Telecommunications Policy 40 (2016) 471–484

Contents lists available at ScienceDirect

Telecommunications Policy

URL: www.elsevier.com/locate/telpol

Are intangibles more productive in ICT-intensive industries? Evidence from EU countries

Wen Chen [a,*], Thomas Niebel [b], Marianne Saam [b]

[a] Faculty of Economics and Business, University of Groningen, Nettelbosje 2, Groningen 9747 AE, The Netherlands
[b] Research Department Information and Communication Technologies, Centre for European Economic Research (ZEW), L7, 1, 68161 Mannheim, Germany

ARTICLE INFO

Available online 22 December 2015

Keywords:
Intangible capital
ICT
Economic growth
Labour productivity

ABSTRACT

There is much firm-level evidence that maximising productivity benefits from investments in information and communication technologies (ICT) requires complementary investments in organisational structures, employee training, and other intangible assets. Yet convincing macro-level analysis to quantify the importance of this effect was not possible until industry-level data on investment in intangibles were developed. With such data now available for 10 European countries, this research shows that the output elasticity of intangible capital is stronger in more ICT-intensive industries. This suggests that intangible capital and ICT capital are complements in production.

1. Introduction

Investment in information and communication technologies (ICT) and investment in intangible assets are key sources of growth in advanced economies. Much anecdotal and micro-evidence confirms that ICT and intangible assets do not only contribute to labour productivity growth individually, but do even more so in combination (Bloom, Sadun, & Van Reenen, 2012; Bresnahan, Brynjolfsson, & Hitt, 2002; Brynjolfsson & Hitt, 2000, 2003; Hall, Lotti, & Mairesse, 2013). While evidence on this complementary relationship between investment in ICT and intangibles is well-established in microeconomic studies, little is known about this relationship at the macroeconomic level as there were no explicit data on intangible investment at the level of the economy or industries.[1] Since the pioneering measurement work of Corrado, Hulten, and Sichel (2005, 2009), which standardised and popularised the approach of measuring business investments in intangible assets, quantifying the impact of intangibles on productivity and economic growth has been made possible in recent years. Many researchers incorporate such assets into a standard 'sources-of-growth' framework and find that intangible capital contributes significantly to labour productivity growth (Borgo, Goodridge, Haskel, & Pesole, 2013; Corrado et al., 2009; Fukao, Miyagawa, Mukai, Shinoda, & Tonogi, 2009; Roth & Thum, 2013). However, the effect of labour productivity from the *combined* investment in ICT and intangibles is still not taken into account in those macroeconomic studies.

* Corresponding author. Tel.: +31 50 363 3917.
E-mail addresses: wen.chen@rug.nl (W. Chen), niebel@zew.de (T. Niebel), saam@zew.de (M. Saam).

[1] To note, there have been other attempts to provide macroeconomic evidence on the complementarity between investment in ICT and intangibles (Basu, Fernald, Oulton, & Srinivasan, 2004; Corrado, Haskel, & Jona-Lasinio, 2014). This paper however differs from the previous works, as this is the first study to explicitly account for intangible investment at the industry level. This is potentially a very useful source of variation that could help to pin down the complementary relationship between ICT and intangibles.

http://dx.doi.org/10.1016/j.telpol.2015.09.010
0308-5961/

By using the industry-level intangible investment data for 10 European countries, this paper tests a much-discussed hypothesis in firm-level studies, namely that intangible capital investment is needed to gain the largest benefits from investment in ICT, and provides corroborating macroeconomic evidence. It is important to establish such evidence at the macroeconomic level as the existing microeconomic evidence may not hold in general and even if the findings can be generalised, the quantitative results could still differ if data with comprehensive coverage are used. This paper also contributes to the literature by shedding light on the magnitude of the output elasticity of intangible capital. Thus, in addition to its qualitative importance this paper also discusses the quantitative importance of intangible capital for labour productivity growth. More importantly, the quantitative implication enables the paper to quantify the growth differentials between industries with varying degrees of ICT intensity, which might be of great interest to policymakers in designing industry-specific policies.

This paper is also related to the strand of literature that studies the productivity gap between the US and continental Europe, as the poorer productivity performance observed in Europe since the mid-1990s may not only be the result of its lower level of investment in ICT relative to the US (Van Ark, O'Mahony, & Timmer, 2008), but also to a less effective exploitation of ICT due to lower investment in intangible capital.[2]

To empirically examine to what extent the growth impact of intangible capital is dependent on an industry's ICT intensity, this paper first defines an industry characteristic that ranks the industries by the extent to which they rely on the use of ICT and calculates this ranking as the ratio of ICT capital services to labour services. The resulting intensity indicator is then interacted with the growth of intangible capital and the interaction term is estimated in an intangibles-augmented Cobb–Douglas production function. Under the assumption of constant returns to scale, this paper tests whether a one percent increase in intangible capital deepening increases output per worker more strongly in more ICT-intensive industries.

Three key findings emerge from this study. First, intangible capital contributes systematically to labour productivity growth and its productive impact is found to be significantly higher in ICT-intensive industries than in those that use little ICT. This result supports the complementarity of intangible capital and ICT in production found in prior microeconomic studies. Second, using industry-level instead of country-level data on intangibles, this paper finds a much smaller mean output elasticity of intangible capital (0.17 as opposed to 0.4–0.7 found in Corrado et al., 2014), as well as a larger differential effect of labour productivity growth across industries. The output elasticity of intangible capital amounts to 9.9% for industries at the lowest quartile of ICT intensity, while it exceeds 19% for industries at the highest quartile. Third, by distinguishing various different intangible asset types, this paper finds that not every single intangible asset exhibits a higher output elasticity in ICT-intensive industries. In the sample of assets investigated, this is only true for organisational structures and research and development (R&D).

The remainder of the paper is organised as follows. Section 2 discusses the concept and measurement of intangible capital and how capitalisation of intangibles changes the traditional output measure and growth accounting framework. The econometric approach to investigate the impact of intangible capital accumulation on labour productivity growth is outlined in Section 3. Section 4 elaborates on the proxy of industry ICT intensity measures. Empirical analyses and robustness checks are presented in Section 5. Section 6 concludes.

2. Measuring intangible inputs and output

This section considers issues related to the concept and measurement of intangible capital. It begins with a discussion on the definition of intangible capital: what is it and how can it be measured? Then, it outlines how capitalising investment in intangible assets changes the conventional output measure, followed by a descriptive overview of the data used for analysis. It is important to emphasise that this section only highlights the main issues, readers should refer to Niebel, O'Mahony, and Saam (2013) for more extensive details regarding the construction of the intangible investment data by industry.

2.1. Defining intangible capital

Intangible capital, also known as knowledge-based capital, comprises a variety of distinctive assets, which create long-lasting benefits for the firm and the economy. Unlike machinery, equipment, and structures, intangible assets do not have a physical embodiment. Well-known examples of intangible assets include computer software and scientific research and development (R&D), both of which are currently recognised as part of the official National Accounts of a country.[3] Since the ground-breaking work of Corrado et al. (2005), a more comprehensive measure of intangible capital that is compatible with National Accounts has been developed and it consists of three categories: (1) computerised information, (2) innovative property, and (3) economic competencies.[4] The first category mainly includes investment in software and computerised

[2] According to Corrado, Haskel, Jona-Lasinio, and Iommi (2013), the US has a much higher propensity to invest in intangibles than the EU. Between 1995 and 2009 (the period during which the productivity gap widened), intangible investment as a share of GDP is averaged around 10.6% for the US, while the share is only about 6.6% for the EU.

[3] Software has been recognised as investment in National Accounts since the 1993 revision of the System of National Accounts (SNA); R&D has been newly added since the SNA 2008 revision.

[4] The need to measure and incorporate these intangible assets into National Accounts is also extensively discussed in Nakamura (2010).