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Article

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DIW Weekly Report

Provided in Cooperation with:

German Institute for Economic Research (DIW Berlin)

Suggested Citation: Belitz, Heike; Gornig, Martin (2019) : German economy needs to invest more in knowledge capital, DIW Weekly Report, ISSN 2568-7697, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin, Vol. 9, Iss. 31, pp. 247-253, https://doi.org/10.18723/diw_dwr:2019-31-1

This Version is available at:

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AT A GLANCE

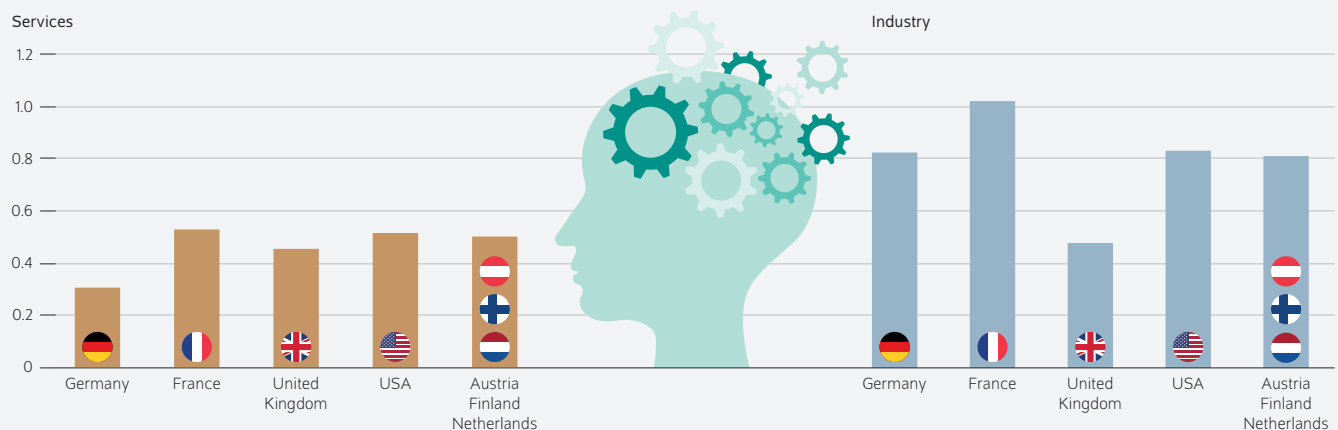
German economy needs to invest more in knowledge capital

By Heike Belitz and Martin Gornig

- Knowledge capital is becoming increasingly important for businesses' international competitiveness
- This Weekly Report analyzes the use of knowledge capital by companies in Germany, the USA, and select European countries
- All types of knowledge capital are taken into account, even those not recorded by national statistics such as financial products and training
- German companies are lagging behind in the services and industrial sectors
- Policies should urgently be reviewed and, in many places, conditions for investment in knowledge capital must be improved

When all components of knowledge capital are taken into account, Germany lags behind the other countries examined

Knowledge capital stock compared to gross value added (capital-output ratio) in 2017



Remark: Austria, Finland and the Netherlands were combined due to similar size and economic structure.
Sources: EU-KLEMS, Eurostat, OECD, own calculations.

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FROM THE AUTHORS

“Even when considering only the elements of knowledge capital recorded by national statistics, Germany does not fare very well in terms of use of knowledge capital compared to other countries. When using a broader definition of knowledge capital, the picture is even gloomier. Germany needs to invest much more than it currently does in knowledge,”
— Heike Belitz —

MEDIA



Audio Interview with Martin Gornig (in German)
www.diw.de/mediathek

German economy needs to invest more in knowledge capital

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ABSTRACT

The efficiency of the German economy is powered by its knowledge-intensive industrial and services sectors. Yet the use of knowledge capital to drive innovation and productivity in Germany is rather low compared to other European countries and the United States. Germany is clearly lagging behind, especially in the services sector. The same applies to the industrial sector, where German businesses are not using knowledge capital to an above-average extent. Moreover, the level of knowledge capital modernity is low in Germany's industrial and services sectors, which jeopardizes the competitiveness of the German economy. The federal government has set a target for increasing R&D expenditure to 3.5 percent of GDP by 2025. In terms of corporate investments in total knowledge capital, this corresponds to an almost 35 billion euro increase in total annual investments. For this target to be achieved, conditions for investing in knowledge capital must be reviewed and improved.

In recent years, the German economy has established a strong competitive position. An important component of this competitiveness is a focus on knowledge-intensive production, which requires a high level of investment activity.

Businesses invest in machinery, devices, vehicles (equipment), and buildings, as well as in the knowledge of what is produced and how it is produced. This is known as knowledge capital.¹ It is made up of different components (Figure 1), including research and development (R&D), software, copyrights, and mineral exploration. These components are recorded as knowledge capital in official statistics under the umbrella term “intellectual property” and are regularly reported in the national accounts. Using these statistics, this Weekly Report examines the period from 1997 to 2017. For the year 2017, we take into account further components of knowledge capital which are not recorded in national accounts, such as advertisements, organizational capital, architecture and engineering design, new financial products, and training.²

When companies invest in equipment, buildings, and knowledge, they expect to reap benefits for a number of years. These investments in tangible and intangible assets thus contribute not only to securing businesses' profitability, but also to increasing an economy's production and productivity.³

1 There is no conclusive definition for the components of knowledge-based capital. The OECD counts the following elements as a part of knowledge-based capital: software, databases, private sector R&D, mineral exploration, trademarks and copyrights, licenses and artistic originals, new products in the financial sector, new architectural and technical designs, R&D in the social sciences and humanities, marketing and advertising, education and training to develop firm-specific human capital, and organizational capital. See OECD, *Supporting Investment in Knowledge Capital, Growth, and Innovation* (Paris, 2013) (available online, accessed July 11, 2019). This applies to all other online sources in this report unless stated otherwise.

2 Within the scope of several EU-funded research projects, DIW Berlin has been involved in developing estimating approaches for comprehensively quantifying investments in knowledge capital that go beyond the elements recorded in national accounts. The estimations for EU countries and the United States are documented in the INTAN-Invest databank (available online). See Carol Corrado et al., “Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth,” in *Investment and Investment Finance in Europe*, ed. Atanas Kolev et al. (European Investment Bank, November 2016), Chapter 2.

3 See Jonathan Haskel and Stian Westlake, *Capitalism without capital: the rise of the intangible economy* (Princeton University Press, 2017); Bernd Görzig and Martin Gornig, “Intangibles, Can They Explain the Dispersion in Return Rates?,” *The Review of Income and Wealth* 59, no. 4 (2013); Thomas Niebel, Mary O'Mahony, and Marianne Saam, “The Contribution of Intangible Assets to Sectoral Productivity Growth in the EU,” *Review of Income and Wealth* 63 (2017): 49-67; for Germany: Heike Belitz, Marie Le Mouel, and Alexander Schiersch, “Company Productivity Increases with More Knowledge-Based Capital,” *DIW Weekly Report*, no. 4/5 (2018) (available online).

At DIW Berlin, we conducted a study for the Bertelsmann Stiftung to analyze the extent to which industry and market services⁴ invest in knowledge capital in Germany, the United States, France, the United Kingdom, the Netherlands, Austria, and Finland.⁵ Included are the types of knowledge capital recorded in the national accounts as well as other important components for which internationally comparable data are available.

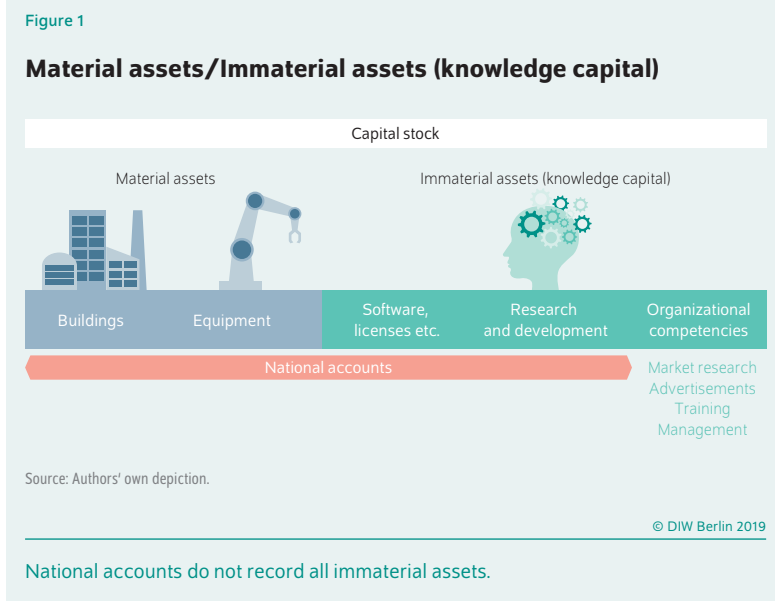
The significance of the capital used and its change is estimated using the capital-output ratio, which indicates the amount of capital which was available for the production volume achieved (in this case, gross value added). The capital is measured using the existing net fixed assets (see Box).

A low capital-output ratio can indicate the use of capital is particularly efficient. However, empirical research indicates investments in capital positively affect production and productivity.⁶

Knowledge capital gaining in importance worldwide

In industry and the market services sector, there are typical combinations of physical capital and knowledge capital recorded in official statistics which can be found in all countries examined.⁷ Buildings dominate the assets of service providers while equipment traditionally dominates in industry (see Figure 2). However, knowledge capital is increasingly gaining in significance. The knowledge capital recorded in the national accounts is particularly large compared to the use of real capital (equipment and buildings) in industry. Knowledge capital already has greater significant in France and the United States; in Germany, it is as important as equipment capital.

Following the global economic crisis of 2009, the use of knowledge capital in industry increased its pace of growth in most countries. However, in the United Kingdom, the relative use of knowledge capital in industry declined between 2007 and 2017. In other countries, the growth momentum in industry remained high or even increased. This could be an expression of an intracompany division of labor: large international companies have strengthened the knowledge industry in continental Europe while concentrating on production in the United Kingdom (“extended workbenches”).



Germany lost the leading position in the use of knowledge capital in industry it had in the mid-1990s, and the United States had caught up by 2007. In 2017, the relative use of knowledge capital in industry in Germany was on par with that of Austria, the Netherlands, and Finland.⁸

The relative use of knowledge capital in the services sectors has increased even more markedly after beginning at a low level. Between 2007 and 2017, the capital-output ratio grew the most in Germany, followed by France and the group of small EU countries, Austria, the Netherlands, and Finland. In contrast, the development in the United States is more subdued, and the capital-output ratio of the British services sector declined both before and after the economic crisis. This development could be related to the United Kingdom’s strong focus on financial services; the knowledge capital components covered by national accounts to date are heavily engineering driven and do not reflect investments in financial innovation.

Overall, Germany and the United Kingdom have the lowest relative use of knowledge capital recorded in the national accounts of all the countries examined. Service providers in the USA and the three smaller EU countries examined here have a significantly higher ratio of knowledge capital to value added, with France taking the lead.

The divergent use of knowledge capital by international standards could be due to contrasting company behavior in individual sectors, but it could also be influenced by the respective weight of more or less knowledge-intensive sub-sectors within industry and the services sector. Using a sectoral decomposition, the differences between the knowledge capital-output ratios (knowledge capital compared to sectoral value added) of Germany and the United States,

⁴ The term “industry” is used here synonymously with the manufacturing sector, as it is referred to in the official statistics. Market services include trade, transport, hotels and restaurants, information and communication, financial and insurance services, business services as well as arts, entertainment, recreation, and other services.

⁵ Heike Belitz and Martin Gornig, “Internationaler Vergleich des sektoralen Wissenskapitals,” Study commissioned by the Bertelsmann Stiftung (2019) (available online) (in German).

⁶ See the literature referenced in footnote 3.

⁷ The EUKLEMS database is used for the international comparison of tangible and intangible investments included in the national accounts and the corresponding capital stocks for the period 1997 to 2015. Kirsten Jäger, *EU KLEMS Growth and Productivity Accounts 2017 release – Description of Methodology and General Notes* (2017) (available online). It was revised to include the most recent data from national statistics and is current up to 2017. See Belitz and Gornig (2019), reference as above.

⁸ Due to the size of these three economies and their similar structure, they have been grouped together here.

Box

Definitions and concepts

Following production theory, the capital-output ratio is used to assess the significance of the use of capital and its change. It indicates how much capital expenditure was available for the production quantity achieved. Knowledge capital, like other types of capital, is viewed as an input factor which is portrayed relative to the output. From the perspective of a macroeconomic production function, production in a sector corresponds to the gross value added achieved. The use of knowledge capital is measured by the existing net fixed assets.

$$\text{Capital - output ratio}_{a,i,j,t} = \frac{\text{Net fixed assets}_{a,i,j,t}}{\text{Gross value added}_{i,j,t}}$$

with a representing the type of capital and i the economic sector, j the country, and t the year.

Formally, the capital-output ratio corresponds to the reciprocal value of capital productivity. Indications of particularly high levels of efficiency could be obtained by incorporating quality indicators for the use of capital. One indicator of the quality of knowledge capital use is its level of modernity. Another way used by official statistics to show the degree of modernity of capital stock is to

show the ratio between gross and net fixed assets. However, since data on gross fixed assets were only available for a few countries, the degree of modernity is determined differently here. The main idea is that the more the capital stock consists of recent investment years, the more modern it is. Accordingly, gross investments were compared to net fixed assets. The number of investment years included is open. Generally, the longer the service life of the type of investment, the more investment years should be included. This Weekly Report shows the results for the last three investment years.¹

$$\text{Level of modernity}_{a,i,j,t} = \frac{\sum_{n=0}^N \text{Gross investment}_{a,i,j,k}}{\text{Net fixed assets}_{a,i,j,t}}$$

with a representing the type of capital and i the economic sector, j the country, and t the year.

Furthermore, $N = \{2\}$ and $k = t - n$ apply.

¹ Alternative calculations with reference to one or five investment years do not show any other country order. See Belitz and Gornig (2019), reference as above.

France, the United Kingdom, and the three small European countries were analyzed.⁹ These differences are mainly due to diverging corporate investment behavior in the respective industrial and services sectors and not structural differences (the relative importance of more or less knowledge-intensive sectors in these countries).

German knowledge capital lacks modernity

When it comes to utilizing knowledge capital in the services and industrial sectors, Germany is far from the top. In fact, in terms of the services sector, Germany and the United Kingdom rank at the bottom. In 2017, knowledge capital use in France and the United States was almost 85 and 30 percent higher than in Germany, respectively. Germany ranked below France and the United States in terms of knowledge capital use in the industrial sector in 2017 as well: in industry, the gap between the capital-output ratios is 30 and 15 percent, respectively.

Germany's current and future position in international competition depend not only on the amount of capital used, but its modernity and quality as well. Our measure of modernity is based on the idea that the higher the share of recent investments in the capital stock, the more modern it is. Accordingly, gross investments were compared to net fixed assets (see Box).

In terms of knowledge capital, Germany lags behind all other countries in modernity (see Figure 3), especially in the services sector. In Germany, the last three investment years account for around 80 percent of capital stock. In contrast, it is between 90 and 100 percent in the United States, United Kingdom, and France, and even over 100 percent on average in Austria, the Netherlands, and Finland.¹⁰

In industry, too, the degree of modernity in Germany is lower than in other countries. However, the gap between Germany and the United States and the smaller EU countries is significantly smaller than in the services sector. The United Kingdom has by far the smallest but most modern knowledge capital stock in industry.

Germany lags even further behind in terms of extended knowledge capital

Only certain parts of knowledge capital are reflected in the national accounts. Components such as investments in design development, new financial products, advertising, training, and organizational capital are not included.

Estimates have been made here in order to gain an idea of the importance of this knowledge capital for economic performance in the countries examined in 2017. The starting point

¹⁰ This means that the capital stock in Germany will be renewed after about roughly three to four years and somewhat earlier in the other countries examined.

⁹ Belitz and Gornig (2019), reference as above.

Figure 2

Capital-output ratio for knowledge, equipment, and buildings

Capital stock compared to gross value added, 1997 to 2017, for the services and industrial sectors



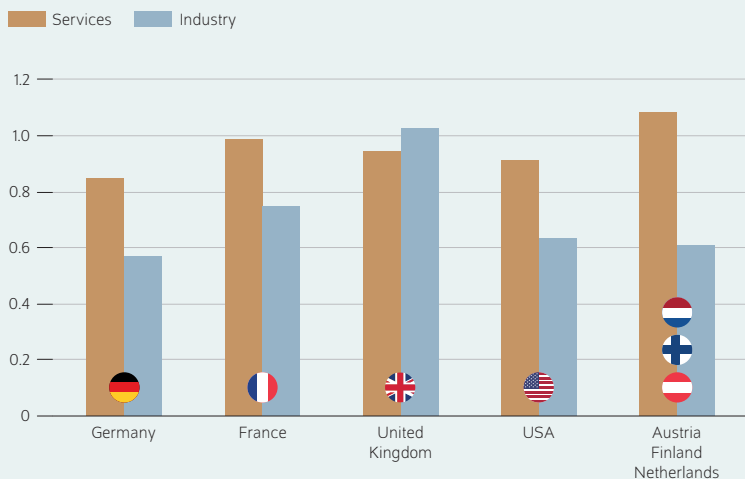
Source: EU-KLEMS, Eurostat, OECD, authors' own calculations.

The capital-output ratio for knowledge is increasing in almost all countries.

Figure 3

Level of modernity of the knowledge capital

In 2017, knowledge capital as recorded in the national accounts



Source: EU-KLEMS, Eurostat, OECD, authors' own calculations.

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The knowledge capital used by German businesses is less modern than in the other countries examined.

is the INTAN-Invest database,¹¹ which provides estimates of the level of investments in knowledge capital for the above fields not covered by official statistics up to 2015. When calculating the capital-output ratio of these components in 2017,

- it was assumed that the components not included have similarly short lifespans to those included,¹²
- that the relationship between the recorded and unrecorded investments can be transferred to the relationship between recorded and unrecorded knowledge capital stock, and
- these relationships within the individual sectors did not change between 2015 and 2017.

To compare the expanded knowledge capital to production, the value-added parameter was adjusted to take account of the additional sales production (self-produced plants). In the services sector, Germany is clearly lagging behind in terms of use of extended knowledge capital (including the components not covered by official statistics). Out of all the countries examined, the capital-output ratio for the use of knowledge capital was lowest in 2017 in Germany. Use of knowledge capital was two thirds higher in the United States, France, and the smaller EU countries. In the United Kingdom, the relative use of knowledge capital is 50 percent higher than in the German services sector.

In German industry, intangible assets accounted for more than half of the total capital used in 2017, taking into account the knowledge capital not recorded in national accounts (see Figure 4). A good half of this knowledge capital stock is R&D capital. Nevertheless, by international standards, Germany's use of knowledge capital is not above average, even in industry. The capital-output ratio for the use of knowledge capital is similarly high as in the United States and the three smaller euro area countries examined. It is noticeably higher in France.

Conclusion: major efforts required for investment in knowledge capital

Accumulating knowledge capital is becoming increasingly important for the innovativeness, productivity, and competitiveness of modern economies. That makes it all the more alarming that companies in Germany use less knowledge capital in Germany than in other European countries and the United States. Germany is clearly lagging behind, especially in the services sector. The situation is not much better in the industrial sector. At the same time, knowledge capital in Germany in both the industrial and services sectors is not very modern. German companies, especially in the industry, have been very successful but have failed to invest their earnings in new knowledge to secure their future prosperity. The automobile industry is one example. Over the years, it has profited greatly from diesel technologies. At the same time, it has been reluctant to invest in the development of new drive systems and mobility concepts. The low degree of modernity and comparatively low amount of knowledge capital contradict Germany's claim of being one of the world's most technologically advanced economies. R&D expenditure in Germany is expected to account for 3.5 percent of GDP in 2025; currently, it is only around three percent.¹³ Assuming that, as in previous years, business R&D expenditure accounts for around two thirds of total expenditure, businesses would have to increase their R&D expenditure from two percent to just under 2.5 percent of GDP.¹⁴ To achieve this goal, they would need to increase their R&D investments by about 0.4 percentage points of GDP—measured according to the GDP in 2018, that would be over 13 billion euros. Investments in further components of knowledge capital must grow in tandem. Annual investment growth would need to be three percent in order to increase overall investments in knowledge capital from the current level of six percent to the target of seven percent by 2025. This amounts to a total of 35 billion euros that companies in Germany would have to spend additionally each year on their knowledge capital.

¹¹ Corrado et al., "Intangible investment in the EU and US."

¹² Bernd Görzig and Martin Gornig, "The Assessment of Depreciation in the Case of Intangible Assets," SPINTAN Working Paper No. 3 (available online).

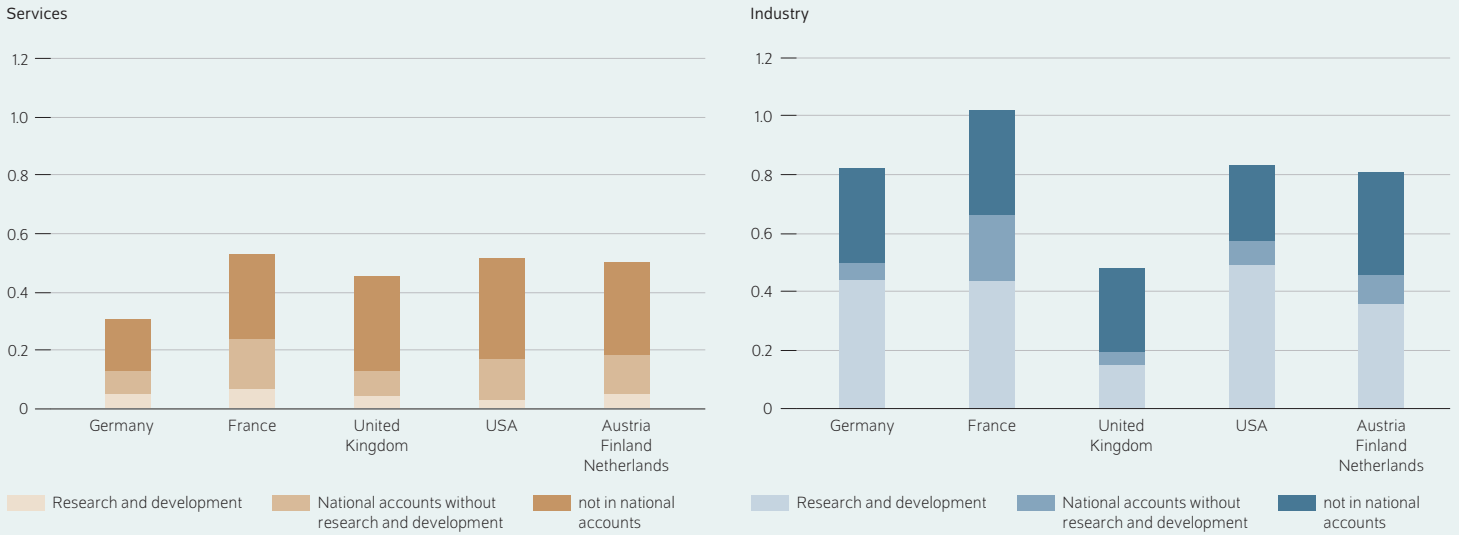
¹³ See Bundesministerium für Bildung und Forschung, "Zukunft made in Germany," News Release, March 29, 2017 (available online) (in German).

¹⁴ See also: Rainer Frietsch et al., *Schrittweise Erhöhung der FuE-Quote auf bis zu 3,5 des BIP – Instrumente und Auswirkungen auf volkswirtschaftliche Kennzahlen*, Study by Fraunhofer ISI, Prognos, and ZEW, commissioned by the Bundesministerium für Bildung und Forschung, (Karlsruhe: January 2019) (available online) (in German).

Figure 4

Capital-output ratios for knowledge capital in 2017

Knowledge capital as reported in the national accounts and including other elements



Source: EU-KLEMS, Intaninvest, Eurostat, OECD, authors' own calculations.

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Under a broader definition of knowledge capital, Germany lags behind all other countries examined in terms of its use of knowledge capital.

In order to achieve this, the conditions in Germany for investing in all types of knowledge capital must be improved. Solely focusing on R&D investments—for which tax incentives are currently being developed—is not enough. Research and development is only one component of knowledge capital, and it can only be effectively efficient in the innovation process together with other components,

such as new organizational solutions, training, and software. One starting point could be to promote high-risk innovation projects that require simultaneous investment in different types of knowledge capital. Promoting joint projects, networks, and clusters should especially help support businesses accumulate a broader range of knowledge capital.

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JEL: E22, D24, C23

Keywords: Knowledge capital, intangibles, manufacturing, services

LEGAL AND EDITORIAL DETAILS



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Volume 9 July 31., 2019

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Phone: +49 1806 14 00 50 25 (20 cents per phone call)

Layout

Roman Wilhelm, DIW Berlin

Cover design

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Composition

Satz-Rechen-Zentrum Hartmann + Heenemann GmbH & Co. KG, Berlin

ISSN 2568-7697

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