The Effect of AI Implementation on Total Factor Productivity

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Introduction

Investment in artificial intelligence has become increasingly important for nations looking to improve their technology and gain a competitive edge. However, the effect of artificial intelligence on productivity is largely unknown. My research aims to determine the effect of artificial intelligence implementation on the overall productivity of a country.

Key Findings

I find that, in the short run, productivity is not influenced by the implementation of artificial intelligence. This is consistent with the productivity paradox found previously. My findings do suggest, however, that the number of startups focused on artificial intelligence does have a positive effect on overall productivity. These results indicate that we see the effects of artificial intelligence in TFP only once it has been implemented by firms.

Methods & Data

I run an OLS model with both time and country fixed effects. Since the countries are vastly different sizes, I utilize per capita values in my model to ensure reliable results. I also use a logarithmic construction in my analysis which was used by Letta and Tol (2018).

The data for my research comes from the Stanford HAI database and the latest edition of the Penn World Tables. I use five independent variables to capture artificial intelligence implementation. My dependent variable is Real Total Factor Productivity using Constant National Prices. This is the same dependent variable used by Letta & Tol (2018) for cross country productivity comparison. My dataset contains 26 countries over 4 years for a total of 104 observations

Results

Two-way FE Model:
$R^2 = 0.80$
$R^2_{Adj.} = 0.70$

Results of Per Capita Specification

	(1)	(2)	(3)	(4)
	rtfpna	rtfpna	rtfpna	rtfpna
numjournalcitationspc	-55.22*	-49.62	-19.19	-87.59***
	(30.99)	(31.31)	(29.99)	(26.61)
numconfcitationspc	36.75	20.85	2.652	36.54
	(40.72)	(42.30)	(30.35)	(34.33)
enrollshare	-0.0394	0.156	-0.188	-0.292
	(0.161)	(0.216)	(0.276)	(0.187)
aiprivateinvestpc	-0.00163**	-0.00143**	0.000252	-0.00161***
	(0.000641)	(0.000651)	(0.000574)	(0.000503)
numstartupspc	14523.4***	13927.6**	1922.3	23388.0***
	(5465.6)	(5484.5)	(7053.9)	(4828.5)
Year FE	No	Yes	Yes	Yes
Country FE	No	No	Yes	No
Region FE	No	No	No	Yes
Observations	104	104	104	104
Mean of Dep. Variable	1.010	1.010	1.010	1.010

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Two-way FE model:
$R^2 = .81$
$R^2_{Adj} = .72$

Results of Logarithmic Specification

	(1)	(2)	(3)	(4)
	logrtfpna	logrtfpna	logrtfpna	logrtfpna
lognumjournalcitations	-0.0268**	-0.0191	-0.0223	-0.0279**
	(0.0124)	(0.0130)	(0.0224)	(0.0125)
lognumconfcitations	0.0207*	0.00544	-0.0195	0.00342
	(0.0107)	(0.0134)	(0.0145)	(0.0125)
logenrollshare	-0.000163	0.0127	0.00336	-0.00287
	(0.00783)	(0.0112)	(0.0195)	(0.0108)
logaiprivateinvest	-0.00924*	-0.00664	-0.00372	-0.00133
	(0.00515)	(0.00527)	(0.00433)	(0.00448)
lognumstartups	0.0239***	0.0282***	0.0299**	0.0247***
	(0.00833)	(0.00870)	(0.0124)	(0.00797)
Year FE	No	Yes	Yes	Yes
Country FE	No	No	Yes	No
Region FE	No	No	No	Yes
Observations	104	104	104	104
Mean of Dep. Variable	0.00848	0.00848	0.00848	0.00848

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusions

My findings suggest that startups focused on artificial intelligence contribute to the development and implementation of new technology that influences the productivity of an economy. The lack of significance on variables capturing journal citations and conferences indicates that we do not see the benefits of this research in Total Factor Productivity statistics. Additionally, technology spillover effects that occur once the initial technology is in use may contribute to the positive productivity impact as well. The significance of the number of startups in each country may have policy implications for nations across the world. Since it is advantageous for a country to have a higher number of startups focused on artificial intelligence, it would be beneficial for policy makers to create easy processes for startup implementation.

One widespread explanation for the productivity paradox with artificial intelligence technology is a time-lag explanation presented by Brynjolffson, Rock, and Syverson (2017). The time-lag explanation suggests that artificial intelligence implementation will have a positive effect on TFP, but we have not given enough time to see the effects. My findings are consistent with this explanation of the productivity paradox. In the short run, artificial intelligence implementation does not appear to affect overall productivity statistics.

References

Brynjolfsson, Erik, Daniel Rock and Chad Syverson. 2017. "Artificial Intelligence and the Modern Productivity Paradox," NBER Working Paper #24001.

Letta, Marco and Richard S.J. Tol. 2018. "Weather, Climate, and Total Factor Productivity." *Environmental and Resource Economics* (73): 283-305.

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