THE SIGNIFICANCE OF THE INNOVATION CYCLE FOR BETTER INNOVATION POLICIES FOR SMES AT THE FIRM LEVEL: A CONCEPTUAL PROPOSITION

Paweł NOWAKOWSKI

Faculty of Social Sciences, The University of Wrocław, Poland; pawel.nowakowski@uwr.edu.pl,
ORCID: 0000-0003-0769-5100

Introduction/background: This paper's aim is to contribute to overcoming the limitations of existing policies intended to facilitate innovativeness. This article addresses the need for more tailored and targeted innovation support measures for small and medium-sized enterprises (SMEs) to help maximize their economic and societal impact.
Aim of the paper: Specifically, the aim is to advance methodological frameworks for segmenting or selecting innovative SMEs by providing a conceptual proposition based on the innovation cycle at the firm level.
Materials and methods: This objective is achieved by exploring the literature on the innovation cycle concept, and adapting the model developed by Abernathy and Utterback (the A–U model) for the purpose of innovation policy. Particular phases of the innovation cycle are transformed into variables and values, and based on the research regarding the behaviour of SMEs illustrative weights are assigned; this assignment depends on the preferred policy approach: either supporting innovativeness in and of itself or supporting innovativeness and an SME's standing in the long run.
Results and conclusions: As a result, the paper presents a tentative working procedure for assessing enterprises according to operationalized criteria derived from the A–U model. Added to this, collaborative efforts in developing innovations are briefly discussed from the innovation policy perspective. It is believed that the new conceptual proposition outlined in the paper will be instrumental in segmenting companies and selecting innovative projects, and will serve policy-makers and intervention organizations in the implementation phase of the innovation policy process, thus contributing to a more efficient and transparent allocation of support instruments by public institution.

Keywords: innovation policy, innovation cycle, decision-making, decision support, SME.

1. Introduction

Innovation policies have become a politico-economic paradigm for governments and public agencies all over the world. Innovation policy comprises a set of interventions aimed to influence the behaviour and decisions of various stakeholders (most notably enterprises)

through a variety of instruments designed to facilitate innovativeness in order to achieve certain policy goals (see Cirera et al., 2020; Fagerberg, 2017). These interventions are targeted at both large companies and small and medium-sized enterprises (SMEs); however, focusing on supporting SMEs has become increasingly popular (see e.g. World Bank, 2014, 2019; European Commission, 2017). The significance of SMEs as beneficiaries of innovation support is recognized due to their important economic role on the one hand and the barriers that tend to hamper their propensity to innovate on the other hand. These barriers include, among other things, a lack of access to finance, a lack of resources, a lack of experience with innovative projects, insufficient capabilities to incorporate innovation activities, and an increased risk of collapse in the event of innovation failure (see Hall and Lerner, 2010; Cirera et al., 2020; Rosenbusch et al., 2011; Victório et al., 2016). Public institution instruments oriented towards promoting SME innovation include, for example, grants, subsidies, loans, tax relief, regulations, standards, and public procurement for innovation.

Innovative projects are selected for grant support based on criteria established by intervention organizations (Victório et al., 2016). As in the case of each policy, innovation policymaking involves a policy process that is usually interpreted as encompassing a few stages, or a cycle (Hill, 2005; Birkland, 2010). Angelelli, Luna, and Suaznábar (as quoted in Cirera et al., 2020, p. 42) indicate the following steps thereof: "(1) formulation of innovation strategies (long-term policy aspirations); (2) design of innovation policies; (3) implementation and supervision of innovation policies; and (4) deployment of innovation instruments and innovation activities." Cirera at al. (2020) suggest that these should be complemented with coordination and planning, which they consider important components.

In recent years, the limitations of existing policies meant to facilitate innovativeness have been noticed, and the need for improvement has been expressed. One of the challenges identified by the European Commission (2017a; cf. Saublens, 2013) concerns targeting existing support instruments to SMEs so as to maximize their economic and societal impact. Viewing this through the lens of innovation policy processes, this issue belongs to the third step, i.e. the implementation and supervision of innovation policy. Furthermore, the challenge in question is directly related to the problem of government failure, which might occur as a consequence of insufficient information regarding the assessed projects and difficulties in analysing that information; it may also be a result of improper implementation, which might stem from the biases of the decision-makers (Victório et al., 2016).

This paper seeks to address the aforementioned weakness and assist policymakers and intervention organizations in advancing innovation policy schemes. I will argue that the innovation cycle is a relevant category that should be integrated into methods of segmenting or selecting SMEs for the purpose of innovation support, and I will propose a tentative working procedure of assessing enterprises according to operationalized criteria derived from the Abernathy–Utterback model (the A–U model). I maintain that the major advantage of taking the A-U model into account is to help public agencies in *ex ante* identification, i.e. deciding

which innovative projects or firms show the most promise for achieving the desired policy goals of an intervention – particularly when it comes to supporting innovativeness per se versus supporting innovativeness *and* an SME's standing in the long run. On the other hand, this refinement could help innovation policymakers avoid misallocating resources, as it would provide a tool for better risk evaluation in the implementation phase. In consequence, this paper is expected to contribute to the improvement of innovation policy processes, and specifically the implementation phase. Having said that, since my proposition is relatively original and conceptual, the aim is to start the discussion rather than provide conclusive findings and fixed solutions.

In the next section, I discuss the conceptual background, i.e. innovation and the innovation cycle. Next, I describe a few phases of the innovation cycle within a firm, most notably the A–U model. Further, I discuss the practical implications and propose a segmenting or ranking approach based on the A–U model. The last section summarizes the paper and outlines research recommendations.

2. Innovation and the innovation cycle

It is vital to adopt an explicit definition of 'innovation' in order to avoid conceptual problems. I adopt here a widely accepted definition – and a definition that is widely used among decision-makers – that was developed by the OECD (2005, p. 46) in its *Oslo Manual:* "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". Hence, two elements of innovation are pivotal: first, that it is something that has already been implemented and as such should be distinguished from an invention that might precede it; and second, that there are four main types of innovation: product, process, marketing, and organizational. Furthermore, innovation is a process (Rosenbusch et al., 2011) that is quite commonly perceived in terms of an innovation (life) cycle.

In turn, the concept of an innovation cycle can be traced back to Schumpeter, who popularized the very term 'innovation' and claimed that product and process innovation plays a crucial role in a capitalist economy (see Mahdjoubi, 1997; Bernard et al., 2014). In fact, particularly since the recession in the 1970s, the attention on his work has increased dramatically (Lemanowicz, 2015; Fagerberg, 2003). Schumpeter emphasizes the dynamic character of capitalism, focusing on the role of intellect and skills in an economy. Hence, he rejects the paradigm of an 'equilibrium economy' as stationary and unrealistic. Added to this, he argues that while radical innovations, underpinned by entrepreneurship and creativity, lead to economic growth, they also cause business cycles that result in inevitable depression,

after which new innovations emerge and drive economic growth again. Schumpeter famously calls this 'creative destruction', thereby showing that the consequences of a business cycle are not wholly negative, as they allow us to set up even more effective companies that offer better products and services (Lemanowicz, 2015). He famously finds that innovation cycles are pertinent to long innovation-related waves of growth (Tinguely, 2013).

Importantly, there has been some controversy regarding Schumpeter's followers. Godin (2006) argues that it is fallacious to claim that Schumpeter supports a processual approach to the innovation model based on a triad of invention–innovation–diffusion, where each component represents respective phases of an innovation process (see Mahdjoubi, 1997). "Innovation is possible without anything we should identify as invention and invention does not necessarily induce innovation," quotes Godin (2006, p. 655) from Schumpeter's *Business Cycles*, and asserts that it was Schumpeter's interpreters, not Schumpeter himself, who proposed a sequential model of innovation.

That said, this seemingly 'Schumpeterian' model has been very popular in the literature. According to Kaya (2015), an invention process first occurs that consists in generating new ideas, i.e. new approaches that may be exploited in a business activity. Inventions are conditioned by scientific knowledge and lack any regularities. The subsequent stage is an innovation process, during which the new ideas created in the former phase are transformed into products and services with market potential. The third and final stage is the diffusion or spread of innovation. It manifests in the loss of the innovator's comparative advantage and leads to the development of the whole economy. This framework can be applied in studies focused on either the firm or macroeconomic level; however, as already stressed, this article deals with the innovation cycle at the firm level.

3. Innovation cycle at the firm level

At the level of a firm, there are two major approaches to the innovation cycle: linear and non-linear. The first corresponds to the cycle derived from the writings of Schumpeter and is based on the reasoning that "innovation starts with basic research, then adds applied research and development, and ends with production and diffusion" (Godin, 2006, p. 639). On the other hand, non-linear models are based on the idea that innovation is not a sequential process (Schoen et al., 2015; Berkhout et al., 2006).

A still very popular (see Udagedara, and Allman, 2019; Bento, and Wilson, 2016; Ozman, 2011; Ian, 2010) example of a linear approach is that of Abernathy and Utterback (1975, 1978), which is critical for the purpose of this paper. Abernathy and Utterback describe an innovation cycle that involves product and process innovations as well as how these relate to each other

throughout the cycle (Ian, 2010). This model comprises three phases of the innovation cycle within a firm (Abernathy, and Utterback, 1978; Malecki, 1981; Ian, 2010):

- Phase I (introduction or fluid phase) – the development of a new line of business (the main innovative effort involves extending the product mix and improving product features).
- Phase II (growth or transitional phase) – process innovations and efforts towards benefiting from economies of scale (main innovative efforts comprise process-oriented R&D aimed at standardization and volume production, where the crucial aspects are the management and organization of production).
- Phase III (mature or specific phase) – ordered and organized management and extensive production based on standardization (efforts are focused on cost reduction, which is achieved by improving management control and standardized production; these are incremental improvements on the products and processes that were created in earlier phases).

Thus, the first phase involves mostly product and/or service innovations, the second phase is dominated by process innovations, and the last involves organizational enhancements and standardized production. The first two phases are the most effort-consuming: the earlier the phase, the more resources a business has to devote to the innovation effort (cf. Malecki, 1981). Adhering to the A–U model, Malecki (1981) argues that the innovation cycle perspective outweighs the product cycle framework, since the former allows for the examination of the processes within a firm more broadly. On the other hand, Ian (2010) discusses the model's limitations and outlines some steps towards improving it.

The European Commission (2015) also considers the innovation cycle as consisting of three stages. The SME Instrument of Horizon 2020 programme addresses its support to companies in the following phases of the innovation cycle: feasibility, innovation projects, and commercialization phase. This approach is similar to the Schumpeterian framework described above, but it is tailored to the logic of the SME instrument that provides funds for companies. Thus, the invention phase is replaced by a feasibility phase, which is justified by the fact that the SME Instrument does not finance mere brainstorming that could lead to ideas that could in turn start the innovation cycle. Potential beneficiaries must present a viable idea before they receive support. Having said that, it needs to be noted that the Horizon 2020 also provides support for research-intensive SMEs. Another recent example of the application of the three-stage innovation cycle – which distinguishes between R&D, trial, and market introduction phases – is the work by Dockner and Siyahhan (2015). On the other hand, Eggers and Signh (2009) provide a four-stage model centred around idea generation, idea selection, idea implementation, and idea diffusion. Another example of the four-stage approach is the study by Hong and Zhao (2017).

However, other researchers such as Schoen et al. (2015) and Berkhout et al. (2006) claim that it is wrong to conceive of innovation as a sequential process. In fact, according to Schoen et al. (2015), the innovation cycle is characterized by the following features:

- the time span of an innovation cycle is often measured in decades,
- non-linearity,
- high importance of market feedback,
- lack of a clearly defined outcome,
- lack of a clearly defined process.

Hence, the uncertain and even unpredictable character of a cycle is stressed. Notably, Schoen and colleagues (2015) point out that one of the most difficult steps for engineers developing technology to take is to move from the invention stage to the innovation stage (i.e. start developing a business model for marketable solutions) since overstating the role of R&D could result in innovation failure. As we can observe, the Schumpeterian stage-based approach might still be involved in the non-linear reasoning on a more general level.

The innovation models used nowadays can be divided into three generations. The first generation represents a linear model based on a 'technology push', inspired by scientific research that leads to commercialization. As Berkhout et al. (2006) argue, the critical drawback of this model is that it does not pay much attention to the market, which often results in releasing technical inventions instead of innovative marketable solutions. Conversely, the second-generation models, also linear, are based on 'market pull', and focus too much "on market-driven improvements of existing products (optimization), resulting in a large variety of short-term projects" (Berkhout et al., 2006, p. 392). Contrary to the first and second generations of innovation models, the third can be characterized by less linear models. These models take into account both technology push and market pull. They focus on product and process innovations, ignoring marketing and organizational motivations. These third-generation models are technology-oriented and do not address institutional barriers or societal needs (Berkhout et al., 2006).

Furthermore, a fourth generation of innovation models has been proposed as more suitable for the new business circumstances created by essential changes in the industry that have resulted in more companies operating jointly across industrial sectors. These models' characteristics are the following (Berkhout et al., 2006, p. 393):

- "innovation is embedded in partnerships: 'open innovation',
- attention is given to an early interaction between science and business,
- hard knowledge of emerging technologies is complemented by soft knowledge of emerging markets,
- the need for new organizational concepts is acknowledged by emphasizing skills for managing networks with specialized suppliers as well as early users,
- entrepreneurship plays a central role".

Berkhout et al. (2006, 2007) proposed their own dynamic and flexible fourth-generation model called the Cyclic Innovation Model (CIM), which is based on cyclical interactions. The CIM is highly dynamic and is based on four 'nodes of change': scientific research, technological change, product development, and market transition. In turn, the 'cycles of change', located between the nodes, allow for mutual impact between processes taking place in the different nodes. Notably, ideas can be created within each node and thus underlie the processes in other nodes. New scientific results interact with industry, and technological changes interact with the market (Berkhout, 2006).

4. Practical implications for innovation policy

Victório et al. (2016) reviewed recent literature on criteria used by intervention organizations for selecting R&D projects. They find that the literature in this field is underdeveloped, especially in regard to public support. Their review reveals a lack of application of the innovation cycle perspective when awarding grants/support; nonetheless, several criteria used by individual agencies can be perceived as corresponding in some way to the criteria that could be derived from innovation cycle analysis. However, as the authors also note, the criteria are sometimes general and thereby not easy to interpret. This is also the case as regards those that could be related to the innovation cycle perspective, i.e.: *maturity of implementation*, *capabilities of firms and partners*, *availability of complementary assets*, *availability of resources*, *availability of technical resources, development risk*, *economic viability*, *creativity, and advanced level*. On the other hand, *A Practitioner's Guide to Innovation Policy*, recently published by The World Bank (Cirera et al., 2020, p. 76), explicitly refers to the innovation cycle in some variation by pointing out that policy measures should support all phases thereof, that is, "the generation of ideas, their prototyping, and their commercialization".

That said, the conclusion from this short introduction to the concept of the innovation cycle is that innovation policy could benefit from a more detailed investigation into the innovation cycle as it is approached in the scientific literature. Indeed, as demonstrated in the previous section, there is no agreement among scientists as to whether an innovation cycle at a firm level has a linear or non-linear character. However, those differences seem to be of a rather secondary importance for policy implications. For including findings derived from an innovation cycle analysis in the methods of segmenting or selecting SMEs for the purpose of innovation support might prove to be successful regardless of whether or not specific phases or stages should be distinguished from one another in the cycle.

An attempt to apply the innovation cycle perspective to grant selection criteria for innovating SMEs is presented below. It is driven by the need to increase the effectiveness of

innovation policies via the better targeting of existing support instruments to SMEs, and it comprises a hypothetical framework based on explorative considerations derived from the review of research on the innovation cycle at the enterprise level. Hence, this attempt should be treated as an invitation for further discussion through providing some insights into a possible use of the framework of the innovation cycle in the innovation policy implementation process.

My main point of reference is the A–U model that was developed by Abernathy and Utterback, which is a linear-type model. Abernathy and Utterback argued that product and process innovations are separated but take place within one model of technological change (cf. Abernathy, and Utterback, 1975; 1978; Malecki, 1981; Akiike, 2013). As mentioned, firms' innovative activities that are related to developing a product or service innovation are the most effort-consuming, whereas activities related to process and organizational innovations are less challenging. Regarding innovation policy, this observation would suggest that support measures should follow the same pattern, that is, the highest support should be oriented towards companies engaged mostly in product or service innovation development. Accordingly, one could conclude that process and organizational innovations should not be prioritized. However, effort consumption does not appear to be an automatically decisive criterion for SME segmentation or ranking.

Notably, Malecki (1981) finds that the second phase of the innovation cycle, i.e. the growth or transitional phase (encompassing process innovations and efforts towards achieving economies of scale and involving process-oriented R&D), might be particularly challenging for SMEs since they may not be able to deal with process-oriented R&D activities aimed at standardization and volume production. These findings are supported by Ortt and Smitts (2006), who argue that firms are often not ready to enter the market with innovative solutions since they lack, inter alia, new organizational practices and do not offer complementary products or services. SMEs might then seek to solve this issue by selling or licensing an innovative output to another, most probably larger company (Malecki, 1981). In fact, research indicates (Arora, 1997; de Rassenfosse, 2010) that small enterprises use licensing more often than big companies, which is due to small firms lacking the capabilities necessary to bring innovative solutions to market. Furthermore, Prabhu et al. (2005) demonstrate that the acquisition of innovation might positively influence the innovative performance of a firm. Clearly, it creates the incentive for larger companies to obtain innovative outputs from outside the firm. However, selling or licensing patents might be challenging, as SMEs possess even more unused patents than large firms (de Rassenfosse, 2010).

On the basis of the above considerations, two approaches to segmenting or ranking innovating SMEs using the A–U model perspective can be proposed. The first rests upon the assumption that an innovation agency aims to facilitate innovativeness per se. The key focus is placed on the process that leads to developing a new solution with market potential, regardless of the level of probability of its commercialization (in terms of an SME's capabilities and resources) and of what kind of companies – SMEs or large firms – may appear to most benefit

from the introduced innovation in the long run. On the other hand, the second approach takes into account both innovativeness and the innovating SME's standing in the long run. The difference is that innovative potential is the only point of reference in the first approach, whereas the second model considers not only the innovative potential of a firm or a project, but also the expected influence that supporting a firm would have on its future behaviour and performance.

Thus, as a consequence of the exploration of the A–U model and its adaptation to the objective of this article, the same variables and values presented for each approach are innovation-type based. Table 1 presents variables, values, and weights differentiated according to a preferred policy approach. For the purpose of illustration, it was assumed that weights can vary from 1 to 3.

Table 1.
A conceptual tool for assessing innovating SMEs based on innovation cycle variables

Variable	Value	Policy approach	Weight
main innovative activities in a firm	focused mostly on a new product or service design	targeting innovativeness per se	3
		targeting innovativeness and the innovating SME's standing in the long run	1
	mostly processes-oriented; R&D activities aimed at standardization and volume production	targeting innovativeness per se	2
		targeting innovativeness and the innovating SME's standing in the long run	3
	mostly focused on improving management control and standardized production, incremental improvements of the products and processes of a firm	targeting innovativeness per se	1
		targeting innovativeness and the innovating SME's standing in the long run	1
enterprises involved in an innovation cycle	two companies – (an) SME(s) and/or (a) large company(-ies)	targeting innovativeness per se	$>x$
		targeting innovativeness and the innovating SME's standing in the long run	x
	two SMEs	targeting innovativeness per se	$>x$
		targeting innovativeness and the innovating SME's standing in the long run	$>x$

Adapted from: own elaboration based on the cited literature.

Thus, if a firm is engaged mostly in product or service design, which is the most effort-consuming activity, the highest weight (3) is assigned to this value, provided that the target is facilitating innovativeness *per se*. On the other hand, when support is aimed at fostering innovativeness *and* the development of the SME in the long run, the proposed weight is the lowest (1). This might seem controversial, but the lower weight stems from the assumption of

a possible risk that an SME would not be able to deal with in the subsequent process innovations (the next phase). The consequence might be that the output with innovative potential would not be commercialized at all, thus keeping policy intervention from achieving its goal. Another, more optimistic scenario, which has already been mentioned, is that the output could be sold or licensed to a larger company. In that situation, however, it could be argued that the large company acquiring a novel output could in fact benefit from the public intervention more than the innovating SME that was expected to be the actual target. On the other hand, one may then claim that selling or licensing a solution with an innovative potential naturally does benefit the SME that created it. Nonetheless, when considering the complex and comprehensive character of innovation policies aimed at creating a broad societal and economic impact, the practice of selling or licensing out new solutions by SMEs to large companies might easily interfere with the holistic dimension of innovation policies. As an example, licensing out does not appear to ensure an SME's independence and stability, which is highly important given their economic role.

When process innovation activities are involved, the situation is different. Namely, if the target is not only innovativeness but also an SME's standing in the long run, the weight is higher (3) than in the case of promoting innovativeness only (2). Besides the fact that process innovation is very effort-consuming, and that SMEs need support at this level, it might be assumed, based on the A–U model, that once the SME is dealing with a process innovation, it has already handled the main efforts related to product or service innovation and is now seeking a way to overcome the difficulties linked to process innovation rather than to selling or licensing the output. Hence, the risk that the output will not be commercialized or that it will be licensed or sold seems much less likely.

Finally, when it comes to activities that focus mostly on organizational innovation, there is no difference in weights for either approach, since there is no higher risk involved for the SME-oriented support. The reason why the weights are the lowest is the expectation that the activities performed at this stage do not involve as much effort or resources, which means that the need for support is relatively low.

An additional situation considered in the conceptual proposal presented in Table 1 is when innovative activities are performed in collaboration by a few companies. Rosenbusch et al. (2011) point out that there is no agreement in the literature about the effectiveness of collaborative innovating. However, in contradiction to a popular view presented in the field of social capital and networking, they report findings from their empirical research that internal innovations have a relatively high impact on a firm's performance compared to a lower impact in the case of collaboration with other companies. They support their findings with other literature and maintain that collaborative innovation development might be unprofitable for SMEs, particularly when it comes to joint undertakings between a small enterprise and a large company. The expected disadvantages include increased complications, more time needed to finalize the project, increased transaction costs, and the inferior bargaining position of small

businesses involved in such collaborations. Instead, the authors advise SMEs to innovate internally. Added to this, Suh and Kim (2012) find that the positive implications of collaborative activities do not tend to materialize for SMEs in the service sector. Furthermore, their findings show the negative results of networking for an SME's propensity to engage in organizational innovation. Furthermore, a more recent study by Najafi-Tavani et al. (2018) finds that collaborative innovation activities do not necessarily facilitate a firm's innovation capabilities, unless the companies have a significant absorptive capacity.

As can be seen in Table 1, the concrete weights for joint undertakings have not been specified, which is due to the inconsistent results provided by the literature. Nonetheless, bearing in mind all the assumptions and analyses, it seems reasonable for intervention organizations to favour working directly with SMEs over working with SMEs and large companies together, unless supporting innovativeness in and of itself is their main target. In Table 1, this is shown with the x and $>x$ distinction.

5. Conclusions

The innovation cycle is a relevant category that may help decision-makers better and more transparently allocate support measures to innovative SMEs. It could be highly beneficial to include the innovation cycle framework within the selection criteria for granting support to SMEs, particularly when it comes to improving the efficiency of existing policy schemes. As shown in this article, the innovation cycle is a broad topic that has been approached in a variety of ways. This paper illustrates a possible application of the A–U model to segmenting or ranking innovative SMEs. An obvious limitation of the study is the lack of empirical evidence; therefore, it would be beneficial to empirically examine the proposed conceptual framework in order to advance the discussion and deliver better-established findings that would help innovation stakeholders more efficiently implement innovation-support instruments, thus improving the innovation policy process.

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