

II. Unlocking investment in intangible assets in Europe

Intangible assets are at the heart of what makes firms competitive. They are vital for productivity and economic growth. A key question is whether the factors that tend to hold back investments in Europe are the same for tangible and intangible assets. Is there a need for specific policy measures addressing intangible assets? This section reflects on the specifics of intangibles, groups relevant characteristics and relates investments in intangibles to a series of potential drivers and barriers.

To unlock investment in intangible assets, regulation enabling a flexible re-allocation of resources, in particular through well-functioning product, labour and capital markets, is pivotal. At the same time, there is a need for an appropriate mix of modern and effective intellectual property rights systems to ensure sufficient returns on investment and a competition policy addressing monopoly power and rent-seeking (together with effective enforcement). Access to finance for intangibles could be improved by amending financing schemes and enhancing the systematic reporting of investments, e.g. with new accounting and corporate disclosure standards. In the event of market failure, public intervention can play an important role by providing direct or indirect support, in particular for assets with high social returns (such as investment in R&D or in training), or ensuring sufficient investment in relevant physical infrastructure. The rise in the importance of intangible assets also means that it is important to get human capital policies right. Finally, we need to broaden our concept of knowledge creation – both in the context of national accounts and at the level of individual firms – to take in R&D, but also other forms of intangible capital, such as economic competence, training or design. In turn, we will need better means of measuring intangible capital. Corresponding policy initiatives are essential for Europe, in particular with a view to closing the investment gap in terms of intangible assets vis-à-vis the United States, and thus stimulating total factor productivity and long-term growth. ⁽³⁰⁾

II.1. Introduction

Knowledge capital (notably ‘intangible assets’ that lack physical embodiment, such as computerised information - databases and software; innovative property - R&D and intellectual property rights (IPRs); economic competences – i.e. training, organisational capital and brand equity) ⁽³¹⁾ is at the core of what makes firms competitive, and thus vital for productivity and economic growth. However, due to the specific characteristics of intangibles, there is reason to believe that overall investments tend to remain below their social optimum.

This contribution looks at drivers of and barriers to investment in intangibles. It thus feeds into the

ongoing thematic work on the third pillar of the Investment Plan for Europe. ⁽³²⁾ It seeks to complement previous contributions by focusing on determinants of investments in intangible assets with a view to identifying factors that hold it back, and assessing the extent to which there are intangible-specific barriers. This is important given the need to design the most effective and efficient policy response.

The chapter is organised as follows:

Sub-section II.2 sets out relevant facts on intangibles according to the empirical and theoretical literature;

Sub-section II.3 reflects on the specific characteristics of intangibles;

Sub-section II.4 discusses corresponding drivers of and barriers to investment, with an emphasis on developing preliminary lessons that could help to guide policy;

⁽³⁰⁾ This section was prepared by Anna Thum-Thysen, Peter Voigt, Christoph Maier (DG ECFIN), Benat Bilbao-Osorio and Diana Ognyanova (DG RTD).

⁽³¹⁾ This definition refers to Corrado, C., Hulten and D. Sichel (2005), ‘Measuring capital and technology: an expanded framework’, in *Measuring capital in the new economy*, C. Corrado, J. Haltiwanger and D. Sichel, eds., *Studies in Income and Wealth* 65, Chicago: The University of Chicago Press. Some of the corresponding investments are included in the NA measure of GFCF, especially ‘computerised information’ and some categories of ‘innovative properties’ (e.g. mineral exploration, R&D and IPRs). However, according to the system of national accounts, spending on other intangible assets is captured as ‘expenditures’ or ‘intermediate consumption’ rather than investment (in particular economic competences, training, new products and design).

⁽³²⁾ https://ec.europa.eu/priorities/jobs-growth-and-investment/investment-plan_en

Sub-section II.5 reports on a series of empirical analyses aimed at testing the arguments put forward in sub-sections II.3 and II.4; and

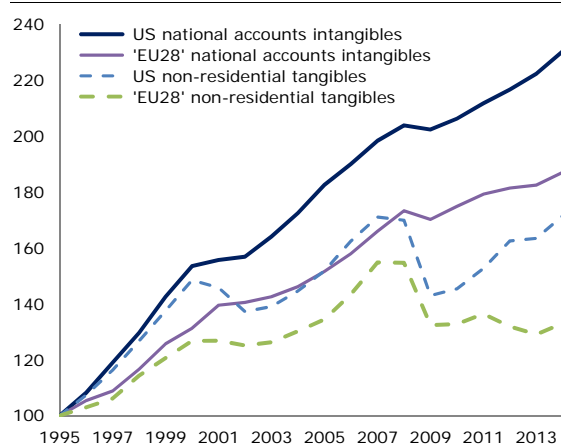
Sub-section II.6 summarises the main empirical findings and key policy messages.

II.2. Stylised facts

Economic growth in high-wage economies stems in good part from investment in knowledge creation. Such expenditures, collectively referred to as knowledge-based capital or ‘intangible assets’, are strategic investments that foster long-run growth potential. Higher levels of investment in such assets are generally associated with higher growth rates. ⁽³³⁾

Evidence from available statistics suggests that investment in EU countries is gradually shifting from traditional physical (tangible) investment to intangible assets. ⁽³⁴⁾

Graph II.1: **Non-residential intangible and tangible investments, EU-28 vs. USA**
(1995–2014, Index: 1995=100)



Source: Eurostat, Bureau of Economic Analysis (BEA).

This is not simply a result of the crisis. The trends had already been observed, e.g. for the UK,

⁽³³⁾ Jorgenson, D.W., and K.J. Stiroh, (2000), ‘Raising the speed limit: US economic growth in the information age’, *Brookings Papers on Economic Activity*, 1, 125–211; Oliner, S.D. and D.E. Sichel, (2000), ‘The resurgence of growth in the late 1990s: Is information technology the story?’, *Journal of Economic Perspectives*, 14, autumn, 3–22; Corrado, C., C. Hulten and D. Sichel (2009), ‘Intangible capital and US economic growth’, in *Review of Income and Wealth*, 55(3), 661–685; Roth, F. and A.-E. Thum (2013), ‘Intangible capital and labour productivity growth: Panel evidence for the EU from 1998–2005’, *Review of Income and Wealth*, 59 (3), 486 – 508.

⁽³⁴⁾ INTAN-INVEST database (www.intan-invest.net).

Germany, Sweden and the Netherlands, before 2007. They are driven *inter alia* by the shift from industry to services, the rise of the digital economy, changing global specialisations in production, and general technological progress. Overall, investment in intangible assets in the EU has been growing faster than tangible investment over the last 20 years (see Graph II.1). It has nonetheless been below the corresponding level in the USA and the gap has been widening steadily.

Growth-accounting exercises find that intangible capital has a substantial effect on growth of gross value added: the contribution of labour to output growth is tending to diminish, while the contribution of the capital component is increasing, so tangible and intangible capital deepening becomes the dominant source of output growth. Empirical findings indicate, moreover, that, in most of the countries observed, the contribution of total intangible assets to output growth is between one and three times that of tangible assets. ⁽³⁵⁾

Further empirical analyses have shown that closing the gap in investment in intangible assets *vis-à-vis* the USA would help to close the total factor productivity (TFP) gap *vis-à-vis* the USA. Also, TFP values across countries (obtained as residuals) seem to vary less when one includes intangibles, so looking at intangibles will arguably improve our understanding of country-to-country TFP differentials. ⁽³⁶⁾

However, investments in intangible assets tend to be underestimated. The system of national accounts captures only about half of all spending on intangible assets and corporate financial reports commonly provide only limited information on companies’ investments in intangibles.

II.3. Economic characteristics of intangibles

Intangibles commonly share specific features that distinguish them from tangible assets. These are decisive for identifying barriers to investment and may justify policy intervention. The literature suggests a fairly long list of such characteristics. ⁽³⁷⁾ For the sake of simplicity (though at the risk of

⁽³⁵⁾ ECFIN discussion paper (forthcoming).

⁽³⁶⁾ Ibid.

⁽³⁷⁾ Andrews, D. and A. de Serres (2012), ‘Intangible assets, resource allocation and growth’, *OECD Economics Department Working Papers* No. 989, OECD Publishing.

over-simplification), they can be grouped as follows:

- (1) specific characteristics that may affect competition;
- (2) risks, uncertainty and high sunk costs typically associated with intangibles; and
- (3) synergies and complementarities among asset types.

Competition-related characteristics

Intangible assets have a series of specific features that tend to distort competition. Many types are characterised by limited appropriability and partial excludability.⁽³⁸⁾ For instance, property rights of intangible assets typically cannot be as clearly defined and well enforced as is the case with tangibles. Accordingly, firms struggle to deter ‘free-riders’ from benefiting from their investments in intangibles. Due to knowledge diffusion and externalities, social returns on intangible investment tend to be higher than the corresponding private returns, especially in cases of limited appropriability, which may lead to under-investment from a social perspective. For firms investing in intangibles (i.e. buying them in or producing them for their own use), some degree of rent-ensuring⁽³⁹⁾ may therefore be needed to increase the appropriability of the returns on innovation before knowledge diffusion takes place.⁽⁴⁰⁾

Separability⁽⁴¹⁾ and transferability⁽⁴²⁾ facilitate the mobility of an asset in terms of ownership. In fact, they are pre-conditions for using assets as collateral and for salvaging value in the event of bankruptcy. While the market for patents and licensing

agreements provides a means of acquiring codified and legally protected intangibles, firms cannot obtain tacit, human-capital-based assets,⁽⁴³⁾ or even codified but not legally protected intellectual assets, through such channels. In order to obtain intangible capital of this kind, businesses can engage either in corporate takeovers or selective recruitment (poaching) of specialists. However, both strategies entail significant risks, suggesting that the efficient allocation of intangible capital of a tacit nature is relatively more complex.⁽⁴⁴⁾

Many intangible assets display specific competition features related to the fact that they can be deployed simultaneously by multiple users (non-rivalry)⁽⁴⁵⁾ without engendering scarcity or diminishing their basic usefulness (e.g. software or designs). In terms of business-sector knowledge creation, intangibles tend to rival each other across, rather than within, firms; this generates increasing returns to scale (scalability)⁽⁴⁶⁾ and, ultimately, monopolistic competition. Positive network externalities can reinforce this phenomenon.⁽⁴⁷⁾

The net effect of these competition-related characteristics depends on the situation of the individual business, the competitive environment and the types of intangible asset the company is relying on / investing in. On the one hand, any investment in knowledge can have positive external effects. All intangible assets give rise to spill-over effects, which (together with the effects due to

⁽³⁸⁾ An asset is characterised by limited appropriability or partial excludability if other businesses can benefit from it.

⁽³⁹⁾ i.e. protecting IP, e.g. by means of patents, brands, design, copyright, etc.

⁽⁴⁰⁾ Note, however, that some intangible assets can be generated internally by firms and remain inherently non-marketable. Their full value is arguably firm-specific, because they cannot be separated from the original unit of creation without some loss of value (Webster, E. and P.H. Jensen (2006), ‘Investment in Intangible Capital: An Enterprise Perspective’, *The Economic Record*, 82 (256)). Brand equity and (to a lesser extent) training are examples of this.

⁽⁴¹⁾ An asset is characterised as separable if it can be separated from the place of creation without loss of value.

⁽⁴²⁾ Transferability refers here to the degree to which knowledge can be transferred across firms. This depends on whether knowledge is tacit or codified. Tacit knowledge could become transferable if it is embodied in human capital, for instance.

⁽⁴³⁾ In fact, tacit knowledge lacks separability, which in turn undermines its transferability in cases of limited mobility of skilled labour. Intangible assets generate firm-specific value that depends on the firm’s assets being kept together (see Hotchkiss, E.S., K. John, R.M. Mooradian and K.S. Thorburn (2008), ‘Bankruptcy and the resolution of financial distress’, *Handbook of Empirical Corporate Finance*, 2, 2-22, Elsevier; Gilson, S.C., K. John and L.H.P. Lang (1990), ‘Troubled debt restructurings: An empirical study of private reorganization of firms in default’, *Journal of Financial Economics* 27, 315-353), which suggests further limits with regard to separability.

⁽⁴⁴⁾ Jennewein, K. (2005), ‘Intellectual property management: The role of technology brands in the appropriation of technological innovation’, Physica-Verlag HD: Heidelberg.

⁽⁴⁵⁾ An asset can be used simultaneously by multiple users.

⁽⁴⁶⁾ The initial cost incurred in creating intangible assets (developing new ideas, designs, etc.) may eventually not be re-incurred once combined with other inputs in the production of goods or services. This may give rise to increasing returns to scale, which are possibly reinforced by network externalities (particularly prevalent in intangible-intensive industries, such as ICT).

⁽⁴⁷⁾ Positive network externalities arise when the value of a good or service increases with the number of users (e.g. subscribers to social or professional networks). This may lead to a winner-takes-all outcome, i.e. network effects can lead to cases of natural monopoly or create high barriers to entry, limiting competition in areas where competitive pressures would raise efficiency.

limited appropriability) mean that the investing firm must be aware *a priori* that competitors may (partly) benefit from their investment. This reduces incentives to invest *ex ante*.⁽⁴⁸⁾ On the other hand, the possibility of benefiting from economies of scale and eventually from a situation of monopolistic competition provides *ex ante* incentives to invest in intangibles.

Risks, sunk costs and uncertainty

Investment in intangibles is associated with risks, costs and uncertainties, as it commonly means entering uncharted territory, i.e. testing and verifying multiple options. This often involves failures and requires major upfront investment. Investment in intangible assets is prevalent throughout the innovation process, but particularly in the early stages of basic research (invention and experimentation), where sunk costs can be high and failures frequent (e.g. in the pharmaceuticals sector). Also, the production of intangible assets (especially tacit knowledge) is likely to be less certain than that of tangible capital, which is easier to replicate through standard routines.⁽⁴⁹⁾ Finally, common difficulties in verifying *ex ante* the ultimate value of investments in any intangible asset tend to lead to financial constraints.

Synergies and complementarities

Evidence suggests the existence of significant synergies and complementarities between types of intangible, and between intangible and tangible assets. In fact, some investments can be productive only if the appropriate complementary assets exist (e.g. ICT hardware + software + training). Accordingly, factors hindering investment in one type of asset may affect the productivity of (and probably also investment in) complementary assets.

Differences between intangible asset types

The economic characteristics outlined above are, to varying degrees, relevant for the majority of intangible asset types. However, there are also major differences between types, primarily between ‘computerised information’⁽⁵⁰⁾ and ‘innovative property’⁽⁵¹⁾, on the one hand, and ‘economic competences’⁽⁵²⁾, on the other. Assets in the first two categories are, for the most part, fully non-rival and only partly excludable, and they can generally be separated from the original firm without substantial loss of value (i.e. they tend to be tradable by means of market-based transactions). In addition, the corresponding type of knowledge capital can more easily be codified and protected through mechanisms that facilitate its transfer. In contrast, rivalry and excludability are more prevalent among the types of asset that reflect ‘economic competences’. For instance, investment in brand equity and human capital generates assets that reflect a high degree of corporate or individual embodiment, in addition to often being firm-specific and thus not so easily separable.⁽⁵³⁾

Overall, almost all intangible asset types have characteristics that tend to distort competition. Also, risks, uncertainty and sunk costs appear to be relevant for all types (to varying degrees). As a result, identifying clear synergies and complementarities with other intangible and tangible assets is not straightforward and would require further investigation.

II.4. Investment in intangibles: drivers and barriers

The economic characteristics identified in the previous sub-section already suggest a range of drivers of and barriers to investment in intangibles. In this sub-section, we present the following non-exhaustive list of five drivers and barriers, drawing

⁽⁴⁸⁾ Privately created knowledge tends to be subject to the forces of diffusion, which cannot be constrained in the same manner as physical assets (Brown, N.C., and M.D. Kimbrough (2008), ‘An examination of differences in the excludability of tangible and intangible assets’, *Harvard Business School Mimeo*); i.e. intangibles tend to diffuse beyond their place of creation, thus providing wider benefits. Rapid diffusion of knowledge may thus deny firms the market power required to price above marginal costs in order to recover the costs of knowledge creation. However, markets tend to fail in properly internalising the positive impact from this diffusion, notably on the productivity of investment in knowledge elsewhere.

⁽⁴⁹⁾ Hunter, L.C., E. Webster and A. Wyatt (2005), ‘Measuring Intangible Investment’, *Melbourne Institute Working Paper Series*, No. 15/05, University of Melbourne.

⁽⁵⁰⁾ Software and databases.

⁽⁵¹⁾ R&D, IP and IPRs, designs, mineral explorations, new services.

⁽⁵²⁾ Training, brand equity, organisational investments, market research.

⁽⁵³⁾ Among ‘economic competences’, investments in organisational capital stand out somewhat as being largely non-rival and scalable (within a firm), but less than fully excludable, although attempting to imitate and implement the business model of a successful rival firm is not a simple task. Also the relevance of spill-overs for this asset type is difficult to assess.

on the relevant literature⁽⁵⁴⁾ and the mapping of the characteristics in sub-section II.3:

- (1) regulatory framework conditions;
- (2) financial conditions;
- (3) availability of human capital and knowledge stocks;
- (4) availability of public support; and
- (5) macro-economic conditions.

Some of the drivers and barriers are common to all intangibles. To the extent possible, the analysis is also broken down per asset type at the end of the sub-section.

Regulatory framework conditions

While efficient resource allocation is important for all types of investment, it is presumably more so in the case of intangibles, given the higher degree of uncertainty stemming from the often exploratory nature of the investment and the risk of its benefits being reaped by others. The greater uncertainty as to return on investment (as compared with tangible assets), given also the risk of quickly forming competition, means that commercialising an idea for a new product may require swift deployment of resources.⁽⁵⁵⁾

To the extent that the production of intangible goods requires investment in intangible assets and flexibility in the allocation of resources, eliminating impediments to entry and exit and to the quick deployment of resources (capital, including human capital, and labour) is more and more crucial. Apart from flexible product and labour market regulations, the development of capital markets, progress towards a European capital markets

union⁽⁵⁶⁾, and a large internal market for goods and services can all help in this respect by facilitating a swift channelling of resources towards the most productive investments and facilitating the scale-up of companies.

Pro-competitive product market reforms can also foster knowledge diffusion, as recent empirical (firm-level) evidence suggests.⁽⁵⁷⁾ The growing productivity gap between technological leaders (frontier-setters) and laggard firms in many OECD countries may be driven by the difficulties being experienced by the latter in transiting to the economy of ideas, or the fact that they are largely sheltered from competition. In this respect, pro-competitive product market reforms can be expected to raise incentives for incumbent firms to adopt new technologies. Competition can also create incentives to improve management, technical and economic efficiency, thus increasing investment in organisational capital.⁽⁵⁸⁾

Competition policy should also address potential market failures and create incentives for companies to invest in intangible assets. In particular, it should take due account of the network effects inherent in intangible assets when identifying anti-competitive behaviour.⁽⁵⁹⁾

However, the relationship between flexible regulation and intangible investment may not be linear: some product market regulations provide innovators with incentives to invest by ensuring high *ex post* rents.⁽⁶⁰⁾ Similarly, some forms of employment protection may increase investment in human capital, e.g. firms have greater incentives to invest in training if workers are less likely to leave

⁽⁵⁴⁾ Andrews, D. and A. de Serres (2012), 'Intangible assets, resource allocation and growth', *OECD Economics Department Working Papers* No. 989, OECD Publishing; Hao and Haskel (2011), 'Intangibles and product market reforms';

http://www.ceriba.org.uk/pub/CERIBA/IntangHaskellHaoXcountry/intangibles_crosscountry_Hao_Haskel_2March2011.pdf;

European Commission (2013), *Flash Eurobarometer 369. Investing in intangibles: economic assets and innovation. Drivers for growth*; Montresor, S. and A. Vezzani (2014), 'Intangible investments and innovation propensity. Evidence from the Innobarometer 2013', *European Commission's Joint Research Centre - IPTS Working Papers on Corporate R&D and Innovation*, No 03/2014.

⁽⁵⁵⁾ Andrews, D. and A. de Serres (2012), 'Intangible assets, resource allocation and growth', *OECD Economics Department Working Papers* No. 989, OECD Publishing.

⁽⁵⁶⁾ EU-wide action to promote competition among national capital markets is estimated to be capable of freeing up to EUR 1.8 trillion in cash and deposits to invest cross-border in more profitable and riskier projects (Valiante, D. (2016), 'Europe's Untapped Capital Market: Rethinking integration after the great financial crisis', *CEPS Paperback*, London: Rowman & Littlefield International).

⁽⁵⁷⁾ OECD (2016), 'Technological slowdown, technological divergence and public policy: A firm-level perspective', *OECD Economics Department Working Papers*, ECO/CPE/WP1(2016)26.

⁽⁵⁸⁾ Hao and Haskel (2011), 'Intangibles and product market reforms'; http://www.ceriba.org.uk/pub/CERIBA/IntangHaskellHaoXcountry/intangibles_crosscountry_Hao_Haskel_2March2011.pdf

⁽⁵⁹⁾ Andrews, D. and A. de Serres (2012), 'Intangible assets, resource allocation and growth', *OECD Economics Department Working Papers* No. 989, OECD Publishing.

⁽⁶⁰⁾ *Ibid.*; Aghion, P., N. Bloom, R. Blundell, R. Griffith and P. Howitt (2005), 'Competition and Innovation: an Inverted-U Relationship', *The Quarterly Journal of Economics* 120(2), pp. 701-28, also provide evidence for an inverted U-shaped relationship between competition and innovation.

subsequently.⁽⁶¹⁾ Such non-linearities suggest that an approach that favours low levels of product and labour market regulation needs to be complemented by appropriate measures, e.g. effective IPR systems (technological patents, industrial designs or brands), to improve the appropriation of returns, thus providing further incentives to invest in intangibles.

Financial conditions

The exploratory nature of investment in intangible assets and their generally lower verifiability and transferability (as compared with tangibles) affects firms' capacity to secure the necessary funding.

Financial conditions, such as interest rates, debt-to-equity ratio and leverage of the banking sector, are important drivers of all types of investment. However, even if intangible investments could ultimately be lucrative against prevailing market financing conditions, they might still not be financed or realised, as the private capital sector is sometimes unable to understand or assess the risks they may entail. Furthermore, investing firms frequently point to a lack of tangible collateral as an obstacle to accessing credit markets.⁽⁶²⁾ Improved accounting standards for the valuation of intangibles (in both corporate and national accounts) could facilitate companies' access to finance and help them to assess the value of their intangibles. The mechanisms for disclosing information on intangible assets in corporate reporting could be improved through narrative reporting,⁽⁶³⁾ as proposed by the OECD.⁽⁶⁴⁾ This is all the more important as evidence suggests that the market value of a firm tends increasingly to be driven by its productive stock of intangibles, rather than its tangible assets.⁽⁶⁵⁾ Lastly, the development

of alternative sources of finance that are more likely to fund riskier or more uncertain investment, e.g. venture capital, crowd-funding and public-private co-financing (as indicated in the European Commission's Investment Plan), would also be helpful.

Human capital and knowledge stocks

The synergies or complementarities of intangible assets with other types of capital, such as human capital, can be an important driver of (or barrier to) investment in intangible assets.

As most types of intangible asset are human-capital intensive, a high level of generic skills (and, for some intangibles, tertiary or technical skills in particular) is a pre-requisite for successful intangible investment. For some assets, such as R&D, achieving a critical mass in terms of specific knowledge and skills accumulation is necessary to the achievement of optimal results. A strong science base is needed to allow new business R&D investments to 'build on the shoulders of giants', in terms of available public R&D/knowledge stock.⁽⁶⁶⁾ In this regard, public R&D can be seen as a major driver of business R&D investments and can play an even more important role in fostering business R&D than (direct and indirect) public funding.⁽⁶⁷⁾ The efficiency and effectiveness of public R&D could be improved, for instance, by using performance criteria when distributing institutional funding, and international peer review standards or competitive peer reviews when allocating project-based funding.

Public R&D also plays a crucial role in building knowledge stocks through strong business/science linkages and enhancing knowledge transfer: these are crucial to support for research and innovation capacity overall. A recent study found that, together with direct and indirect support for business R&D, investments in university research

⁽⁶¹⁾ Ibid.

⁽⁶²⁾ Montresor, S. and A. Vezzani (2014), 'Intangible investments and innovation propensity. Evidence from the Innobarometer 2013', *European Commission's Joint Research Centre - IPTS Working Papers on Corporate R&D and Innovation*, No 03/2014.

⁽⁶³⁾ Narrative reporting is a descriptive section in the annual reports (documents reporting on companies' activities throughout the preceding year) that uses non-financial information to give a picture of a firm's business, market position, strategy, performance and future prospects.

⁽⁶⁴⁾ OECD (2012), 'Corporate reporting of intangible assets: a progress report', *OECD Publishing*.

⁽⁶⁵⁾ The link between the market and book value of a company has weakened increasingly in recent decades (Lev, B. and F. Gu, (2016), 'The end of accounting and the path forward for investors and managers', *Wiley Finance Series*), while there is evidence of a positive correlation between the market value of a firm and its investment in intangible assets.

⁽⁶⁶⁾ Caballero R. and A.B. Jaffe (1993), 'How high are the Giants Shoulders: An empirical assessment of knowledge spillovers and creative destruction in a model of economic growth', *NBER Macroeconomics Annual 1993*, Volume 8.

⁽⁶⁷⁾ European Commission (2016a), 'Science, research and innovation performance of the EU. A contribution to the open innovation, open science, open to the World agenda'.

and high-skilled human capital, support for R&D cooperation increases private R&D. ⁽⁶⁸⁾

Other forms of public intervention

Limited appropriability, spill-overs and other market failures (including the failure of capital markets properly to assess risks, costs and benefits) mean that investment in intangible assets requires public policy support.

Government intervention can mitigate market failures by lowering the risks and associated costs a company faces, directly through grants and public investment or indirectly through tax incentives. In particular, governments can stimulate investment in R&D by helping firms to access finance for R&D activities (e.g. through direct loans, loan guarantees, state-backed venture capital or public procurement). Recent evidence supports this finding, ⁽⁶⁹⁾ although results differ in some cases – the ambiguity is partly attributable to the large array of policy instruments used to provide public support, ⁽⁷⁰⁾ the effectiveness of which depends on many factors, including design and implementation, appropriate targeting and complementarity between instruments. Public support for private investment could also be extended to other types of intangible asset, such as firm-specific training or, potentially, computerised information. Lastly, direct public support includes investment in infrastructure, public R&D and the public education system.

Many EU Member States use their tax system to stimulate R&D and training. Such indirect instruments include (R&D) tax incentives, ⁽⁷¹⁾ which – depending on their design, administration and implementation ⁽⁷²⁾ – are found to be effective in stimulating business investment in R&D.

Public policy can also help strengthen relevant links with the creation of knowledge hubs through

cooperation programmes or intermediary institutions that can bring actors (e.g. public research centres, universities, private companies) together.

Lastly, it is important to bear in mind that the market failure argument and the related justification for public intervention may not hold for types of intangible that (unlike R&D, for example) are not characterised by potentially high social returns. This applies particularly where more investment is not socially desirable, e.g. investment in certain types of firm-specific economic competence, which can create barriers to entry and prevent competitors from accessing information and technology.

Macro-economic conditions

Macro-economic uncertainty is an obstacle for investment in general. However, as it is characterised by additional inherent risk, investment in intangible assets may be affected more by demand uncertainty. ⁽⁷³⁾ It may also be affected by the sectoral composition of the economy. However, the evidence is mixed on whether a more service-oriented economy tends to be more intangible-intense. ⁽⁷⁴⁾ One reason for this could be that the manufacturing sector involves an increasing volume of services that could indirectly increase the role of intangibles in the sector. Lastly, the degree of digitalisation of the economy can also determine investment in intangible assets.

The role of barriers and drivers by type of intangible asset

The drivers and barriers discussed above may affect different types of intangible asset differently. Direct public support and tax incentives, for instance, have been identified as being most useful

⁽⁶⁸⁾ Becker, B. (2014), 'Public R&D Policies and private R&D investment, a survey of the empirical evidence', *Journal of Economic Surveys* 29 (5): 917–42.

⁽⁶⁹⁾ Ibid.

⁽⁷⁰⁾ Aristei D., A. Sterlacchini and F. Venturini (2015), 'The effects of public supports on business R&D: firm-level evidence across EU countries', *MPRA Paper* 64611, University Library of Munich, Germany.

⁽⁷¹⁾ The tax system as a whole (e.g. corporate income taxation) can also function as a driver of or barrier to intangible investment.

⁽⁷²⁾ Criscuolo, C., M. Bajgar, S. Appelt and F. Galindo-Rueda (2016), 'R&D tax incentives: design and evidence', *OECD Publishing DSTI/IND/STP(2016)1*.

⁽⁷³⁾ Bontempi, M. (2016), 'Investment–uncertainty relationship: differences between intangible and physical capital', *Economics of Innovation and New Technology*, 25(3). The author shows, on the basis of a theoretical model and Italian firm-level data, that uncertainty may delay R&D investment in particular, due to a caution effect whereby firms have an incentive to wait in the event of demand uncertainty.

⁽⁷⁴⁾ Corrado, C., J. Haskel, C. Jona Lasinio and M. Iommi (2014), 'Intangibles and industry productivity growth: evidence from the EU', paper prepared for the *LARIW 33rd General Conference*, Rotterdam, The Netherlands, 24-30 August 2014. The authors find that investment in intangibles has grown more strongly in the services sector, while OECD (2013), 'New sources of growth: knowledge-based capital – synthesis report', *OECD Publishing* shows that in some countries investment in intangibles is higher in the manufacturing sector.

in the case of scientific R&D and firm-specific human capital, both of which are generally characterised by high social returns (relative to private returns). In the case of ‘computerised information’, public support may play a role in encouraging small and medium-sized enterprises to invest in new technologies. However, favourable tax treatment may remove a firm’s incentive to grow further.⁽⁷⁵⁾ Public support should not target ‘economic competences’ that build monopoly rents, e.g. brand equity.

Financial conditions matter for all intangibles, as they are difficult to collateralise, but they may be more important for assets that are not easily transferable or verifiable, e.g. organisational capital. The regulatory framework should promote a competitive and flexible environment, but at the same time allow for sufficient IP protection to ensure that rents cover investment uncertainty. This holds mainly for the production of computerised information and innovative property; for most ‘economic competences’, which are mostly firm-specific, IP protection should be less of a focus.

Finally, different asset categories require different types of human capital: scientific R&D requires tertiary graduates, computer software needs technical skills and creative skills are required in design.

II.5. Empirical analysis

In this sub-section, we test the relevance of the above determinants. A regression analysis is performed, relating investments in intangible assets to a series of variables capturing the broad categories of drivers and barriers, i.e. regulatory framework (flexible markets), availability of human capital, other forms of public intervention and financial conditions.⁽⁷⁶⁾ Box II.1 describes the methodology used for this macro-level analysis, which is then complemented with further empirical (micro-level) evidence from the relevant literature in the area of R&D.

⁽⁷⁵⁾ European Commission (2012), ‘Tax reforms in EU Member States: tax policy challenges for economic growth and fiscal sustainability’, *European Economy* 6.

⁽⁷⁶⁾ Framework conditions were also tested with the share of the service sector in total value added. Findings suggest that investment in intangible assets is more strongly associated with the service economy. However, as evidence is mixed, this result would require further investigation.

Table II.1 shows results per asset type from the regression model described in equation (4) in Box II.1. In particular, we distinguish between tangibles and intangibles, and between two sub-categories of intangibles:

(1) ‘national accounts (NA) intangibles’, which include private R&D, artistic originals, mineral exploration and computerised software. These are the intangibles included in the NA measure of gross fixed capital formation (GFCF); and

(2) ‘non-NA intangibles’, which include economic competences, design and new products. The NAs still count these as expenditure.

We also tested for further potential investment barriers separately to avoid multi-collinearity (see equation (4)).⁽⁷⁷⁾ When reading the results, one should bear in mind that the estimated coefficients refer to EU-15 country averages and therefore hide some country heterogeneity. The main findings are reported below.

First, tangible capital tends to be more sensitive than intangible capital to GDP developments; regression results show the accelerator term to hold more strongly for tangible capital. Potential reasons could be that:

(1) the general upswing in intangible investment resulting from a sectoral shift towards the knowledge economy is a more significant determining factor than the business cycle;

(2) the very long lags between the launch of the investment and the associated returns could imply that short-term cyclical fluctuations matter less (e.g. R&D activity in general); or

(3) demand for the goods or services, produced with intangible assets (e.g. pharmaceuticals) is relatively immune to cyclical fluctuations.

⁽⁷⁷⁾ Other indicators tested are indicators for alternative financing (venture capital, gross-operating surplus, debt-to-equity ratios and surplus-to-debt ratios of non-financial corporations), taxation indicators (corporate income tax rates, implicit tax rates), quality of IPRs, shares of SMEs and allocative efficiency. However, within the fixed effects model with robust error terms (robust to heteroscedasticity and intra-group correlation), these variables do not seem to be significantly correlated with investment in intangible assets. However, the standard robust estimation method used is also known to provide large standard errors in cases of small sample size.

Box II.1: Panel fixed-effects regression analysis of investment in intangible assets

To test the potential drivers of intangible investment empirically, we estimate an investment equation based on an accelerator model, ⁽¹⁾ as described in IMF (2015). Investment in time *t* and country *i* I_{it} (intangible or tangible) is commonly modelled as a function of a desired capital stock K_{it}^* , potentially some lags thereof (to account for a slow adjustment of the capital stock to its desired level) and depreciation δ_i (see Oliner *et al.* 1995): ⁽²⁾

$$I_{it} = \sum_{j=0}^J \omega_j \Delta K_{it-j}^* + \delta_i K_{it-1} \quad (1)$$

where *j* indicates the respective number of time lags.

Based on the accelerator model, which postulates that changes in capital are proportionally related to changes in economic output, we can write:

$$\Delta K_{it}^* = c \Delta Y_{it} \quad (2)$$

Inserting equation (2) in equation (1), dividing the equation by K_{it-1} , introducing an error term ϵ_{it} and a fixed effect γ_i , and lagging the output term by one year to somewhat correct endogeneity problems, yields the following econometric model:

$$\frac{I_{it}}{K_{it-1}} = \gamma_i + \sum_{j=1}^N \beta_{1j} \frac{\Delta GVA_{it-j}}{K_{it-1}} + \epsilon_{it} \quad (3)$$

This model is augmented by other potential explanatory factors of investment, such as interest rates, debt-to-equity ratios, product market regulation, employment protection legislation, financial regulations, taxation, education, public investment, access to finance, etc., denoted by DRI_{it-1} (drivers):

$$\frac{I_{it}}{K_{it-1}} = \gamma_i + \sum_{j=1}^N \beta_{1j} \frac{\Delta GVA_{it-j}}{K_{it-1}} + \beta_2 DRI_{it-1} + \epsilon_{it} \quad (4)$$

The model is estimated using a fixed-effect panel estimator with standard errors corrected for autocorrelation, heteroscedasticity and intra-group correlation, and is based on annual data for the EU-15 ⁽³⁾ Member States over the period 1995-2013 (the final sample size depends on the availability of data for measuring drivers of intangible investment). The data for intangible investment stem from experimental academic data from the INTAN-Invest database. ⁽⁴⁾ Data for the accelerator term and drivers of intangible investment are taken from various sources. ⁽⁵⁾

⁽¹⁾ The accelerator describes the relation between an increase in income and a resulting increase in investment. As described in Knox (1970), the principle of accelerator postulates that, with increasing income, people's demand for consumer goods increases. Consequently, investment must increase to raise the productive capacity to meet the increased demand.
⁽²⁾ IMF (2015) suggests adding a constant in equation (1). This specification was tested, but the constant was found to be insignificant. Similarly, further lags of the capital stock were tested, but, beyond the first lag, no significant results were found.
⁽³⁾ Data for the total capital stocks in the business sector are not available for Luxembourg (in previous year prices) or Portugal; these Member States therefore had to be dropped from the sample.
⁽⁴⁾ The INTAN-Invest.net database is a harmonised (open-access) database on macro-economic intangibles across a selection of countries, which complements the work done by the INNODRIVE and COINVEST-projects (both funded by the FP7 SSH programme). The updating of the database is based on voluntary cooperation by academic project partners.
⁽⁵⁾ Eurostat, OECD, AMECO, World Bank and European Commission (DG RTD).

Secondly, all the dimensions that have been tested are significant, confirming the importance of drivers and barriers relating to the regulatory framework, financial conditions, human capital and other forms of public intervention. In particular,

public R&D intensity and science/business linkages (in terms of public support provided), tertiary education (mirroring the availability of human capital), flexibility in product and labour markets (reflecting the regulatory framework) and

Table II.1: Fixed-effect regressions, introducing selected determinants per category (public support, availability of human capital, finance and regulation), by asset type

	Total intangibles			NA-intangibles	Non-NA intangibles	Tangibles	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Accelerator term	0.121*** (0.0287)	0.126*** (0.0192)	0.119*** (0.0194)	0.00885 (0.0427)	0.0771*** (0.0195)	0.0444*** (0.0125)	0.336*** (0.0402)
Tertiary education	0.000744*** (0.000200)				0.000363** (0.000152)	0.000381*** (8.74e-05)	0.000238 (0.000415)
Interest rate	-0.000667** (0.000274)				-0.000502** (0.000214)	-0.000165* (8.10e-05)	-0.00200*** (0.000240)
EPL	-0.00643*** (0.00160)				-0.000292 (0.00231)	-0.00613*** (0.00165)	0.00203 (0.00214)
PMR		-0.00673* (0.00331)					
Public R&D intensity			0.0338*** (0.0106)				
Debt-to-equity				-0.000704* (0.000372)			
Constant	0.0539*** (0.00587)	0.0614*** (0.00521)	0.0272*** (0.00713)	0.0545*** (0.00206)	0.0242** (0.00796)	0.0297*** (0.00563)	0.0788*** (0.00552)
Country dummies	yes	yes	yes	yes	yes	yes	yes
Time trend	insignificant	correlated	correlated	correlated	insignificant	insignificant	yes
Crisis control	yes	yes	yes	yes	yes	yes	yes
Observations	194	195	219	213	194	194	194
R-squared	0.487	0.182	0.199	0.124	0.362	0.512	0.696
Number of countries	13	13	13	13	13	13	13

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

(1) When controlling for additional variables the time trend becomes insignificant for all asset types apart from tangible capital which is characterised by a negative trend. For reasons of multi-collinearity we drop the trend from those regressions for which the trend is insignificant or highly correlated with trending variables (i.e. we believe that the variables included in the model jointly explain more than the trend). Explanatory variables are added in lag-form as described in Box II.1. (2) NA-intangibles refer to those intangible asset types that are included in the national accounts' measure of Gross Fixed Capital Formation (GFCF), namely computerized information and some categories of innovative properties (e.g. mineral exploration, R&D and intellectual property rights). Non-NA intangibles refer to those intangible asset types that are captured as expenditure or intermediate consumption in the national accounts.

Source: Own calculations based on various databases.

the long-term interest rate and debt-to-equity ratio (capturing financial conditions) are all statistically significant determinants of investments in intangibles.

Thirdly, drivers of investment in tangible and intangible assets differ significantly.⁽⁷⁸⁾ Our measures of financial conditions seem generally to matter more for tangible than for intangible capital.⁽⁷⁹⁾ This might be because intangible capital tends to be financed from internal funds and

venture capital, rather than other external funds (partly because it lacks the type of collateral that would allow easy external funding). Tangible capital also appears to be more cyclical than intangible capital, which implies a stronger correlation with cyclical variables such as financial indicators. When one compares the effect of financial variables across intangible asset types, the results suggest that the long-term interest rate matters statistically more for NA than for non-NA intangibles. This could be read as an indication that R&D and computerised information (the main asset categories included in NA intangibles) could be financed by external funds, provided there were enough elements to reduce the uncertainty surrounding such investments. Specific action

⁽⁷⁸⁾ Some of these results are shown in Table II.1; the other results are available on request.

⁽⁷⁹⁾ This applies especially to the interest rate, but also to the leverage of the banking sector and the debt-to-equity ratio of financial corporations.

could therefore serve to broaden funding opportunities beyond the usual internal sources.

The (product and labour market) regulatory framework is found to matter more for intangibles than for tangibles, which corroborates previous findings in the literature.⁽⁸⁰⁾ Most measures used as proxies for the regulatory framework are found to have statistically significant effects on intangible investment and have the expected signs. Less flexibility) in product market regulation is associated with lower investment in intangible capital, while proximity to the country with the lowest regulatory stringency (in terms of *Doing Business* indicators) is associated with higher investment in intangibles. Equally, regression results indicate that regulations that support job transitions and self-employment are closely associated with investment in intangible capital. Given the identified positive relationship between intangible capital and skills, measures that support the acquisition of new skills and lifelong learning could also enhance investment in intangibles. Results suggest that employment protection legislation is more strongly associated with non-NA intangibles (i.e. economic competences, design and new products) than with NA intangibles, which would appear to indicate that flexible resource allocation is particularly important for uncertain investments with short maturities, e.g. new products and design.

Of the public intervention measures tested in the model, evidence suggests that tertiary education is vital for investment in (both NA and non-NA) intangibles, while it does not seem to have a significant effect on tangible investment. This may be because intangible capital is potentially more skills-intensive than tangible capital. Also, skills mismatch is found to matter negatively (in the case of under-qualification) and positively (in the case of over-qualification) for intangible investment. Other types of skill, such as vocational training, generic cognitive and non-cognitive skills, could also play a role, in particular for non-NA intangibles (this could be subject to further analysis). Intangible assets include firm-specific human capital, which is bound to be correlated with tertiary education and qualifications, but the result captures more than

this correlation, as it applies also to NA intangibles (which do not include training).

The results also indicate that public R&D intensity seems to matter most for NA intangibles. This finding is intuitive, as NA intangibles include private R&D, which is known to benefit greatly from public R&D (see sub-section II.4). Science/business linkages, as proxied by public-private co-publications, appear to matter for (NA and non-NA) intangible investment.

The evidence confirms strong complementarities between intangible and tangible assets. This holds in terms of simple correlations and also when controlling for the accelerator effect and other controls in the regressions. The latter⁽⁸¹⁾ show a strong relationship between tangible and intangible capital, while complementarity among intangibles seems weaker.

Further evidence, including micro-level analysis for R&D investment, generally confirms the above results, but adds some more nuanced insights and allows us to measure the micro-economic features of investment in intangible assets. For instance, there is evidence that the relationship between employment protection legislation and R&D investment depends on wage-bargaining schemes and the type of industry.⁽⁸²⁾ There is additional evidence for the importance of alternative funding schemes, such as venture capital, complementing the findings that financial conditions matter.⁽⁸³⁾ The literature further suggests that corporate skills (in addition to tertiary education) are a driver of R&D investment.⁽⁸⁴⁾ Finally, policies in favour of science/business linkages and R&D tax incentives also appear to play a role, although their effects depend ultimately on policy design.⁽⁸⁵⁾

⁽⁸⁰⁾ Hao and Haskel (2011), 'Intangibles and product market reforms'; http://www.ceriba.org.uk/pub/CERIBA/IntangHaskelHaoXcountry/intangibles_crosscountry_Hao_Haskel_2March2011.pdf

⁽⁸¹⁾ The complementarities derived from the regression analysis should cautiously be interpreted as correlations.

⁽⁸²⁾ Bassanini, A. and E. Ernst (2002), 'Labour market institutions. Product market regulation and innovation. Cross country evidence', *Economic Department Working Papers* 316, OECD.

⁽⁸³⁾ Kortum S. and J. Lerner (2000), 'Assessing the contribution of venture capital to innovation', Boston University and National Bureau of Economic Research, *RAND Journal of Economics*, 31 (4).

⁽⁸⁴⁾ Piva M. and M. Vivarelli (2007), 'Corporate skills as an *ex ante* incentive to R&D investment', *IZA Working Papers* 2562.

⁽⁸⁵⁾ Becker, B. (2014), 'Public R&D policies and private R&D investment. A survey of the empirical evidence', *Journal of Economic Surveys* 29 (5): 917–42.

II.6. Concluding remarks and policy implications

Policy implications of the above analysis go well beyond the intangible sector. For instance, as regards closing the gap between Europe and the United States in terms of investment in intangible assets, and accelerating TFP through the emergence of the knowledge economy and stimulating long-term growth, we can draw the following conclusions:

- All four sets of investment drivers that were identified appear to be relevant for intangibles. Some key drivers and barriers appear to affect tangible and intangible assets differently: human capital, public investment in R&D and higher education, and regulation matter more for intangible assets, while financial conditions and GDP developments tend to have a stronger effect on tangible investment. Also, due to the synergies between tangible and intangible assets, but also between intangible asset types, a barrier to investment that is relevant for one asset type may indirectly impede investment in other assets. Training and human capital formation appear to be essential for investment in intangible assets. Policy measures to tackle barriers to such investment should focus on these areas.
- Policy-makers need to strike a balance between promoting flexible and competitive markets and the need constantly to modernise IPRs. Given the uncertain nature of intangibles, regulation enabling the flexible and swift allocation of resources and flexible markets is pivotal for investment in them. Also, knowledge diffusion can be improved by pro-competitive regulations. Well-functioning markets are essential and policy needs to ensure conducive framework conditions in this respect. However, appropriability is also an important issue for investment in intangibles and IPRs are an increasingly important framework condition for investment in knowledge-based capital. IPR rules need to be constantly modernised to keep pace with technological change and factor in the needs of intangible-intensive industries. To protect and encourage innovation, there is therefore a fundamental need for an appropriate blend of modern/effective IPR systems (to ensure sufficient returns on investment) and regulatory and competition policies addressing monopoly power and rent-seeking (together with effective enforcement).
- Knowledge-based industries raise new issues for competition policy, particularly through network effects, which may play an important role in the digital economy. Non-rivalry of intangible assets (within a firm) may lead to increasing returns to scale and ultimately monopolistic competition. Positive network externalities (where the value of and demand for goods or services increase with the number of network users) can reinforce this phenomenon. Due to these specific characteristics of intangible assets, there is a risk of investment remaining below the social optimum if such monopolies are allowed to develop.
- Access to finance could be improved through greater availability of risk-prone capital and better information on the assets being developed. The crowding-in of private investments should be fostered, in order to meet common challenges affecting investment in intangibles (higher uncertainty, significant sunk costs, lack of ‘second-hand’ markets for intangible assets). Efforts could be made to amend financing schemes. Effective measures could include stimulating early-stage equity finance, venture capital and crowd funding. Consideration could be given to the use of European Fund for Strategic Investments in this regard. It is also important to improve the systematic reporting of investments in all relevant intangibles. This may improve access to finance (with capitalised intangibles being used as collateral), corporate governance and market transparency. New accounting and corporate disclosure standards could support the market value of firms investing in intangible assets.
- Investment in intangible assets and the creation of a knowledge-based economy could be stimulated by means of direct public support (e.g. investing in public R&D and building a strong science base), tailoring taxation schemes accordingly, public procurement⁽⁸⁶⁾ and promoting business/science linkages and

⁽⁸⁶⁾ See in this regard also the comprehensive analyses conducted in the context of the INTAN and SPINTAN FP7 projects; www.INTAN-Invest.net and www.SPINTAN.net

knowledge transfer. If tax policy instruments to support business investment in intangibles are to be effective and crowding-out to be avoided, the careful design, administration, implementation and regular evaluation of such instruments are of paramount importance.

- It is crucial to invest, and stimulate investment, in tertiary education, skills and training. Growing investment in intangibles makes it even more important to get human capital policies right, as they may have profound implications for employment and earnings inequality. Clearly, a knowledge-based economy tends to reward certain types of skill, including corporate skills, and those who perform non-routine manual and cognitive tasks (as well as the investors who ultimately own much of the intangibles). ⁽⁸⁷⁾
- Complementarities between intangible assets

and physical capital are also important, and this calls for both public- and private-sector action to deliver key infrastructures. Some intangible assets can only be productive in combination with a tangible asset. Consequently, drivers of or barriers to investment in one type of asset may have an equal effect on investment in the complementary asset.

- Lastly, we need a fuller understanding of intangibles as a source of macro-economic growth, and corresponding means of measuring knowledge creation and intangible capital (including R&D and taking account of the complementarity and synergies with other intangibles, such as computerised information and economic competences). Policy-makers could help, e.g. by developing common measurement guidelines to be applied by statistical offices. ⁽⁸⁸⁾

⁽⁸⁷⁾ OECD (2013), *New sources of growth: knowledge-based capital – synthesis report*.

⁽⁸⁸⁾ The OECD encourages countries to develop additional measures via satellite accounts so as to maintain the international comparability of GDP (*ibid*).