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**Why and how innovation vouchers work: disentangling the roles of serendipity and funding[[6]](#footnote-7)**

**Abstract**

Innovation vouchers are policy instruments supporting the collaboration of SMEs with specialized knowledge suppliers. These innovation vouchers are typically appreciated by beneficiaries because of their simple application and reporting procedures. However, because of their small size, innovation vouchers seem to have relatively limited impacts.

This study analyses the outcome of an innovation voucher scheme through a survey of 582 Italian firms receiving these vouchers in 2011. Findings show that the voucher effects are mainly indirect: the vouchers foster new skills development and trigger unforeseen results. Given the local nature of the voucher measure, results also control for geographical, technological, and social proximity among beneficiaries and suppliers.

**Keywords**: innovation policy, innovation vouchers, output additionality, serendipity, non-geographical proximity

*JEL Classification codes: R11*, *O31*

**Word count:** 10,261

# Introduction

Coe and Helpman (1995) spurred a vast literature providing evidence on the fact that domestic R&D contributes significantly to a country’s productivity growth. R&D stimulates the growth not only directly through innovation, but also indirectly through technology transfer, i.e. by improving the ability of firms to learn about cutting-edge advances (Griffith et al., 2004; Guellec and Van Pottelsberghe de la Potterie, 2002).

Moreover, small firms use informal networks to gain information concerning product development, competitors and other business-related issues (Kingsley and Malecki, 2004; Caragliu et al., 2019). Openness to external inputs improves innovative performance and provides the basis for learning effects, increasing the benefits of future openness (Love et al., 2014). Face-to-face encounters and casual information flows are part of the so-called *cafeteria effects* beneficial to innovation (Camagni, 1991). These *happy accidents* can be triggers, catalysts and accelerators of ideas and actions.

Sourcing external knowledge makes firm innovation activities more efficient, as firms can learn from benchmarking, external ideas, knowledge and problem-solving approaches, and identify new opportunities for innovation (Asimakopoulos et al., 2020). Governments can improve competitiveness through policies to foster learning, technology development and firms interaction (von Tunzelmann, 1995). Policy-makers support inter-firm collaboration because firms with networking experience are more inclined to enter new alliances, fostering a virtuous self-reinforcing cycle (Gulati, 1999).

However, Small and Medium Enterprises (SMEs) tend to rely more on the knowledge contained in the vertical chain (suppliers, customers’ manufacturing operations) than on research organisations (Cohen et al., 2002). Indeed, knowledge institutions seldom see benefits in working with small firms (Massa and Testa, 2008). Moreover, traditional national and regional funding schemes are, in many cases, administratively too burdensome for SMEs, and the long time necessary to obtaining funds does not fit with the needs of firms often pressed by fierce competition (Sala et al., 2016).

The last piece of this canvas is related to the geographical, social, and technological context where firm collaboration takes place. In fact, a niche but relevant Regional Science literature discusses the perks of geographically close locations (Capello, 2009) and technologically and socially coherent productive environments (Caragliu, 2015 and 2021). The closeness of actors and regions along these axes is often labelled *proximity*; this is typically found to be conducive to easier cooperation and more effective knowledge diffusion among actors and regions (Capello and Caragliu, 2018).

To bring together the pieces of the puzzle, this paper focuses on innovation vouchers. Innovation vouchers are policy instruments meant to support the networking activities of small and medium enterprises (SMEs). Issued by a regional or national government agency, they consist of mini-grants funding the acquisition of external knowledge (Sala et al, 2016). Known also as Technological or Technology vouchers, they finance services related to new product/services development, process improvements, patenting, audits, or other knowledge-intensive services (Iazzolino, 2013).

Initially introduced to make expertise from universities and public research centres available to beneficiaries, innovation vouchers have been extended to cover a wide range of services provided by a variety of knowledge suppliers (Coletti and Landoni, 2018). They have been categorised as part of clustering and networking policies (Brown and Mason, 2014), though Shapira and Youtie (2016) include them among technology and innovation advisory services.

Despite the potential impact of innovation vouchers on SMEs innovativeness, this topic has received limited coverage in the scientific literature, and often with contrasting evidence. This paper provides insights on the innovation voucher’s effectiveness by quantitatively analysing a scheme proposed in Italy’s Lombardy. The Lombardy regional authority was among the forerunners in Europe by introducing the voucher scheme in 2003 with the aim of nudging SMEs to adopt a more open approach to innovation by collaborating with knowledge suppliers. Our data are based on a unique survey that, to the best of our knowledge, is the largest ever carried out on this topic, covering a cross-section of 582 beneficiary firms.

This paper presents three main novel contributions to the literature of innovation in cities. *Firstly*, our work aims at shedding light on the benefits of vouchers exploiting the largest quantitative survey ever collected on this topic. *Secondly*, given the inherently local nature of the innovation voucher scheme, we also assess whether, and how, the impact of vouchers depends on the local characteristics of firms and territories where the voucher scheme has been enacted, through the notions of geographical and non-geographical proximity. *Lastly*, our work relies on the latest identification techniques to rule out possible reverse causality issues,[[7]](#footnote-8) thereby identifying the direction of causality in the voucher scheme.

The paper is organized as follows: Section 2 critically reviews the relevant literature for this applied study and introduces the research questions. Section 3 describes the empirical methodology adopted to address those questions, the effects investigated, and the data collected. Section 4 discusses the results of the empirical analysis by breaking down the effectiveness of the voucher into the three effects described in Section 3. In Section 5, the managerial and policy implications are presented.

# Literature review

### 2.1 Collaborative innovation and SMEs

Firms increasingly leverage the competencies and skills of external actors to develop new ideas and products (Chesbrough, 2003). They rely on external ideas and knowledge to innovate (e.g. Dodgson et al., 2006), so they can acquire most technologies even without internal R&D functions (Gassmann, 2006). Companies that have entered into cooperative agreements with knowledge providers report a higher proportion of their sales due to innovative products (Abramovsky et al., 2005). Successful economies have robust, yet adaptable, network connections, so that organizations can work together to use new knowledge and transform it into new products and services and improved processes and capabilities (Dodgson et al., 2011).

Social networking leads to knowledge serendipity (Baruffaldi et al., 2017; Carayannis and Rakhmatullin, 2014). A networking policy may induce serendipity and strengthen the whole ecosystem (Spigel, 2017). Serendipity relations are those whereby one unexpectedly meets people bringing valuable knowledge or who introduce other valuable people. Other forms of serendipity are analytical, described as a combination of concepts, or temporal, when an unexpected circumstance provides an opportunity that would be otherwise missed. Serendipity is crucial in many scientific discoveries, although it depends on chance and wisdom (Copeland, 2019).

Large firms are more likely to maintain ties with public research organizations, thanks to their internal R&D labs and researchers (Kim and Marschke, 2005), allowing for an effective combination of internal and external knowledge (Barge-Gil, 2010; Cohen and Levinthal, 1990). By contrast, SMEs tend to have fewer collaborations with external sources of knowledge (Tether and Tajar, 2006) and prefer collaborations with suppliers and customers (Doloreux, 2004). Generally, SMEs interact insufficiently with knowledge suppliers; this behavior reduces the potential of external sources to stimulate innovation (Un et al., 2010). In fact, the value and potential of collaborations are difficult to assess for SMEs; therefore, they do not master the skills to manage those relationships (de Jong and Hulsink, 2012).

Yet, contrasting evidence suggests that small firms would instead be more capable of leveraging knowledge from external sources than larger ones (Link and Rees, 1990; Acs et al., 1992). SMEs enjoy a comparative advantage in exploiting knowledge spillovers from external sources (Acs et al., 1994). Knowledge suppliers are an important option for SMEs to foster their competitiveness, because these firms are unable to cover the spectrum of knowledge and technology needed for their R&D efforts.

In smaller firms, internal innovative activities are often haphazard because of their difficulty to sustain financially internal R&D (O'Regan and Kling, 2011). Therefore, SMEs need to be supported when choosing their knowledge partners and learning to collaborate with them (Coletti and Landoni, 2018).

### 2.2 Innovation policies

The rationale for subsidizing research activities is classically based on the notion of market failure. When the private rate of return to the potential innovator is too low to invest in an innovation, while the social rate of return for the rest of the economy is high, firms will underinvest in R&D w.r.t. the social optimum. Another policy rationale is the systemic failure approach. Rooted in evolutionary economics, it has been proposed either as an alternative to the market failure rationale or as a more general and comprehensive form of failure (Bleda and Rio, 2013). The main tenet is that innovation is the result of complex processes whereby several agents exchange and create resources and knowledge. Therefore, learning is not only an individual but also a cumulative and collective process. Public and private organizations interplay systemically in a context-specific fashion, which makes difficult to identify an optimal situation, though it may still be possible to understand when the system does not work efficiently. Systemic failures might occur if these mechanisms are not efficiently working. Bach et al. (2014) identify four types of failures:

* infrastructural, which relate to the lack of facilities such as research centres and laboratories;
* institutional, such as laws and regulations, but also political and socio-economic norms and values;
* capabilities, relating to the cognitive capacity of agents in the system and their limits;
* interaction, when the coordination between the agents is not enough or too much, hampering innovation in both cases.

At every institutional level, policy-makers promote research and innovation to improve the competitiveness of their territories. Despite the importance attributed to R&D policies, a major concern of policy-makers is how they can foster innovation thereby maximizing the impact of public funding on the competitiveness of a productive system (Bronzini and Piselli, 2016). On the other hand, government intervention in science and technology could displace or crowd out private resources (González and Pazó, 2008). Moreover, beyond a certain level, public support becomes ineffective (Guellec and Van Pottelsberghe de la Potterie, 2003). This issue is even more important when, due to tight public budget constraints and increasing global competition, the chances of European firms to create new jobs and to maintain high standards of living are threatened (Missikoff et al., 2012).

The benefits from policy initiatives are called ‘additionalities’. Input additionality is the investment in R&D that the beneficiary would not have done without public subsidies. Output additionality is what was developed thanks to the subsidy, being new products, improved processes, or the innovation pipeline and related knowledge. Behavioral additionality is both the beneficiary’s increased innovation capabilities and the involvement in new business relationships (Coletti and Landoni, 2018). In practice, things are less clear-cut: Antonioli et al. (2014) define behavioral additionality as the change in the way a company carries out R&D and includes improved competencies, cooperation with business partners, and extra-regional collaboration as the elements to measure it. Output additionality is more elusive and subject to a wider range of definitions. Besides the typical increases in sales and turnover, there may be new prototypes and patents, but also learning, attitude changes, and new collaborations (Cunningham and Gök, 2012).

Collaborative research projects increase the innovativeness of companies and the innovation output is proportional to the amount financed by the firms and to the number of partners, which points out to the importance of knowledge spillovers among participants (Szücs, 2018). However, there is an ongoing debate on whether R&D subsidies crowd out firm-financed R&D activity, or rather complement it (input additionality, or crowding-in effect). Certain scholars affirm that public funds foster private R&D investment (BenHassine et Mathieu, 2020), whereas others found evidence of crowding-out especially for larger subsidies (Marino et al., 2016). Because SMEs have limited resources in all business functions, when they receive public funds for research activities, they could divert some of the R&D capabilities to support the non-technological elements of the subsidized product. This should not be seen as partial crowding-out or a limitation of input additionality, but a way to maximize the chance of success of the development activity and thus enable full additionality (Radas and Anic, 2013).

R&D grants increase innovation outputs such as patent applications especially for small firms (Bronzini and Piselli, 2016). R&D and innovation capabilities of SMEs can be increased by public subsidies, though there is a positive correlation between the initial R&D capabilities of the firm and the outputs fostered by these subsidies (Radas et al., 2015). Understanding the outcome of innovation policies is crucial when public funds are limited. Funds need to be directed towards promising projects rather than assigned to companies that do not need them (Marino et al., 2016).

In other words, R&D subsidies should make a positive impact, both at the firm level and the regions involved. To stimulate innovation, policy-makers can adopt a range of instruments, which are usually clustered into two main categories (Rothwell and Zegveld, 1981; Edler and Georghiou, 2007):

* Supply-side policies, defined as “*instruments providing additional inputs for the private innovation process*” (Aschhoff and Sofka, 2009; p. 1236) which include R&D funding or tax credits.
* Demand-side policies, defined as “*public measures to induce innovations and/or speed up diffusion of innovations through increasing the demand for innovations, defining new functional requirements for products and services or better articulating demand*” (Edler and Georghiou, 2007; p. 952). Such measures include systemic policies, regulation, and public procurement (Gheorgiou et al., 2014).

At first, innovation policies were implemented through supply-side schemes such as the funding of science through collaborative projects or fiscal incentives to R&D spending (Georghiou, 2006). Segerstrom (2000) found that permanent increases in R&D subsidies trigger higher firm investments in R&D expenditures. However, this does not directly translate into more innovation, because with more R&D resources, technological complexity increases rapidly, too. This causes a decline in the productivity of the R&D function, and, consequently, the innovation rate declines over time. Supply-side instruments aim at supporting the recipients to innovate more quickly or in different directions, as the interaction with new partners may cause (Edler et al, 2016).

More recently, policy-makers started to pay more attention to demand-side policies to enable entrepreneurs to commercialize their ideas on the market (European Commission, 2009). Demand-side instruments foster demand for innovation by public and private organizations. However, if demand-based measures are rolled out prematurely, there is the risk of high transaction and learning costs (Izsak and Edler, 2011). It is crucial to identify the success factors driving the effective implementation of demand-side measures, especially when new measures developed in a country are replicated in a different context.

Nonetheless, many public programmes aim at strengthening the interplay of demand and supply, therefore the distinction between the two kinds of instruments may be not so straightforward in practice (Bleda and Del Rio, 2013). In this sense, it is worth mentioning a classification of innovation policies as basically belonging to three subsequent waves, the first (taking place after WWII) institutionalizing government support for R&D with the goal to address market failures; the second, following globalization mega-trends, and stressing the role of national and regional systems of innovation for knowledge creation and diffusion; and the third, recently emerging and connected to present-day social and environmental challenges, requiring transformative change (Schot and Steinmueller, 2018).

### 2.3 Innovation vouchers

Linkages between SMEs and knowledge suppliers can foster innovation. However, SMEs are not very effective at identifying their needs and access relevant knowledge (Hussler et al., 2010). Some guidance to address these weaknesses can be useful. Technology and innovation advisory services are real services that differ from general business support because they are directly provided to SMEs by specialists (Shapira and Youtie, 2016). These services may include audits, consulting, financial analyses, supplier and IT solutions sourcing, with the aim of business operations improvement in terms of productivity, efficiency, quality, and of course innovation. Their main targets are small firms with an established business cycle and a mature technology focus. The government may support technical services and advice as well as innovation network schemes. These policy instruments are considered supply-side when they target preliminarily producers of innovation, i.e. the beneficiary firms.

The innovation voucher, called also or technology voucher, is a type of technology and innovation advisory service increasingly popular in Europe. Éupolis Lombardia has mapped more than 50 voucher initiatives in European Countries and Regions since 2003 (De Crinito et al., 2013). Innovation vouchers are financial provisions in the form of a credit note intended to foster links between SMEs and knowledge providers by financing the acquisition of specialist services (Sala et al, 2016). These instruments foster collaboration by empowering SMEs to establish relationships with knowledge holders while providing an incentive for the latter to work with SMEs (e.g. Cornet et al., 2006).

The main features of innovation vouchers can be summarized as follows (Schade and Grigore 2009):

* They are issued by national or regional policy-makers with a specific commitment to pay the service provider (or to reimburse the firm’s expenses)
* The contribution paid is generally small. In fact, vouchers range from 500€ to 25,000€, with an average of 8,000€. In many cases, projects are not evaluated, but beneficiary firms need to match public funding with private resources (up to 50%)
* Types of services that can be acquired with the voucher are proofs of concept, technical development, testing, design, and technology exploration. In some cases, consulting services (innovation management, intellectual property rights, business process re-engineering, and market studies). Only a few schemes involve training.
* Eligible service providers differ among programs. Often public or semi-public bodies such as universities and research labs are those that can deliver the services.
* Innovation vouchers are lighter and more flexible than standard funding schemes in terms of the application procedure, time to receive approval, and reporting.

Although the policy’s broad rationale is consistent, innovation vouchers schemes have been implemented in many different ways, which may significantly affect their impact (Flanagan et al., 2011). Moreover, given the small amount of money involved, it is rare to see a huge impact of these programs (Bakhshi et al., 2015). However, even small grants can have a significant impact on smaller firms, because their limited access to capital makes additional resources welcome, but also for the so-called certification effect, i.e. receiving a public grant certifies a firm’s quality to banks making it easier to obtain loans or credit (Srhoj et al., 2019).

The first study on innovation vouchers was conducted by Wintjes (1999) on the Limburg experience. The assessment was carried out by means of interviews with SMEs that had received the voucher, leading to the conclusion that vouchers were effective in solving technical problems, but there was no evidence about lasting effects. By introducing a control group (i.e. a sample of firms that had not received a voucher), Cornet et al. (2006) added insights on the effectiveness of vouchers. Observing the SMEs involved in the Dutch voucher programme, they found that without public funding most beneficiaries would not have involved external providers in their projects, in other words, they provided evidence of behavioural additionality. An analysis of the same Dutch program showed that while knowledge-intensive firms collaborate quite easily with knowledge suppliers, this is less frequent for more traditional companies, due to their limited absorptive capacity. Therefore, the former may not need the subsidies, while for the latter the voucher may not be enough to build mutual understanding with universities, triggering little behavioural additionality (Noteboom and Stam, 2008). Moreover, Radas and Anic (2013) found that the more advanced the beneficiary firms, the better it is able to leverage the financial support provided by vouchers. Interestingly enough, they discovered higher additionality in projects involving universities and research centres as knowledge suppliers, than in those involving private companies, which often were already business partners of beneficiary firms.

Assessing the impact of the voucher scheme that involved the University of Szczecin and Polish entrepreneurs, Szymański (2011) found that the benefits were both for the knowledge supplier and the recipients. The firms acquired scientific knowledge applicable to business, while the academics confronted real issues and learnt business practices. In many cases, further contracts were signed between beneficiaries and the University.

However, van Hemert et al. (2013) claim that the interaction of SMEs with universities triggered by voucher schemes focuses on the early stages of innovation, but small firms need support also in the following phases of development and knowledge interaction would be beneficial also in the commercialization stage.

A study with over three hundred British micro and small had received voucher grants found that the biggest benefit of innovation vouchers was the increased openness of their managers to external knowledge (Chapman and Hevitt-Dundas, 2018).

Sala et al. (2016) found that voucher programmes do not deliver homogenous impacts. They also showed that in some cases, these instruments led beneficiaries to improve their innovation processes reducing the time-to-market, i.e. proving output additionality. Concerning input additionality, they found that often projects would have been carried out anyway, so there was some crowding out. However, the several follow-up projects implemented without public money may imply that vouchers have triggered fresh investments in innovation. Moreover, this study shows that most beneficiaries were already acquainted with collaborative innovation and its public funding, though they attribute this to the “first come, first served” distribution mechanism, which penalises the firms that have never accessed this kind of programs. Analogously, an assessment of Czech innovation voucher schemes found that firms from the most advanced regions benefit more than firms from less advanced parts of the country (Klímová and Žítek, 2020).

### Proximities in knowledge diffusion

The last branch of literature that needs to be briefly summarized here is related to the concept of proximity. The first half of the twentieth century witnessed the emergence of quantitative economic studies whose modelling framework was based on a frictionless world where space played no role. This statement leaves room for notable exceptions, mainly in the celebrated Hotelling model (Hotelling, 1929) showing the role of spatial imperfect competition for the formation of market areas, and the economic/geographic school describing the mechanisms leading to the formation of urban hierarchies (the celebrated Central Place Theory spurred by Christaller, 1933 and Lösch, 1940).

Dissatisfaction with this simplistic approach eventually led to the emergence of a new discipline, regional science, founded by Walter Isard (Boyce, 2003), precisely with the aim to look more closely at the proximity mechanisms enhancing, or hampering, economic interactions.

While initially this literature focused primarily, if not totally, on the role of geographical space as a lubricant of economic exchange, subsequently first theoretical, then empirical work shifted towards a more complex view of proximity (Caragliu, 2022). In fact, proximity can be broken down into several classes beyond pure geography. For instance, higher technological proximity may foster inter-regional knowledge diffusion (Caragliu and Nijkamp, 2016). By the same token, social proximity between local actors can stimulate firm productivity (Becattini et al., 2009).

This paper will delve into the role that geographical and non-geographical proximity play in shaping the impact of local innovation policies.

### Research questions

The extant literature provides ambiguous and incomplete answers regarding the effectiveness of innovation vouchers. In this paper, we address three specific issues loosely related to the additionalities previously introduced, addressing different forms of outcome additionality. The first issue is whether receiving a voucher improves the firm’s economic performance in a direct way, i.e. causing turnover increases. This is consistent with the concept of output additionality even in its narrowest interpretation. A second issue is whether the beneficiary firm acquired new skills during the collaboration with the knowledge supplier entailed by the voucher. Many authors will agree in qualifying also this one as an output additionality (Cunningham and Gök, 2012). A third question investigated here, and one under-researched in the innovation policy literature, is whether the collaboration funded by the voucher spurred results that were not initially foreseen. Though the term ‘results’ can be quite generic, it has a character of tangibility that allows one to classify it among Output additionalities. However, these are unexpected results, i.e. not those for which the project was funded, and ultimately the taxpayer paid for. Shedding light on this point may help assess the lesser-known and most difficult to measure impacts of voucher schemes. [[8]](#footnote-9)

Therefore, the three questions addressed by our paper are:

*RQ.1 Does the innovation voucher enhance firm turnover?*

RQ.2 *Does the innovation voucher foster the development of new skills within the firm?*

*RQ.3 Does the innovation voucher foster the emergence of results not originally anticipated?*

The analyses reported in this paper aim at providing an empirical answer to each of the three above research questions, thereby capturing three different dimensions of the effectiveness of the innovation voucher. Moreover, we also address a question relevant to the local nature of the policy assessed:

*RQ.4 What is the role of geographical, social, and technological proximities in the voucher effect?*

This fourth question will be dealt with by controlling for local characteristics in driving the impact of the innovation voucher on the three economic outcomes object of RQ.1 through 3.

In the next section we first introduce Lombardy’s innovation vouchers (Section 3.1); next (Section 3.2) we introduce the research methodology and describe the sample analyzed; lastly, in Section 3.3 we describe our indicators of proximity.

# 3. Data and methodology

### 3.1 The Lombardy region voucher program

In June 2011, the Lombardy regional authority opened a call for *Vouchers for research and innovation*; the call was managed by the Chambers of Commerce. The goal of this scheme was to increase SMEs innovativeness through collaboration with knowledge-intensive firms. Consistently with the regional innovation system theoretical framework (Cooke et al., 1997), Lombardy policy-makers aimed at strengthening regional competitiveness by actively involving firms, universities, research centers and other institutions in the implementation of innovative processes.

With a total budget of eight million euros, the scheme funded a wide range of technical and advisory services: technology audits, new product/process development, participation in European collaborative research programs, business planning for startups and hiring of innovation personnel (Regione Lombardia, 2011).

Table 1. Types of voucher, amounts of funds granted, and number of firms surveyed

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Action** | **Type of support** | **Minimum investment** | **Maximum public contribution** | **Number of beneficiaries** | **% of the sample** |
| **A1** | Detection of areas of technological improvement | € 4,000 | € 2,000 | 69 | 12% |
| **A2** | Technological support in innovation projects | € 15,000 | € 9,000 | 65 | 11% |
| **B** | Financial analysis for the development of start-ups | € 7,500 | € 4,500 | 6 | 1% |
| **C1** | Application and management in EU projects | € 12,000 | € 7,000 | 12 | 2% |
| **C2** | Inclusion of firms as consortium partners | € 4,000 | € 2,000 | 11 | 2% |
| **D** | Consultancy in terms of financial check-up | € 3,000 | € 2,000 | 279 | 48% |
| **E1** | Recruitment of a young researcher | € 15,000 | € 12,000 | 41 | 7% |
| **E2** | Recruitment of an innovation manager | € 20,000 | € 10,000 | 99 | 17% |
| ***Total firms in the sample*** | ***582*** | 100% |

*Source: Authors’ elaboration on Regione Lombardia (2011) data*

For each action of this scheme, Table 1 shows the minimum investment allowed to the beneficiary as well as the maximum amount of the voucher. In actions such as A1, C2, and E2, the voucher covered up to 50% of the firm expenditure, while this share peaked at 80% for Action E1. Firms could ask up to three vouchers, but only one for any action.

Beneficiaries were asked to identify, and find an agreement with, a collaboration partner before applying for the voucher, so that they could plan the activity and estimate the budget together with the service provider. For actions A, B and C, firms could select the knowledge partner among a list of structures certified by the regional government. The government provided a public database that allowed beneficiaries to check services competencies, technological infrastructures, previous projects and to compare them. Action A financed solutions to technical issues (duration 6 months); action B supported start-ups in developing a business plan (duration 6 months); action C helped firms in participating in EU projects, from searching the most suitable call and partners to managing the application (duration 8 months).

For action D, firms were free to use the voucher with consultancy firms that could help them to assess the financial sustainability of projects and to perform market analyses (duration 6 months). Action E1 could be used to involve young researchers or post-doctoral students, while action E2 involves professionals with more than 10 years of experience in complex innovation projects. In these last two cases, voucher recipients signed a fixed-term contract for a maximum of 6 months.

As part of the reporting, beneficiaries answered a survey questionnaire. Eventually, 582 responses out of the total of 1,162 beneficiaries were collected, with an excellent response rate of 50 per cent. In Table 1 we detail the number of respondents for each action and their share of the total sample.

Most interventions took the form of financial check-ups (279 projects carried out at the time of the survey), followed by the hiring of innovation managers (99 cases). The survey collected information on the type of voucher received, the impacts of the voucher, and the beneficiary characteristics (R&D and human capital intensity, workforce composition as well as firm’s attitude towards collaboration). Additional information on the respondents and their providers of technical services was obtained by matching data from the Chamber of Commerce with those in the register of authorized providers (QuESTIO).[[9]](#footnote-10)

### Research methodology and sample description

Innovation program evaluation typically takes place by matching treated units to a comparable control group (Klette et al., 2000). However, in most cases treatment (i.e. whether the firm is the object of a policy intervention) is not independent from firm characteristics, because of both direct and indirect channels. Among the first, some firm features may make a company more prone to apply for a voucher. Among the latter, firms with some specific characteristics could be more likely to access the subsidy. In both cases, the treatment cannot be considered exogenous, and methods specific for endogenous treatment must be resorted to in order to make causal inferences about a program’s impact. This is the so-called *Rubin causal model* (counterfactual model; Rubin, 1974), whose key assumption is that treatment assignment is dependent on outcomes because unobservables affecting treatment assignment and outcomes are in fact correlated (Wooldridge, 2010).

In the Lombardy scheme, innovation vouchers differ in the intensity of the treatment among different units, ranging from a maximum contribution of € 2,000 for vouchers targeting technological scouting activities (A1 type), consortium-enhancing vouchers (C2 type) and financial check-up advisory activity (D type), through a maximum co-financing of € 12,000 for hiring junior researchers. The intensity of treatment is what is formally defined dose, and the outcome is termed response (hence, the definition of dose-response function).

Among the responses collected in the questionnaire, three items were selected as measures of firm performance to match the research questions introduced in Section 2.5. Table 2 shows the main descriptive statistics of the three questions (in bold) used as dependent variables in the empirical models as well as for the main covariates used for calculating the GPS.

All dependent variables have a binary nature, i.e. they reflect a yes/no question; the questionnaire verified whether as a consequence of being treated by the voucher, beneficiary firms had witnessed a turnover increase, developed new skills (either managerial or technical), and if they were achieving initially unexpected results.

Table 2. Firm performance and characteristics indicators; descriptive statistics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Obs.** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| **Firm turnover has increased** | 569 | 0.81 | 0.39 | 0 | 1 |
| **The firm has developed new skills (either managerial or technical)** | 562 | 0.51 | 0.30 | 0 | 1 |
| **The firm has achieved results not initially foreseen by the project** | 568 | 0.51 | 0.50 | 0 | 1 |
| The firm had an innovative idea prior to receiving the voucher | 578 | 1.35 | 0.56 | 0 | 2 |
| Log firm turnover | 539 | 13.77 | 1.80 | 7.31 | 18.06 |
| Log amount of funding received | 580 | 8.19 | 0.76 | 7.60 | 9.39 |
| Amount of public co-funding | 580 | 0.58 | 0.13 | 0.06 | 0.80 |

*Source: Authors’ elaboration*

In order to rule out possible bias in calculating GPS, we also included the following control variables:

* firm size, captured by the log of a one-year time-lagged firm turnover;
* the beneficiary firm had (or not) a well-developed innovation idea prior to receiving the voucher.

The second set of data used in the analyses covered the characteristics of the vouchers received by the companies, and in particular:

* amount of subsidy granted (in order to measure possible dimensional effects);
* share of public co-funding, which aims at uncovering possible crowding-out effects or show some input additionality.

Lastly, in order to model the role of local externalities in driving the impact of this policy, in calculating DRFs we also control for geographical, social, and technological proximities among beneficiaries and service suppliers. The indicators are described in the following subsection.

### Indicators of proximities

The local context where policies land may crucially affect the likelihood that (i.) firms get access to the voucher program, and (ii.) that the impact of the voucher is stronger when supporting cooperation between geographically, technologically, and socially close firms. To measure these last effects, we calculate three indicators for firms being respectively beneficiaries (*i* indices in the equations below) and providers (*j*-indexed firms).

* **Geographical distance** is calculated as the distance (in kilometers) between *i* and *j*
* **Social proximity** is calculated, following Basile et al. (2012), Caragliu and Nijkamp (2016), and the implementation in Caragliu (2021), on the basis of a multidimensional matrix of social similarity between NUTS3 areas termed $W\_{soc}$. In *Wsoc*, each entry *i*, *j* is obtained as the difference between endowments of social capital in each NUTS3 area where firms analyzed in the observed sample are located, along the two of the axes defining social capital as suggested in Putnam (2000). Entries are next calculated according to Eq. (1.), which shows that social distance between regions *i* and *j* is calculated as normalized Euclidean distances between regional social capital features:[[10]](#footnote-11)

|  |  |
| --- | --- |
|  | (1) |

where  are social capital indicators (with Q=2). For calculating this indicator we pick up two NUTS3-specific variables available from ISTAT (2021), namely the percentage of firms incorporated as cooperative, as a proxy for community organizational life, and the incidence of petty crime per one million population, capturing social trust (Akçomak and Ter Weel, 2012).

According to this specification, social proximity between regions increases as their social values are more similar; this is corrected by also including at the denominator the pair of regions’ overall social capital, which implies that absolute differences are less relevant when regions couples are both very rich in social capital.

* **Technological proximity** is instead calculatedon the basis of the matrix*Wtech*. In *Wtech*, each entry i, j is obtained as a difference between the ATECO six-digit codes each firm has indicated as their main sector of activity.

We are now ready to illustrate our findings.

# Findings and discussion

### 4.1 Findings

Dose-response functions are calculated with the use of the intensity of public funding as a measure of treatment. The non-negligible heterogeneity across the voucher scopes (Table 1) also translates into varying treatment intensities that can be exploited as dose. Moreover, because the type of voucher firms applied for clearly depends on a number of characteristics, both internal to the firm as well as related to their geographical, social, and technological context, treatment can be considered as endogenous.[[11]](#footnote-12)

Table 3 shows the estimates of the voucher program impact on the basis of an endogenous treatment specification as described in Wooldridge (2010). Columns (1) through (6) vary for the choice of the dependent variable (probability to increase turnover, Columns 1-2, develop new skills, Columns 3-4, and achieve unforeseen results, Columns 5-6, respectively).[[12]](#footnote-13) In Table 3, the POmeans section displays the potential outcome means for the two treatment groups (firms receiving, or not, the voucher). The OME0 and OME1 sections display the regression adjustments (RA) coefficients for the untreated and treated groups, respectively. Lastly, the TME1 section of the table shows coefficients for the *Probit* treatment model.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   | *(1)* | *(2)* | *(3)* | *(4)* | *(5)* | *(6)* |
| *Model* | *Dose-response function, Per capita revenues I* | *Dose-response function, Per capita revenues II* | *Dose-response function, New skills I* | *Dose-response function, New skills II* | *Dose-response function, Serendipitous results I* | *Dose-response function, Serendipitous results II* |
| Average Treatment Effect | -2.318\*\*\* | 1.999\*\* | -171.7\*\*\* | 72.88\*\*\* | -6.278 | 96.81\*\*\* |
| Treated VS. non-treated | (-2.66) | (2.02) | (-3.14) | (2.46) | (-1.39) | (2.59) |
| POmean | 0.825\*\*\* | 0.779\*\*\* | 0.566\*\*\* | 0.546\*\*\* | 0.475 | 0.472 |
| treat=0 | (3.96) | (4.99) | (3.37) | (2.99) | (1.35) | (1.10) |
| TME1 |  |  |  |  |  |  |
| The beneficiary had a clearly defined innovative idea before the project | 0.479 |  | 0.311 |  | 0.407 |  |
|  | (1.24) |  | (0.76) |  | (1.04) |  |
| Log firm turnover | 0.191\*\* | 0.207\*\* | 0.187\*\* | 0.199\*\* | 0.161\* | 0.173\* |
|  | (1.88) | (1.95) | (1.84) | (1.93) | (1.67) | (1.74) |
| % cofinancing | -0.115 | -0.0933 | 0.0495 | 0.0914 | 0.171 | 0.195 |
|  | (-0.05) | (-0.04) | (0.02) | (0.04) | (0.08) | (0.08) |
| Social proximity | -1.776 | -2.384 | -1.365 | -1.724 | -1.693 | -2.206 |
|  | (-0.85) | (-1.11) | (-0.67) | (-0.83) | (-0.82) | (-1.05) |
| Technological proximity | -3.51E-07 | -3.23E-07 | -5.31E-07 | -5.27E-07 | -1.63E-07 | -0.00000012 |
|  | (-0.44) | (-0.41) | (-0.64) | (-0.65) | (-0.20) | (-0.14) |
| Geographical proximity | -0.00161\* | -0.00151 | -0.00127 | -0.0012 | -0.00138 | -0.00128 |
|  | (-1.52) | (-1.41) | (-1.36) | (-1.26) | (-1.40) | (-1.28) |
| Constant term | -4.036\*\* | -3.559\* | -3.929\*\* | -3.651\* | -3.770\*\* | -3.351\* |
|   | (-2.11) | (-1.72) | (-1.95) | (-1.67) | (-1.99) | (-1.63) |
| OME0 |  |  |  |  |  |  |
| The beneficiary had a clearly defined innovative idea before the project | -0.225 |  | 0.0958 |  | -0.323 |  |
|  | (-1.25) |  | (0.79) |  | (-1.35) |  |
| Log firm turnover | 0.0219 | -0.00249 | 0.0436 | 0.0446 | 0.0512 | 0.0309 |
|  | (0.46) | (-0.06) | (1.19) | (1.02) | (0.79) | (0.34) |
| % cofinancing | 0.168 | 0.289 | -0.412 | -0.452 | -0.15 | -0.0156 |
|  | (0.30) | (0.51) | (-0.87) | (-0.92) | (-0.22) | (-0.02) |
| Social proximity | -0.475 | -0.117 | -0.294 | -0.349 | 0.126 | 0.454 |
|  | (-0.90) | (-0.19) | (-0.69) | (-0.68) | (0.15) | (0.35) |
| Technological proximity | -0.00000019 | -1.64E-07 | 2.19E-08 | 3.14E-08 | -1.25E-07 | -0.000000108 |
|  | (-1.26) | (-1.05) | (0.10) | (0.14) | (-0.50) | (-0.40) |
| Geographical proximity | 0.0000821 | 0.000144 | -0.000141 | -0.00013 | -0.00000798 | 0.0000231 |
|  | (0.34) | (0.66) | (-0.73) | (-0.64) | (-0.02) | (0.05) |
| Constant term | 0.791 | 0.664 | 0.104 | 0.228 | 0.322 | 0.0446 |
|   | (1.00) | (1.08) | (0.22) | (0.52) | (0.35) | (0.05) |
| OME1 |  |  |  |  |  |  |
| The beneficiary had a clearly defined innovative idea before the project | 0.783\*\* |  | 15.69 |  | 0.0863 |  |
|  | (1.81) |  | (0.72) |  | (0.09) |  |
| Log firm turnover | 0.108 | -0.237\*\*\* | 9.383\*\* | -4.328\*\*\* | -0.0793 | -5.657\*\*\* |
|  | (1.21) | (-3.64) | (1.90) | (-2.60) | (-0.20) | (-2.37) |
| % cofinancing | 0.473 | 0.0396 | 2.803 | -1.867 | 0.0765 | -6.665 |
|  | (0.30) | (0.03) | (0.02) | (-0.04) | (0.02) | (-0.10) |
| Social proximity | 1.133 | 2.076\*\* | -53.78 | 31.85 | -1.043 | 64.47 |
|  | (0.74) | (1.84) | (-0.70) | (0.84) | (-0.28) | (1.15) |
| Technological proximity | -0.0000007 | 0.000000234 | -0.0000283 | 0.000011 | 0.000000497 | 0.00000491 |
|  | (-1.04) | (0.49) | (-0.65) | (0.70) | (0.20) | (0.23) |
| Geographical proximity | -0.00242\* | 0.00120\*\* | -0.0685 | 0.027 | -0.00168 | 0.0402 |
|  | (-1.74) | (2.19) | (-0.97) | (1.09) | (-0.49) | (1.22) |
| Constant term | -3.977 | 5.723 | -306.5 | 126.8 | -4.685 | 169.5 |
|   | (.) | (.) | (.) | (.) | (.) | (.) |
| TEOM0 | -0.173 | -0.49 | 0.374 | 0.24 | -0.00149 | -0.0717 |
| Constant | (-0.14) | (-0.56) | (0.34) | (0.20) | (-0.00) | (-0.03) |
| TEOM1 |  |  |  |  |  |  |
| Constant | 2.646\*\*\* | -1.976\* | 191.0\*\*\* | -81.23\*\*\* | 7.647 | -109.6\*\*\* |
|   | (2.57) | (-1.77) | (3.31) | (-2.42) | (1.30) | (-2.60) |
| Observations | 67 | 67 | 65 | 65 | 66 | 66 |
| Adjusted *R*2 |   |   |   |   |   |   |

Table 3. Dose-response function estimates of voucher program impact

*Heteroskedasticity-robust standard errors in brackets. \*\*\*, \*\*, and \*: significant respectively at the 98%, 92.5%, and 85% confidence level.*

Results suggest a positive and highly significant association between treatment intensity and the three policy outcomes. Interestingly, across all specifications only when not controlling for having a clearly defined idea is the assessed impact of the voucher positive and significant. This means that the voucher programme really started a process of knowledge churning, evident in particular in Column (6), which tells us that firms not having an initially clear idea developed serendipitous results, that firms that did not receive the voucher eventually did not achieve (as evident by the insignificant potential outcome for non-treated firms).

Estimates suggest that the amount of public co-funding did not have a statistically significant effect, while firm size does enhance the probability to obtain the voucher, which reinforces the expectation that firm size comes with a larger skill set, capable of addressing complex public procurement tenders more easily. Moreover, among other relevant controls, some evidence that geographical proximity between beneficiaries and service providers enhances cooperation is presented, with strong statistical significance for models showing the impact of vouchers on firm turnover (Columns 1-2).

Lastly, the voucher did manage to bring firms located in technological and social contexts together. Evidence about the impact of such factors in driving the effectiveness of vouchers is mixed and typically not significant, thereby suggesting that firms located in technologically diverse spaces and in social contexts marked by cultural differences are not necessarily more prone to cooperate, or benefit more from voucher-types of programs.

A crucial question of this study is whether voucher impact varied along the range of treatment defined by this program. This is graphically illustrated in Figures 1.x, showing dose-response functions of innovation vouchers concerning higher turnover (Figure 1.a), development of new skills (Figure 1.b), and achieving unforeseen results (Figure 1.c). In Figure 1, all LHS panels show level effects, while RHS panels display growth ones.

All figures suggest that the impact of the voucher on firm turnover is positive and significant for relatively limited amounts of funding. As the intensity of treatment increases, response quickly approaches nil. Even controlling for heterogeneity in types of vouchers employed, this outcome suggests that turnover increase is stronger for smaller doses, and quickly vanishes afterwards.

### 4.2 Discussion

Consistently with the small size and narrow scope of innovation vouchers, the literature on innovation vouchers tends to suggest a positive albeit limited impact (Bakhshi et al, 2015). This piece of research focuses on output additionalities such as revenue increase, new skills development and unexpected results. The first two have been at the center of most evaluations (Coletti and Landoni, 2018). However, to the best of our knowledge, this is the first study on a large sample showing the achievement of unforeseen results through vouchers. This is consistent with prior evidence from a multiple case study from two schemes implemented by Lombardy Region in 2003 and 2005 (Sala et al., 2016). Case studies, including three SMEs belonging to the manufacturing sector, three for the ICT sector and one in the chemical industry, aimed at investigating how beneficiaries selected and interacted with suppliers and which benefits and outcomes were accomplished. In almost all the cases, voucher-based projects, devoted to solving technical issues and testing improvements in innovative products, yielded considerable results. Furthermore, it turned out that in four out of seven cases close interaction with knowledge suppliers gave rise to follow-up projects to develop new business ideas.

Serendipity is a key ingredient of discovery (Copeland, 2009), but policymakers tend to shy away from seeking objectives that are not linear or look somewhat haphazard. The main contribution of this paper is in fact that the indirect impact of innovation vouchers can be at least as important as the direct one. Most beneficiaries

Figure 1.a - DRF of innovation vouchers on higher turnover

|  |
| --- |
| **Figure 1.b - DRF of innovation vouchers on development of new skills**  |
| **Figure 1.c - DRF of innovation vouchers on achieving unforeseen results** |
|  |

*Source: Authors’ elaboration*

acquired or developed new competencies through technology transfer from the knowledge supplier, or during the collaboration with them. Another mechanism for acquiring competencies is hiring qualified people, and this was among the actions supported by the scheme.

The achievement of unforeseen results is as much likely as developing new skills, which can be somewhat expected in an innovation project, no matter how small. The survey neither dug into the nature of these results, nor investigated what the beneficiary firms did with unforeseen outcomes. However, it is likely that decisions were taken accordingly. The scope of these projects was broadened in directions not conceivable in the initial proposal. The novelty here is that serendipity is associated with an innovation policy, and specifically with voucher schemes.

### 4.3 Managerial and policy implications

This study confirms that vouchers have a positive impact despite their limited funding. This applies in particular to the Lombardy scheme, where funding was allocated on the basis of a first-come, first-served basis.

Managers can use vouchers as opportunities to test new ideas or explore alternative paths for innovation, or experiment a collaboration with qualified technology and advisory service suppliers. This study shows that besides the hope to increase revenues thanks to the innovation funded with the voucher, there are high chances to acquire new competencies and find valuable though unexpected insight.

Combining our findings with previous studies, we can conclude that through vouchers, managers will not only achieve positive and tangible outcomes but also discover new sources of innovation and improve their attitude to collaboration. It is easy to forget how fortuitous encounters, casual conversations or unexpected outcomes of certain actions spurred new ideas, triggered other actions, and ultimately shaped the future.

The market and system failure arguments that constituted our starting point assume that there are perfect optimal states to be achieved or regained. Through the innovation voucher instrument, specialized suppliers will transfer relevant knowledge to the beneficiary firms so that they can develop their innovation strategy. Our findings suggest that this is beneficial to the system, but the unplanned outcomes are as much as beneficial to both the firm and the system. The implemented projects will certainly be more relevant and inspire more trust in collaboration with knowledge partners. The main implication for policymakers is that unforeseen outcomes should be explicit policy goals for instruments such as innovation vouchers, and programs should be evaluated accordingly.

Innovation vouchers are cost-effective policy instruments in times of limited public resources and financial rigor. However, they can be beneficial even in pandemic and post-pandemic times: with sluggish economies needing stimuli, vouchers help smaller firms to break the isolation in which they may have fallen because of lockdowns. Moreover, they provide beneficiaries access to knowledge and ideas that partly they knew were needed, and partly will come as the unforeseen outcome of the collaboration with the service providers.

# 5. Conclusions

This paper has analyzed the effects of the Lombardy regional authority’s innovation voucher program along three main outputs:

* Probability of increased firm turnover;
* Probability to develop new skills;
* Probability to achieve initially unexpected results.

This breakdown allows us to disentangle direct and indirect policy effects. Empirical analyses have been carried out with a treatment effect estimator, using the intensity of policy treatment as dose and thus minimizing reverse causality issues.

Results hint at the existence of mostly indirect types of impacts. Firms receiving the innovation voucher tended to develop new skills, either managerial or technical, or to find serendipitous results. Our research shows that the indirect effects can be both expected, like the acquisition of new skills, and unexpected, like new ideas or information that will steer the project and possibly the strategy of the beneficiary in an unforeseen but predictably more successful direction.

The evidence found on the role of geographical, social, and technological proximity among beneficiaries and service providers is mixed. Results suggest that firms located in technologically diverse spaces and social contexts marked by cultural differences are not necessarily more prone to cooperate; however, evidence is available on the fact that firms located in close proximity do tend to cooperate more easily, thereby enhancing the impact of innovation vouchers.

The role of serendipity in innovation policies has never been fully acknowledged in academic literature. Based on our findings, it should instead become an explicit goal of policymakers, and therefore subject to evaluation. This is even more relevant in times of post-pandemic recovery efforts, when innovative products and services are the answer to a world that is going to change but no one knows yet how.

Several improvements to our estimates can be foreseen. However, three of them stand above. First, additional evidence on the medium and long-run perception by the beneficiary of voucher effectiveness would be useful. Second, the identification of a control group to make use of more sophisticated program evaluation techniques and further increase the accuracy of the estimated impact. Third, a cost-benefit analysis of how estimated serendipitous findings rank with respect to direct impacts would be beneficial, in order to assess the policy’s real returns to the taxpayers.

# Disclosure statement

No potential conflict of interest was reported by the authors.

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<https://www.tandfonline.com/eprint/RI9SDFKPS3GIKBKQCTMM/full?target=10.1080/10630732.2022.2035886> [↑](#footnote-ref-7)
7. Reverse causality, also termed endogeneity, characterizes econometric specifications whereby an explanatory variable is correlated with the error term (Wooldridge, 2010); this represents a violation of the assumptions of the classical linear regression model. [↑](#footnote-ref-8)
8. The classification of innovation policy impacts as accruing directly, i.e. through channels foreseen by the policymaker, or indirectly, viz. through unintended goals, dates back to Bach et al. (1995), but still representes a sound way to look at these empirical differences. [↑](#footnote-ref-9)
9. QuESTIO is a system designed by the Lombardy regional authority to identify and monitor the Centres of Research and Technology Transfer (CRTT) on its territory. Being listed in QuESTIO is a necessary condition for participating in tenders and calls for financing managed by the Region’s administrative bodies. [↑](#footnote-ref-10)
10. The use of a composite indicator allows to avoid the limitations associated with measuring social capital on the basis of regional trust levels only (Glaeser et al., 2000). [↑](#footnote-ref-11)
11. This assumption has actually been tested. The three outcomes of interest have been proven to be endogenous to treatment with the 5 per cent (higher turnover) and 1 per cent (new skills and serendipituous results) confidence level. This result further reinforces the need for choosing endogenous treatment models. [↑](#footnote-ref-12)
12. The three outcomes may be both conceptually as well as empirically not independent from one another. From a theoretical perspective, this is not a major concern, in that the timing of our analyses leaves room for multiple impacts and the paper does not aim at a comprehensive cost-benefit analysis of the net impact of the voucher scheme, which is left as a future research avenue. From an empirical perpective, only one Pearson’s correlation index, between higher turnover and serendipituopus results, turns out to be positive and saignificant, although the level of correlation remains moderate (=.17).We would like to thank an anonymous reviewer for pointing us at this potential issue. [↑](#footnote-ref-13)