European Commission

JRC SCIENCE FOR POLICY REPORT

Modes of Innovation: Evidence from the Community Innovation Survey

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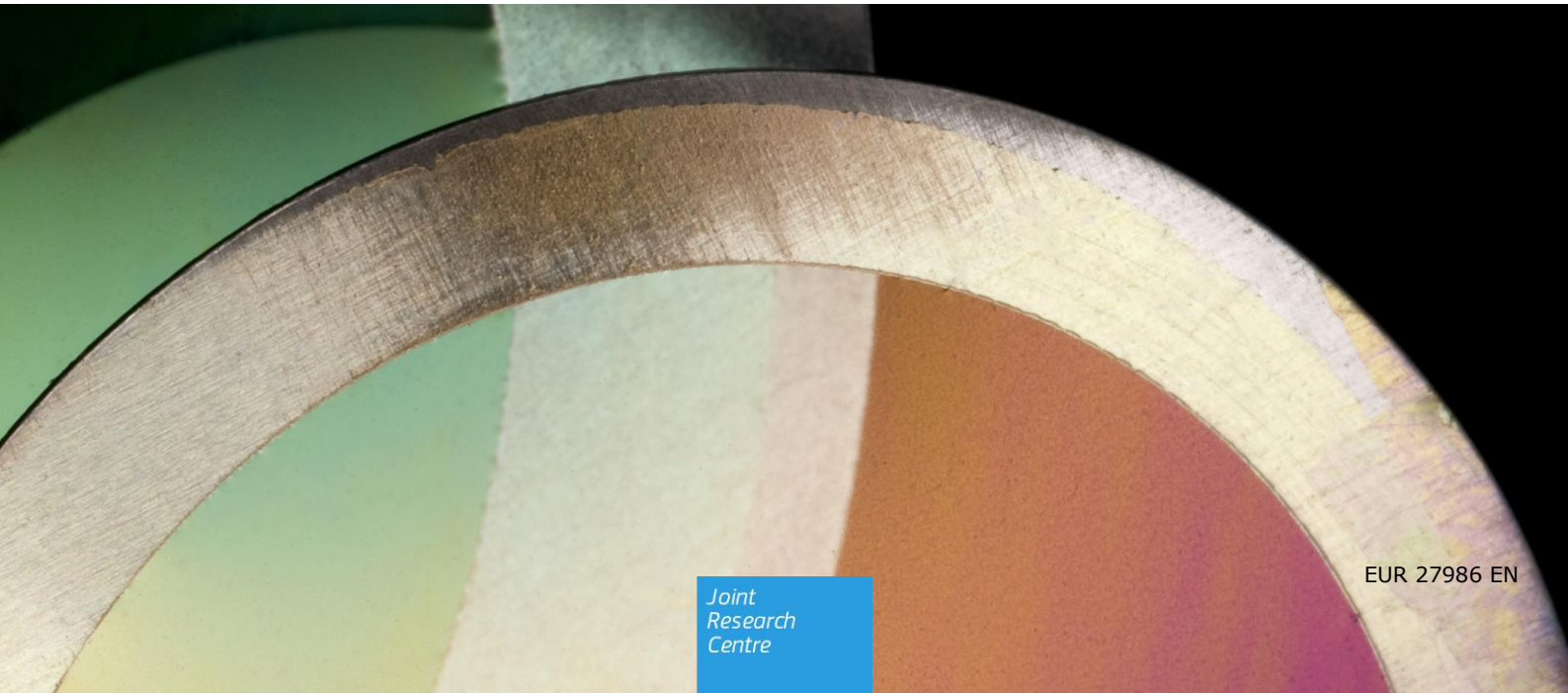
2016



EUR 27986 EN

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JRC101636

EUR 27986 EN

PDF ISBN 978-92-79-59751-0 ISSN 1831-9424 doi:10.2791/297083

Luxembourg: Publications Office of the European Union, 2016

How to cite: Federico Biagi, Annarosa Pesole, Juraj Stancik; Modes of Innovation: Evidence from the Community Innovation Survey; Joint Research Centre EUR 27986 EN; doi:10.2791/297083

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Abstract
This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift[1] (EURIPIDIS). This project was jointly launched in 2013 by JRC-IPTS and DG CONNECT of the European Commission. It aims to improve understanding of innovation in the ICT sector and ICT-enabled innovation in the rest of the economy.
In the context of the EURIPIDIS project, this report analyses innovative activities by ICT-producing firms and provides evidence on innovative activity in the ICT sector, compared to the overall economy. This analysis, based on a set of different indicators, aims to provide a deeper understanding of the modes of innovation adopted by ICT producing firms. To carry out the analysis, we created a panel dataset which matched the information collected by different Community Innovation Survey (CIS) waves from 2004 up to 2012 in twenty EU Member States. We then investigated the major innovation patterns that emerged, and compared the ICT sector to the whole economy.
The main findings show that, in general, firms in the ICT sector tend to innovate more with respect to the economy as a whole: the shares of both innovators and technological innovators are consistently higher within the ICT sector than they are in the economy as a whole. Moreover, the ICT sector has a higher share of innovative firms which perform R&D and a higher share of Framework Programme-funded innovative firms. In order to capture the modes of innovation of ICT-producing firms, we used "complex" indicators that condense information from more than one measure and allow us to make multi-dimensional phenomena uni-dimensional. These complex indicators indicate that the share of international and domestic innovators is higher among ICT firms than it is in the economy as a whole. In other words, ICT firms tend to have a higher than average in-house R&D capability and are more likely to introduce new-to-the-market product or process innovations in both international and domestic markets. Looking at international or domestic "modifiers" (i.e. firms that mainly adopt and/or modify innovation made by others), we find no evidence that ICT-producing firms are more likely than the average firm to modify or adopt innovations developed elsewhere.

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Foreword

This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift (EURIPIDIS) jointly launched in 2013 by JRC-IPTS and DG CONNECT of the European Commission. This project aims to improve understanding of innovation in the ICT sector and ICT-enabled innovation in the rest of the economy.

The purpose of the EURIPIDIS project is to provide evidence-based support to the policies, instruments and measurement needs of DG CONNECT for enhancing ICT Innovation in Europe, in the context of the Digital Agenda for Europe and of the ICT priority of Horizon 2020. It focuses on the improvement of the transfer of best research ideas to the market.

EURIPIDIS aims to:

1. better understand how ICT innovation works, at the level of actors such as firms, and also of the ICT "innovation system" in the EU;

2. assess the EU's current ICT innovation performance, by attempting to measure ICT innovation in Europe and measuring the impact of existing policies and instruments (such as FP7 and Horizon 2020); and

3. explore and suggest how policy makers could make ICT innovation in the EU work better.

This report concentrates on point 1 above. It analyses innovative activities by ICT-producing firms and provides evidence on innovative activity in the ICT sector.

Abstract

This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift[1] (EURIPIDIS). This project was jointly launched in 2013 by JRC-IPTS and DG CONNECT of the European Commission. It aims to improve understanding of innovation in the ICT sector and ICT-enabled innovation in the rest of the economy.

In the context of the EURIPIDIS project, this report analyses innovative activities by ICT-producing firms and provides evidence on innovative activity in the ICT sector, compared to the overall economy. This analysis, based on a set of different indicators, aims to provide a deeper understanding of the modes of innovation adopted by ICT producing firms. To carry out the analysis, we created a panel dataset which matched the information collected by different Community Innovation Survey (CIS) waves from 2004 up to 2012 in twenty EU Member States. We then investigated the major innovation patterns that emerged, and compared the ICT sector to the whole economy.

The main findings show that, in general, firms in the ICT sector tend to innovate more with respect to the economy as a whole: the shares of both innovators and technological innovators are consistently higher within the ICT sector than they are in the economy as a whole. Moreover, the ICT sector has a higher share of innovative firms which perform R&D and a higher share of Framework Programme-funded innovative firms. In order to capture the modes of innovation of ICT-producing firms, we used "complex" indicators that condense information from more than one measure and allow us to make multi-dimensional phenomena uni-dimensional. These complex indicators indicate that the share of international and domestic innovators is higher among ICT firms than it is in the economy as a whole. In other words, ICT firms tend to have a higher than average in-house R&D capability and are more likely to introduce new-to-the-market product or process innovations in both international and domestic markets. Looking at international or domestic "modifiers" (i.e. firms that mainly adopt and/or modify innovation made by others), we find no evidence that ICT-producing firms are more likely than the average firm to modify or adopt innovations developed elsewhere.

[1] http://is.jrc.ec.europa.eu/pages/ISG/EURIPIDIS/EURIPIDIS.index.html

Executive summary

This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift[2] (EURIPIDIS), jointly launched in 2013 by JRC-IPTS and DG CONNECT of the European Commission. This project aims to improve understanding of innovation in the ICT sector and ICT-enabled innovation in the rest of the economy.

The aim of this report is to give a clearer picture of innovative activities by ICT-producing firms, in absolute and relative (to the whole economy) terms. First, we provide evidence on "simple" indicators of innovative activity in the ICT sector, compared to the overall economy. In addition, we also compute some "complex" indicators, in the spirit of Arundel and Hollanders, (2005) and OECD (2009), in order to provide a deeper understanding of the modes of innovation adopted by ICT-producing firms in the period under scrutiny.

Simple indicators give direct information on the measures observed. Complex indicators, on the other hand, condense information from more than one measure and allow us to make multi-dimensional phenomena uni-dimensional.

We use Community Innovation Survey (CIS) data for the period 2004-2012 for 20 EU countries (not all years are available for all countries), namely Bulgaria (BG), Cyprus (CY), the Czech Republic (CZ), Germany (DE), Estonia (EE), Spain (ES), France (FR), Croatia (HR), Hungary (HU), Ireland (IR), Italy (IT), Lithuania (LT), Luxembourg (LU), Latvia (LV), the Netherlands (NL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), and Slovakia (SK).

When looking at the simple indicators (e.g. for the share of firms that introduce some type of innovation), our results indicate that, relative to the overall economy, the ICT sector is especially innovative in terms of the share of firms that perform R&D and the share of firms that produce technological (product or process innovation) or generic (product or process or organizational or marketing) innovation[3]. At the same time, the data show large variations between countries.

The complex indicators capture the modes of innovation of ICT-producing firms and indicate that the share of international and domestic innovators is higher among ICT firms than it is in the whole economy. In other words, ICT firms tend to have a higher

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2 http://is.jrc.ec.europa.eu/pages/ISG/EURIPIDIS/EURIPIDIS.index.html

3 The Oslo Manual (OECD 2005) distinguishes between four types of innovation: product, process, organisational and marketing. The first two (product and process) are also referred to as technological innovation, while the last two are considered as non-technological innovation. We distinguish between technological innovation (i.e. when either product or process innovation happens) and generic innovation (i.e. when at least one of the four types happens).

than average in-house R&D capability and to be more likely to introduce new-to-the-market product or process innovations in both international and domestic markets. Looking at international or domestic "modifiers" (i.e. firms that mainly adopt and/or modify innovations made by others) we find no evidence that ICT-producing firms are more likely than the average firm to modify or adopt innovations developed elsewhere, whether they operate mainly on international or domestic markets. However, once again the data point to large variations between countries.

We also look at collaboration patterns and we find that innovative ICT firms carry out a wide range of cooperation activities, particularly with clients and suppliers. At the EU level, the picture in 2004 is similar to the one in 2012, but this hides important differences between countries. We also find that firms are more like to cooperate with other firms in their home countries than they are with firms in the rest of the EU. Cooperating with firms in the EU is, however, more likely than cooperating with firms outside the EU.

Internal and market sources of knowledge appear to be more important than education and research centres, and innovative ICT firms are more likely to receive RTD funds than the average firm.

When considering barriers and drivers of innovation and competitiveness, Intellectual Property Rights (IPR) are not mentioned as very important drivers of competitive advantage. Secrecy and lead-time advantage matter more. Again, we find large differences between countries.

Lack of finance, lack of qualified personnel and uncertainty over demand appear to be important barriers (with variations between countries).

To summarise, the main results of our study are:

a. R&D investment still plays an important role in the innovative ICT sector.
b. A large fraction of ICT innovative firms report that IPR are not used to increase or maintain their levels of competitiveness.
c. Firms cooperate widely with clients and suppliers, but their cooperation with universities and government varies considerably across the Member States.
d. Lack of finance and qualified personnel are perceived to be the most frequent barriers to innovation.

1 Introduction

This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift[4] (EURIPIDIS), jointly launched in 2013 by JRC-IPTS and DG CONNECT of the European Commission. This project aims to improve understanding of innovation in the ICT sector and ICT-enabled innovation in the rest of the economy.

In the context of the EURIPIDIS research project, this report has two main objectives. First, with the use of simple and complex indicators of innovation output, it investigates the innovative performance of firms in the ICT-producing sector, comparing it to that of firms in the economy as a whole. The latter refers to firms from all sectors (including ICT) for which we have data in the Community Innovation Survey (CIS) (see Box 1 for a detailed description of the CIS).

Second, the report focuses on ICT innovative firms and describes their behaviour, in terms of R&D and non-R&D activities, modes of cooperation, information sources for innovative activity, and also the drivers and barriers to innovation (including public funding from the EU Framework Programmes).

The ICT-producing sector (as defined in the Annex) is the sum of two sub-sectors: ICT manufacturing and ICT services. In this report, we consider the two subsectors jointly because, for some countries and years, the number of observations on each separate ICT subsector would be too limited to provide reliable information. During the years covered by this study (2004-2012), the statistical definition of the ICT sector (both manufacturing and services) changed, due to a revision in NACE codes (from Rev. 1.1 to Rev. 2).[5] In practice, this amounted to a reduction in the "size" of the ICT sector.[6] The fact that in this report we focus on shares (e.g. the share of ICT innovating firms) instead of absolute values (e.g. the number of ICT innovating firms) mitigates the consequences of the NACE revision on data comparability across years.

The main novelties of our study, as compared with others described in the literature, are the following: our study focuses on the ICT sector which is compared to the economy as a whole, it covers a large number of EU countries and builds on data from more than one CIS wave (for some countries, we have five different year-observations).

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4 http://is.jrc.ec.europa.eu/pages/ISG/EURIPIDIS/EURIPIDIS.index.html

5 See the Annex for details.

6 EU27 ICT Business enterprise expenditure on research and development (BERD) in 2007 based on NACE Rev 1.1 is reported to be 36.6mil EUR, while it was only 25.9mil EUR when estimated based on NACE Rev 2 (M Mas, Robledo, J.C. and Pérez J. (2012) ICT Sector Definition Transition from NACE Rev. 1.1 to NACE Rev. 2, JRC Technical Report, ISBN 978-92-79-28089-4 (pdf) http://ftp.jrc.es/EURdoc/JRC77364.pdf

The CIS data used in this report cover the period 2004-2012 for 20 EU countries (not all years are available for all countries), namely Bulgaria (BG), Cyprus (CY), the Czech Republic (CZ), Germany (DE), Estonia (EE), Spain (ES), France (FR), Croatia (HR), Hungary (HU), Ireland (IR), Italy (IT), Lithuania (LT), Luxembourg (LU), Latvia (LV), the Netherlands (NL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), and Slovakia (SK).

Box 1: Community Innovation Survey[7]

The CIS is an important source of information on firms' innovative activity, in terms of both input and output. It also allows us to combine characteristics in order to better describe ICT firms' innovative behaviour.

Looking at inputs to innovation activities, the CIS provides data on (i) whether a firm has engaged in R&D (in-house; external) activities; (ii) whether a firm has engaged in non-R&D activities (such as acquisition of machinery, equipment, software and buildings; acquisition of existing knowledge from other enterprises or organizations - including copyrights, and patents; training for innovative activities; activities related to marketing of innovations; and activities related to design or others activities such as feasibility studies, testing etc.). The CIS also provides information on the output of innovation activities by firms. In particular, it reports whether a given firm in the previous three years has introduced (a) a new product or/and (b) a new process (or both) and whether these products or processes were new to the firm and/or new to the market. The CIS also asks firms to report if, in the previous three years, they have introduced (c) an organizational innovation or (d) a marketing innovation. Information on product and/or process innovation, together with organizational and marketing innovation, plus the data on R&D and non R&D activities, allows us to better understand the innovation input and output performance of ICT firms and how they compare to the average firm in the economy as a whole.

Moreover, product and process innovations can be developed by a firm alone and/or in collaboration with others (firms and institutions), or they can be the result of adoptions or modifications of innovations originally developed by other firms or institutions.

Especially interesting for us is the fact that the CIS provides data on the sources of information and on cooperation for product and process innovations (but only for the innovative firms, i.e. firms that have achieved a product or/and process innovation, or that have at least put in place activities geared towards innovation).

The sources of information mentioned in the survey are: (i) internal (within the firm or within the enterprise group); (ii) market-driven (suppliers, clients or customers, competitors, consultants and commercial labs); (iii) education and research institutes (universities and other higher education institutions; government, public and private research institutes); (iv) other sources (conferences, trade fairs, exhibitions; scientific journals and trade/technical publications; professional and industry associations).

[7] http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey

As regards cooperation, the survey distinguishes between four types of cooperation partners (which reflect the variables used to characterize the information flows): (i) other firms in the same group; (ii) suppliers, clients and customers, competitors, and consultants; (iii) universities and other higher education institutions; (iv) government, public and private research institutes.

Concerning the location of the cooperating partners, the CIS distinguishes between partners located: (i) in the same country; (ii) inside the EU; (iii) outside the EU (distinguishing between the US, China or India and all other countries).

The CIS also reports on how effective the different methods for maintaining or increasing the competitiveness of product and process innovations have been during the previous three years (only innovative firms were asked about this). The methods considered in the survey are: patents, design, copyrights, trademarks, lead-time advantage, complexity and secrecy.

In addition, the CIS provides information on whether an innovative firm has received any public financial support for its innovation activities, from (i) the local or regional authorities, (ii) the central government and (iii) the EU (distinguishing between Framework Programme and non-Framework Programme funding).

Finally, the CIS provides information on the main barriers and drivers to innovation (all firms were asked about this). While this information does not immediately help to define the innovation modes, it provides us with a link between innovation and policies. The main barriers to innovation, as captured by the CIS, are: lack of demand; lack of qualified personnel; lack of adequate finance; high cost of access to new markets; high cost of meeting government regulations or legal requirements; strong price competition; strong competition on quality, reputation, brand; innovations by competitors; dominant market share held by competitors.

The report is structured as follows: Section 2 briefly summarizes the literature on measuring modes of innovation in the ICT sector. Section 3 describes the methodology used in this report. Sections 4 and 5 contain an analysis of ICT and total economy firms' innovative performance, using both simple (Section 4) and complex (Section 5) indicators. Section 6 describes the behaviour of innovative ICT firms. Section 7 contains the conclusions we have drawn from our work.

2 A summary of the (ICT-relevant) literature on modes of innovation

This work is mainly inspired by Arundel and Hollanders, (2005) and by OECD (2009).

Arundel and Hollanders distinguish between four groups of innovative firms based on: a) the level of innovations' novelty (new to the market or to the firm), b) the degree of creative in-house activity (in-house R&D activity, on a temporal or permanent basis), and c) the exposure to national or international markets. Arundel and Hollanders (2005) define the following mutually-exclusive innovation modes:

a) ***Strategic innovators**:* innovation is at the heart of these firms' competitive strategies. They have introduced a product or process innovation that has been developed at least partly in-house, they perform R&D on a continuous basis, they have introduced at least one product that is new to their market, and they are active in national or international markets. These firms are the source of many innovative products and processes that are adopted by other firms in their domestic economies and internationally.

b) ***Intermittent innovators**:* these firms perform R&D and develop new-to-market innovations at least partly in-house. However, innovation is not a core strategic activity for them and their innovations are unlikely to diffuse to other firms. This class includes three sub-groups:

   i) Firms that meet the criteria for the strategic innovators (group A), except for the fact that they only perform R&D occasionally. This group includes firms that innovate in-house intermittently when required by a new product line.

   ii) Continuous R&D performers which are only active on local or regional markets. Often these firms make only minor adjustments to products or processes that are largely acquired from other firms.

   iii) Firms that do not perform R&D but have introduced new-to-market innovations, on a national or international market. These innovations are likely to be at least as innovative as the first two categories, since they must compete in a larger market.

c) ***Technology modifiers**:* these firms modify products and processes through in–house non-R&D activities. They differ from technology adopters (group D) because they have some in-house innovative activities. Those that are active on national or international markets have not introduced a new-to-market innovation (otherwise they would be classified as intermittent innovators). Those that are active in local or regional markets may have introduced a new-to-market innovation and have slightly modified it for this market. Many firms that are essentially process innovators, which innovate through production engineering, fall within this group.

d) ***Technology adopters**:* these firms innovate by adopting innovations developed by other firms. These firms innovate through diffusion.

We find the study by Arundel and Hollanders very interesting but not fully satisfying, for two main reasons. First, the conditions imposed by Arundel and Hollanders in some cases appear ad hoc and the resulting picture is not immediately interpretable in terms of mutually exclusive characteristics[8]. Second, Arundel and Hollanders only look at CIS-3, which covers the time interval 1998-2000.

Another relevant report is OECD (2009), which contains both simple and complex indicators of innovative activity. While the simple indicators proposed by OECD (2009) are quite standard (measures of firms introducing technological and non-technological innovation; measures of inputs to and outputs of the innovation process; measures of some key policy-relevant characteristics), the most interesting contribution from this OECD report consists of the complex indicators (or modes of innovation). OECD (2009) proposes the following list of complex output-based indicators of innovation modes:

a) **New-to-market international innovators:** firms that have introduced a product innovation that is new to international markets and have developed new products or processes in house. Their innovations have the highest degree of novelty. At the same time, the fact that they are developed in-house (product or process innovation developed by the enterprise alone or together with others) indicates that these enterprises possess (at least some of) the capability to create novel products.
b) **New-to-market domestic innovators:** firms that have introduced new product innovations to their domestic markets, but not necessarily to international markets. These enterprises only operate on domestic markets. As with new-to-market international innovators, these innovations are at least partially developed in-house.
c) **International modifiers:** firms that carry out some in-house development activities, but product and/or process innovations already exist on international markets (new-to-enterprise product or process innovators). Innovations may or may not be new to domestic markets.
d) **Domestic modifiers:** firms that only operate on domestic markets. Product and/or process innovations already exist on domestic markets (new-to-enterprise domestic product or process innovators). These enterprises are able to adopt and implement the new technologies themselves.
e) **Adopters:** firms that have not developed product or process innovations in house, but have had them developed by others. This group thus includes all product and

[8] This is especially true when one considers the groups of intermittent innovators and the group of technology modifiers.

process innovators that have had all their product or process innovations developed externally, regardless of novelty.

It should be noted that, unlike the complex indicators proposed by Arundel and Hollanders (2005), those proposed by OECD (2009) make no reference to (continuous or intermittent) R&D activity. The variables that are used to generate the various groups deal with:

- whether the good is new to the international market, new to the national market or new to the firm;
- whether the firm operates on the international, national or local market;
- whether the firm has participated more or less significantly in the innovation process (without reference to formal R&D).

3 Methodology

One of our aims was to look at a longer time interval than Arundel and Hollanders (2005) and OECD (2009). However, this came with a cost, because not all the variables were present in all the countries for the whole period we chose (from 2004 to 2012). So, when computing single and complex indicators, we limited our attention to those variables on firms' innovative activities that, for the period 2004-2012, were available for the largest number of EU countries. These variables were:

i. the degree of novelty of a firm's product or process innovation (new to the firm vs. new to the market; first in the EU/world vs. first in the home market);

ii. the ability of the firm to realise part of the innovation process through in-house R&D activity;

iii. the openness of the market to which the firm is exposed (international vs. domestic/local).

The **simple indicators** use data on outputs of the innovation process –such as product, process, organizational and marketing innovation[9]. In practice, we computed the following innovation-output indicators:

a) the share of firms that have introduced some type of innovation (either product, or process, or organizational or marketing);

b) the share of firms that have introduced technological innovations (i.e. only product or process);

c) the share of firms that have attempted some type of innovation activity but have not (yet) succeeded in it;

d) the share of firms that have not even attempted any type of innovation.

We did this analysis separately for the ICT sector and for the economy as a whole (which includes the ICT sector), so that we could compare –for each simple indicator- the performance of the average firm in the ICT sector to that of the average firm in the whole economy[10]. This gave us a better understanding of the relative innovativeness of the ICT-producing industry.

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[9] Since information on R&D and other inputs to the innovation process is available only for innovative firms, we have chosen to discuss these aspects in Section 6 where we characterize the innovation patterns of ICT firms vs those of firms in the whole economy firms.

[10] For instance, for a given year and country, we can compare the share of ICT firms performing R&D activities (the denominator is given by the number of firms in the ICT sector) to the share of firms performing R&D in the whole economy (the denominator is the number of firms in the whole economy).

As regards the **complex indicators** (or **modes of innovation**), our aim was to provide a clear and simple view of the intensity of innovation activities by ICT firms, using the information available in CIS data. For this, we created the following four mutually-exclusive groups:

i. **High international innovators**: these firms have developed both a product and process innovation, at least partially in-house. These innovations are new to the market and first in the EU or to the world. These firms sell their products on the international market[11].
ii. **High domestic innovators:** these firms have developed both product and process innovations, at least partially in-house, that are new to the market and first in the domestic country. These firms sell their products only on the domestic market.
iii. **Intermediate international innovators**: these firms have developed both product and process innovations that are new to the market, but that consist of modifications of existing products or processes. These firms sell their products on the international market[12].
iv. **Intermediate domestic innovators:** these firms have developed both product and process innovations that are new to the market but consist of modifications of existing products or processes. These firms sell their products only on the domestic market.

We think that it is reasonable to interpret the degree of innovativeness as decreasing from the first to the fourth group. The first two groups (high international and high domestic innovators) are firms that use internal resources to develop product and process innovations. These are new to their particular market, which is (also) international in the first group of innovators and only domestic in the second group.

The second two groups (intermediate international and intermediate domestic innovators) represent firms that develop product and process innovations that are new to the market, by adapting existing products and processes. They sell their products either on international or domestic markets.

We are aware that these four groups do not exhaust the list of possible modes of innovation. We have focused our attention on them because, in our opinion, they reflect different degrees of medium-to-high innovative capacity, which is the right focus for ICT-producing firms. In particular, when looking at intermediate (international and domestic) innovators, we have added the condition that they must introduce a new-to-the-market product. In our opinion, this is reasonable because both groups capture firms that modify innovations made by others. Adding the condition that their modifying efforts

[11] These firms could also be selling in the domestic market.
[12] These firms could also be selling in the domestic market.

result in innovations that are new to the market guarantees that these firms are "real" innovators and not simply imitators of innovations developed by others. For this reason, we do not directly consider firms that have low innovative capacity (such as firms producing only new-to-the-firm product or process innovations and selling them only on the local market).

It should be noted that our approach is essentially prescriptive. We started from a definition of the modes of innovation which was based on a specification that characterized the "intensity of innovation" that could be derived from observable characteristics. An alternative approach would have been to reduce the structure to a minimum and "let the data speak". This was done in Chapter 2 of OECD (2009) and again in Frenz and Lambert (2012), who used factor analysis to deduce the (empirically-based) modes of innovation of firms from recurrent patterns. While this method is certainly interesting in its own right, it does not lend itself easily to analysis across countries and times[13].

[13] Following OECD (2009), we have applied Factor Analysis to our CIS data, in order to gather clear indications of common patterns of ICT innovative activity. However, our results so far have been quite unsatisfactory.

4 Simple indicators: results

This section aims to describe how the ICT sector performs as compared to the rest of the economy in terms of innovation outputs. Using the definition of innovation provided by the Oslo Manual (OECD 2005), we distinguish between technological and non-technological innovation. The former refers to innovation that results in new products or processes, while the latter also includes market and organisational innovations. The CIS data tell us about the share of firms that have engaged in any of these forms of innovation, the share of firms that are attempting to innovate with outcomes as yet unknown or that have failed, and the share of firms that do not even try to innovate. We can therefore distinguish four groups of firms:

i. Innovators, which report having introduced at least one type of innovation;

ii. Technological innovators, which have introduced either a new product or a new process or both;

iii. Aspiring innovators, which are trying to innovate in product or process but have not as yet been successful or have not completed their attempts and, finally,

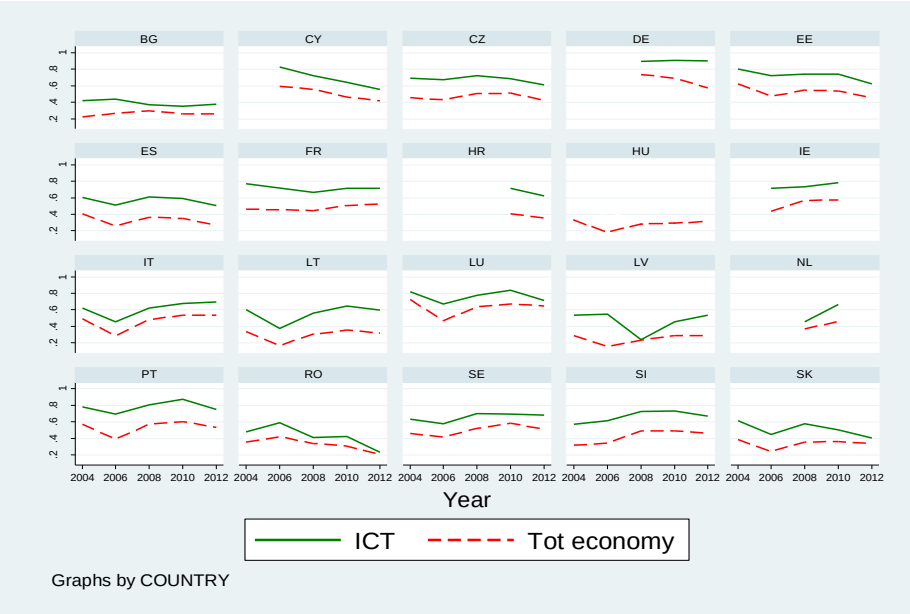
iv. Non-innovators, which declare that they do not undertake any product- or process-innovative activity.

4.1 Innovation activities

Figure 1 shows the share of firms that report having undertaken at least one type of innovation (i.e. product, process, organizational or marketing). Even when using such a broad definition of innovation output, the ICT sector still presents higher values than the whole economy.

In general, the ICT sector seems to follow the same trend as the rest of the economy except for Bulgaria, Germany, Luxembourg, Latvia, Romania and Slovakia. After 2008, the share of innovators in the whole economy in Germany followed a downward trend while the share of innovators in the ICT sector remained constant, increasing the difference between the ICT sector and the whole economy. On the other hand, in Luxembourg, Romania and Slovakia, the share of ICT innovators decreased after 2008, reducing notably the gap with the whole economy share. In Bulgaria, the share of innovators among ICT firms started to fall earlier (around 2006), while Latvia presents a U-shaped curve for ICT firms with its lowest value in 2008 (possibly due to a reduced number of observations).

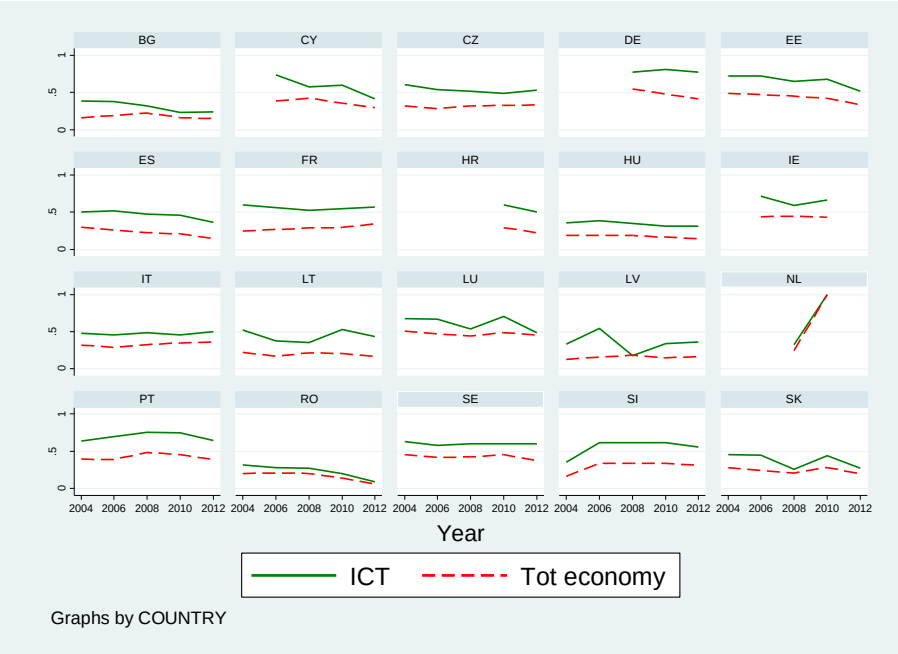
Figure 1: Share of firms undertaking at least one type of innovation –ICT vs total economy



Source: Authors' calculation on CIS data

In Fig. 2, we focus on technological innovators (i.e. product or process). Not surprisingly, the share of technological innovators in the ICT sector is higher than it is in the whole economy.

Figure 2: Share of firms undertaking technological innovation–ICT vs total economy



Source: Authors' calculation on CIS data

Figure 2 confirms the picture in Figure 1 and suggests that most of the gap between the average ICT firm and the average firm in the whole economy is explained by technological innovation. This is more evident in Table 1, which reports the coefficients obtained by regressing each relevant indicator against country dummies (the constant is omitted) and a time trend. The relevant indicators are: a) the share of ICT innovators (column 1), the share of ICT technological innovators (column 2), the difference between the shares of ICT and whole economy innovators (column 3) and the difference between the shares of ICT and whole economy technological innovators (column 4). All coefficients are significant in the four cases. The intuitive way of reading the table is, for each column, to look at the colour scale. For each specification (i.e. column), the coefficients highlighted in green represent the higher values for the country dummies coefficients, grading down to red, which represents the lowest values. When we look at columns 1 and 2 we find that Germany scores the highest in both ICT innovators (column 1) and ICT technological innovators (column 2), followed by Portugal. Bulgaria and Romania have the lowest coefficients in the first two specifications (column 1 and cololumn 2).

When we consider the differential performances of the ICT sector relative to the whole economy (i.e. columns 3 and 4), the countries where ICT firms have a better relative performance are Lithuania, Germany and Portugal among innovators (column 3) and Germany, Portugal and France among technological innovators (column 4). On the other hand, in Romania Finland, Bulgaria (columns 3 and 4), Luxembourg (column 3) and Slovakia (column 4) the differences between the innovation performance of the ICT sector and that of the whole economy are lower (for innovators and technological innovators respectively).

Table 1: Indicators coefficient on country dummy and time trend

	ICT innovators	ICT tech. innovators	Diff innovators	Diff tech. innovators
BG	0.497	0.362	0.163	0.169
CY	0.797	0.641	0.215	0.256
CZ	0.781	0.585	0.243	0.251
DE	1.009	0.857	0.279	0.353
EE	0.830	0.708	0.229	0.257
ES	0.668	0.511	0.265	0.267
FI	0.714	0.596	0.159	0.152
FR	0.815	0.612	0.266	0.303
HU	0.553	0.391	0.197	0.202
IE	0.847	0.705	0.248	0.251
IT	0.718	0.526	0.180	0.180
LT	0.660	0.493	0.290	0.279
LU	0.866	0.665	0.164	0.177
LV	0.566	0.401	0.243	0.229
PT	0.885	0.745	0.278	0.306
RO	0.531	0.282	0.132	0.104
SE	0.762	0.652	0.190	0.210
SI	0.765	0.599	0.273	0.285
SK	0.613	0.424	0.203	0.167

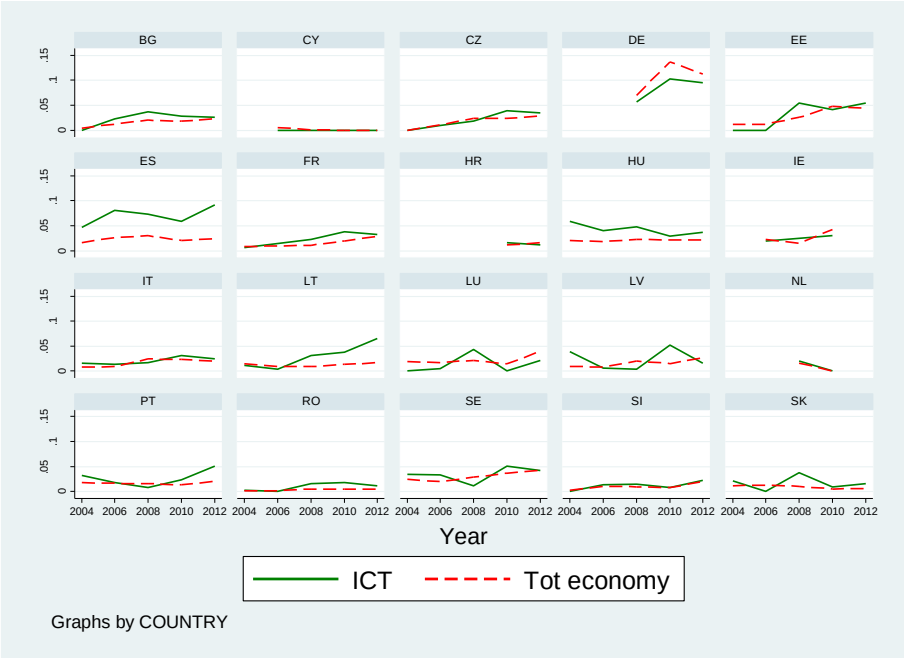
Source: Authors' estimation on CIS data

4.2 Ongoing or abandoned innovation activities

Figure 3 provides a less clear-cut picture on the difference between the ICT sector and the whole economy. Indeed, when looking at the share of aspiring innovators, the relatively better performance of ICT firms disappears. Exceptions are Lithuania, Spain and Hungary, where ICT firms tend to perform better than firms in the total economy. Interestingly, in Germany the share of aspiring innovators in the whole economy is higher than in the ICT sector (but the share of successful innovators in the ICT sector is higher than it is in the whole economy: see Figures 1 and 2).

Comparing Figure 3 to Figures 1 and 2, in most of the countries the share of aspiring innovators in the ICT sector is close to what it is in the whole economy. However, the ICT sector seems more successful in producing innovative outputs, suggesting higher efficiency in its innovation development.

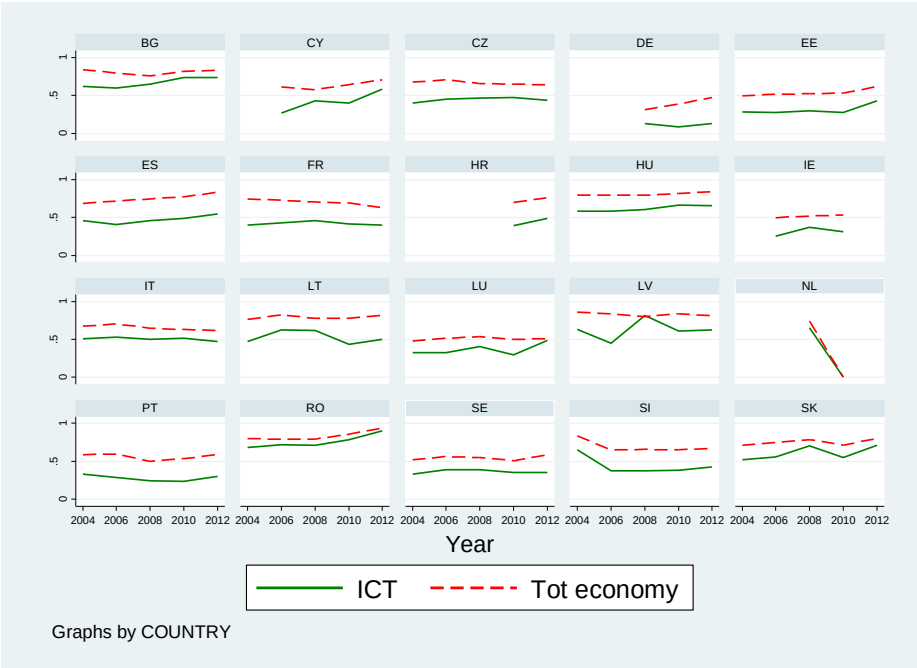
Figure 3: Share of aspiring innovative firms–ICT vs total economy



Source: Authors' calculation on CIS data

Finally, Figure 4 presents the share of firms that declare they do not undertake any product or process innovation. Here, as expected, the picture is completely reversed with a clear predominance of non-innovative firms in the whole economy over the ICT sector. The results of Figure 4 validate the consistency of firms' replies to the survey.

Figure 4: Share of non-innovative firms–ICT vs total economy



Source: Authors' calculation on CIS data

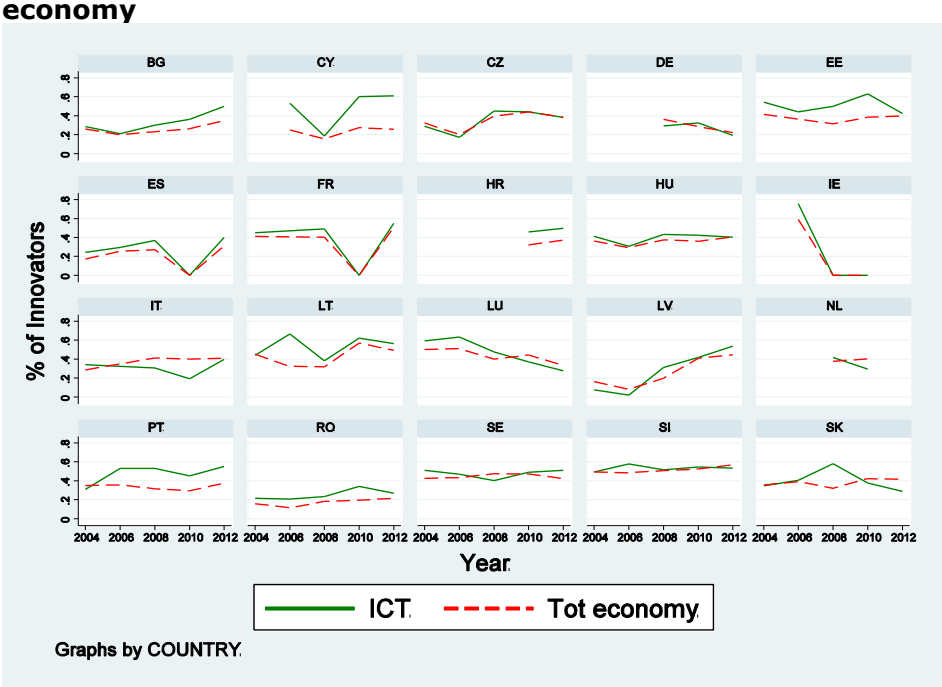
5 Complex indicators: results

In this section, we present the evidence on the complex indicators meant to capture modes of innovation. We focus on innovators that perform both product and process innovation (i.e. technological innovators). Within this broad group, we distinguish four different subgroups (as described in Section 3) based on two main parameters: a) whether the original innovation is "at least partially developed in-house" and b) whether the main market is domestic or international. For each of the four groups we compare the share of innovators in the ICT sector to the share in the whole economy, starting with the firms with the highest innovation intensity, as defined in Section 3.

5.1 International vs. domestic innovators

Fig 5 describes the share of technological innovators who sell principally on the international market (i.e. high international innovators). As shown in the graph, there are important variations between countries in the relative performance of ICT firms. In Bulgaria, Cyprus, Estonia, Spain, France, Croatia, Lithuania, Portugal and Romania the performance of firms in the ICT sector is steadily higher than the one of firms in the whole economy, while for the other countries the evidence is mixed, although generally in favour of ICT sector firms, with Italy and the Netherlands showing a relatively worse performance of the ICT sector vis a vis the whole economy (after 2006 in Italy and after 2008 in the Netherlands). In Slovakia the performance of ICT firms declines after 2008 and it is worse of that of the whole economy after 2010.

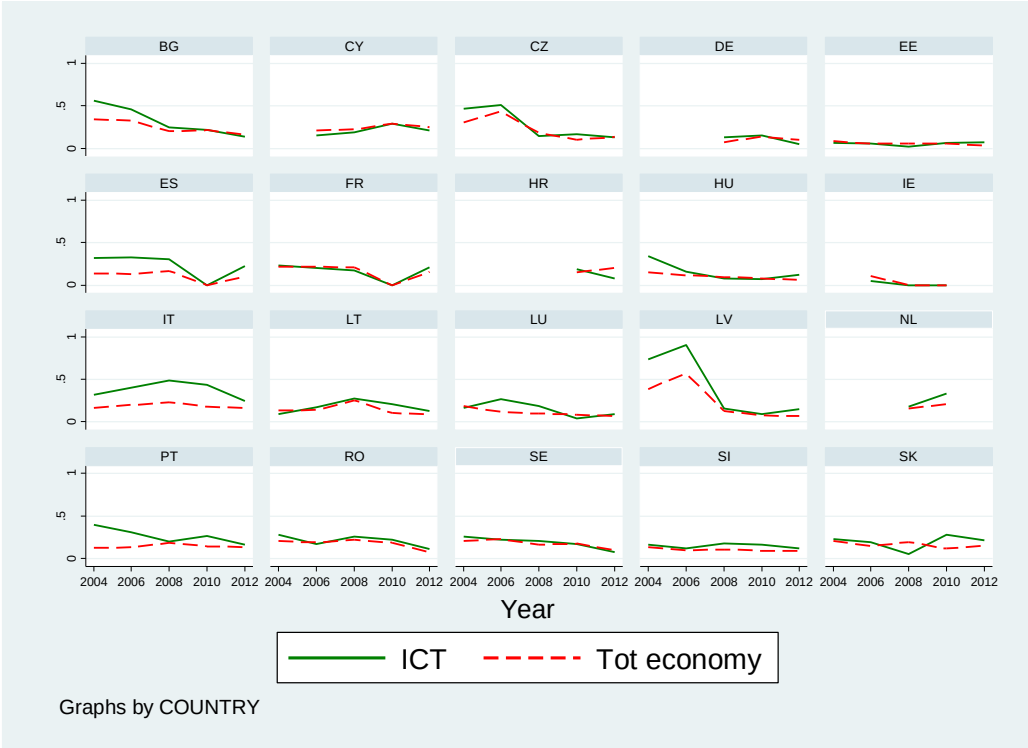
Figure 5: Share of international product and process innovators –ICT vs total economy



Source: Authors' calculation on CIS data

Figure 6 looks at the share of high-intensity innovative firms that operate only on domestic markets (i.e. high domestic innovators). Once again, it is difficult to establish a common trend for the ICT sector across countries. The ICT sector performs relatively better than the whole economy in Bulgaria, Spain, Italy, Latvia, the Netherlands and Slovenia, but this relative gain has declined over time in most of these countries. Interestingly, in Italy and the Netherlands, the share of high domestic innovators is consistently greater among ICT firms than it is in the whole economy (in Slovakia, ICT domestic innovators perform relatively better after 2010).

Figure 6: Share of domestic product and process innovators – ICT vs total economy



Source: Authors' calculation on CIS data

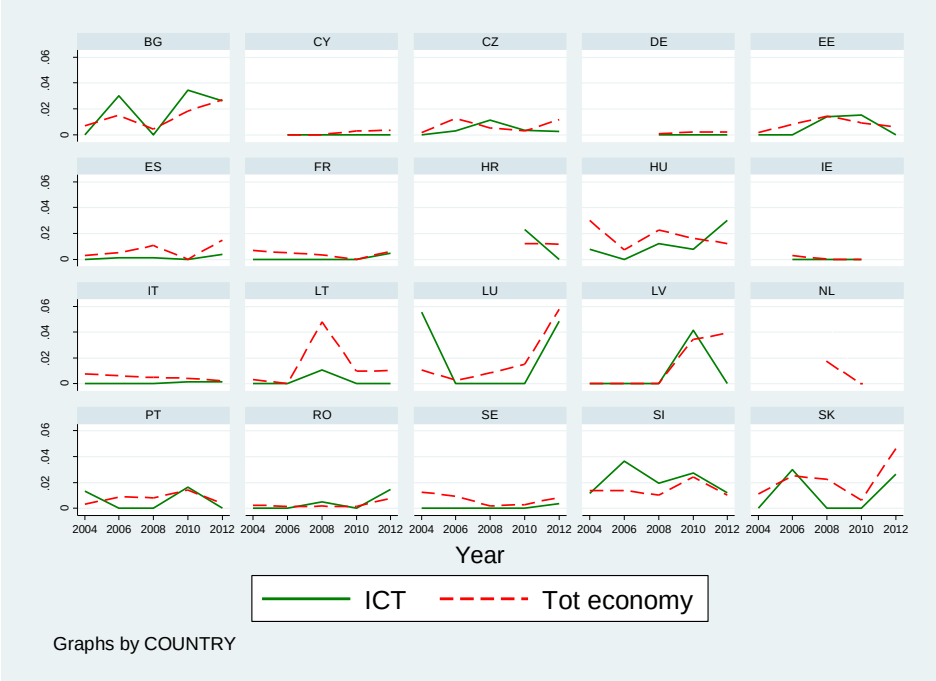
5.2 International vs. domestic modifiers

Figures 7 and 8 show the share of ICT and whole economy process and product innovators that innovate by modification (i.e. Modifiers) and sell either on the international market (Figure 7) or on the domestic market (Figure 8).

The data show country-year variations, but, overall, among both groups, the share of modifiers is on average greater in the whole economy than it is in the ICT sector. That is, at a lower level of "innovativeness", we cannot confirm that the ICT sector performs better (relative to the whole economy).

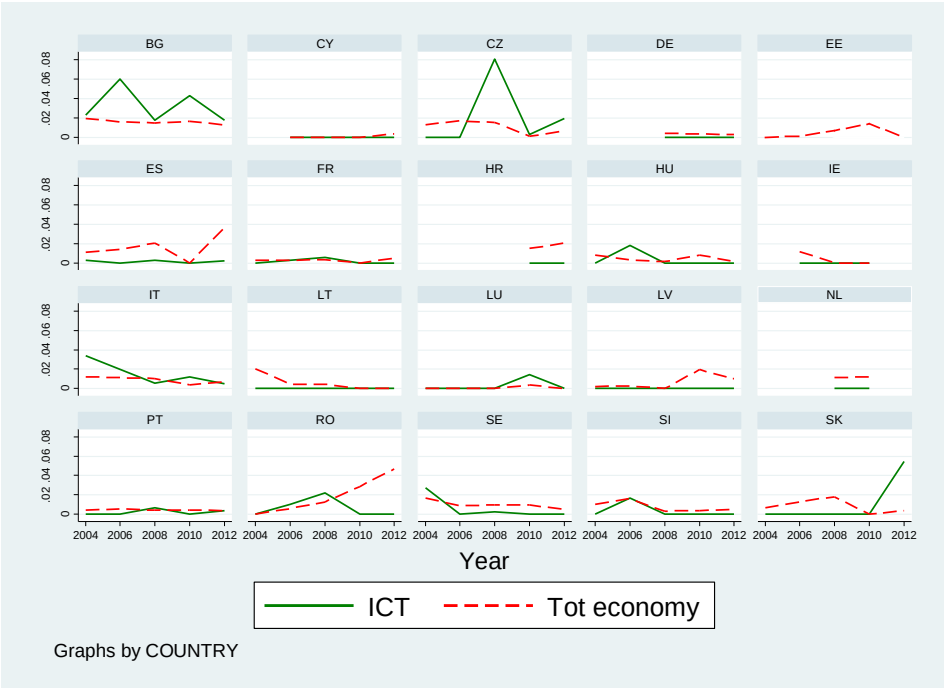
We also note that for some countries (Bulgaria, Lithuania, Luxembourg, Latvia, the Czech Republic and Slovakia), there are large year-to-year variations in the data for the ICT sector, possibly due to the reduced number of observations.

Figure 7: Share of international product and process modifiers – ICT vs total economy



Source: Authors' calculation on CIS data

Figure 8: Share of domestic product and process modifiers – ICT vs total economy



Source: Authors' calculation on CIS data

6 Characterizing ICT firms innovation

In this section, we try to provide a better understanding of the innovative behaviour of firms in both the ICT sector and the whole economy.

In Section 6.1, we consider R&D and non-R&D activities, comparing firms in the ICT sector with firms in the whole economy. Section 6.2 looks at public funding from the European Union Framework Programmes and, again, firms in the ICT sector are compared to firms in the whole economy.

In Sections 6.3, 6.4, 6.5 and 6.6 we look at ICT-producing firms only. We consider their drivers of competitiveness, cooperation patterns (types and location), knowledge sources for innovative activities and reported obstacles to innovation activity.

6.1 R&D vs non-R&D activities

Here, we characterize the likelihood of observing R&D and/or non-R&D activities among ICT innovative firms and we compare it to that observed among innovative firms in the whole economy. This comparison, which looks at innovation input activities among innovative firms, is interesting as it complements the comparison on innovation outputs presented in Sections 4 and 5.

Figure 9 shows the share of firms that invest in R&D activities (both in-house and external) among innovative[14] firms in the ICT sector compared to the share of firms investing in R&D activities among innovative firms within the whole economy. The figure shows that innovative firms in the ICT sector in all countries account for a larger share of R&D spending than the rest of the economy. This complements the finding that ICT firms tend to have higher-than-average R&D intensity[15].

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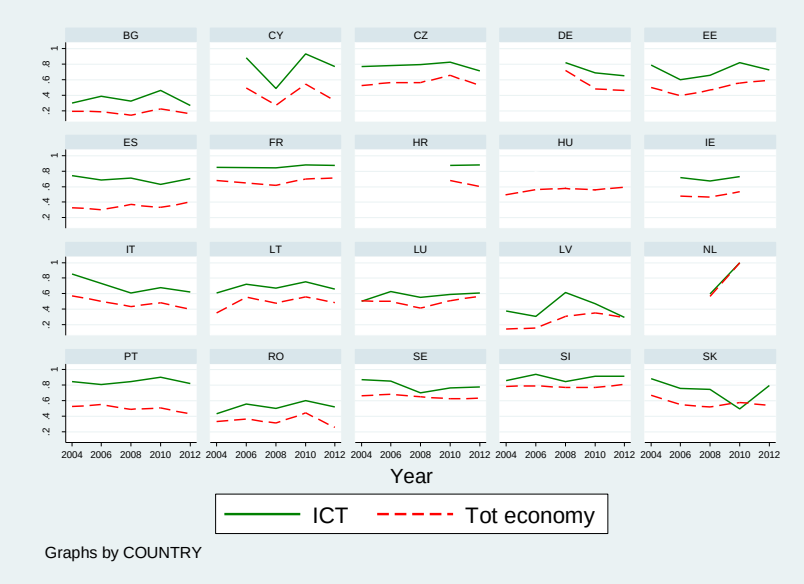
[14] Innovative firms are firms that introduced either product or process innovations or performed some innovation activities during the years covered by the CIS wave. In the CIS, the information on R&D and non-R&D activities is provided only for innovative firms.

[15] For further details on ICT R&D intensity: M. Mas & Fernandez de Guevara J. (2015) *The 2015 Predict report: An Analysis of ICT R&D in the EU and Beyond,* JRC Science and Policy Report, p.20 Fig.12. http://is.jrc.ec.europa.eu/pages/ISG/PREDICT/PREDICT2015/Report/BERD/overview.html

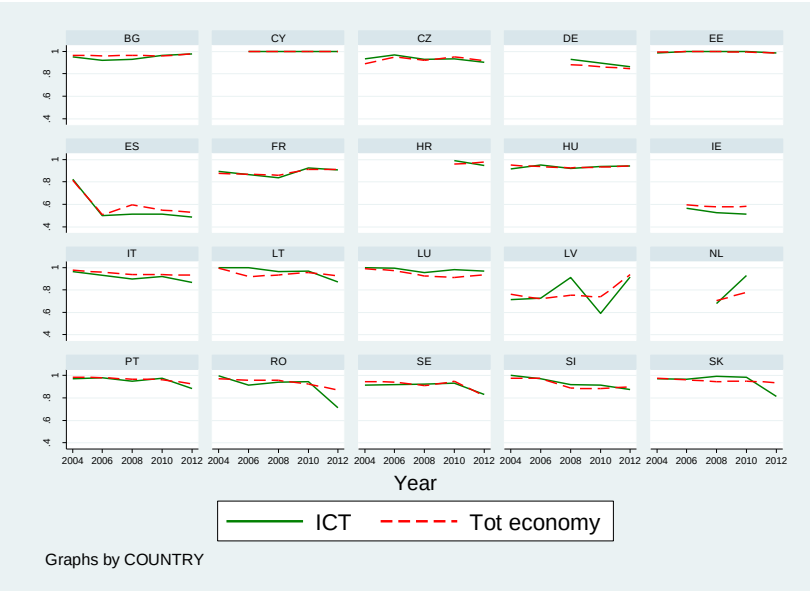
Figure 9: Share of firms investing in R&D – ICT vs total economy



Source: Authors' calculation on CIS data

However, when measuring innovation, aspects other than R&D should be included, such as spending on machinery and software, IP rights and spending on training for innovative activities (as defined in the Oslo Manual (OECD 2005)). Figure 10 describes the relative spending on innovative activities other than R&D for innovative ICT firms and for innovative firms in the whole economy. Differently from Figure 9, the share of innovative ICT firms investing in non R&D inputs does not differ very much from that of the innovative firms in the whole economy.

Figure 10: Share of firms investing in innovation activities other than R&D –ICT vs total economy



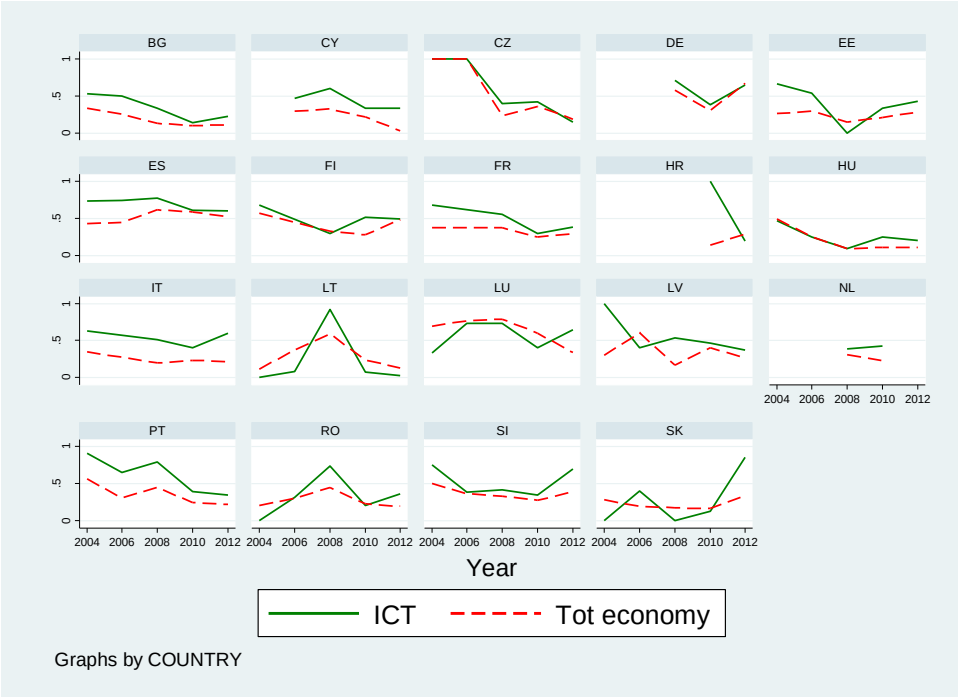
Source: Authors' calculation on CIS data

A comparison between Figure 9 and Figure 10 suggests that R&D may play an important role in determining the innovativeness of the ICT sector.

6.2 Funding by Framework Programmes

The development of innovation is both expensive and risky for a firm. An important determinant of the successful development of innovation is access to finance and/or public funding. The CIS reports information on the number of innovative firms that have been funded through European Union Framework Programmes (FP). The share of innovative FP-funded firms for both the ICT sector and the whole economy is shown in Figure 11, which shows that innovative ICT firms –on average- are more likely to receive FP funding than innovative firms in the whole economy. We also note wide variations between countries and interesting time profiles. For instance, France, Spain, Portugal and Italy, followed by Bulgaria and Cyprus, are the countries that have the highest average difference between the share of innovative ICT firms and innovative whole economy firms funded by FP programmes. However, we also note that this difference tended to be higher at the beginning of the period (2004) than it was at the end (2012). This is due to the fact that, for these countries (and for others as well), both the shares of innovative ICT and whole economy FP-funded firms declined during the time period 2004-2010. The shares of the former declined more than those of the latter. We also note that for some countries, 2010 was the year in which the share of both innovative ICT and whole economy FP-funded firms reached its lowest point (i.e. in Bulgaria, France, Germany, Italy). On the other hand, we also note that other countries, such as Slovakia or Romania, exhibit U-shaped or inversely U-shaped profiles for their shares of FP-funded firms.

Figure 11: Share of firms funded by FP funds – ICT vs total economy



Source: Authors' calculation on CIS data

6.3 Competitiveness drivers and the role of IPR

Figure 12 looks at the role of IPRs: patents, trademarks, registered design and copyright. Using 2012 as a reference, for each country and for each driver of competitiveness, we report the shares of innovative firms that responded to the following question: "How effective were the following methods for maintaining or increasing the competitiveness of product and process innovations introduced during 2010 to 2012[16]?" The possible answers are "High", "Medium", "Low" and "Not used". This means that, for instance, in Figure 12 (similar reasoning applies to Figure 13), for each country, the height of the blue bar over the "No" answer measures the share of innovative firms that answered that patents are not used in fostering the competitiveness of product and process innovations developed between 2010 and 2012 (analogous reasoning goes for the possible answers "Low", "Medium" and "High"). Very interestingly, and with almost no variation across the countries, the vast majority of innovative firms in the ICT sector declare that strategies based on the protection of IPRs are not used in increasing or maintaining the level of competitiveness of their innovations. This might have to do with either the underlying "economic irrelevance of IPR" for ICT-producing firms or, more likely, with the fact that the current institutional setting governing IPR reduces their relevance as a competitiveness driver for ICT firms.

[16] Note that only innovative firms were asked this question.

Figure 12: Competitiveness –ICT sector

Source: Authors' calculation on CIS data

In Figure 13, we report the results for the other IP protection strategies that affect the competitiveness of innovative firms, such as i) lead-time advantage, ii) complexity of the good or service, and iii) secrecy. Here the picture changes and a less clear-cut pattern emerges for innovative ICT firms in the different countries. For example, lead-time advantage is considered highly effective in Germany, Finland, Slovenia and Sweden but not in Bulgaria and Italy. Secrecy seems to matter more for innovative ICT firms in Romania, Germany, Finland and Slovenia, but it does not appear to be very important in Belgium, Italy or Estonia. Complexity of goods and services is considered to be the most effective strategy for competitiveness by Slovakian and Slovenian innovative ICT firms, while it is not commonly reported by Bulgarian, Italian and Luxembourg innovative ICT firms.

Figure 13: Competitiveness –ICT sector

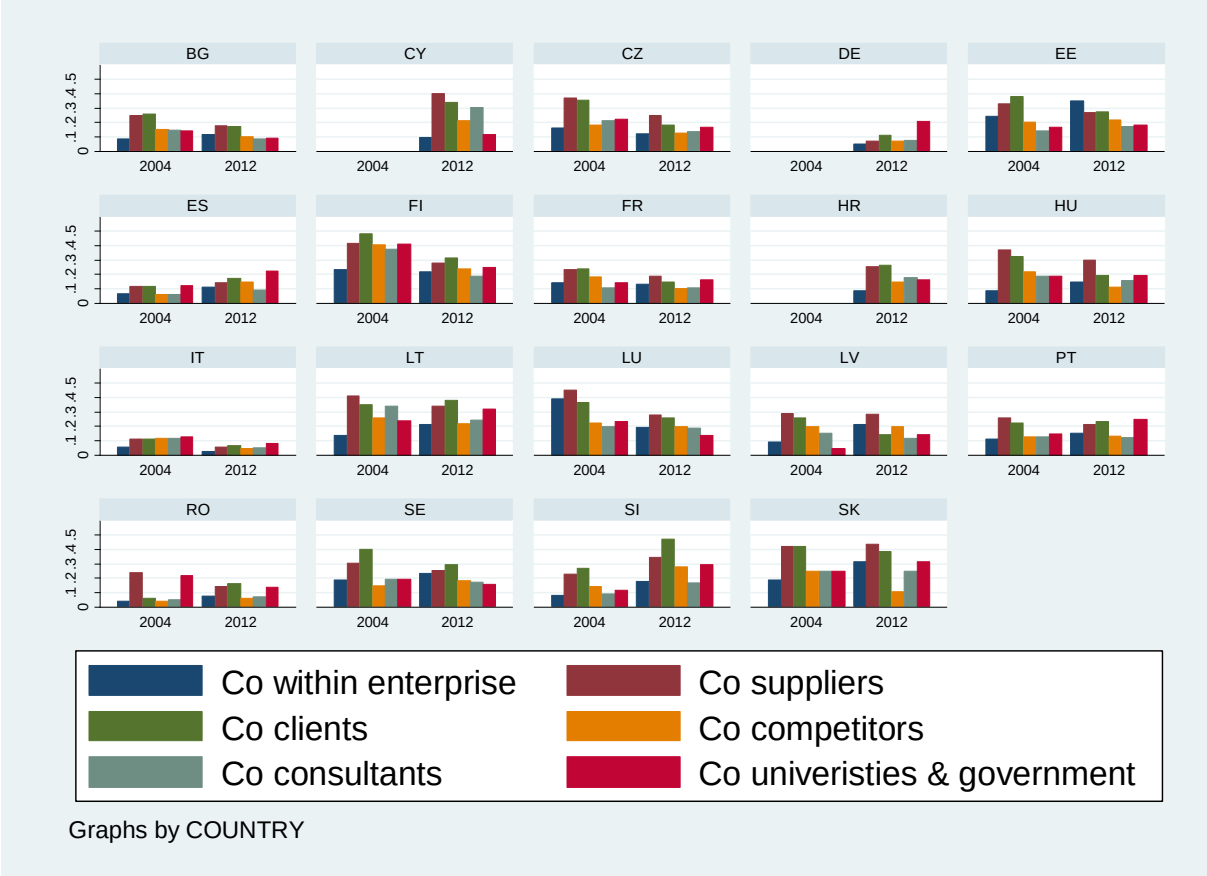
Source: Authors' calculation on CIS data

6.4 Cooperation

Figure 14 shows the type of cooperation partners that innovative ICT firms have, comparing for each country data for the initial (2004) and the last (2012) year available in the CIS panel. We have identified six different types of cooperation partners: i) cooperation internal to the enterprise group, ii) cooperation with suppliers, iii) cooperation with clients, iv) cooperation with competitors, v) cooperation with consultants and vi) cooperation with universities and government.

For almost all countries, the most frequent type of cooperation is cooperation with clients and suppliers (i.e. along the vertical chain), while cooperation with universities and government is quite diversified across countries (relatively higher values are reported for Spain, Finland, Germany, Lithuania, Portugal, Romania and Slovakia). There are no big differences in the choice of cooperation partners between the two CIS waves for 2004 and 2012. However, the share of innovative ICT firms which report cooperation activities –on average- is lower in 2012, with the exception of Slovenia. In 2012, innovative ICT firms in Spain, Portugal and Slovenia reported a considerable increase in their collaboration with government and universities.

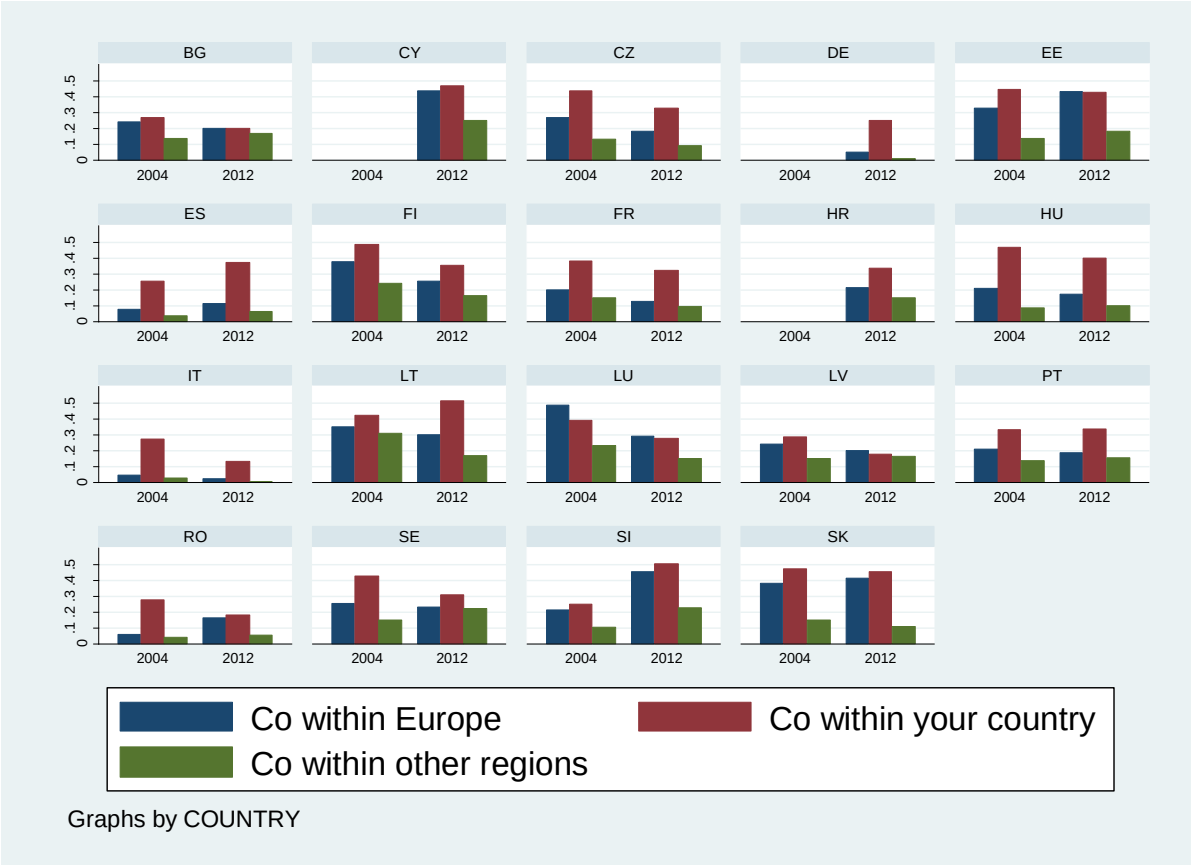
Figure 14: Type of cooperation partner – ICT sector



Source: Authors' calculation on CIS data

We also analysed the spatial distribution of ICT sector firms' cooperating partners, in order to understand whether innovative ICT firms cooperate mostly within their own country, within Europe or worldwide. The results are presented in Figure 15 and show that ICT firms cooperate mostly within their own countries or within Europe. Interestingly, when considering the time interval 2004-2012, the level of cooperation, in particular with other European ICT firms, increased in Estonia, Romania, Spain and Slovenia, while it decreased in the Czech Republic, Finland, France and Luxembourg. On the other hand, Italy shows a decrease in overall cooperation in the period 2004-2012, particularly as regards within-country cooperation.

Figure 15: **Cooperation partner by location – ICT sector**



Source: Authors' calculation on CIS data

6.5 Sources of information

Here we look at the knowledge sources that contributed to the creation or completion of innovation by ICT firms. The knowledge/information source could be classified as: i) internal, which includes all information from the enterprise group; ii) market source, which includes information from suppliers, clients, competitors and consultants; iii) education, which refers to information from universities and public research institutes, and iv) other sources, which includes information from conferences, scientific publications and professional associations. Figure 16 shows that in all countries innovative ICT firms consider market source and other sources as highly important, while education is generally viewed as less important, or not used at all. Equally, almost all countries consider internal information sources of medium importance except Bulgaria, Cyprus and Latvia where these sources are considered to be of medium-high importance.

Figure 16: Information source – ICT sector

Source: Authors' calculation on CIS data

6.6 Obstacles to innovation

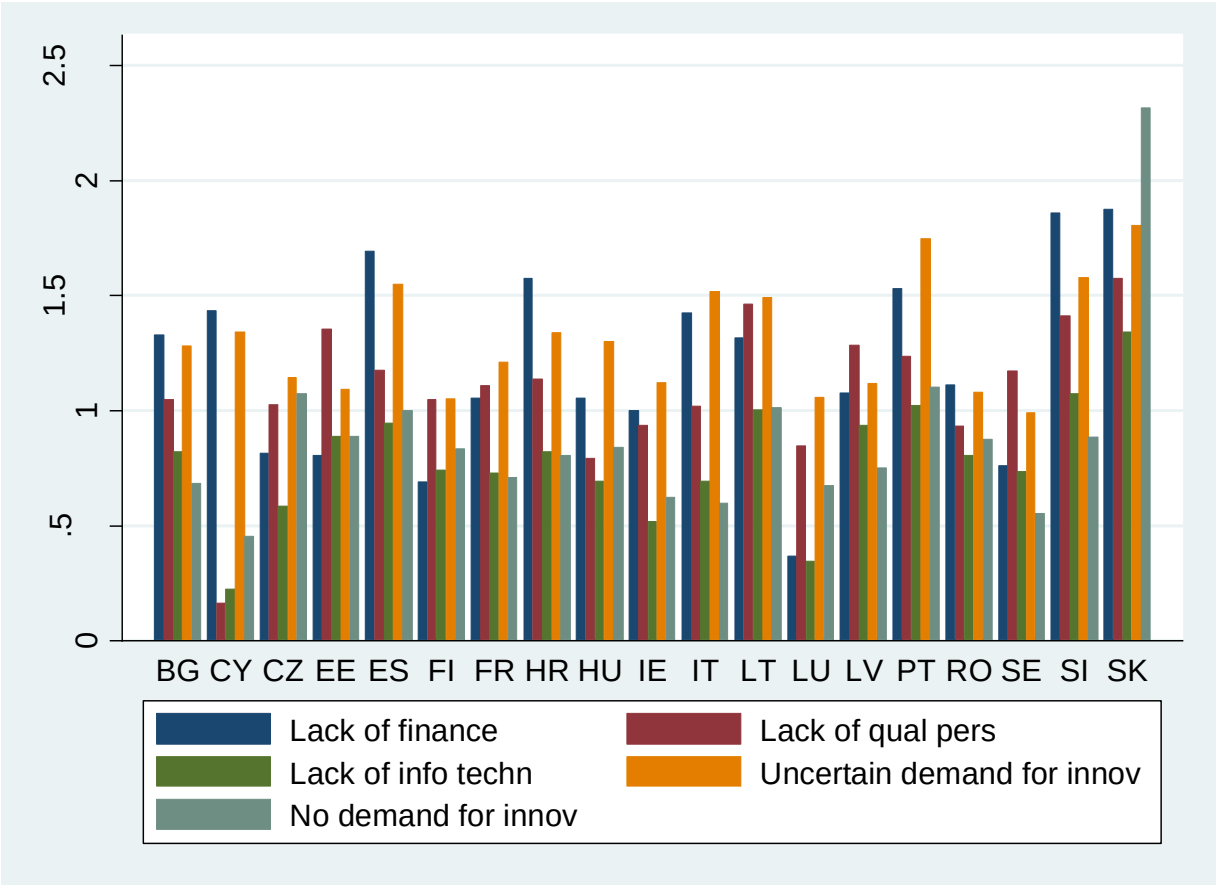
Finally, in Figure 17 we present an overview of what ICT firms perceive as major obstacles to fulfilling their innovation aspirations. The data presented in Figure 17 comes from the CIS 2010, which covers the years 2008-2010, and refers to the entire sample (i.e. not restricted to innovative firms). The survey categories the obstacles as "cost factors", "knowledge factors", "market factors" and "reasons not to innovate". Each of these categories is further divided according to more detailed descriptions of obstacles. For example "cost factors" encompasses: i) "lack of funds within your enterprise or group"; ii) "lack of finance from sources outside your enterprise" and iii)" innovation costs too high". We refer the reader to the CIS 2010 questionnaire for the full list[17]. The interviewees were asked to grade the importance of each obstacle as "*High*" (value of 3), "*Medium*" (value of 2), "*Low*" (value of 1) or "*Not experienced*" (value of 0). In Figure 16, we looked only at the obstacles that were most often cited in the responses

[17] See: http://ec.europa.eu/eurostat/documents/203647/203701/CIS_Survey_form_2010.pdf/b9f2c70e-0c46-4f82-abeb-c7661f1f2166

to the survey questionnaire and we computed the average over the possible answer values. Therefore, Figure 17 reports by country the degree of importance of each obstacle. That is, for example, in Bulgaria "*lack of finance*" is the most important obstacle (i.e. the tallest bar on the bar graph for that country) followed by "*uncertain demand for innovation*" and so on.

For most of the countries, the major obstacles are lack of finance and uncertainty of demand for innovation, followed by lack of qualified personnel. In particular, Bulgaria, Cyprus, Spain, Croatia, Romania and Slovenia report "*lack of finance*" as the most important obstacle. "*Uncertain demand for innovation*" is the top obstacle to innovation in the Czech Republic, Finland, France, Hungary, Ireland, Italy, Lithuania, Luxembourg and Portugal. "*Absence of demand for innovation*" is seen as the biggest obstacle to innovation in Slovakia, whereas in the remaining countries (i.e. Estonia, Latvia and Sweden) it is lack of qualified personnel.

Figure 17: Selected obstacles – ICT sector, 2010



Source: Authors' calculation on CIS data

7 Conclusions

The aim of this report is to shed some light on the innovative behaviour of firms, particularly those in the ICT sector. We created a panel dataset and matched the information collected by different CIS waves from 2004 up to 2012. We then investigated the major innovation patterns that emerged, comparing the ICT sector to the whole economy.

The main findings show that, in general, firms in the ICT sector tend to innovate more with respect to the economy as a whole: both the shares of innovators and technological innovators are consistently higher in the ICT sector than they are in the economy as a whole. Moreover, the ICT sector has a larger share of innovative firms performing R&D and a larger share of Framework Programme-funded innovative firms.

In order to provide a deeper understanding of the modes of innovation adopted by ICT-producing firms, we also computed some complex indicators that allowed us to categorise innovators in four groups, according to the intensity of their innovation activities: high international innovators, high domestic innovators, intermediate international innovators and intermediate domestic innovators. In our definition, we take into account both the in-house development of the original innovation and the market in which they mainly operate (i.e. international or domestic). High innovators develop at least part of the original innovation in-house. Intermediate innovators, on the other hand, use innovations created somewhere else, which they may modify internally. Our findings show that the share of high innovators in the ICT sector is larger than it is in the economy as a whole. However, the share of intermediate innovators is higher in the whole economy than it is in the ICT sector. We also find that in the ICT sector, the share of high innovators is larger than the share of intermediate innovators (i.e. modifiers). This leads us to conclude that overall, firms in the ICT sector are more innovative than firms in the economy as a whole. Not only are they more likely to perform R&D, but they are also more likely to develop in-house product and process innovations which are then sold on international markets.

When focusing on the ICT sector, innovative firms tend to cooperate in their innovative activity, particularly with clients and suppliers. This cooperation is mainly concentrated within their national borders or within Europe. The major source of information for innovative project creation or completion comes from the market and scientific publications; while direct cooperation with universities or public research institute is quite diversified across countries.

Quite surprisingly, ICT innovative firms do not mention IPR rights as an important competitive advantage in analyses of the drivers and barriers to innovation. They do,

however, perceive lack of finance, uncertainty of the demand for innovative products and lack of qualified personnel as strong barriers to the uptake of innovation activities.

Future research could improve our understanding of how policies could eliminate or reduce the most important barriers to ICT innovation (in particular, financing and human capital). We also think that a deeper understanding of the role of IPRs (and their reform) is urgently needed.

References

Arundel, A. and H. Hollanders (2005), *EXIS: An Exploratory Approach to Innovation Scoreboards*, Brussels: European Commission, DG Enterprise, 2005.

Frenz, M. and R. Lambert (2012), *Mixed Modes of Innovation: An Empiric Approach to Capturing Firms' Innovation Behaviour*, OECD Science, Technology and Industry Working Papers, 2012/06, OECD Publishing. http://dx.doi.org/10.1787/5k8x6l0bp3bp-en

Hollanders, H. (2008), *Strategic innovators drive innovation performance at the sector level: A sectoral analysis of innovation modes,* Europe Innova Innovation Watch. Brussels: European Commission, DG Entrprise, 2008.

OECD (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264013100-en

OECD (2009), *Innovation in Firms: A Microeconomic Perspective*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/9789264056213-en

M. Mas, Robledo, J.C. and Pérez J. (2012), *ICT Sector Definition Transition from NACE Rev. 1.1 to NACE Rev. 2,* JRC Technical Report, ISBN 978-92-79-28089-4 (pdf): http://ftp.jrc.es/EURdoc/JRC77364.pdf

M. Mas and Fernandez de Guevara J. (2015), *The 2015 Predict report: An Analysis of ICT R&D in the EU and Beyond,* JRC Science and Policy Report, p.20 Fig.12. Ed: De Prato G. and Rohman I., ISBN 978-92-79-52698-5 (pdf): http://is.jrc.ec.europa.eu/pages/ISG/PREDICT/PREDICT2015/Report/BERD/overview.html

Annex

List of NACE Rev. 1.1 ICT Sub-sectors:

NACE rev. 1.1	Description
	ICT Manufacturing sub-sectors
30	IT Equipment
32	Components, Telecom and Multimedia Equipment
33	Measurement Instruments
	ICT Services sub-sectors
642	Telecommunication services
72	Computer Services and Software

List of NACE Rev. 2 ICT Sub-sectors:

NACE rev. 1.1	Description
	ICT Manufacturing sub-sectors
261	Manufacture of electronic components and boards
262	Manufacture of computers and peripheral equipment
263	Manufacture of communication equipment
264	Manufacture of consumer electronics
268	Manufacture of magnetic and optical media
	ICT Services sub-sectors
4651	Wholesale of computers, computer peripheral equipment and software
4652	Wholesale of electronic and telecommunications equipment and parts
5820	Software publishing
61	Telecommunications
62	Computer programming, consultancy and related activities
631	Data processing, hosting and related activities; web portals
951	Repair of computers and communication equipment

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LF-NA-27986-EN-N

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doi:10.2791/297083

ISBN 978-92-79-59751-0