Cost efficiency of intangible capital

The economic impact of NIC drivers in the ELSS model is calculated as percentage share in GDP formation, and accordingly it is natural also to estimate the economic *input(s)* as percentage of GDP.

Cost efficiency of a NIC indicator (driver) can be calculated as a simple ratio between input and output. A value = 1 would then mean that input equals output and a value >1 that output is bigger than input.

The benefit of a driver can thus be calculated as (output-input)/input*100%. These values are cross country comparable and reliable (see 1.3. points 3 and 4).

1. Methodology

Cost efficiency is calculated by estimating inputs as expenses for each driver. The impacts and efficiency are tested via test parameters.

1.1 Input parameters and their implementation

Input parameters are three positive (+) and two reciprocal (-) economic figures:

1. EDUE (+) Total expenditure in education as percentage of GDP
2. RNDE (+) Total expenditures in R&D (investments in R&D) as percentage of GDP
3. GOVE (+) Government total expenditures as percentage of GDP
4. CONS (-) Household private consumption leftover as percentage of GDP
5. GFCF (-) Gross fixed capital formation (investment ratio) leftover as percentage of GDP

Expenditures in education and R&D are expenditures in intangible capital *per se*. Adding government expenditures to positive expenditures in intangible capital is motivated by the fact that big parts of government expenditures are investments in infrastructure, societal development and welfare. These items strengthen utilization of intangibles and intangible capital as such. ??

Correlation analysis shows that household expenditures and gross fixed capital formation (tangible investments) correlate negatively with increasing impacts of intagible capital in GDP formation. This correlation is robust, i.e. it is negative for all indicators. These are therefore used as reciprocals. The underlying practical logic seems to be that neither investments in tangible drivers (GFCF) nor consumpstion as such do not promote structural changes towards utilization of intangibles. Accordingly, sheer consumption and investments in tangibles tend to uphold the present more than

support progress towards a knowledge economy. The robust reciprocal relation between both household consumption and gross fixed capital formation means that all the resources that do not go to consumption or tangible investments increase exploitation and impact of intangibles in the economy.

For each NIC indicator, e.g. the cost of the "R&D researchers nation vide, FTE" (NHC12) as input is estimated as the sum of percentage shares in education, R&D and government total expenses, and as the sum of percentage shares in leftovers from consumption and gross fixed capital formation. This means that to produce the cost efficiency value for "R&D researchers nation vide" parts of education, R&D and government expenses as well as parts of consumption and tangible investment leftovers must be included.

The relations of the NIC indicators to economics vary; for some indicators it is easier easier to estimate than for the others. For instance "Public expenditure on education as % of GDP" (NHC5) is rather clear, whereas "Freedom of speech" (NPC12) is harder to define via expenses for the society. The estimated shares for the NIC as a whole (human, market, process, and renewal capital) and i for all the indicators individually, are presented in Appendix Axx together with the rationales for the made decisions.

1.2 Use of test parameters

Four test parameters are used to verify the impact and cost efficiency of each NIC indicator:

1. TRADE (+) Trade to GDP ratio as percentage of GDP (export+import / 2*GDP)
2. EMPL (+) Employment as percentage of total labor force
3. INFL (-) Consumer price inflation, percentage annual change
4. PROD (-) Productivity real growth, percentage annual change

Trade and high employment are drivers of the economy. These test parameters are added in order to analyze whether the increase of trade and employment also increase economic impacts of intangibles. If the hypothesis is correct, promoting trade and employment is simultaneously a mean to increase the share of intangibles in GDP formation.

Moderate inflation is an active driver of the economy. However both deflation (negative inflation) and extremely high inflation (above 5-7 % annually) hampers the economy. In general inflation between 2-4% is considered favorable, even though research results to some extent vary. When adding inflation as a test parameter, the question is whether inflation by acting as a driver for economy also drives the structural change towards intangible driven economy – or does it only endorse growing volumes of GDP?

Productivity growth is usually linked to GDP growth. However, in recessions this connection may vanish. The mediator here is employment. I.e. less may do more even in resession times when overall GDP is declining. When adding productivity as a test parameter the following question can be

answered: Does productivity support structural change towards intangible economy or is productivity growth mostly achieved by other than intangible measures?

1.3. Calculations and estimates

1. Estimates for expenses are not made country vise, i.e. the same estimation for expenses linked to a NIC indicator is used for all countries (Appendix Axx).
2. The results must be regarded as estimates, because the input expenses are also based on estimates. Some estimates are more valid (e.g. “Public expenditure on education as % of GDP”) than others (“Freedom of speech”).
3. However, as a corollary of (1) cost efficiency for a single driver is cross country comparable. Higher is *de facto* higher and lower is *de facto* lower when comparing countries.
4. Results are robust concerning the structural differences of GDP, since both the output impact as percentage of GDP and the input expenses as percentage of GDP refer to the same GDP.

2. Estimates for cost of national intangible capital NIC

Estimating *costs* for national intangible capital NIC as *expences* involves estimating 1) what the total input for NIC is, 2) how inputs for NIC are distributed between NIC sub-categories human, market, process and renewal capital and 3) structure of input as cost for single, simple driver in each category. E.g. when expences for education are 4.85 % of GDP we can assume that this benefit NIC 100 % (all is used as input for NIC), but how is this input distributed between HNC, NMC, NPC and NRC as economic drivers (2) and how much can be considerd to be input for i.e. NHC10 “Gender equality” (3)?

This is to say that i.e. expences in education (NIC59 average = 4.85 % of GDP) as input benefit all drivers and is distributed over human, market, process and renewal capital and within i.e. human capital further distributed as input for single drivers.

To answer these questions estimates are made in three successive stages (see Appendix XXX):

1. Esimates for *NIC total* inputs (as percentages of GDP) are made on available statistics for
    a. public expenditures on education (EDUE)
    b. public and private expenditures on R&D (RNDE)
    c. share of government general expenditure benefiting NIC (GOVE)
    d. share of private consuption leftovers benefiting NIC (CONSE)
    e. share of tangible investments leftovers benefiting NIC (GFCFE)
2. For each input 1.a - 1.e the weight as *percentage share* how input benefit human, market process and renewal capital is estimated. Practically this means that 100 % from (1) is distributed as percentage shares for each category.
3. Finally for each indicator estimates whether a single indicator, driver uses *more or less* of potential inputs are presented. Deviation expressed as percentage deviation from (2).

Estimates for (1) are rather reliable as statistics and research results are availabe.

Estimates for (2) and (3) are vaguer as statistics and reseach results are hard to followup and pinpoint to different sub-categories of NIC.

> However, reasoning and heuristics can here be substantiated by following correlation of impact growth to economic structure of inpacts in general, e.g. correlation between input 1.a – 1.e and output in general. i.e. where correlation is high weight will be increased and respectively where correlation is low weight will be decreased. This way the weights will be adjusted properly.

In this paper results for cost efficency are based on inputs as percentage shares of GDP and weights (percentage shares of total input) for NIC sub-categories as presented in table A.

Table A: Basic inputs and weights (NIC 2014)

	Basic inputs as % of GDP	**Education**	**R&D**	**Government general expendtures**	**Leftovers Private consumption**	**Leftovers Tangible investments**	**TOTAL**
	Input as percentage of GDP*	4.85	1.43	35.44	42.99	77.82	
1	Percentage share of input						Total input
	NIC	100	100	16	8	4	
	Percentage of GDP	4.85	1.43	5.67	3.44	3.11	18.5
	Relative percentage share	26.20	7.71	30.66	18.60	16.83	100
2	Percentage share in NIC sub-category						Total share
	Human capital	40	10	30	20	30	26
	Market capital	10	10	10	30	10	14
	Process capital	20	20	40	40	40	32
	Renewal capital	30	60	20	10	20	28
	TOTAL	100	100	100	100	100	100
	*) Unweighted averages for NIC 59 / Varies significantly country vise						

2. Summary results

Table 1: Correlation between input and test parameters vs impact anfd efficiency

Correlation analysis for NIC

Correlation 2001-2014		Input EDUE	RNDE	GOVE	Leftover from CONS	GFCF
Output	Efficiency	0.373	0.668	0.341	0.283	0.280
	Impact	0.526	0.730	0.525	0.347	0.276

Correlation 2001-2014		Test parameter TRADE	EMPL	INFL	PROD
Output	Efficiency	0.324	0.371	-0.519	-0.393
	Impact	0.278	0.331	-0.528	-0.388

Correlation analysis (Table 1) support the notion that expenditures in education (EDUE), R&D (RNDE) and government general expenditures (GOVE) all are positive actors shaping the knowledge economy. Remarkably both education *and* government general expences correlate on same level to both impact of intangibles (r=0.526/0.525) and cost efficiency (r=0.373/0.341). That is to say both are equally important in building up and benefiting from intangible capital.

Wheras education and government expences both are important R&D is notably the strongest driver with respect to impact in GDP formation (r=0.730) and cost efficiency (r=0.668).

Leftovers from consumption (CONS) and gross fixed capital formation (GFCF) operate as positive actors shaping the knowledge economy, but on lower levels for impact (r=0.347/0.276). However, leftovers relations to cost efficiency are close to those for education and government general expences (r=0.283/0.280). Practically this indicates that resources not spent on mere consumption and/or tangibles tend partly to boost intangibles.

Looking at test parameters trade (TRADE) and employment (EMPL) correlate positively with intangibles impact in GDP formation and cost efficiency. Practically this indicates that a dynamic and global economy has positive imapct on the structuring of the economy towards intangibles and their usage, i.e. correlations for efficiency slightly higher than for mere impact.

Notably inflation (INFL) and productivity (PROD) correlate negatively. Practically this means that an inflation driven economic growth does not restructure the economy towards intangibles, nor does mere productivity growth. I.e. the roots to the structure of GDP with respect to intangibles are other than mere GDP or productivity growth.

Table 2: Cost efficiency of intangible capital NIC

Cost efficiency
National intangible capital NIC
Averages 2012-2014

		Average	Median	Max	Min	Range
Output	Efficiency	4.02	3.99	5.77	2.24	3.53
	Efficiency %	302	299	477	124	353

Looking at the summary results in Table 2: 1 $ spent in education, R&D and government general expences with additional leftovers from consumption and investments in tangibles will induce an impact of intangibles in GDP formation worth 5 $. In other words: The net average gain is 300 % (max = 477 % and min = 124 %).