illogical with the knowledge of those days.

References

Allen, R.C. (2003), *Farm to Factory*: A Reinterpretation of the Soviet Industrial. Revolution, Princeton: Princeton University Press

Barro, Robert, and Xavier Sala-i-Martin (2004), *Economic Growth*, The MIT Press.

Becker, A.S. (1969). Soviet national income, 1958-1964: National accounts of the USSR in the seven year plan period. Berkeley: Univ. of California Press.

Bergson, A. (1961). Real National Income of Soviet Russia since 1928. Cambridge (Mass.): Harvard University Press, 1961.

Bergson, Abram, 'Toward a New Growth Model', in Abram Bergson, Productivity and the Social System-the USSR and the West (Cambridge, MA, Harvard University Press, 1978 [1971]).

Datta, Madhusudan, Net Material Product and Net Domestic Product: Significance of the Two Concepts for Less Developed Countries, *Economic and Political Weekly,* Vol. 22, No. 1/2 (Jan. 3-10, 1987), pp. 47-53

Didenko, Dmitry, Peter Foldvari, and Bas van Leeuwen (2011), Human capital in the former Soviet Union area: Sources and methodes for the time-series Construction,' Unpublished paper, 2011 (www….).

Duczynski, Petr, 'Adjustment costs in a two-capital growth model,' Journal of Economic Dynamics and Control, 2002, Vol. 26, 837-850.

Duczynski, Petr, 'On the Empirics of the Imbalance Effect,' International Journal of Business and Economics, 2003, Vol. 2, No. 2, 121-128.

Easterly, W. and Fischer, S. The Soviet Economic Decline: Historical and Republican Data. World Bank Policy Research Working Paper Number 1284, April 2001. Also published in the World Bank Economic Review 9(3): 341-371, 1995. (World Bank accessed, 2011).

Ellman, Michael (1973), Planning Problems in the USSR. The Contribution of Mathematical Economics to their solution, 1960-1971, University of Cambridge Department of Applied Economics Monograph 24.

Easterly, W. and Fischer, S. The Soviet Economic Decline: Historical and Republican Data. World Bank Policy Research Working Paper Number 1284, April 2001. Also published in the World Bank Economic Review 9(3): 341-371, 1995.

Erk, N., Altan Cabuk, H., and Ates, Sanh (1998), 'Long-Run Growth and Physical Capital-Human Capital Concentration,' Working Paper presented in International METU Conference on Economics II (http://idari.cu.edu.tr/sanli/academic.htm).

Khanin, G.I. (1991). *Dinamika ekonomicheskogo razvitiia SSSR*. Novosibirsk: Nauka, Sibirskoe otdelenie.

Kaplan, Norman M., 'Retardation in Soviet Growth', Review of Economics and Statistics, 50, 3, August 1968.

Kontorovich, Vladimir, 2001, "Economists, Soviet Growth Slowdown and the Collapse," *Europe-Asia Studies,* Vol. 53 (5), 675-695.

Maddison, Angus, Contours of the World Economy, 1-2030 AD. Essays in Macro-Economic History, Oxford University Press, Oxford, 2007.

Steinberg, D. (1990). The Soviet Economy 1970 - 1990: A statistical analysis. San Francisco: Intern. Trade Press.

Solow, Robert M., ‘A Contribution to the Theory of Economic Growth,’ *Quarterly Journal of Economics*, Vol. 70 (1) 1956, 65-94.
Solow, Robert M., ‘Technical Change and the Aggregate Production Function,’ *Review of Economics and Statistics*, Vol. 39 (1957), 312-20.
van Leeuwen, Bas and Péter Földvári, 'Capital accumulation and growth in Central Europe, 1920-2006,' Unpublished paper , 2010. (www.basvanleeuwen.net/papers.htm).