



Centre for Industrial Policy Studies

Robotization Economics

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The Impact of New Technologies on Labour Income Share in Russia - Intersectoral Micro-based Approach

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Research Motivation

labor income share decline - empirical stylized fact
- Berg et al., 2018; Freeman, 2015...

Level of estimates

If LS dynamics is well-understood on the global (p.e. Karabarbounis&Neiman, 2013) or national level, intersectoral estimates are poor (only Young, 2013) and the field is underresearched

As per the reason of decline - examples

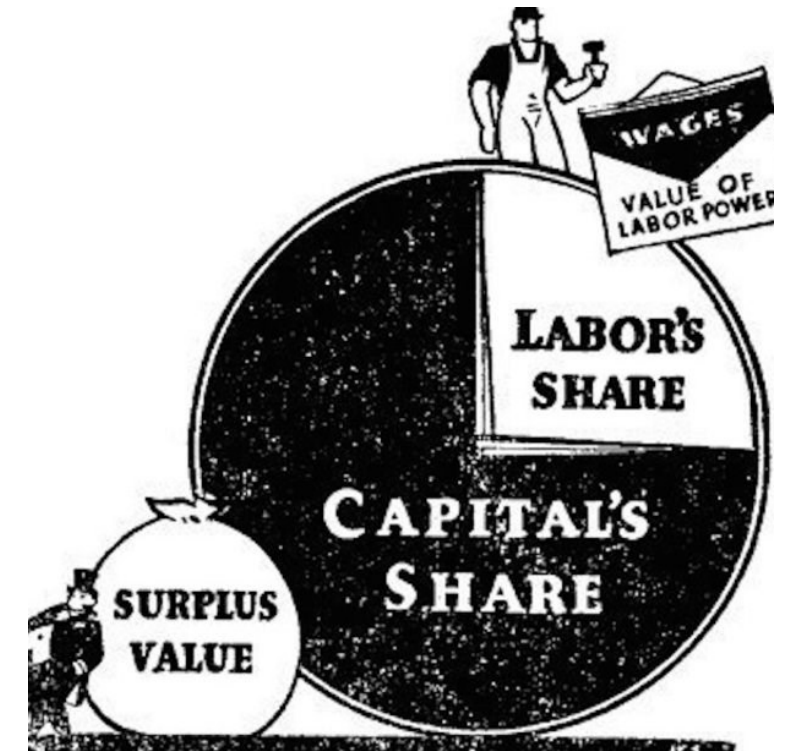
Karabarbounis&Neiman, (2013) say that “the decrease in the relative price of investment goods, often attributed to **advances in information technology**...explains roughly half of the observed decline in the labour share, even when...increasing profits, capital-augmenting technology growth, and the changing skill composition of the labor force” are considered

McKinsey review five reasons for the U.S. labor share decline (Manyika et al., 2019)

- Supercycle and boom-bust effects - 33%
- Rising and faster depreciation due to higher capital stocks and a shift to intangible assets - 26%
- Superstar firms - 18%
- Capital substitution of labor and automation - 12%
- Globalization and decreased labor bargaining power - 11%

As per the origin of decline – a connection to technological progress parameters

From another angle, LS is analyzed through empirical estimation of **labor-to-capital substitution elasticity**



Source: <https://socialismoryourmoneyback.blogspot.com/2019/04/bumper-dividends-for-share-holders.html>



Data and Research Method

Subject

Russian manufacturing sector analyzed on intersectoral level

Panel data

7 years 2011-2017

1716 observations (firms' financial data)

4 factors of new technologies

Virtual Reality – Robotization - Artificial intelligence - 3D-printing

Not possible to include these 4 factors of robotization as dummies into the regression equation primarily because of their insignificance being included (very small sub-samples for different industries does not allow to gain significance) and sometimes abnormal values. Hence, had to work with 4 subsamples, in each of which one factor at once was **excluded**, p.e. to illustrate VR impact on labour-to-capital elasticity of substitution, the elasticity of substitution obtained on the full sample was compared to the same of the sample in which companies with VR-technologies were excluded

Initial sample

NAs and abnormal values (obtained after taking logarithms) were omitted only after transforming the panel into the long format (with NaRV.omit function in R).

Manufacturing subsector	OKVED	Subsample size	Subsample size without...			
			VR	AI	Robots	3D-printing
Food	10	967	940	879	806	931
Textiles	13	91	66	75	72	85
Apparel	14	110	84	90	87	98
Electrical equipment	15	54	38	54	23	40
Wood (processing and manufacturing except furniture)	16	181	176	157	154	162
Paper	17	139	125	124	79	119
Coke and petroleum products	19	42	35	35	28	42
Chemicals	20	228	178	185	195	186
Pharmaceuticals	21	130	111	107	96	116
Plastics and Rubber	22	305	267	264	205	257
Other non-metallic mineral products	23	485	456	444	384	437
Metallurgy	24	209	202	191	174	186
Finished metal products except machinery and equipment	25	314	254	249	225	281
Computers, electronic and optical equipment	26	100	67	48	39	73
Electrical equipment	27	223	193	198	173	190
Other machinery and equipment	28	407	364	330	283	359
Motor transport, trailers and semi-trailers	29	154	136	128	116	142
Other transport equipment	30	91	83	77	59	60
Furniture	31	98	75	68	85	92
Repair and installation of equipment	33	141	131	136	119	137
Total		4469	3981	3839	3402	3993



Data and Research Method

In the regarded short timespan Hicks-Neutral production function [1] allows to obtain substitution elasticity σ parameter, which reflects the current labour-to-capital substitution effect. Comparing σ -s for different subsamples we derive the impact of a factor excluded from a subsample. This is done on intersectoral level. Equating marginal products of [1] to prices of the respective production factors in [2] leads to [3]. Regression equation is derived from [3] by taking logarithms.

$$Y_{it} = A_t \left(\delta K_{it}^{\frac{\sigma-1}{\sigma}} + (1-\delta)L_{it}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad [1]$$

$$\frac{\frac{\partial Y}{\partial L}}{\frac{\partial Y}{\partial K}} = \frac{w}{r} \quad [2] \quad \Leftrightarrow \quad \frac{w}{r} = \frac{1-\delta}{\delta} \left(\frac{K}{L} \right)^{\frac{1}{\sigma}} \quad [3]$$

$$\ln \left(\frac{w}{r} \right) = \ln \left(\frac{1-\delta}{\delta} \right) + \frac{1}{\sigma} \ln \left(\frac{K}{L} \right) \Rightarrow \ln \left(\frac{w}{r} \right) = \beta_0 + \beta_{KL} \ln \left(\frac{K}{L} \right) + \varepsilon \quad [4]$$

$$\ln \left(\frac{K}{L} \right) = \ln \left(\frac{1}{\alpha} - 1 \right) + \sigma \ln \left(\frac{w}{r} \right) \Rightarrow \ln \left(\frac{K}{L} \right) = \delta_0 + \beta_{wr} \ln \left(\frac{w}{r} \right) + \varepsilon \quad [5]$$

δ – distribution parameter
 σ – capital-labor elasticity of substitution

Raw collected data

L and K – number of employees and fixed assets volume, th. Rubles in company i

Y_{it} - operating revenue turnover, th. Rubles of company i

$Labsh$ – [labour share] expenses for labour costs, th. Rubles in company i

Calculated data

$$w = \frac{Labsh}{L} - \text{wages}$$

$$r = \frac{Y - Labsh}{K} - \text{rental rate of capital}$$

Correct panel model choice via the triad of following tests

F-test – FE vs Pooled – H_0 : No fixed effects

Breuch-Pagan test – RE vs Pooled – H_0 : No random effects

Hausmann test - H_1 : RE are inconsistent



Aggregate Results

Positive sign in columns “influence of introducing of factor (1-4) on sigma” means that factor of technology increases substitution of labour with capital in the respective manufacturing subsector

Green cells stand for significant difference between σ -s according to t-test (standard errors for these tests are taken as s.e. for β_{KL} in the respective Pooled, FE or RE full (aggregate) model)

In the truth of Hicks-Neutral technological progress (in the short-run) the increase in the value of labour-to-capital substitution elasticity means that the regarded factor of new technologies helps to save labour consequently imposing a negative effect on labour income share

New technologies - VR (virtual reality), AI (artificial intelligence), ROBOTS (robotization processes), 3D (3D-printing)

Manufacturing subsector	OKVED	Model type	influence of introducing of factor (1-4) on sigma				sigma aggr	sigma without ...			
			VR	AI	ROBOTS	3D		VR	AI	ROBOTS	3D
			(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
Food	10	FE	-0,059	0,015	0,018	0,043	1,129	1,187	1,114	1,111	1,086
Textiles	13	Pooled	0,203	0,197	0,016	0,016	0,988	0,785	0,791	0,972	0,972
Apparel	14	RE	0,102	0,004	-0,017	-0,003	0,984	0,882	0,98	1,001	0,987
Electrical equipment	15	FE	0,079	0,013	0,242	0,02	0,813	0,734	0,8	0,571	0,793
Wood (processing and manufacturing except furniture)	16	RE	0	0,035	0,002	-0,008	1,118	1,118	1,083	1,116	1,126
Paper	17	FE	-0,021	-0,073	-0,103	-0,039	0,946	0,967	1,019	1,05	0,985
Coke and petroleum products	19	RE	0,091	0,037	-0,021	0	0,951	0,86	0,915	0,973	0,951
Chemicals	20	FE	-0,034	0,029	0,062	0,077	0,983	1,017	0,954	0,921	0,906
Pharmaceuticals	21	RE	0,081	0,105	-0,204	0,094	0,968	0,887	0,863	1,173	0,874
Plastics and Rubber	22	RE	0,059	-0,01	0,035	-0,024	0,946	0,887	0,955	0,911	0,97
Other non-metallic mineral products	23	FE	0,07	0,042	0,063	0,033	1,165	1,095	1,122	1,102	1,132
Metallurgy	24	RE	0,059	-0,001	-0,016	0,039	0,983	0,923	0,983	0,999	0,944
Finished metal products except machinery and equipment	25	FE	-0,06	-0,031	0,023	-0,008	0,936	0,996	0,966	0,912	0,944
Computers, electronic and optical equipment	26	Pooled	-0,014	0,007	0,077	0,004	0,802	0,816	0,795	0,725	0,799
Electrical equipment	27	FE	-0,011	-0,028	-0,209	-0,035	0,841	0,851	0,869	1,05	0,876
Other machinery and equipment	28	RE	0,002	-0,017	-0,047	-0,05	1,094	1,092	1,111	1,141	1,144
Motor transport, trailers and semi-trailers	29	RE	0,226	0,095	0,027	0,031	1,199	0,972	1,104	1,172	1,168
Other transport equipment	30	FE	0,033	0,182	-0,145	-0,176	0,767	0,735	0,585	0,913	0,944
Furniture	31	RE	0,11	0,154	-0,142	-0,075	1,218	1,109	1,065	1,36	1,293
Repair and installation of equipment	33	RE	0,145	0,006	0,119	0,022	1,226	1,081	1,22	1,107	1,204



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Thank you for attention!