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Public intangible capital: complements or substitute?*

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SUMMARY

Objectives of the research

The purpose of our research was to test whether intangible capital is a substitute or, to some degree, a complement to standard inputs in the production process. The analysis is conducted for public sectors.

Scientific approach / methodology

To verify substitutability, we include intangible capital as an additional input in a production function. This presupposes the use of a production function that allows for any substitution elasticities between any two inputs. Consequently, the analysis applies a nested Constant Elasticity of Substitution (CES) function.

New knowledge and/or European added value

Simple OLS estimations with and without controlling for year, country or industry effects find that intangible capital significantly contributes to the production of public goods. Its output elasticity is only a bit smaller than that of tangible capital. The analysis by means of CES functions reveal that intangible capital is just weakly substitutable with either labour or tangible capital.

Key messages for policy-makers, businesses, trade unions and civil society actors

Due to the weak substitutability, each and every investment plan or stimulus program should not just focus on tangible assets, but also include investments in intangibles in order to achieve maximum output and efficiently use public money. It also follows that austerity programs focusing on intangible assets will undermine investments in tangible assets.

*This Policy Brief based on SPINTAN Working Paper No. 15: Schiersch, A. and M. Gornig (2016): "Intangible capital: complement or substitute in the creation of public goods", available on the SPINTAN website. <http://www.spintan.net/c/working-papers/>

Objectives of the research

Since the millennium, research on intangible capital accelerated with new forms of intangible assets coming into focus. The literature, however, always implicitly assumes a specific substitutability between intangibles and other inputs. This is due to the fact that these studies rely on the Cobb-Douglas production function framework. Specifically, it is assumed that the substitution elasticity is equal to 1 between all inputs at any point on the production function.

The purpose of our research was to test whether intangible capital is a substitute or, to some degree, a complement to standard inputs in the production process. The analysis is conducted for public sectors in which governmental institutions are directly responsible for both efficiently producing public goods and for investing in new production factors. Knowing the substitutability of inputs is important for achieving the best possible result for the invested money, *inter alia*, when designing stimulus programs.

The project focuses on intangible capital in public sectors. This comprises the industries public administration and defence, compulsory social security (ISIC4 code O); education (ISIC4 code P); human health and social work activities (ISIC4 code Q); and arts, entertainment and recreation (ISIC4 code R).

Scientific approach / methodology

The starting point of the analysis is a production function that includes intangible capital as an additional input. We use so-called Constant Elasticity of Substitution (CES) functions, as they allow for any substitution elasticities between any two inputs.

To differentiate elasticities of substitution between the inputs, we use a nested structure to construct CES functions with more than two inputs. Essentially, a nested CES function approach uses at least one additional CES function within an upper-level CES function. This, however, requires that the scale elasticity of the lower-level CES function and its productivity parameter is normalized to one. Additionally, the assumption that the inputs aggregated within the lower-level CES function share the identical substitution elasticity toward the other lower-level CES function or the third input is imposed.

The estimation procedure starts with a simple OLS estimation in order to gain an initial impression of whether intangible capital has any measurable influence within the production process. We then estimate the parameters of the CES function directly by using different optimization algorithms as provided by the literature. Depending on the starting point of the calculation, which is defined by a set of starting values, the routines potentially stop at local minimums. Therefore, we apply a grid search. Within a grid search,

the routines run across a set of predefined substitution parameters estimating the remaining parameters such that the residual sum of square is minimized.

But even the grid search cannot prevent economically unreasonable parameters. E.g. the optimal parameter combination might imply that the output is produced without using any labour input. This is clearly implausible. The estimation strategy, therefore, contains an additional step, in which a set of upper and lower values is defined for each parameter. These values are partly derived from the results of the OLS estimation.

New knowledge and European added value

At first a simple OLS estimation of output elasticities without controlling for year, country or industry effects shows that intangible capital is just as important as tangible capital for the production of public goods. In this specification, the coefficient for labour is 0.71, that of tangible capital is 0.18, and the coefficient of intangible capital is 0.14. All coefficients are significant. This significance persists if we include dummies for year, country and industry, although the output elasticities of tangible and intangible capital increase. This result is in line with previous findings in the literature for market sectors. However, this study is the first to confirm a positive elasticity for intangible capital in public sectors.

To evaluate the substitutability of inputs, we reduced the possible parameters to the ones that are economically interpretable by introducing upper and lower limits. These boundaries are partly derived from the OLS results. Applying these boundaries, we can state that intangible capital is just weakly substitutable with labour, capital, or the respective nested CES function, in 9 out of 12 estimations. In addition, in 7 of the 9 estimations, elasticities are significantly smaller than 1. Admittedly though, only 8 out of all 24 substitution elasticities, this includes the parameters of labour and capital, are significantly different from 1. This is due to the high standard deviation. Thus, other tests, like for $H_0=0$, i.e. implying a Leontief production function, would also fail. Summing up, our findings indicate weak substitutability between intangible capital and other inputs.

Key messages for policy-makers, businesses, trade unions and civil society actors

Stimulus programs were heavily used during the economic crisis of 2009. Policymakers are also discussing stimulation programs as a part of both the Growth Pact and the Investment Plan for Europe. It is important to understand the mechanisms of stimulus programs, but it is equally important to rethink the composition of such programs. This study tries to evaluate whether investments in intangible capital should be considered in any public investment program. For this purpose, the newly developed SPINTAN

database is used as it contains various types of intangible assets at the one-digit and two-digit industry levels.

Our analysis shows that intangible capital is just weakly substitutable with other inputs, *inter alia*, tangible capital and intangible capital are weak substitutes for each other. The implication of this finding for economic policy is straightforward. Public investment in the public sectors should not only focus on the classical tangible assets, but also on intangible capital. This will not only increase the output through the positive effect of intangible capital, but it is also required because intangibles and other inputs are just weakly substitutable. An excessive focus on one specific input category, say tangible capital, will not lead to the expected results because the other inputs are also required, such as intangibles, in order to achieve the maximum output possible. This finding also implies that investment programs for tangible assets should not be undermined by austerity programs focused on intangible assets.

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Coordinator	Instituto Valenciano de Investigaciones Económicas (Ivie), Spain
Consortium	<p>Instituto Valenciano de Investigaciones Económicas (Ivie), Spain</p> <p>National Institute of Economic and Social Research (NIESR), United Kingdom</p> <p>LUISS Libera Università Internazionale Degli Studi Sociali Guido Carli (LUISS), Italy</p> <p>Istituto nazionale di statistica (Istat), Italy</p> <p>Imperial College of Science, Technology and Medicine, (IC), United Kingdom</p> <p>The Conference Board Europe (TCBE), Belgium</p> <p>Organisation for Economic Co-operation and Development (OECD), France</p> <p>Zentrum für Europäische Wirtschaftsforschung (ZEW), Germany</p> <p>Deutsches Institut für Wirtschaftsforschung (DIW), Germany</p> <p>Wiener Institut für Internationale Wirtschaftsvergleiche (wiiw), Austria</p> <p>Forum för reformer och entreprenörskap, (FORES), Sweden</p> <p>Kopint-tarki Konjunkturakutató Intezet (Kopint), Hungary</p>
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Website	www.spintan.net
Further reading	
Related websites	
For more information	info@spintan.net or matilde.mas@ivie.es