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Incentivising Innovation and Adoption of ICT: ICT Innovation Voucher Programmes

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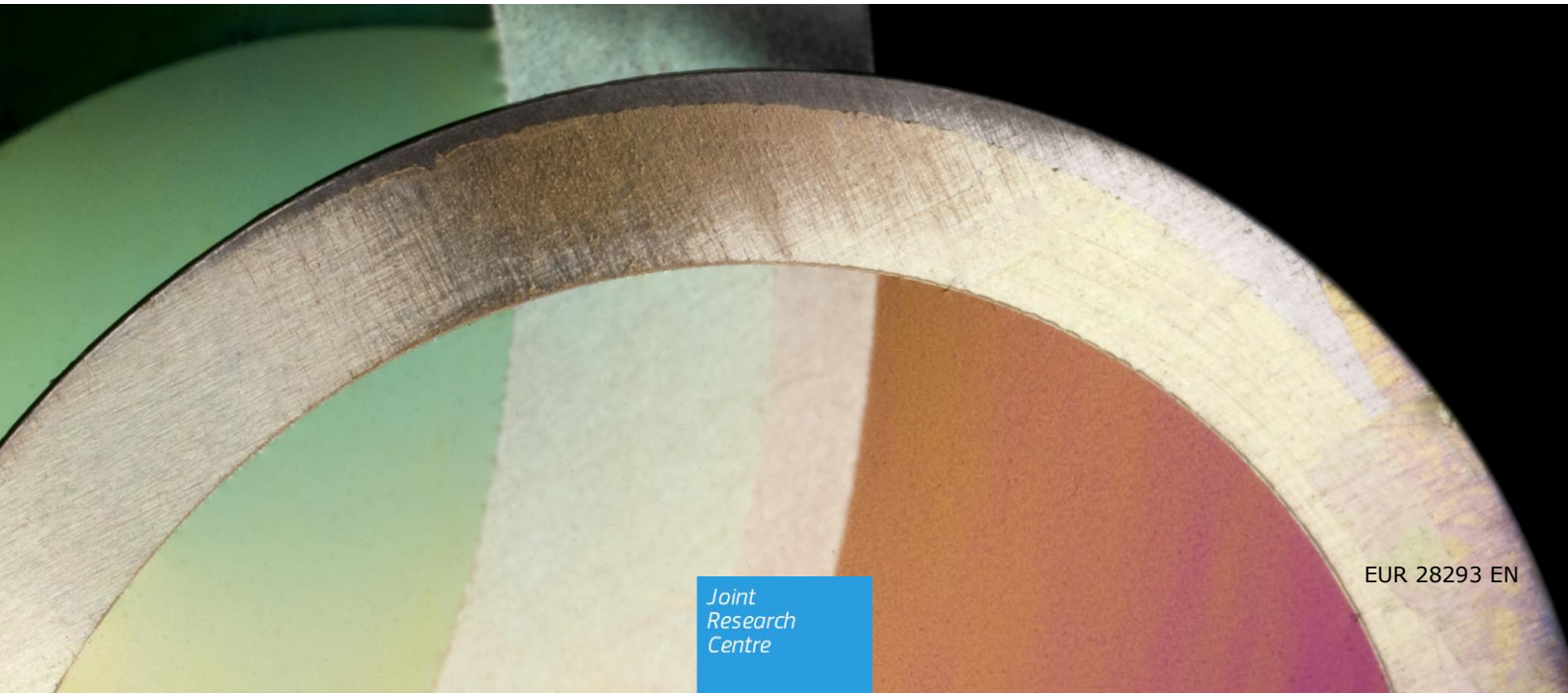

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Abstract
This report analyses ICT Innovation vouchers and provides insights on how these instruments could be used to support small- and medium-sized enterprises (SMEs) in developing and adopting information communication technology (ICT) and digital innovation in order to enhance their competitiveness and growth. This report suggests that the effectiveness of ICT innovation voucher programmes is affected by the choices made by the government that grants them. They should be grounded on a preliminary analysis of the needs of SMEs in the region/area considered. In particular, as regards the ICT-based innovation and digital needs of SMEs, it would be useful to map the actual 'level' of ICT adoption and diffusion among local firms (SMEs in particular). This would provide a better understanding of the ICT services and applications that could improve firms' competitiveness and growth, especially by stimulating product, process, organisational and marketing innovation. By defining the firms' needs and the goals of the programme, this preliminary analysis could also highlight the specific competences required from actors – the "Knowledge Service Providers" (KSPs), which supply and develop the ICT applications supported by the ICT innovation voucher programme.
The report also discusses how to implement a voucher programme, and examines best practice. Indicators for additionality (i.e. input, output and behavioural) and their information needs are also illustrated. In addition, we discuss how to perform a counterfactual analysis as part of the impact evaluation of an ICT innovation voucher programme.

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Executive Summary

This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift[1] (EURIPIDIS), jointly launched in 2013 by the Joint Research Centre (JRC) and the Directorate General for Communications Networks, Content and Technology of the European Commission (DG CONNECT) of the European Commission. The EURIPIDIS project aims to improve understanding of innovation in the ICT sector and ICT-enabled innovation in the rest of the economy.

This report is part of the EURIPIDIS project, and aims to get a clearer picture of how to help small- and medium-sized enterprises (SMEs) to develop and adopt information communication technology (ICT) and digital innovation and thus enhance their competitiveness and growth. This report presents some tentative ideas on how to achieve this goal, specifically through ICT and digital innovation voucher programmes. If properly designed and managed, voucher programmes can directly provide firms with incentives to put maximum effort into innovating and/or adopting innovations.

Diseconomies of scale and limited autonomy, a propensity not to take risks, highly centralised decision-making processes and limited geographical interactions are elements which characterise the production and business activities of SMEs. Moreover, market failures such as liquidity constraints and limited access to credit, and factors such as information constraints and unwillingness to take risks, affect SMEs more than they do large firms. Finally, certain features of ICT investments could have specific implications for SMEs; that is, network and lock-in effects may mean that SMEs have few incentives to adopt ICT and digital innovation. All these elements are discussed in detail in this report, which provides a rationale for an appropriately-designed ICT innovation voucher programme to encourage SMEs to invest in and/or adopt ICT and digital innovations. However, the question of how to design an effective voucher programme remains.

This report presents the common steps for granting ICT vouchers (see Box 1, *Common steps in ICT innovation voucher implementation*), and it examines best practices. Indicators for additionality (i.e. input, output and behavioural; see Box 2, *Examples of indicators to evaluate additionality*). Their information needs are also illustrated (see Box 3, *Examples of specific questions to address behavioural additionality; Box 4, Examples of questions for the global assessment of behavioural additionality*). In addition, in order to evaluate a voucher's impact, we discuss how to perform a counterfactual analysis for an ICT innovation voucher programme.

This report suggests that the effectiveness of an ICT innovation voucher programme is affected by the choices made by the government that implements it. These choices should be based on a preliminary analysis of the needs of SMEs in the region/area considered. In particular, as regards the ICT-based innovation and digital needs of SMEs, it would be useful to map the actual 'level' of ICT adoption and diffusion among local firms (SMEs in particular). This would allow a better understanding of the ICT services and applications that could improve firms' competitiveness and growth, especially by stimulating product, process, organisational and marketing innovation. By defining firms' needs and the goals of the programme, this preliminary analysis can also highlight the specific competences required from actors: i.e. the "Knowledge Service Providers" (KSPs) which supply and develop the ICT applications supported by a particular ICT innovation voucher programme.

The relevant options available when designing an ICT innovation voucher programme have to be evaluated in depth to increase the efficacy and penetration of these

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

incentives. First of all, the delivery agency should define the voucher programme's target(s), budget and timing, to be coordinated along with other – potential or already operative - public support for ICT and digital innovations. Moreover, the voucher design and the information needs at different stages deserve particular attention. Similarly, when managing an ICT innovation voucher programme, the information flows among the actors involved (i.e. the delivery agency, the potential applicants, the vouchers' recipients and the KSPs) are relevant as – when properly designed - they can determine the success of the programme itself. In this perspective, the delivery agency could also consider running a pilot programme.

Second, advertising for the voucher programme should reach potential applicants effectively and provide information about eligibility, the selection process, and the amount of resources granted and conditions. As the adoption of ICT is often characterised by network and lock-in effects, careful attention should be devoted to the channels used by the delivery agency to spread the information on the ICT innovation voucher scheme. It should be guaranteed that a minimum number of SMEs participate in the programme. Examples of best practice show that, apart from the usual advertisement channels (i.e. press, social media, e-mail flyers), some 'advanced measures' could be developed, for example:

i) forums to connect researchers, start-ups and SMEs, which could potentially be involved in the programme; and

ii) forums to present to these agents each activity supported by the voucher programme.

On the one hand, the delivery agency could spread the call for applications through press advertisements, e-mail flyers and social media promotions. On the other hand, the knowledge and service providers involved in the voucher programme could undertake their own marketing of the incentives provided, using their institutional channels, without charging costs to the voucher programme itself.

iii) knowledge and service providers (KSPs) should be selected according to the target(s) of the voucher programme. In particular, the delivery agency could opt to:

I. limit the choice to KSPs that have been pre-approved and are members of a pre-defined list,
II. let SMEs freely propose KSPs, which fulfil minimal requirements, or
III. let SMEs freely propose KSPs, without any minimal requirement.

In the first option (i), the delivery agency should run an ex-ante screening to select the KSPs to be included in the voucher programme. E-platforms and consulting activities could be developed to provide SMEs with information about the pre-selected KSPs and instruct the SMEs' choice.

Finally, when the project supported by the voucher is completed, the delivery agency pays the voucher either to the supported firm, in which case the voucher is then transferred to the KSPs, or ii) directly to the KSPs. This choice about voucher payment should be taken according to the reporting requirements by the firm and/or by the KSPs that need to be collected to assess the programme.

In this report, we also discuss assessment carried out both during the voucher programmes and on their completion, along with the information these assessments require. Assessment during the programme could be done by collecting information through interviews with the SME and KSP managers receiving the support, in order to test for critical elements in the voucher's implementation. Changes/improvements in the ongoing voucher programme are thus likely to be adopted following results from this first evaluation.

As for the final programme assessment, examples of indicators for input, output and behavioural additionality of the voucher programme are discussed in this report, along

with the information required. These indicators can help us to assess a firm's performance before and after receiving the support, especially in terms of productivity, output and employment. They can also help us to identify the strategies and organisational and business models adopted, as an effect of the vouchers received.

Further evaluation of the vouchers' impact could be conducted by comparing firms that received the support (i.e. 'treated' firms), with firms that did not receive support. In this way, a 'counterfactual' impact analysis could be developed to estimate the difference between the value of the performance variable observed in the treated firm and the value that the same variable would have had, had the firm not received the voucher (i.e. in the counterfactual state). However, finding the appropriate control group is probably the most difficult task when evaluating an ICT innovation voucher. The delivery agency could try to collect relevant information i) from firms that are eligible for the support but did not receive the voucher or, alternatively, ii) from firms that received the voucher and were analysed before receiving it. Note that the delivery agency's ability to define/estimate the counterfactual will determine the robustness of the impact evaluation analysis. This counterfactual would work better if it was defined from the very first stage of the voucher programme design.

As discussions in this report show, the effectiveness of ICT innovation vouchers may very much depend on the choices made by the authority that grants them. This is especially true with regard to certain elements of the programme. In other words, this is a case in which 'the devil is in the detail'. The effect of these choices would be clearer if an impact evaluation of ICT innovation voucher programmes were carefully conducted, and the results were made public. Deeper consideration regarding all the relevant options available when designing an ICT innovation voucher programme, along with what we have learned from other public support for innovation, could greatly increase the effectiveness of these incentives.

'… there are two distinct research activities: the activity of turning up ideas and the activity of turning the ideas into innovations. These are assumed to take place in two sectors, loosely called universities and firms. Universities (and other public laboratories) are mainly charged with producing knowledge, interpreted here as a flow of ideas or investment opportunities. Firms commercialize the ideas.'

Suzanne Scotchmer, 2011, *Ideas and Innovations: Which Should Be Subsidized?*

1. Introduction

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 the JRC 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.

Within the EURIPIDIS project, the aim of this report is to get a clearer picture of how to support small- and medium-sized enterprises (SMEs) to develop and adopt information communication technology (ICT) and digital innovation in order to enhance their competitiveness and growth.

Investments in the development and adoption of ICTs and digital innovations represent a global challenge for governments as both play key roles in increasing productivity. They underpin industrial competitiveness and (at least potentially) address new solutions for environmental and societal challenges. This is clearly stated in the Digital Agenda, one of the seven pillars of the Europe 2020 Strategy which aims to fully exploit the potential of ICT in fostering innovation, sustainable and inclusive growth and progress.[3] These goals are also confirmed in the European Union's Digital Single Market (DSM) Strategy.[4]

The advantages for businesses that invest and adopt ICT and digital products/services are not confined to productivity gains or the reduction of co-ordination and transaction costs. Digitalisation for firms can enlarge the size of their potential markets and offer new opportunities for growth. It can thus exploit efficiency gains in conjunction with employment growth. The recent literature on SMEs has highlighted that ICT adoption offers them important opportunities to attain increased business competitiveness and enhanced profitability (Aragón-Sanchez and Sanchez-Martin, 2005; Jones et al., 2014; Simmons et al., 2011) by improving the efficiency and effectiveness of their business processes. However, digitalisation also represents a challenge for the existing organisational and business models of most SMEs, since it provides them with new tools/approaches to work with, such as the following:

- Cloud-based accounting services, such as *Wave Accounting*, *FreshBooks, Zoho Books* and *QuickBooks*, which can be accessed on various platforms and synchronised across devices;

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

3 Regarding the EC May 2015 Communication, see http://ec.europa.eu/priorities/digital-single-market/index_en.htm.

4 Regarding the EU official website, see https://ec.europa.eu/digital-agenda/en/digital-single-market.

- Applications that allow the sharing of files and ideas, such as *Evernote*, *Dropbox*, *Trello*, *Basecamp* and *Google Drive*, which can make communication with remote staff (through *Skype* and *Viber*) much easier;

- Platforms that support online searches for human capital, such as *Upwork* (formerly *oDesk*), *Elance*, *Raket.ph* and *Freelancer.ph;*

- Search engine optimisation, an Internet marketing practice for online businesses to increase their website's visibility on search engine results pages;

- Platforms that support brand awareness and customer relations, such as *Facebook, Twitter, Pinterest, YouTube, Google+, LinkedIn, Reddit, Tumblr* and *Instagram.*

These new tools permit firms to exploit new forms of interactions. Chan et al. (2012) argue that SMEs organise their e-collaboration in stages (i.e. evaluation, adoption and routinisation). They point out that factors such as information sharing, market trends, competition intensity, trust and technological readiness affect the diffusion of e-collaboration differently.

Furthermore, the needs and potentials of SMEs are not uniform across the EU regions, and the successful design and implementation of delivery mechanisms for financial and non-financial support services to SMEs' innovation and ICT adoption is key to their competitiveness and growth (see the *EU Report on Regional Policies for Smart Growth of SMEs*, 2013). Potential gains from ICT and digital innovation will also benefit the demand side of the market. More specifically, businesses would be able to supply and share their products, services and 'bright ideas' across a single digital market so that consumers can benefit from the best available content, sales and services without being geo-blocked.

The results from theoretical and empirical literature demonstrate that market processes (i.e. market power, networking and systemic failures) often do not lead firms to make optimal investments in innovation (Scotchmer, 2004). Specifically referring to SMEs' investments in ICT and digital innovation, the elements that lead to non-optimal efforts can be summarised as follows:

i) Indivisibility of ICT investments: the scale of innovation activities and related investments could represent a high sunk cost relative to a firm's size;

ii) Presence of network and lock-in effects, which affect the value SMEs obtain from ICT adoption;[5]

iii) Limited information on the characteristics (and hence, of their potential value) of ICT capital and ICT applications;

iv) Uncertainty related to the outcome and value of investments in ICT capital and ICT applications;

v) Market failure in the financial system to support investments in ICT capital and ICT applications[6] (i.e. information asymmetry in innovation investments[7]).

[5] In the context of enterprise resource planning (ERP) software, for example, network effects are at play. That is, the more such ERP software is adopted and becomes a standard for the industry, the more other firms will want to adopt it as well. This is to ensure that their software is compatible with that of other network users. However, after adoption, firms might find themselves locked-in; this occurs when it is costly to switch to other competing products/services. This effect can create larger inertia in ICTs' initial adoption by SMEs, given that, for these firms (considering their budget constraints) the switch would be more expensive than that for large firms.

For these reasons, public funding to help SMEs adopt ICT and digital innovation is a common practice in many countries. Examples of countries that have used similar practices include Canada (see the ITAC Report (2010) for surveys and discussions);[8] the United States (seethe U.S. ICT R&D Policy Report);[9] and the European Union (see the Bordwiis Report and the European Commission (2013c)).[10] Note that the set of policies used have changed over time. In fact, after it became clear that limited tax offsets do not deliver the expected changes in ICT investments, the need for a broader range of complementary policies emerged, i.e. a policy mix that supports business innovation (OECD, 2011; OECD, 2010). These interdependent policies may include direct assistance targeted towards technology adoption by SMEs and the design of effective ICT operational and business strategies for the companies (i.e. voucher programmes).

The rest of this report is as follows. Section 2 discusses the rationale for ICT innovation voucher programmes as subsidies specifically for SMEs[11] and compatible with the EU state aid regulation. Section 3 briefly recalls the steps taken in the implementation of an ICT innovation voucher programme. Finally, Section 4 includes an in-depth discussion on how specific features (i.e. voucher amount, recipient screening, pre-selection of KSPs by the delivery agency etc.) can affect the outcome of ICT vouchers. In addition, we discuss how impact analysis of ICT innovation vouchers could be developed and examine the related informational needs.

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6 See Hall and Lerner (2009) for a survey on financial market characteristics that lead to underinvestment in innovation.

7 Arrow (1962) argued that the sale of knowledge is affected by a fundamental asymmetry in information between the buyer and the seller. The former has less information than the latter, and the gap can often be reduced at the cost of the seller who gives away his/her knowledge free of charge.

8 See http://www.itac.ca/uploads/news/Leveraging_ICT_Adoption_-_January_2010.pdf.

9 See Andersen and Coeffly, 2011.

10 See http://www.bordwiis.eu/data/files/Bordwiis-report-Regional_ICT_Policies_final.pdf and http://www.technopolis-group.com/wp-content/uploads/2014/05/1720_Lessons-from-ten-years-of-innovation-policies-.pdf

11 In what follows, if not differently specified, we will refer to SMEs as including micro-enterprises as well.

2. Rationale for economic incentives in the form of ICT vouchers to SMEs

Voucher programmes usually consist of economic incentives granted by local, regional and national governments to private firms to address pre-defined goals. Public support to private firms is a controversial issue, since the balance between 'positive' and 'negative' effects, which ultimately affect total welfare, are often difficult to assess given the lack of data for building coherent counterfactuals for their analysis. Economic literature has highlighted the conditions under which public subsidies could improve welfare. In particular, the literature has focused on market failures affecting the R&D phase of the innovation process, especially since the seminal paper by Arrow (1962).[12] Similarly, there is abundant literature which discusses specifically how ICT adoption can lead to improvements in productivity, efficiency and innovation.[13] Conversely, almost no scientific literature can be found on how innovation vouchers can be used to stimulate the adoption of new technologies, which can generate opportunities for process, product, organisational and marketing innovation.[14]

Thus, the first point of this report is to discuss why SMEs might not choose to invest in the optimal number of ICT systems and applications. When focusing on this question, the following distinctive features of SMEs need to be taken into consideration:

i) SMEs suffer from dis-economies of scale and limited autonomy, as they often have reduced resources (Beck et al., 2005). They usually have low capitalisation and, as a result, cash flow problems, and they are often price-takers on both sides of the market by buying and selling small quantities (Davison and Dutia, 1991). This latter feature also means that SMEs have higher unit costs than larger firms (Curran and Blackburn, 2001).

ii) SMEs are usually risk-averse, since a large part of their capital is often from their owners, unlike larger firms, whose managers often have no direct (or restricted) stake in the financial success of the firm (Wiklund et al., 2005). Moreover, SMEs' capacity to take economic risks and invest in long-term objectives is limited, given their reduced resources and access to the credit market (Beck et al., 2005). SMEs' risk-averse attitude can negatively affect their adoption of new technologies, as compared with larger firms (see discussion below).

iii) SMEs are characterised by a highly centralised decision-making process, and the same people/department often carry out multiple tasks and functions (i.e. administrative tasks, business decisions etc.). This aspect of their management often results in informal decision-making, i.e. decisions about outsourcing/in-house productions are adopted without formal planning and control procedures (Boohalis, 1996). As a result, small firms often have a vague accounting system. This, combined with a highly centralised decision-making process, could result in a weak incentive to adopt new technologies (Nayak and Greenfield, 1994). More recently, Cosh et al. (2012) empirically investigated a large sample of SMEs in the United Kingdom and highlighted the fact that a decentralised structure (along with written and formal plans) supports SMEs' ability to innovate. These authors also found that younger SMEs are more innovative than older ones in the high-technology sectors, whereas they found very few differences between these two types of SMEs in the low-technology sectors.

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[12] For a survey on empirical investigations over the past five decades, see Zúñiga-Vicente et al. (2014).

[13] For a review, see Biagi (2013).

[14] This corresponds to the notion of embodied technological change.

iv) SMEs often have limited geographical interactions: their suppliers, customers and employees typically come from the same area as they do. SMEs' geographical clusters are well documented in several industries and countries (Chiarvesio et al., 2004, among others). Their local operations also rely on strong ties to networks of families, communities and kinship. These strong, informal ties can give rise to both lock-in effects and business trust through repeated interactions (Bennett and Robson, 2004). The incentives for SMEs to progressively open up their networks can be weaker than they are for large firms. This in turn prevents SMEs from accessing other information, sources and inputs (Grabher, 1993).

These distinctive features of SMEs help define the rationale for providing public support in the form of ICT innovation vouchers. According to the *European Commission Staff Working Document—SMEs Going Digital* (European Commission, 2013a, p. 5, stress added), SMEs '*do not have sufficient knowledge or resources in order to introduce ICT-related activities in their business models*'.

Considering how SMEs face markets, in what follows, we discuss how ICT vouchers can address market failures. In particular, we refer to i) liquidity and information constraints, ii) information constraints and risk attitude, and iii) aspects that are specific to investments in ICT and digital innovation.

***i) Liquidity and information constraints**:* As compared with large firms, SMEs have liquidity constraints and less access to credit. These issues – widely related to the information gap between lenders and SMEs - may negatively affect SMEs' investments in ICT adoption and digital innovation. This has been especially true since the credit crunch began six years ago.

The difficulties encountered by SMEs (relative to large firms) in obtaining credit from banks, capital markets and other financial suppliers are the well-known issues of 'information asymmetries' (in the form of moral hazards and adverse selection) between borrowers and lenders.[15] In particular, the information gap between an innovating firm and potential lenders/investors is, in principle, greater for a small/medium-sized firm than for a large firm, since the latter can access more information tools than the former. In addition, large firms have a better use of the IP system, which, in turn, reduces the information asymmetries between the borrower and the lender (Burrone, 2005; Wilson, 2015). Thus, credit rationing emerges as a consequence of asymmetric information between the borrower and the lender. This can, however, be mitigated by collateral in the credit contract (e.g. Stiglitz and Weiss, 1981) and by there being a relationship between the borrower and the lender (Voordeckers and Steijvers, 2006).[16] Stronger creditor protection from collateral can lead to better credit terms[17] or even the approval of credit that would otherwise not be granted.[18] The presence of relationship lending also works in the same manner.[19] Compared with large firms, SMEs are usually at a

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[15] See Binks and Ennew (1996) and Beck et al. (2006), among others.

[16] Relationship-based banking is defined as the provision of financial services by a financial intermediary on the basis of long-term investments in obtaining firm-specific information or borrower-specific information through multiple interactions with the customer.

[17] From the banks' perspective, collateral and screening for loan approval can be considered as substitutes. Since the latter represents a more costly procedure, banks often rely on collateral as an alternative, and they charge a fee for screening SMEs. This cost reduces SMEs' incentives for applying for external credit.

[18] More specifically, economic literature has highlighted the fact that collateral may signal borrower quality (e.g. Chan and Kanatas, 1985; Bester 1987; Besanko and Thakor, 1987; among others). This may lower the agency costs of debt by preventing the problem of asset substitution (Jensen and Meckling, 1976) and mitigate underinvestment (Stulz and Johnson, 1985).

[19] Note that there is also a different view on relationship lending, according to which the latter may result in a higher cost of credit. Petersen and Rajan (2002) pointed out that the private

disadvantage when providing collateral and in relationship lending, and given their weaker bargaining position, SME owners often use personal collateral and commitments in credit/lending contracts (Blumberg and Letterie, 2008; Colombo and Grilli, 2007; Voordeckers and Steijvers, 2006, among others). Recent investigations have highlighted that relationship lending may have lost ground because of a change in banks' business models, and this could ultimately affect SMEs' use of this type lending (Steijvers et al., 2010; Memmel et al., 2008). Thus, vouchers could successfully resolve financial constraints and credit rationing issues for SMEs. Moreover, vouchers could give rise to spillover effects in terms of digital adoption and they could also give a positive signal to the banks, as regards providing further credit.

The size/scale of investment for innovation in ICT innovation and/or for its adoption might not be 'affordable' for SMEs. This may have been exacerbated by the financial crisis of 2009. Indeed, owing to their financial/resource constraints, SMEs are often unable to master all of the activities required to successfully realise (or simply adopt) ICT and digital innovation.[20] This was indirectly confirmed by the work of Brunswicker and Vanhaverbeke (2013) who showed that SMEs base a large part of their innovation activities and/or their adoption decisions on external knowledge sourcing (a form of inbound open innovation).[21] In this respect, vouchers could play a relevant role in facilitating SMEs' external knowledge sourcing through ICT acquisition, i.e. access to platforms/programmes that exchange information with customers, suppliers, network partners, research institutions and experts.

Moreover, vouchers can specifically foster interactions between SMEs and public/private research institutions (see Section 4.5), thereby producing effects on the ICT supply side as well. Indeed, if there was a credible voucher programme to support SMEs, ICT suppliers could be incentivised to adapt/adjust their products and services for SMEs' needs.

ii) ***Risk attitude and information constraints:*** SMEs tend to be more risk-averse than larger firms when performing/adopting innovations. Moreover, SMEs may be less well informed than larger firms about the benefits of adopting ICT innovations.

Information about innovations and the potential benefit from their adoption are likely to be differently distributed among SMEs and large firms. In particular, SMEs may not be fully informed about the benefits of ICT innovations and their adoption. This information asymmetry between large firms and SMEs can mean that SMEs have fewer incentives to invest in innovation.

This lack of information – often reinforced by SMEs' limited geographical interactions and lock-in effects that reduce a firm's access to information, sources and inputs, which are external to the local area - can also produce further negative effects if SMEs have a risk

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information of correspondent banks keeps them in a dominant market position, which can then be used to extract higher loan rates from borrowers. If firms turned to other banks, then they would face high conversion costs because of information rent acquired by the correspondent bank.

[20] Note that the existence of budget and credit constraints affecting SMEs' investments in ICT/digital innovation and adoption might result in higher additionality of the ICT-IV voucher programme, thereby having a larger effect when additionality is at work (see Section 4.6).

[21] In particular, these authors categorise different firms' interactions, representing SMEs' sources of external knowledge affecting SMEs' ICT/digital innovation and adoption as follows:
- Interactions with direct and indirect customers;
- Interactions with suppliers;
- Interactions with universities and research organisations;
- Interactions with experts on intellectual property rights;
- Interactions with network partners.

averse risk attitude to digital innovation and adoption of ICT. Innovation activities, indeed, are inherently risky, and SMEs may perceive these risks as greater than large firms do, especially if the former have fewer technical and managerial competences and reduced access to 'hard' information (i.e. information whose value has been verified).[22]

The financial constraints on SMEs also interact with their access to information and their risk averse attitude. Indeed, limited financial resources make it more difficult for SMEs to outsource technical and managerial competences. Thus, the risk of 'getting it wrong' may be a real threat to the survival of an SME. Moreover, SMEs are usually more reluctant than large firms to undertake ICT and digital innovation and ICT adoption. As highlighted by Bakhshi et al. (2011), SMEs are often affected by inertia (i.e. the tendency to accept the status quo) and by myopia (the tendency to opt for short-term gains at the expense of long-term strategic decisions).

ICT innovation voucher programmes which support SMEs with small non-refundable grants and direct access to Knowledge Service Providers (KSP) services decrease the risk embedded in SMEs' innovation activities by providing them with (i) technological information at a reduced costs and (ii) the opportunity to interact with researchers and innovators who are active in the field, thus sharing part of the innovative risk. Moreover, ICT innovation vouchers for SMEs would help prevent the above-mentioned behavioural failures.[23]

iii) ***Aspects that are specific to investment in ICT and digital innovation:*** We believe that network effects, first mover advantage and lock-in effects, all of which influence SMEs' incentives to adopt ICT, should be taken into consideration.

Network effects (and first-mover advantage): when the value of the innovative product/service depends on the number of other subjects using it. This effect influences firms' decisions to adopt ICT solutions and applications: the incentive to adopt them increases with the number of firms that have already adopted them. For instance, the more the same enterprise resource planning (ERP) software is adopted (i.e. it becomes a standard in that industry), the more other firms will want to adopt it as well to ensure that their software is compatible with that of other network users.[24] SMEs, owing to their limited financial abilities and higher risk-aversion, may be more reluctant to adopt ICT solutions and applications in the initial phase (i.e. when network effects have not fully materialised). This may reinforce the **first-mover advantage** of incumbent firms

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[22] Differently, 'soft' information refers to forecasts, unaudited statements and press releases (Bertomeu and Marinovic, 2015).

[23] Huizingh and Mulder (2015) presented results from an interesting field experiment on the effectiveness of regulatory intervention on SMEs' e-commerce rules. They compared SMEs' compliance with e-commerce rules, since SMEs are firms addressed by three different channels of information transmission: email letters, current post mail letters and industry guidance (i.e. press releases, periodicals of firms' representative organisations, etc.). They found that SMEs do not seem to change their behaviour in response to industry guidance. A letter by post mail slightly improved firms' compliance with respect to an email letter; however, overall, they recorded large SMEs' inertia, which was not affected by the different information transmission adopted. The authors suggested proposals to increase the effectiveness of the information transmission, such as the publication of scoring on SMEs' compliance.

[24] Note that investments in R&D activities and the adoption of innovation/ICT are strongly intertwined, since the latter can determine a type of 'snowball effect' on the former. That is, the more successful the innovation/ICT adoption, the more publicity the innovation/ICT receives, which generates further sales. This, in turn, will determine a higher expected value for further related innovations, thus providing an incentive for new investments in R&D. The wars of standards provide real examples of these snowball effects (see Chapter 2, p. 39 in The Oxford Handbook of the Digital Economy). Specifically considering ICT adoption, the 'War of 56K Modems' represents an interesting case whose effects have been well documented by Augereau, Greenstein and Rysman (2006).

(Lieberman and Montgomery, 1998), thereby raising the barrier to entry – i.e. to digitalisation - even higher for SMEs.[25]

Lock-in effects: once adopted, ICT solutions and applications tend to lock-in their customers, since it is costly to switch to other competing products and services. This effect can create greater inertia in the initial adoption of ICT by SMEs as, given their limited budgets, switching can be more expensive for them than for large firms.

Thus, considering the above-mentioned market failures which affect SMEs' incentives to adopt ICT and digital innovation, in what follows, we discuss how an ICT innovation voucher programme could be best designed (in terms of costs and benefits) to make ICT adoption by SMEs more likely.

[25] For more about network effects, lock-in effects and first-mover advantage, see Shy (2001).

3. How ICT innovation vouchers could be better implemented: Common steps

ICT innovation vouchers are typically small grants directed at stimulating ICT and digital innovation development and adoption by SMEs. A non-exhaustive list of services, which could be supported by an ICT innovation voucher programme, is provided by the European Commission (2013a, p. 12). It includes ICT design and development, e-commerce platforms, business solutions services, evaluation tools, IPR protection services, application of ICT to new business models, e-skills empowering services, and networking services. The definition of activities and services to be supported by ICT innovation vouchers largely affects the vouchers' design, the related implementation features and the information requirement for the vouchers' impact evaluation (i.e. ongoing and ex-post evaluation). Box 1 takes all of the features into account and presents the steps and elements that are usually included in the implementation of an ICT innovation voucher programme.

Note that, in an ICT innovation voucher programme, the information flows among various actors (i.e. the delivery agency, the potential applicants, the vouchers' recipients and the KSPs), are particularly important. When a programme is properly designed, these flows can determine the success of the programme. Other specific options in voucher design also deserve careful consideration and we discuss them in the next section by providing elements for best practice.

Box 1*: Common steps in ICT innovation voucher implementation*

STEP 1 **Policy target and voucher design**	Preliminary analysis on local SMEs' needs for ICT/digital innovation. On these grounds, the delivery agency defines: - The ICT innovation voucher programme's target(s), budget and timing, - The voucher's design, - Information needs at different stages for evaluation impact analysis. Accordingly, the delivery agency sets and manages the programme. Note that the delivery agency can also consider running a pilot programme.
STEP 2 **Vouchers' advertisement**	ICT innovation vouchers are advertised along with information on which firms are eligible, how to apply, the selection procedures, the amount of resources granted and the conditions/timing for the use of the vouchers. The programme is advertised through e-platforms, flyers, forums, meetings, etc.
STEP 3 **SMEs' application and information collection**	SMEs apply by providing the information required to enter the programme. This can be detailed in cases where some type of screening is adopted, or it can be more general if no screening is adopted. When an ongoing and/or ex-post impact evaluation of the voucher is planned, detailed information should be required. E-platforms collect SMEs' applications and relevant information.

STEP 4 **Knowledge and service providers' selection**	When Knowledge Service Providers are involved in the voucher programme, the delivery agency could allow the SME to select one: i) From a list of pre-defined KSPs, or ii) Freely, but the chosen KSP has to fulfil the minimal requirement set by the delivery agency, or iii) Without any limits. In i), the delivery agency should run an ex-ante screening to select the KSPs to be included in the voucher programme (i.e. in STEP 1). E-platforms and consulting activities can provide SMEs with information about KSPs.
STEP 5 **Project ongoing assessment**	Interviews with the SMEs' managers and KSPs to test how the voucher's project is implemented. The first assessment is made public through an e-platform. Changes/improvements in the ongoing programme are made as a result of the first evaluation.
STEP 6 **Project completed, voucher's payment and information requirement**	When the project supported by the voucher is completed, the delivery agency pays the voucher: - to the supported firm, and the voucher is then transferred to the KSPs if involved, or - directly to the KSPs. Some reporting requirements by the firm (and by the KSPs) are collected by the delivery agency through an e-platform in this phase.
STEP 7 **Project ex-post impact evaluation: additionality**	The delivery agency develops an ex-post impact evaluation on the voucher round(s). The final assessment and other relevant information on the implemented voucher programme are made public through an e-platform.
STEP 8 **Further information requirements**	Further information could be later required by the delivery agency from the supported SMEs in order to calculate the vouchers' impact (i.e. output additionality) in the long-term.

4. How to allocate knowledge and resources: A non-exhaustive discussion on the best practices for ICT innovation vouchers

In this section, we present and discuss the most important elements in the design of a successful ICT innovation voucher scheme:

- Definition of the ICT innovation voucher targets and design (4.1).
- Advertisement of the voucher programme (4.2).
- Addressing SME participation (4.3).
- Recipient selection and voucher value (4.4).
- Knowledge and service provider selection (4.5).
- Additionality issues (4.6).
- Data requirements (4.7).
- Impact evaluation analysis (4.8).

Please note that all the materials about cases of innovation vouchers which this report refers to are organised by countries in the References section at the end of this report.

4.1 Defining the ICT innovation voucher targets and designing the voucher scheme

Given the importance of institutional, social, economic and location-specific features which affect the survival, growth and success of SMEs, the first step in the design of an ICT innovation voucher programme should be a preliminary analysis of SMEs' needs in the region/area considered.[26] As regards SMEs' ICT-based innovation and digital needs, it would be useful to map the actual 'level' of ICT adoption and diffusion among local firms (SMEs in particular) in order to gain a better understanding of the ICT services and applications that could improve firms' competitiveness and growth, especially by stimulating product, process, organisational and marketing innovation.[27] By defining the firms' needs and the goals of the programme, this phase could also highlight the specific competences required from the actors supplying and developing the ICT applications to be supported by an ICT innovation voucher. These actors include KSPs, which could represent a relevant part of the policy by fostering local sustainable development. Indeed, SMEs and their adoption of ICT and digital innovation is 'one side of the coin' with the other is KSPs, which could develop (as a result of interactions with SMEs through the voucher programme) further innovation over the medium and long term.

Note that the preliminary analysis, which should involve all of the relevant stakeholders in defining the basic goals of the ICT innovation vouchers' scheme, might also reveal the need for ICT-related (public) structural investments (such as broadband infrastructures). More generally, the preliminary analysis described in this paragraph could help policymakers develop a vision for SMEs, by identifying competitive advantages/weaknesses and setting a knowledge-based strategy for sustainable growth and the specific goals of the voucher innovation programme. Once the aims of the voucher programme have been defined, the delivery agency (i.e. a local/regional authority) would set the following:

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[26] A good example of a preliminary analysis for innovation vouchers is given by the OECD report (2013) on the Pilot Programme for Innovation Vouchers in Montenegro. The feasibility assessment of these incentives is achieved by investigating the economic conditions and the SMEs' needs in the area and the existing policies supporting SMEs and their alternatives.

[27] European Commission (2013a).

- The eligibility criteria for the ICT innovation vouchers in terms of firm size (i.e. number of employees and/or budget) and/or industry, productive sector, plant location.
- The timing for applying and using the voucher (and eventually disclose the planned number of voucher rounds).
- The voucher size (see Section 4.4) and type (if more than one, contextually).

Finally, note that a well-specified and detailed definition of the target(s) of the ICT innovation voucher programme would also be of practical importance for the impact evaluation of the vouchers (see Sections 4.6 and 4.7).

4.2 Advertising the ICT innovation vouchers

As previously highlighted, SMEs often lack information about the potential benefits of innovation and, in particular, of the adoption of ICT and digital systems and applications. The information flow in advertising the voucher programme is therefore important for the success of the entire programme**.**

First, information should clarify the following: i) which ICT innovation services are supported by the ICT innovation voucher programme, ii) the potential benefits of these services and iii) how to apply. In this respect, Northern Ireland's IV programme[28] is an interesting example. The delivery agency (Invest NI) takes the leading role in advertising the call for application through press advertisements, e-mail flyers and social media promotions. In addition, the KSPs undertake their own marketing of the innovation voucher programme using their institutional channels, without charging costs to the voucher programme itself.

Second, as the adoption of ICT is often characterised by network and lock-in effects, careful attention should be devoted to the channels used by the delivery agency in order to spread the information concerning the ICT innovation voucher scheme and guarantee that a minimum number of SMEs participate in the programme. An example of best practice is the voucher scheme implemented in the Baden-Württemberg Federal Region. Here, apart from the usual advertisement channels (i.e. press, social media, e-mail flyers), several 'advanced measures' to inform SMEs were developed, which included the following:

i) Forums regularly organised to present the voucher innovation programme and inform SMEs about its development;

ii) Forums to connect researchers, start-ups and SMEs, which could be involved in the programme;

iii) Specific forums to present each activity supported by the voucher programme (i.e. training and coaching programmes, support for accessing technologies for electronic trade and international markets, business coaching and business plan consultancy).

Moreover, the Baden-Württemberg Federal Region established further measures to spread information about the innovation voucher scheme and its adoption by the local SMEs. Among these, it organised an important business plan competition for the high-

[28] See: http://www.investni.com/support-for-business/products-and-services/innovation-vouchers.html

tech sector in Baden-Württemberg, with an Innovation Prize of €10,000 to the five most successful start-ups.[29]

4.3 Making SMEs participate in the ICT innovation voucher programme

Effective participation in the programme should be monitored, including the take-up rate. This could be achieved, for instance, by comparing the estimated number of potential applicants (within a given area) with i) the number of firms showing interest in the programme (through meetings or online platforms); and ii) with the number of firms actually applying to the programme.

A voucher scheme should take 'fast and light' as its motto in order to foster SME participation (see European Commission, 2013a). However, a scheme like this could also run the risk of voucher misuse, i.e. support could be granted to inefficient ICT adoption (though it would also have several important advantages). To reduce risk, careful monitoring by the delivery agency could be activated, but this would be costly and it might reduce SMEs' participation in the scheme. In order to find a balance between the need to avoid misuse of public funds and the need to ensure participation in the programme, some forms of light control could be appropriate. For instance, it could be made clear that a firm misusing the ICT innovation voucher would not be allowed to participate in further rounds of vouchers or other support programmes funded by the same agency.

4.4 Setting the value of the voucher, the funding quota and selection criteria

ICT innovation voucher programmes fall under the *de minimis* aid regulation, which refers to the EU control on state aid.[30] When applying for a voucher, the firm is usually required to declare that it has not received more than €200,000 over any three fiscal years in the form of equities/grants/loans/subsidies from a state body/agency/department at the local/provincial/regional/national level. The rationale for the *de minimis* aid exemption and consequently for ICT innovation vouchers is that such small amounts of state aid have (over the medium and long term) a negligible impact on competition and trade among firms, and they do not 'tilt the playing field' in Europe's single market.

The ICT innovation voucher scheme should be horizontal; that is, it should support the objectives of common interests in a less discriminatory manner. From this perspective, ICT innovation vouchers which deal with market failures related to low spending by SMEs on ICT adoption (see Section 2) would favour EU cohesion (as opposed to sector-specific aids that distort the competitive process and efficient allocation of resources) and maximise the number of firms that could potentially benefit from the support itself.

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[29] This voucher programme included four different types of vouchers (see the programme's website: https://mfw.baden-wuerttemberg.de/en/people-and-economy/smes-and-crafts/innovation-vouchers/).

[30] The legal basis for this control is given by Articles 107–109 of the EU Treaty, which indicate that state aids to firms are normally incompatible with the common market. However, there is also a long list of exceptions. Specifically, Article 107 confines legitimate aid to cases that promote relevant projects of European interest, training, research and development (R&D), regional economic development in 'weak' areas or to remedy a serious disturbance in a member state economy. Article 108 gives the commission the power to investigate potentially illegal aids. Details about state aid procedures and their implementation can be found here: http://ec.europa.eu/competition/state_aid/overview/state_aid_procedures_en.html.

Considering the definition of voucher value, we discuss two extreme cases. In theory, the value of ICT vouchers could be equal for every firm, or it could vary by firm (i.e. through projects of ICT investment). A 'one-size-fits-all' type of voucher would be appropriate when the aims of the programme are very well-defined and imply a limited number of actions, with equal/similar costs (i.e. standards). The advantage of this option is mainly that it would be easy to implement and evaluate. However, the greatest limitation of a one-size-fits-all voucher is its lack of flexibility in adjusting to the possible needs of different SMEs.

Thus, a 'case-by-case' approach may be more appropriate under several circumstances. A committee (typically appointed by the delivery agency) evaluates the 'quality' of the proposals and sets the voucher amount accordingly (see, for example, the work performed by the Baden-Württemberg innovation voucher commission). This is a more costly process (in terms of timing and the resources required) and is affected by information asymmetries among parties. However, it includes the advantage that, if the voucher size is properly calculated and awarded, then it can achieve the highest additionality (i.e. impact). Indeed, in this case, each voucher is precisely addressed to each beneficiary, and its impact would be maximal.

A more practical interpretation of the 'case-by-case approach' requires that firms propose a project (related to ICT adoption) and quantify their expected costs. Some of their costs are funded by the voucher (according to the programme's criteria). The selection committee then has the task of checking whether the proposed project fits well with the programme's objectives and whether the proposed costs are appropriate. The advantage of this solution is that the committee would not have to actually set the value of the voucher, since this would be determined in the firm's proposal, and the committee would simply have to accept or reject the latter (acceptance would be possible up until the the moment when the programme's budget was exhausted).

It is also possible to fix the maximum quota per project to be financed with the voucher, as well as the voucher's value. By fixing the voucher's value and the maximum quota funded by the voucher, the delivery agency indirectly sets both the maximum size of the project and how much the private sector must contribute,[31] thereby also setting the direct incentives for SMEs to participate. Indeed, the 'definition' of the funding quota by the voucher *de facto* quantifies the economic risk taken by the SMEs. By increasing the level of the voucher funding quota, it is possible to create greater incentives for SMEs to apply to the programme.

In the case of the Baden-Württemberg voucher programme,[32] the different designs of the vouchers included different quota requirements: Voucher A (*Support for Research and Technology Services: Studies*) grants a maximum of €2,500, which represents a funding quota of 80% of the project's value; Voucher B (*Support for Research and Technology Services: Implementation*) grants a maximum of €5,000, which represents a funding quota of 50% of the project's value and Voucher B High-tech (*Support for High-tech Start-ups*) grants a maximum of €20,000, which represents a funding quota of 50% of the project's value. In the Murcia ICT Innovation Voucher, a programme co-financed by the EBDR, up to 75% of the cost of the ICT service was directly granted through the voucher.[33]

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[31] For instance, if the value of the voucher is set to €5,000 and the maximum funding quota is 50%, then the maximum value of an admissible project is €10,000.

[32] See: http://mfw.baden-wuerttemberg.de/de/mensch-wirtschaft/mittelstand-und-handwerk/innovationsgutscheine/

[33] See: http://www.institutofomentomurcia.es/c/document_library/get_file?uuid=defb63e1-415b-4845-a745-43d27848adaa&groupId=10163.

Similarly, in the case of the *SME e-wallet* in Flanders, a large voucher programme supporting innovation solutions and other consultancy services to SMEs (i.e. consultancy for international business, coaching, training etc.), application for 'Advice innovation and technology exploration' can receive a maximum grant of €10,000, which must correspond to 75% of its cost. This grant can be combined with other grants for consultancy services financed by the same programme up to a maximum of €15,000 a year. (Note that it is possible to allow firms to collect more than one voucher in the same year.)

A further important element in voucher design is the process for the selection of recipients. There are at least three approaches to selecting voucher recipients:

i) First-come, first-served;

ii) Lottery;

iii) Evaluation of each applicant's merits.

The choice between these three approaches depends on the policy's aims and design, and the size of the voucher. Allocations following the 'First come, first-served' and 'Lottery' principles are well-suited to small and 'one-size-fits-all' vouchers, since they reduce administrative costs, simplify participation and guarantee some form of fairness in the allocation process (based on luck or the time of application).[34]

However, the less standardised the ICT and digital activities supported by the voucher programme are, and the larger the potential amount of the voucher, the more appropriate it is to adopt a selection procedure to evaluate the applicant's merits. The recent ICT innovation voucher programme, *Chèques Transformation numérique*, implemented by the Région Aquitaine (France) and co-financed by the European Regional Development Fund, adopted the following criteria for the recipient selection:

- Relevance of the overall proposed project to be supported;
- Quality and references of the selected KSPs for the project;
- Spillover effect and areas concerned (i.e. rural or sensitive areas);
- Maturity of the financing plan, estimated costs and the share to be financed by the firm.[35]

On the basis of the evaluation (and the weight assigned by the delivery agency) of each criterion, it is possible to rank projects. In this case, the funded projects are those ranked higher or equal to the minimum compatible with the budget available for the programme.

Note that in this case, the selection committee would play a fundamental role in choosing voucher recipients. However, as stressed by Stiglitz and Wallsten (1999, p. 58), there 'is the widespread belief that the government is not very effective in choosing good projects (i.e. picking winners) and managing research'. Moreover, economic literature has highlighted at least four elements that can negatively affect the choices

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[34] When a 'one-size-fits-all' voucher is awarded through a lottery, all of the eligible SMEs have an equal opportunity to obtain the grant. A ban from participating in further calls once that firm has won a voucher could further increase the equal opportunity of all the firms in being financed at least once (see the INDEX – Innovation Deliver Expansion, a voucher programme supported by the European Regional Development Fund in the West Midlands. See http://www.aston.ac.uk/aston-business-school/business/innovation-vouchers/.

[35] See http://les-aides.aquitaine.fr/article1160.html.

made by the selection committee (entitled by the delivery agency) of the recipients of ICT innovation vouchers:

i) Asymmetric information between applicants and the selection committee entitled by the delivery agency;

ii) The selection committee can be influenced by the private interests of lobby groups;

iii) Even in the presence of perfect information and no lobby groups at work, the selection committee (entitled by the delivery agency) can have incentives to 'cream skim' firms. They may grant vouchers to firms that will apparently obtain higher commercial returns (though they may be irrelevant in terms of additionality) in order to provide support to the programme;

iv) The selection committee entitled by the delivery agency could be risk-averse, fearing the loss of political support if the voucher programme fails. This would not lead to optimal strategic choices in the selection phase;

v) The *Matthew effect* can occur:[36] the selection committee entitled by the delivery agency may select firms according to their previous participation in other public programmes.

Together, all of these elements lead us to conclude that a combination of the 'pre-selection' and 'lottery' phases might be an interesting solution. The pre-selection phase would ensure that only 'good' projects receive financing, and the lottery mechanism would be used to select the 'winners' among those who are chosen as potential beneficiaries of the voucher scheme. In this case, however, the amount financed by the vouchers would have to be equal for all of the firms, since it would be extremely difficult to justify (on equitable grounds) a lottery system that awards different amounts.

4.5 Selecting the knowledge and service providers (open vs closed list)

The delivery agency could consider at least the following options when selecting KSPs to implement ICT innovation vouchers:

i) They could opt to allow SME applicants complete freedom of choice (as in the Baden-Württemberg IV programme), in which any private and public institution located in the region or active at the international level could be chosen by the applicant, or

ii) They could limit the choice to KSPs that have been pre-approved and are members of a pre-defined list as in Murcia's Pilot ICT Voucher Programme Call 2013. Here the delivery agency selected 18 KSPs from over 114 applicants. A similar solution was adopted in the Pilot ICT Voucher Programme in Extremadura, Spain.[37]

Restricting the number of KSPs to a pre-defined list could result in only a small number of providers collecting most of the vouchers. For instance, in the Northern Ireland innovation voucher programme, only four knowledge institutions (i.e. Queen's, Ulster, CAFRE and South West College) accounted for more than 85% of the projects. However, a pre-selection process of this kind has the following advantages:

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[36] This theory, originally presented by Merton (1968), was recently revisited by Rigney (2010).

[37] See: https://ec.europa.eu/digital-agenda/en/ict-innovation-vouchers-action-1.

- It guarantees that only KSPs with a track record and reputation participate in the project, which might be important if target SMEs do not know the market for ICT services and applications.
- It can simplify information collection from KSPs by the delivery agency when it evaluates the vouchers' impact.
- It can induce more structured interactions between SMEs and providers, as the latter are selected and directly monitored by the delivery agency. Hence, it can become part of the innovation effort in the local area (i.e. the delivery agency could better co-ordinate support for SMEs directly by interacting with the selected providers).[38]

An interesting solution would be to combine the flexibility of open participation with the benefits of some screening. This could be achieved by requiring the pre-approval of KSPs which participate in the voucher programme. Meanwhile, interested providers are also allowed to apply at any time (i.e. even KSPs that are not included in the original list can take part if they apply and satisfy the minimum requirements).

In the case of EU's transnational vouchers for innovation, the issue of selecting KSPs becomes more complex, as highlighted by the Region of Marche (Italy) Cross Border Voucher programme. A possible solution is to create a digital platform for certification, a tool often adopted in public procurement. In the UK, for example, public contracting authorities regularly open access to certification on digital platforms, and firms obtaining certification are added to the list of qualified suppliers, after which they are allowed to participate in the public procurement auction for goods, services and furniture. Similarly, if an EU digital platform for provider certification is implemented, qualified providers could then be chosen by SMEs for cross-border vouchers.[39] Note that if the certification for KSPs is to be issued for a medium- to long-term voucher programme, then it could also be useful to include reputational features as a precondition for remaining on the list of qualified providers. Conversely, continuing poor performance in the voucher programme should be included as a criterion for a provider's exclusion at any time.

The delivery agency could also decide to provide SMEs with some brokering/consultancy activities in order to match SMEs to KSPs. These brokering/consultancy activities could offer significant benefits to SMEs, particularly when the voucher programme is designed to cover a wide range of services (i.e. digital auditing, ICT design and development, implementation of e-commerce solutions, platforms and facilities, customised e-business solutions services, evaluation of processes or product design, solution architecture, product testing, validating, prototyping, ICT training for digital entrepreneurship to be embedded in a coherent manner, etc., see EU Commission, 2013a). According to the entrepreneurs involved in the Cheque Innovacion programme, implemented in Andalucia (Spain), these brokering/consultancy activities have been extremely useful and should

[38] In this respect, the Northern Ireland Innovation Vouchers programme represents an interesting case. The delivery agency selected 39 KSPs (i.e. universities, private services, public institutions) which - once interviewed during the voucher programme - declared that the costs of delivery had been covered by the financing provided by the IV programme. However, they also highlighted that 'the financial viability of the programme has become increasingly marginal over the evaluation period for some providers, as costs have increased including for materials and staff costs' (SQW Report, 2014, p. 24). In other words, with the provided voucher of approximately £4,000, and in presence of rising costs for the KSPs, a) there has been the risk of the sustainability of the programme itself; and b) some KSPs might have chosen not to participate in the programme (or to exit it).

[39] Notice that the relevant cost in implementing an EU digital platform for KSP certification would be in defining the certification criteria that would be accepted by all of the potential delivery agencies.

be further reinforced.[40] A similar point is made in the SQW Report (2014) about the Northern Ireland Innovation Vouchers programme.[41]

4.6 Characterising the programme's impact: Input, output and behavioural additionality

Investigating the actual impact or 'additionality' of a voucher programme means studying the extent to which the vouchers have produced effects that would not have materialised in the absence of that programme. These effects could be higher usage of ICT applications and services (input additionality), higher productivity and/or innovative activities (output additionality), and higher employment and competitiveness (outcome additionality). Moreover, the vouchers could also induce behavioural/organisational changes in a firm (behavioural additionality). In all of these cases, irrespective of the type of additionality, the important question is: '*Has the voucher modified the input/output/outcome/behaviour in a way that would not have been observed in the absence of that voucher?*'

We have full additionality when a firm (because it has received a voucher) engages in activities or achieves results that it would not have done, had there been no programme. If, on the other hand, a firm uses the voucher to purchase ICT services that it would have bought anyway (and in the same amount) and does not change its behaviour, the additionality of the programme would be zero, especially since public money would simply have been used as a substitute for private money.

Testing for additionality is not a simple task, and a large body of empirical research has attempted to determine whether public subsidies to R&D or innovation are complementary or substitute the firm's own investment in R&D and innovation activities (i.e. whether a 'crowd-out' or a 'crowd-in' occurs in such activities; see David et al., 2000 and Kettle, 2000).

In a recent survey on the empirical literature about the effects of public subsidies on firms' R&D, Zúñiga-Vicente et al. (2015) provided a list of 118 representative empirical studies carried out since the mid-1960s. Approximately 60% of these studies found support for the 'crowding-in' hypothesis, whereas some reported evidence in favour of the 'crowding-out' hypothesis. In addition, some studies obtained insignificant or mixed effects. The same authors stressed that, from all of these empirical investigations, there is no unambiguous and conclusive answer about the effects of public subsidies on R&D and innovation, especially since one should consider that differences in these results can be explained by differences in the datasets (among others things), in the industries and countries considered and in the time period covered by the analysis (see also González and Pazó, 2008). In particular, since the studies typically focused on different countries with different institutional structures, generalisation is complex. Similarly, the fact that different empirical approaches and estimation techniques were used can make comparisons and robustness analyses extremely complex. However, Zúñiga-Vicente et al. (2015) highlighted that some results can be reasonably posited as follows:

i) The effect of public subsidies on private R&D investment seems to be characterised by an inverted U-shaped curve. This effect is positive up to a certain threshold in terms of financial amount (i.e. the crowding-in effect would prevail) and negative beyond it (with the crowding-out effect dominating).

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[40] For a description of the activities supplied, see: http://www.juntadeandalucia.es/economiainnovacioncienciayempleo/chequedeinnovacion/programa-cheque-innovacion/servicios-incentivados/.

[41] Note that, among the services offered by the Northern Ireland delivery agency, there were also the following: i) Assistance for SMEs' applications; ii) Consulting in the SMEs' choice of the KSP; iii) Assistance in understanding why the application was rejected.

ii) The crowding-in effect of public subsidies on private R&D investment will be stronger in financially constrained firms, and it is expected to weigh more for small and young firms.

iii) The response of firms to public subsidies might depend on the composition of R&D investments. That is, the greater the weight of research activities and the smaller the weight of development activities in the firm's R&D investments, the stronger the crowding-in effect.

iv) The effect of public subsidies on private R&D investment might not be instantaneous but rather distributed over several years (and/or related to the different additionality concepts).

Recent papers investigating the support of R&D and innovation activities distinguish the following main types of additionality:

1) *Input additionality*: i.e. the impact of the innovation programme on inputs to the innovation activities, which are typically related to R&D and innovation expenditures (see, among others: González et al., 2005; González and Pazó, 2008; Takalo et al., 2013; Görg and Strobl, 2007).

2) *Output and outcome additionality*: i.e. the impact of the innovation programme with respect to i) outputs (such as the likelihood that a subsidised firm introduces a product or a process innovation; see Hujer and Radic, 2005; Czarnitzki et al., 2007; Hussinger, 2008; Bérubé and Mohnen, 2009) or ii) outcomes (such as employment, turnover, productivity or profitability of the innovation activity; see Merito et al., 2010).

3) *Behavioural additionality*: i.e. medium- to long-term modifications in firms' behaviours, which are hence concerned with changes in technological trajectories or organisational/managerial/business models (Clarysse et al., 2009; Busom and Fernandez-Ribas, 2008; Gök and Edler, 2012). Behavioural additionality is often evaluated with qualitative information collected through direct interviews.

An important issue in evaluating input, output and behavioural additionality is timing, i.e. when the additional effects are more likely to materialise, relative to the period in which the firm received the subsidies. Some effects, such as those related to input additionality,[42] are typically short-term (1–2 years).[43] However, they can also have medium- to long-term indirect effects (e.g. through learning-by-doing behaviour, which enhances the absorptive capacity of the firm). Other effects, such as those related to output additionality, are typically observed over a medium-term period (3–5 years), whereas others, especially those related to outcome and behavioural additionality, might be found over longer horizons.

Input, output and outcome additionality are usually measured with a quantitative (econometric) analysis, whereas behavioural additionality is detected through case studies and qualitative surveys (interviews and questionnaires).[44]

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[42] Such as an increase in the number of R&D workers.

[43] An interesting evaluation on short-term additionality and back-of-envelope calculations is presented in the Nesta Report (2011) on Creative Credits for SMEs' Innovation. See https://www.nesta.org.uk/sites/default/files/creating_innovation_in_small_and_medium_enterprises.pdf.

[44] A good example of behavioural evaluation can be found in the INDEX – Innovation Deliver Expansion East Midlands (UK) - Voucher Programme in which recipient SMEs were asked to report on the probability that they would have implemented the innovation in the absence of the support that they received from academics through the voucher's programme. On average,

Note that the economic literature discussed above mainly refers to the additionality of R&D or innovation subsidies (which include innovation vouchers). To the best of our knowledge, there are very few specific investigations on the additionality of ICT innovation voucher programmes for SMEs.[45]

Given the focus of this report, in what follows we elaborate on some additionality features which belong to ICT innovation vouchers designed to support a) the implementation of e-commerce solutions, platforms and facilities, the creation of a firm's website, e-marketing etc.; and b) the adoption of Enterprise Resource Planning (ERP) and business software applications. We have chosen these two examples because they correspond to actual possible targets for ICT innovation vouchers.

a) *ICT innovation vouchers granted to a SME to support the development of e-commerce.* The supported firm should invest in creating a webpage and join an existing e-commerce web platform or create its own. For the latter, it should take the following steps:

   - Establish new distribution and storage processes. These processes will typically be cheaper than the traditional ones (for instance, through 'brick-and-mortar' stores).
   - Invest in e-advertising.
   - Establish and manage new sales-support services (i.e. contacts and assistance online) in order to gain the trust of buyers, given that physical distance makes it difficult to inspect the products and directly interact with salespersons.
   - Organise the efficient delivery of the commercialised products/services. It is important a large enough online market size is reached quickly, that allows for economies of scale and scope in delivery.
   - Collect key data on its existing and potential customers. This data could be valuable for the design of the new firm's pricing strategies, i.e. price discrimination, which (through e-sales) could have very different characteristics, as compared with usual sales in physical shops.[46]

The costs of all the above complementary activities should be considered when setting the value of the voucher, especially since a small voucher (relative to the costs of the overall activities) might deliver low SME participation and, consequently, low additionality. A preliminary exploration of the potential costs related to the supported activities should therefore precede the definition of the voucher's size.

Evaluating the impact of innovation vouchers requires the collection of ex-post quantitative information. This can include i) the number of e-contacts with customers made by the SMEs in a defined period; ii) the absolute and relative (to overall sales) size of e-sales; and iii) the location of e-customers and delivery costs. This data could then be compared with the same data in the period prior to e-commerce adoption.

Moreover, the delivery agency could collect qualitative data in order to test for behavioural additionality. Interviews with SME managers (and with KSPs) could produce

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the final evaluation estimated that, in 39% of the cases, the firms responded that they would not have been able to implement innovative new products or processes without such support.

[45] The first (incomplete) evaluations of ICT innovation vouchers have been provided by the Murcia and Andalucia programmes. See the websites for these programmes in the References section. Previous reports that assessed the additionality for innovation vouchers include Invest NI (2014) and the Report by the Scottish Founding Council (2010).

[46] Note that this data could raise privacy issues that the firm should care about concerning the online buyers.

information of this kind (see the examples of indicators and questions provided in Section 4.7).

b) *ICT innovation voucher* granted to support the acquisition of Enterprise Resource Planning. ERP application packages cover, as a 'single umbrella product', all the departmental functions of an enterprise: that is, ERP adoption/implementation aims to reunite all the functions of an enterprise in a single system. ERP application packages for SMEs can also bring many advantages to the firm: e.g. comprehensive planning of resources; increased reactivity to demands; reduction of production and stock costs; elimination of waiting time in production; and increased product/service quality and productivity.

Considering all of these advantages, the ICT innovation voucher should cover ERP costs and reduce the related risks belonging to uncertainties connected to software adaptability and personnel training (hopefully with consultancy and orientation activities). Evaluating the impact of a voucher that supports EPR adoption requires (as with vouchers that support e-commerce) quantitative and qualitative information. The former is mainly related to changes in a firm's productive cost and timing, whereas the latter is related to changes in a firm's organisational business model.

Note that, for existing SMEs with low ICT adoption, ICT innovation vouchers could simply support SMEs' connection to the Internet, grant resources for specific electronic business applications and/or increase the degree of security for electronic transactions. For SMEs which have already implemented ERP and have adopted some ICT, innovation vouchers could usefully support further applications, e.g. e-marketing or an e-business-tailored solution.

4.7 Evaluating an ICT innovation voucher programme: Indicators and information needs

The first step in evaluating the impact of an ICT innovation voucher programme is to define the qualitative and quantitative indicators that will be used. As highlighted in the brief presentation above of the e-commerce and the EPR cases, these indicators should be identified by taking into account the programme's aims and design. In this section, we list and discuss both the quantitative information (which will be used to evaluate input, output and outcome additionality) and the qualitative information (which will be mainly used for behaviour additionality).

Quantitative Information – The delivery agency should collect the following data at each voucher round,[47] using, for example, an electronic platform and managing it in a 'lighter and quicker' way:

- The identity of the applicants and their characteristics: i.e. productive sector, number of employees, location of productive plant(s), year budget, year sales etc.

- The educational attainment of the workforce (i.e. managers and employees) available at firm level.

- The diffusion and type of ICT already adopted by each firm (i.e. number of personal computers and software, fixed and mobile Internet connections, use of an intranet

[47] For each voucher round, the delivery agency defines the openings and deadlines for firms' application, award, eligibility etc. From the start of the voucher programme, the delivery agency can disclose the number of rounds that will be run. This can increase firms' participation since it gives a firm the possibility to organise its application for one of the announced rounds.

network in the firm, electronic interactions with customers, suppliers, firm's web page etc.).

- Some measure of each firm's innovative performance (i.e. R&D expenses) over the previous five years.

- Each firm's market share and market orientation/presence (i.e. local, regional, national and/or international, based on official statistics or on the firm's own evaluation).

Similarly, the delivery agency should collect information about the KSPs (i.e. sector of activity, size, human capital available at each firm, number of researchers potentially interested in the programme, field of activity, innovative efforts, patents and research outputs obtained and active international research co-operations). If, as in the ICT innovation voucher programme in Murcia, the delivery agency pre-selects the KSPs, the information could be collected before the programme begins. On the other hand, if, as for the innovation voucher programme in Baden-Württemberg, KSPs are not pre-selected, this information could be collected at the initial stage of the voucher's implementation, i.e. when the KSP is selected by the applicant firm.

However, a trade-off exists during this preliminary stage. On the one hand, excessive informational requirements, which can be perceived as a burden, could negatively affect participation by SMEs. On the other hand, the lack of information makes ex-post impact evaluation weak or even impossible.

Once the projects supported by the innovation voucher programme have ended, information about the main input, output and outcome indicators should be collected by the delivery agency, possibly through a questionnaire (to be completed when the voucher is redeemed). Note that information should also be collected in cases when a project has not been completed.

For each round and for the overall programme, this quantitative information could be used to assess the programme's additionality (see Box 2).

Box 2: ***Examples of indicators to evaluate additionality***

Input Additionality	
Indicator	**Information required**
Timely programme expenditures	The amount of expenditure by periods, during the programme.
R&D expenditure over the firm's sales	R&D expenditure over the firm's sales value (R&D intensity). This is an indicator of the input into the innovation activity.
Employment	Change in the firm's employment before and after the voucher programme.
Others	…
Output Additionality	
Indicator	**Information required**
Application success rate	The proportion of successful applicants over the total number of applicants.
Completion rate	The proportion of voucher recipients that succeed in completing the project over the total number of recipients.
Innovation activity	Introduction of product (number), process and organisational or marketing innovation as a consequence of the programme. This is an indicator of innovation output.
Labour productivity	Change in labour productivity before and after the voucher programme.
Profitability from investment	Use of profitability indicators to measure the change in profitability before and after the voucher programme.
Others	…
Behavioural Additionality	
Indicator	**Information required**
Recipient firms' investment in ICT	Qualitative change in expenditures in ICT before and after the voucher implementation.
Main reasons for investing in ICT	Description of the expected results of the ICT investments.
Knowledge and service providers' investment in innovative activities	Expenditure in innovative activities due to participation in the voucher programme.
Others	…

Qualitative Information – Qualitative information could be collected in two ways. The easier method would be to add a qualitative section in the evaluation questionnaire mentioned above. Alternatively, it would be possible to conduct interviews with the voucher recipients. The questionnaire is more cost-effective, but it is possibly less informative.

Irrespective of whether the questionnaire or interviews are chosen, the qualitative information gathered could be elicited with questions such as those listed in Box 3.

Box 3*: Examples of specific questions to address behavioural additionality*

Organisational, managerial and marketing change	To what extent has investment in ICT changed the organisational and business operative model usually adopted by the firm?
Attitude towards innovation	Has the ICT investment resulting from the ICT voucher changed the firm's attitude towards innovation? Has it created or helped solve conflicts within the firm? (e.g. between old and new mentality)
Bottlenecks and barriers	What (if any) have been the most important barriers to ICT investment? What bottlenecks has your firm experienced (e.g. human capital, financing etc.)?
Direct question on perceived additionality	Would the firm have achieved the outcomes without the ICT voucher at the same speed, scale and quality? Would the firm have achieved the same outcomes but not as quickly? Would the firm have achieved the same outcomes but not on the same scale? Would the firm have achieved the same outcomes but not of the same quality?
Other questions	What types of additional investments and/or finance were required to reap the full benefits of the ICT voucher? Did the ICT adoption induced by the voucher lead the firm to stop or postpone other productive activities? Was the relationship with the KSPs useful in having a better understanding of what ICT can do for your firm? As a consequence of the voucher, did your company enter into contact with other firms or KSPs that provided ideas for further improvements in your organisational/business model?

Note that answers to the qualitative questions in Box 3 can lead to a subjective perspective on additionality and (as stressed in the evaluation report on innovation vouchers in Northern Ireland, p. 55).[48] This is because answers could be affected by 'optimality bias' (i.e. effects are likely to be remembered as being more significant than was probably true). This issue can be better corrected if the interviewer carefully explains the evaluation scale for subjectively scoring and coherently collecting the data.[49] Qualitative information is also useful in understanding whether the ICT innovation voucher has led to a change in the firms' activities. This could be achieved by asking questions about the potential unexpected consequences of the voucher (i.e. if the firm had to drop development activities that differed from the one funded by the voucher).

[48] See http://www.sqw.co.uk/files/3414/2188/1186/innovation-vouchers-final-evaluation-report-nov-2014.pdf.

[49] Typically, very simple evaluation scales are adopted in interviews. For instance, in the evaluation of behavioural additionality of the Andalucia ICT innovation vouchers, a scale from 0 to 10 was used, and the relative weights were assigned (0.2 to answers from 0 to 5, 0.6 to answers from 5 to 7 and 0.85 to answers from 8 to 10, respectively).

Finally, the interviews or questionnaires could also include some questions about the global assessment of the programme; that is, if there are specific factors that have contributed to the success/failure of the projects, and if there are factors not included in the programme that have the potential to increase the probability of reaching the programme's goals. Box 4 presents some examples of the questions that can be used for this goal. Note that, for easy comparability, answers are subjectively scored according to a simple scale.

Box 4: ***Examples of questions for the global assessment of behavioural additionality***

a) ***Has the support provided by the ICT innovation voucher increased the innovation returns from the firm's current human capital?***   RATING: 1__ 2__ 3__ I don't know__   *Where: 1 = Never; 2 = Occasionally; 3 = Regularly*
b) ***Has the support provided by the ICT innovation voucher increased the innovation returns from the firm's current inter-organisational linkages?***   RATING: 1__ 2__ 3__ I don't know__   *Where: 1 = Never; 2 = Occasionally; 3 = Regularly*
c) ***Has the support provided by the ICT innovation voucher produced returns from the firm's new organisation linkages?***   RATING: 1__ 2__ 3__ I don't know__   *Where: 1 = Never; 2 = Occasionally; 3 = Regularly*
d) ***Has the support provided by the ICT innovation voucher increased the innovation returns from the firm's current organisational routines?***   RATING: 1__ 2__ 3__ I don't know   *Where: 1 = Never; 2 = Occasionally; 3 = Regularly*
e) ***Has the support provided by the ICT innovation voucher produced returns from the firm's new organisational routines?***   RATING: 1__ 2__ 3__ I don't know   *Where: 1 = Never; 2 = Occasionally; 3 = Regularly*

This type of qualitative information could be collected at different intervals after the voucher has been used. Moreover, it could produce different results on the voucher's impact according to the timing chosen for evaluating the programme's additionality. Finally, ICT innovation characteristics and spillover effects from their adoption suggest that running a short-term and a long-term analysis on additionality (collecting qualitative and quantitative data accordingly) to uncover different effects during different stages of the voucher programme could be beneficial.

4.8 Evaluating the impact of ICT innovation vouchers: How to build the counterfactual

Qualitative and quantitative information presented in the previous section can help us to measure the impact of vouchers on a firm's adoption and development of ICT and digital innovation. This information can also help us to assess the firm's performance before and after receiving the support, especially in terms of productivity, output and number of employees. It can also help us to determine the strategies and organisational and business models adopted.

Further evaluation of the vouchers' impact could be conducted by comparing those firms that received the support (called 'treated' firms) with those firms that did not. In this way, a 'counterfactual' impact analysis could be developed in order to estimate the difference between the value of the performance variable observed in the treated firm and the value that the same variable would have taken had the firm not received the voucher (i.e. in the counterfactual state). However, observing the treated firm in a counterfactual state is not possible. Thus, we have to use methodologies that compare the treated firms' behaviour with that of a 'control group', i.e. other firms that have similar characteristics to the treated firms but did not receive the voucher; or also we could observe treated firms in the periods before they receive the voucher).

Finding the appropriate control group is probably the most difficult task in evaluating an ICT innovation voucher. The delivery agency should first try to collect relevant information from firms that did not receive the voucher. Note that the delivery agency's ability to define/estimate the counterfactual will determine the robustness of the impact evaluation analysis.

Empirically, one should first select some target variable (or indicator) for the analysis such as expenditures in R&D over sales, profitability, etc. Then, a comparison should be made with the average of each target variable for the treated group of firms with the average of the same variable for the counterfactual group. The counterfactual group could include:

i) Firms that are eligible for the support but did not receive the voucher.

ii) Treated firms, i.e. firms that received the voucher but had also been analysed before receiving the voucher.

For subgroup *i)*, it is important to select (as counterfactuals) firms that are closer in terms of observable characteristics to the treated firms. This is because these 'un-treated' firms should inform us about what could have occurred with the treated firms if they had not received the voucher. In this perspective, the aim is to reduce the selection bias issues.[50] For this reason, subgroup *i)* should include the non-treated firms with the closest characteristics (i.e. size, industry, location, budget indicators) to the treated firms. Since vouchers are typically geared towards SMEs, we are unlikely to find the appropriate control group in databases which collect financial statement data (along with company and management information) such as *Orbis* or *Amadeus*.[51] A better and

[50] A selection bias is a type of bias caused by choosing non-random data for statistical analysis. The bias exists due to a flaw in the sample selection process in which a subset of the data is systematically excluded due to a particular attribute. The exclusion of the subset can influence the statistical significance of the test or produce distorted results (see Wooldridge (2002, Ch.17)).

[51] Data in Orbis and in Amadeus (the European subset) are collected from official business registers, annual reports, newswires and web pages. They include balance sheets and profit and loss accounts of private and public firms. The listed firms are 1% of the sample. These

simpler option would be to use, as a control group, the set of firms that applied for vouchers but did not receive one owing because the budget ran out. This option works extremely well when the budget is allocated according to a lottery mechanism or on some quantitative evaluation of the proposals (i.e. ranking). Typically, in such cases, there is a cut-off evaluation value: firms above this value are financed and firms below it are not financed. Firms that are close below the cut-off level are excellent counterfactuals for those that are above and close to the cut-off point (regression discontinuity design).

Once the proper treated and control groups have been defined, it is possible to use the most appropriate 'matching' technique[52] and associate each treated firm with one (or more) non-treated firm(s) with similar characteristics.[53] Then, the variables' averages computed for both the treated groups of firms and the counterfactual group of firms can be estimated and compared. In addition, the difference between the two can provide an estimate of the causal effect of the programme.

As an alternative to subgroup *i)*, it is also possible to use, as a control group, the treated firms in the period prior to the treatment[54] (i.e. before receiving the voucher), as defined in subgroup *ii).* When the variable investigated varies in time (i.e. output, productivity, number of employees etc.), one can compare the average of this variable before and after the voucher programme. However, this option works properly only if there are no other time-varying effects that could affect the change in the treated firms' performance in the time period before and after treatment. In the presence of economic cycle effects or season effects, for example, one should determine how to correct for them.

A more robust approach is to use a 'difference-in-differences' estimator, which allows one to compare the 'before-after' treatment change in the outcome variable for the treated firms with that observed for the same time interval among the firms in the control group.[55] Since it is based on the comparison of changes, this method is robust to firm-specific effects that do not vary with time (i.e. they are differenced away).

To sum up, for the quantitative impact evaluation analysis on ICT vouchers, we have presented a combination of matching techniques (first step), with the difference-in-differences estimator (second step). In this perspective, information needs that build up a coherent counterfactual should be evaluated according to the programme's targets and planned from STEP 1, as highlighted in Box 1.

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datasets contain detailed industry classifications (4-digit) and they mimic the official size distribution for most European countries.

52 See Caliendo (2006) Ch. 2 and Ch. 3; Angrist and Pischke (2009); Imbens and Wooldridge (2009).

53 Note that the higher the number of characteristics on which treated and non-treated firms are matched, the lower the probability of finding an appropriate match for each treated firm.

54 This works if there are no time-varying effects that can affect the firm's performance before and after the treatment.

55 The assumption is that there are no firm-specific, time-varying effects.

5. Conclusion

This report focuses on support systems for the adoption and development of information communication technology (ICT) and digital innovation among small- and medium-sized enterprises (SMEs) to enhance their competitiveness and growth. In particular, the report looks at ICT and digital innovation voucher programmes in depth. It seeks to determine how an effective programme could be designed, by considering those factors and market failures that specifically affect SMEs. It then presents the different stages of voucher programmes and discusses the options available in each, along with their *pros* and *cons*.

This paper suggests that the effectiveness of these ICT innovation voucher programmes may very much depend on the choices made by the government that implements them. The relevant options in the design of an ICT innovation voucher programme, along with other public support for innovations, need to be evaluated in depth, specifically referring to the setting in which they will be applied in order to increase their efficacy and penetration. Particular attention should be given to running a preliminary analysis on local SMEs' needs for ICT/digital innovation. This analysis would provide precise and relevant information for the design of ICT innovation voucher programmes. Note that there is no "one-size-fit-all" ICT innovation voucher programme, and this really is a case in which 'the devil is in the detail'.

In order to evaluate the impact of ICT innovation voucher programmes, indicators (i.e. input, output and behavioural) for additionality and their information needs are also presented, along with the suggested timing for data collection. The development of counterfactual analysis for the final assessment of an ICT voucher programme is also discussed and the main issues in the definition of a control group are addressed.

This report emphasises the importance of carefully planning and conducting an impact evaluation of ICT innovation voucher programmes. In this perspective, prior to the implementation of the voucher programme, the government implementing it should define which indicators for additionality will be adopted. It should also specify how to build a counterfactual for the impact evaluation analysis, making clear what information is required and at what stage it should be collected.

In designing a voucher programme, particular attention should also be paid to information flows among the agents involved in the voucher programme (i.e. delivery agency, potential and effective recipients, KSPs, institutional regional/local actors). The use of an e-platform to collect and share information about the programme could be envisaged, provided that both the potential and actual recipients/agents of the vouchers involved can afford it. If information flows underlying the implementation of ICT vouchers are properly addressed, both formal and informal cooperative interactions - exploited by SMEs in their daily business and innovative activities - could benefit from the programme itself. ICT vouchers could push informal cooperative interactions towards (further) innovative paths, reinforcing local innovative networks and digital activities in the SMEs' supply chain. ICT vouchers could also foster formal cooperation by SMEs with KSPs, research centres and universities. This would strengthen investment and adoption of ICT/digital innovation by SMEs and thus enhance their competitiveness and growth. Many research papers argue that both formal and informal cooperative interactions stimulate knowledge and innovation[56] and, from a social point of view, they could be highly important. In this perspective, ICT voucher programmes have great potential as a driver for cooperative innovation.

[56] See Cassiman and Veugelers (2002); Bonte and Keilbant (2005), De Faria et al. (2010) among others.

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EU:

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