Dieter Dohmen, Galiya Yelubayeva

Adult education and Innovation

Study within the project "Economic and regional costs, funding structures and benefits of continuing education" (VoREFFi-WB)

FiBS-Forum No. 59

Berlin, September 2018

ENHANCING LIFELONG LEARNING FOR ALL

www.fibs.eu

FiBS

**Forschungsinstitut für
Bildungs- und Sozialökonomie**

Research Institute for the Economics
of Education and Social Affairs

Michaelkirchstr. 17/18
D- 10179 Berlin
Tel.: +49 (0)30 8471223-0
Fax: +49 (0)30 8471223-29

Table of Content

FiBS

List of Tables

Annex

FiBS

1 Introduction

A new and challenging task of the research project VoREFFi-WB (Volks- und regionalwirtschaftliche Kosten, Finanzierungs- und Förderstrukturen und Erträge der Weiterbildung) is to contribute to the understanding of knowledge of adult education in the context of innovation and economic development. This paper is an ambitious attempt to do so. Although it presents a preliminary overview of the literature and econometric modelling, the paper identifies several ways in which macro-level understanding of the triggers of knowledge-based economy is important, alongside the more micro-level insights. These insights are valuable for governments, economic sectors, and public and private institutions when they are seeking to improve their knowledge to foster innovation performance, which is increasingly important to function in a learning society.

Involvement in adult education is in the importance of the European Union agenda, especially with fast changing demand for skills and competence and raising migration pressure in EU. Our study demonstrates the importance of work-based cognitive skills in explaining the diversity in the economic performance of European countries. This represents our major contribution to the debate. There is less investigation of impact of adult learning to innovation, especially supported by data and cross-country analysis. The research is concerned with 'human capital' and 'innovation' studies and the importance of working environment for innovation. We aim to investigate: the importance of adult education/learning in improving the capabilities of individuals and organizations, hence contributing to growth and innovation benefits in Europe. While some authors tried to quantify the return on formal education to economic growth, mainly suggesting the long-term impact and using years of schooling as a relevant proxy. We admit that investments in education bring long term returns, especially primary and secondary education. There is a lot of attention given to early phases of education as in general policy concerns ("United Nations Millennium Development Goals," 2000) and in relation to economic growth (Hanushek & Woessmann, 2012) while adult learning considerations in policy agenda is still lagging. However, in the fast changing environment with increased life span and rising demands for skills we attempt to prove that we can reach short-term increased output and innovation if adult education provision is implemented. This paper's contribution resides in a new effort to raise the adult education issue. In this regard, innovation studies may offer a complementary approach to growth literature, where benefits of working environment and adult skills are discussed considerably, while growth literature can complement innovation studies in their approach of statistical modelling.

The first main strand of research aims to describe the key transmission mechanisms leading from the adult education system to macroeconomic reflection in innovation performance. This is broken down into three interlinked areas – following each other in a chain of causality: 1) the link of training and education to individuals, 2) the link of working environment to capacity of firm to innovate 3) the link of adult learning and working environment to country innovation performance. Then we present methodological part with selected analysis description, and results.

FiBS

	Work package 1: Defining further education and its benefits	Work package 2: Literature review in relation to working environment and innovation	Work package 3: The relationship of adult learning, working environment and innovation
Objective	Establish an overview of further education landscape of Europe Analysis of the surveys on further education Establish an overview of endogenous growth theory and its application for innovation studies	Establish an overview of Adult education within the workplace Workplace environment stimulating innovation	Establish an overview of adult learning and working environment to innovation Econometrically test the relationship Cross-analysis of WP2 and WP3 Policy and practice recommendations
Method	Qualitative	Qualitative	Qualitative Quantitative: Panel data analysis
Scope	28 selected European countries	28 selected European countries	28 selected European countries

Table 1 Overview of research approach

FiBS

2 Further education and Innovation

The relationship between the workplace learning and innovation performance has triggered extensive interdisciplinary research throughout the last two decades. To identify the rationale of innovation in organizations and economy, first we need to define the term and elaborate different forms of it. Yet, the meaning attributed to the notion of Innovation differs markedly among both managers and policymakers alike. Innovation was first defined by Schumpeter (1934), who considered innovation to be introduced to the market by entrepreneurs who create and introduce innovations and hence establish "creative destruction" as an essential ingredient of economic development (Schumpeter, Opie, & Elliott, n.d.). This definition of innovation has broadened over the years (see (Fagerberg, Srholec, & Verspagen, 2010) for review). In European Union studies, innovation is understood as the implementation of a new or significantly improved product or process. (Eurostat's Concepts and Definitions Database). The widely accepted term, which will be used in this study is a terminology and definition proposed by OECD in Oslo manual, which defines innovation as "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" (OECD & Eurostat, 2005). That shows the change of the concept of innovation, from a technological approach to a wider perspective, which includes the non-technological innovation and the organizational innovation.

Education and training — the major elements of human capital formation — have long been recognized as indispensable to the development process. This section establishes a conceptual framework for the notion of 'human capital' and 'adult learning', pointing to positioning this research within multiple understandings of what is meant by them. The relationship between innovation and individual's competence and skills are in two directions, that on the one hand, innovation pushes the change and demands new skills, on the other hand, skills drive development of entrepreneurship and innovation.

As largely discussed in the literature some innovation may worse off some groups (usually unskilled labor) and raise inequality averse social welfare function (Stiglitz & Greenwald, 2014). While innovation achieved through increase of skills and learning is sustainable and intended to benefit especially those vulnerable groups and give 'second chance' for social inclusion (*3 GLOBAL REPORT ON ADULT LEARNING AND EDUCATION The Impact of Adult Learning and Education on Health and Well-Being; Employment and the Labour Market; and Social, Civic and Community Life*, 2016).

Many different skills make up human capital – learning acquired at school, on the job training, learning by doing, and shared and social knowledge and conventions. Human capital theory regards education as an investment in the upskilling of individuals which is rewarded through higher productivity, wages and salaries in the future (Johnes & Johnes, 2004; Krueger & Lindahl, 2001). A common trait of human capital studies is that the concept and measurement of this capital and its quality are confined to what is learned in formal education. Despite education and skills are interdependent, this interdependence of the relationship is not perfect. Attaining a prominent level of education does not necessarily guarantee having a high level of skill, nor does it ensure a given skill proficiency for the duration of one's life career. Unlike educational attainment, an individual's skill set can considerably fluctuate over the life course. Some authors suggest that level of education achieved serves only as an expectation of the productivity level (Arrow, 1973; Spence, 1973), background information about socio-economic status and cultural capital (Bourdieu & Passeron, 1977; Collins, 1979). Indeed, skills can be treated to more precisely describe the productivity level as it can reflect knowledge and competencies. Within the recent innovation studies, it is accepted that 'all levels of skills are important, and that a sound basic education is the foundation upon which all adaptive innovation-related skills are based' (Green, Jones, & Miles, 2007). However, the performance of EU Member States regarding educational outcomes whether it is

FiBS

cognitive skills or educational attainment still differs considerably. The skills level difference is also evidenced by the fact that PISA and PIAAC score level differences persist after accounting for differences in students' migrant and cultural background of Member States (OECD, 2017). The current policy systems for adult education also varies (for an European adult education overwiew see papers (European Commission, Directorate General for Employment, 2015), (Bonnafous, 2014)).

There are some aspects that remains uncertain. First of all it is about how to evaluate the various aspects of human capital formation as theoretically it is not very clear how human capital should be proxied. Recent growth studies used cognitive skills data over education intensity (e.g. average years of schooling for the population) or educational attainment levels (qualifications) as this, coming from the standardized OECD methodology tests (PISA, PIAAC, etc.) and is fully comparable across countries and regions. In this regard, it is often argued that qualifications or one additional year of schooling do not nearly have the same quality across countries. Especially, during the changing workplace requirements ability to learn along with other skills (digi skills, critical thinking, creative thinking, problem solving, learning how to learn, etc. (Stiglitz & Greenwald, 2014; Toner, 2011)) comes to the first position in the changing structure of economies toward knowledge based society.

Work-based learning, embedded in working tasks, complements more formal forms of continuing training. A range of major European Union policy statutes have acknowledged the potentials of workplace learning for adults, pointed that it requires increased political attention and strategic action and have therefore called for promoting and using it (*RIGA CONCLUSIONS 2015*, 2015).

The further education, including training provided by employers brings positive benefits, including increased job satisfaction and lower absenteeism, and improves the chances of business survival, greater productivity and innovation (Cedefop, 2011). Here it is important to distinguish between individual, company and national outcome of education. Individual outcome from adult education can result in higher productivity and better employment (skill match) and wage. As the individual outcome of education and training is not limited to higher productivity and higher wages so-called non-monetary returns may be considered as well. Non-monetary returns accrue due to better health and safety at the workplace, reduced risk of unplanned pregnancy etc. (FiBS/DIE, 2013; Grubb & Ryan, 1999; Wolfe & Haveman, 1997). As non-monetary effects are probably more relevant for benefits than for costs returns are probably underestimated. Furthermore, several of these non-monetary benefits to the individual accrue also to society and are called social benefits. Regarding to national outcomes we may suggest that the increased participation and skills match leads to lower unemployment rate, higher productivity leads to more economic output and skilled workforce is likely to innovate. Overall, there are strong grounds to believe that adult learning of all kinds results in returns for individuals as well as society as a whole (Cedefop, 2017). However, ith the general improvement of adult education provision, adults with the greatest education and training needs still have the least opportunity to benefit from lifelong learning (European Commission/EACEA/Eurydice, 2015) Additionally, the barriers for the low-qualified vary a lot from the better-off, therefore the vulnerable groups are to be targeted properly by addressing their specific needs jointly (Dohmen, 2016).

Learning through working or while working implies that the work environment is organised in a way that encourages workers to take some degree of responsibility to solve problems by themselves. From that the workplace itself has become a source of learning (Jovanovic & Nyarko, 1995). In these lines of thought research of learning at the workplace deserves to be fully explored.

On-the-job learning is dependent on workplaces that provide quality work, in which people learn by having to undertake challenging tasks, by using their judgement, applying new knowledge and learning from their peer workers (Fischer & Boreham, 2004). Nowadays when one's skills became the proxy of

FiBS

innovativeness, the literature defined broad range of 'generic' or 'employability' skills. And some authors argue that generic skills are derived from formal learning, however the 'employability' skills which are specified to tasks complexity and problem solving in organization, and accordingly "the primary location for the creation and development of higher order work skills remains the workplace" (Payne, 2017).

Work-based learning is therefore crucial for maintaining the level of skills and developing skills, irrespective of the initial level of qualifications. It is essential to improve learning opportunities as such environment makes employees to be open to changes. However, there are some studies which implied that workplace learning do not outperform more formal forms of training, but still firms can complement workplace learning through workplace learning to improve the firm's outcome (Cedefop, 2010).

FiBS

3 Features of organization – that stimulates learning and innovation

Organizational learning is also nowadays cautioned not to use interchangeably with the notion the learning organization, and learning undertaken by its individuals (Genkova & Ringeisen, 2017). Additionally, there is an ongoing debate on differences of notions of organizational climate, organizational culture, organization of work and organizational context .However, within this paper we will limit our discussion with the set of features needed for 'learning' in the organization and with these foundations in place, we turn to a discussion of operalization of components of organizational learning. Therefore, measuring the level of organizational learning we consider the related indicators of learning embedded in organization structure.

The firm's ability to innovate moved to the central stage of discussion as there are some studies revealed that innovative firms tend to demonstrate persistent profitability, sales growth, greater market value, and improved survival changes (Tsoukas & Mylonopoulos, 2004). Many studies revealed the importance of tacit knowledge and specific organizational forms that can enhance the intellectual potential (Dierkes, 2001). This is the case of the work by Arundel et al. (2007), they show that in the countries where the working environment supports higher problem solving by employees, firms and overall country level has higher activity in the development of endogenous innovation, while countries with higher prevelance of working organization that restricts learning and problem solving while working are more involved in supplier dominated innovation strategy (Arundel, Lorenz, Ke Lundvall, & Valeyre, 2007).

Initially, we will briefly review the relevant literature on absorptive capacity and then on dynamic capabilities as they constitute the main basis of theoretical studies on organizations stimulating innovation. Then we will define the determinants ob both theories, and then give theoretical excurs on the impact of presence of certain components in an organization that can present competitive advantage and give benefits to a firm, and thus to a country level performance. Since the publication of Cohen and Levinthal the research community widely accepted their definition of absorptive capacity as the 'ability to recognise the value of new information, assimilate it and apply it to commercial ends'(Cohen & Levinthal, 1989). The concept usage has expanded widely and found to be applicable from firm level to industry performance (Leahy & Neary, 2007) and entire nations (see (Van Den Bosch, F. A. J., Van Wijk, R., Volberda, 2003) as well as varied usage in different research fields such as industrial organization, strategic management, etc. (Zahra & George, 2002). Cohen and Levinthal (1990) defined the level of the individual and of interaction between individuals as relevant antecedents. According to them "An organization's absorptive capacity will depend on the absorptive capacities of its individual members. To this extent, the development of an organization's absorptive capacity will build on the prior investment in the development of its constituent, individual absorptive capacities." However, Cohen and Levinthal and other research papers regarding absorptive capacity do not provide clear links between the individual's skills and organization-level absorptive capacity. That issue reveals the gap that there should be more research on transmission of individual level capabilities to organizational, then to national level of absorptive capacity. Regarding to the determinants of absorptive capacity, some studies attributed the absorptive capacity to the environmental context of joint ventures, alliance partners, etc. (Stuart, 2000; Volberda, Foss, & Lyles, 2010). Tobias Schmidt defined the three determinants that are embedded in organization- R&D activities, related prior knowledge and individuals' skills, organizational structure and human resource management practices (Schmidt, 2005). Here, he points the importance of individual and organizational learning. Tsai (2001) in his research found that formal hierarchical structure, in the form of centralization, has a significant negative effect on knowledge sharing. In

FiBS

contrast, informal lateral relations, in the form of social interaction, have a significant positive effect on knowledge sharing, thus increasing absorptive capacity of firm (Tsai, 2001).

Second theory, which highlight the firm capacity to learn and innovate is Dynamic capabilities theory. Dynamic capabilities is an extension of resource based view, which is about higher order capabilities. As defined by Teece et al. dynamic capabilities is the firm's ability to "integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece, Pisano, & Shuen, 1997). As defined by Teece, dynamic capabilities are high-order capabilities that an organization uses to shape and deploy its resource base to meet the current and anticipated needs of the market (Teece et al., 1997). Dynamic capabilities are reflected in the capability to 'reconfigure' and 'refresh' existing resources and 'create' new resource bases (Ambrosini, Bowman, & Collier, 2009). Teece (2007) disaggregated dynamic capabilities into three clusters of processes and activities: (1) sensing (the identification and assessment of opportunities), (2) seizing (the mobilization of resources internally and externally to address opportunities and to capture value from doing so), and (3) transforming (continued renewal of the organization). Sensing is an entrepreneurial core capabilities that involves exploring opportunities, probing markets, and scanning the other elements of the business system. Seizing capabilities include designing business models to capture value, and transforming capabilities are about managing to achieve evolutionary fitness (Teece, 2007).

According to some authors, capabilities is about collective learning, which does not depend on individual learning, however to a considerable extent dynamic capabilities influenced by management team (Leih, Sohvi; Linden, Greg; J. Teece, 2015). Organizational design can also influence dynamic capabilities as sensing new opportunities can dictate some changes in business model. That means working environement with high degree of delegation and vertical communication are often better at sensing, and that in turn allows the flow of information with stakeholders (Leih, Sohvi; Linden, Greg; J. Teece, 2015).

After disaggregated vision of dynamic capabilities, we can say that it is what is acknowledged as learning organization. After the consideration of the literature the main idea for us was to identify the features of organizational learning that stimulates innovation. Snell and Morris (2014) argue that concept of dynamic capabilities are backed by the basis of organizational learning. In their view, learning organizations are ones with high dynamic learning capacities, where innovation takes place. (A. Snell & S. Morris, 2014). According to Eisenhardt and Martin, (2000) and Teece (2010) the processes of purposeful and planned learning constitutes dynamic capability which improves innovation (Eisenhardt & Martin, 2000; Teece, 2010). Some authors also see that training, on the job learning is an important part of innovation strategy and related to dynamic capabilities (Lynch, 2007). However on that grounds, some authors argue that changing learning behavious needs changes of routines, collective behavious, which present the biggest challenge for implementing (Eisenhardt & Martin, 2000; Helfat & Winter, 2011). Indeed Teece in his works admits that capabilities are developed by collective learning, however provides little description of dynamic capabilities. We in general from a review of the literature on Dynamic capabilities can indicate key elements of an innovation climate, which include risk-taking and flexibility; job challenge and problem-solving orientation and extensive internal and external communication (Ekvall, 1997; Patterson et al., 2005).

While absorptive capacity and dynamic capabilities theories have the potential to unlock our understanding of the innovation in organisations, their study of these phenomena are limited to cases of specific companies and industry level. The absorptive capacity and dynamic capabilities frameworks are limited in their application, because they have not yet developed sufficient understanding to link the development of capacity and capabilities with organisational structure and strategies, which affect innovation behavior. Additionally, ass pointed by Borras and Edquist, the mentioned theories tend to the

role of educational and training frameworks in development of capability of firm to innovate. They argue that 'firms are highly dependent on the ability of the innovation system to provide them with some fundamental assets that they can develop as their internal competences' while educational and training frameworks that generate and develop competences are vital for the innovativeness of firms (Borras & Edquist, 2015). Here by theoretical analysis we pointed features that form 'absorbtive capacity' and 'dynamic capabilites', and revealed these features in organizations. The microfoundations which treated as delegation of tasks, flexibility, problem solving gives us possibility to select these variable as a study unit and operate in our analysis.

The extended literature considerations have shown that working environments itself provoking continuous learning are likely to create and adapt innovation. OECD study (2005) based on Lorentz (2000) way of mapping European wide work organizations conducted a study of relation of that to innovation. With the regression analysis, they identified that working environment that presents high discretion in learning, solving complex tasks contributes to innovation performance. Their study was the first to move these concepts into an integrated country wide study. On the same vein, Lam (2005) in his work contrasted the two forms of work organization – discretional and lean production. She concluded that they have different impact on innovation. She observed that high levels of discretional learning provide basis for new knowledge and tend to push high capacity for radical innovation. In comparison with discretional learning, lean production is relatively bureaucratic that relies on formal team structures and rules of job rotation. In such organization employee have view of stable career within their company, so that they have incentives for continuous improvement, that contributes to incremental innovation (Lam, 2006). In the study of Cedefop and FiBS (2012), the defined complexity of working environment through complex tasks and problem solving are to have positive significant impact on innovation. Lorenz and Valeyre further, it their studies presented that different working environment tend to demonstrate different modes of innovation and different HRM practices Lorenz and Valeyre presented that different working environment tend to demonstrate different modes of innovation (Arundel & Lorenz, 2007), as well as differences in training systems (Lorenz, Lundvall, Kraemer-Mbula, & Rasmussen, 2016). By another study, job complexity and workplace dynamism show positive correlations in skills development while controlling for workers' characteristics and organizational features. This research was based on data of the European Skills and Job Survey (ESJS) by Cedefop study in 2014 (Russo, 2016).

To operationalize, we can proceed with accepted four types of work organization by OECD: Discretional, Traditional, Taylorist and Lean production. The differences of the organization of work includes many aspects, such as layout of the work, skill mix of those workers on the job, pace of work (speed of an assembly line, quotas), work load, number of people performing a job (staffing levels), hours and days on the job, assignment of tasks and responsibilities, and training for the tasks being performed.

Discretionary working environment is characterized with the high problem solving environment, and where empoyees tend to be highly involved in managing tasks that can generate discretion in the behavior that leads to increased performance. Numerous authors have developed an extensive list of management practices for generating high involvement and high performance among employees. This form of work organization nowadays tends to be called High-performance organizations (HFO). The features characterizing this working environment include long list of autonomous and discretion features such as incentive-based pay, problem solving, team work, flow of information within organization, rotation of tasks, and commitment to training and skill development. Other advantages are the ability of such forms of work organization to increase the potential for innovation that may add value to products or services (Reilly, 2007; The Boston Consulting Group inc., 2011).

Traditional organization of work is characterized with the simple organization of work. It is opposite in all sets to discretional work (Lorenz, Edward, Valeyre, 2005).

FiBS

The Taylorist work organization is named after the US industrial engineer Frederick Winslow Taylor. He emphasized gaining maximum efficiency from both machine and worker, and maximization of profit for the benefit of both workers and management (Taylor, F.W. 1911). The basic fundamentals of Taylorism – aims to achieve maximum job fragmentation to minimize skill requirements and job learning time; separates execution of work from work-planning; separates direct labor indirect labor; replaces rule of thumb productivity estimates with precise measurements (Terence T. Burton, 2015). Nowadays in the literature of International Business the Taylorist work organization is defined by tasks and responsibilities specialization, and a pyramid hierarchical structure. This type of work organization means that each of employees has predefined with narrowed tasks, which is more monotonous and repetitive . However, as noted, this form of organization of work does not provide enough room for innovation (Terence T. Burton, 2015).

Lean production or J-form of work organization include practices designed to involve employees in problem-solving and operational decision-making such as teams, problem-solving groups and employee responsibility for quality control. Such practices of work organizations were developed by large Japanese automobile and electronics firms in the 1970s and 1980s. Many authors under "lean production" associate the working environment of Toyota . The development of Japanese-style work practice transformed the Taylor's approach of task specialization (Bhasin, 2015; Kochan, Lansbury, & Macduffie, 1997).

On macroeconomic level innovation performance, innovation is considered as an outcome of R&D inputs and patents. Even according to endogenous growth models, technological innovation is created in the research and development sectors using human capital and existing knowledge (Romer, 1989). According to it, an initial stock of human capital in a previous period is likely to generate innovation growth and productivity effects, downstream as well as upstream with lots of 'spillovers' and positive 'externalities' (e.g. (Lucas, 1988). This theory postulates that endogenously determined innovation can enable sustainable economic growth. The positive relationship of R&D and productivity growth were evidenced by many authors (Aghion & Howitt, 1990; Hulten, 2010). However there is no direct link between R&D expenditures and successful innovative outcomes as the transmission involves lags and uncertainty (Dosi & Nelson, 2013; Fagerberg, Mowery, & Nelson, 2006). Also in many studies the proxy for innovation served to be patents data, which has multiple disadvantages as patents better proxy product innovation rather than process innovation (Mairesse & Mohnen, 2010)

In the last decade, the Summary Innovation Index (SI) from the UIS was introduced and is frequently used as a catch-all indicator of innovation. Innovation performance is measured using a composite indicator summarizes the performance of a range of different indicators on annual basis. The Innovation Union Scoreboard distinguishes between 3 main types of indicators – Enablers, Firm activities and Outputs – and 8 innovation dimensions, capturing in total 25 indicators (European Commission, 2016). Some researchers - Hollanders and Foray - argue ideas that Innovation scoreboard by using existing data is better at measuring innovation in industry than in services, also they do not provide much information on policies needed. Moreover, due to weighting variations, the index results can be changed. Additionally, for policymaking purposes to improve results in innovation some scores are more 'resistant' to any policy intervention simply because policy in these cases would have to aim at structural changes and major transformations (Foray & Hollanders, 2015). Others argue that the Summary Innovation Index is highly misleading by pointing out that composite innovation indicator need to be analyzed in much greater depth in order to reach a correct measure of the performance of innovation systems (Edquist, C., Vonortas, N. S., Zabala-Iturriagagoitia, J. M., & Edler, 2015). They argue that input and output indicators need to be considered as two separate types of indicators and each type should then be measured individually.

Additionally, simply because a firm's possession of high levels of absorptive capacity or its access to knowledge sources do not necessarily imply that a firm realize its potential out of knowledge (Zahra & George, 2002). On that regard, case studies revealed that dynamic capabilities show no clear spillover ways in knowledge utilization (E. Ployhart & Hale, Jr., 2014). What we have done by analyzing the theories

FiBS

of firm capacity to innovate is provide some insight into how we can model this complexity while still taking advantage of large-scale generalizable empirical survey research. In considered theories, a great proportion of skilled workers increases the ability of a company to absorb and explore the external knowledge and to innovate. Hence, organization of work and provision of training in mutually enhancing phenomena, as based on data of EWCS, it is seen that companies that adopt new forms of work organisation, which encourage innovation, employee autonomy, on-the-job learning and quality management, tend to provide higher training opportunities to their staff (Eurofound, 2017). This could be also explained by the idea, that employees that carry challenging, complex problem solving tasks are likely to need further education, while employees who perform monotonous tasks and easy repetitive tasks tend to feel overskilled and temptate to involve in training.

FiBS

4 Methodology

Guided by the aforementioned research questions, this study explored extensive literature review and recent empirical studies on impacts of education to innovation and its discourse at national level. The rationale for this approach was that the data and results are expected to provide a general picture of the issue from practical point of view.

Before proceeding this part, we want to highlight some previous results finding that naturally lead us to come to our final model.

The results of the joint study of FiBS with CEDEFOP (see Tabel 1) considered the innovation level of countries for 2010 year period and regression is made by OLS. This study shows that cognitive factors are the strongest predictor of the innovation level of a country. Here under cognitive factors meant the organization of work which is characterized with high the complexity of the tasks and high problem solving with the high autonomy, which is somehow can be threated as partially discretionary learning. The recommendations for this set of variables were that Factor score of Organization typology is two timely derived factor score, where initially four factors of different typology of working environments were identified as factors. Then one factor score from four factors were derived characterizing in general the organization of work, but this factor score fails to derive conclusions of what exact feautures and typology enhances or lowers innovativeness. Another variable, which is needed to be revised, is Human Capital Formation, which contained 6 variables, in which two were complex indices. That HCF variable needed desagregation and proper set of variables to consider. The other recommendation was to improve the OLS regression with more advancement ones.

Innovation index (2010)	Factor 1 (Organisation typology)	0.11	0.84
	Factor 2 (Human Capital Formation)	0.27	
	GDP per capita (2010)	0.03	
	Cognitive factors (all years)	0.78***	
	Share of tertiary education (2005)	-0.01	

Another previous study of FiBS leading to the the consideration of that variables given is the study on (FiBS, 2015), where the same set of independent variables were studied over the years. In these Tabelle 1 Resutls of regression analysis from FiBS/CEDEFOP study, 2012

regression models Cognitive factors and Human capital formation seems to be the significant and positively contributing factors to innovation level of a country. With applied time lag effect, we see that over the other years Factor score of human capital formation and organization typology still significant with diminishing rate. That lead to the suggestion that skills have long term impact and if not ceteris paribus upgraded there is diminishing marginal effect saying that skills deteorate.

	Innovation index 2012	Innovation index 2013	Innovation index 2014	Innovation index 2015

Tabelle 2 Resutls of regression analysis from FiBS study (2015)

Constant	-0,153	-0,071	-0,272		-0,256		-0,172	
Factor 1. Organizational typology	-0,016	-0,071	-0,015	-0,63	-0,014	0,062	-,006	-0,027
Factor 2. Human capital formation	0,072*	0,392*	0,065*	0,322*	0,063*	0,330*	0,068	0,375*
Cognitive factors	0,837*	0,487*	0,971	0,522*	0,977*	0,544*	0,859	0,510*
GDP per capita, PPP	1,509E-6	0,125	2,347E-6	0,177*	1,897E-6	0,155	1,660E-6	0,147
Educational attainment	0,001	0,062	0,002	0,89	0,002	0,081	0,001	0,067
R-square	78%		83,2%		84%		86,8%	

4.1.1   Setting and data

The econometric models proposed aims to investigate the impact of formalized training, working environment to the innovation level of a country while controlling for the secondary school skills test results, higher education level achievement and GDP per capita, R&D expenditure. We will use panel data analysis to see these relationship for the years 2005-2015.

The current changes on adult training could be tracked based on existing data from the continuing vocational training survey (CVTS), the European working conditions survey (EWCS) and the adult education survey (AES). The overwiew and analysis of the current surveys and the distinctions of further education are presented in paper (Orr & Cristóbal López, 2016).

In the panel dataset we have 2005, 2010, 2015 years according the waves of EWCS and CVTS. The other variables were taken accordingly to these years. Panel data analysis accounts for country heterogeneity and allows to control for variables like difference in organization of work and further education practices across countries. In our context of interest, the framework condition variables GDP per capita, the share of tertiary educated people, R&D expenditure, PISA numeracy scores are crucial for consideration. We take log values of PISA, GDP per capita values to have comparable values.

Most measures were adapted from the extant literature. The data used in this research are secondary data, collected through European surveys and statistical office of the European Union. The key to our methodology is to minimize the extrapolations and keep the data as close as possible to those directly available from European surveys. In terms of understanding the determinants of innovation, the international data have several advantages. Firstly, all sources come from standardized European surveys which makes sources comparable and reliable cross-country data in time series. Secondly, these survey data provide systematic heterogeneity across countries.

As regards the geographical scope for the study, this is the 28 European countries (see the list of countries in the Appendix 1.

To derive the variable of Human Capital formation we used five variabels taken from CVTS and EWCS. In

FiBS

one previous study, Makkonen and Lin saw positive correlations of CVTS variables and innovation (Makkonen & Lin, 2012). However, for innovation level they took the patend data, which has onw limitiations and for CVTS variables they used simplified sum average. We in our analysis extend the complexity with more variables, with factor analysis to get grounded results.

To derive the variables of organization of work we use principal component analysis as it was done in OECD study and other research papers (Arundel & Lorenz, 2007; Chaminade, Intarakumnerd, & Sapprasert, 2008; Lorenz et al., 2016; Lorenz edward, 2005). Innovation index is calculated to represent output related innovation performance, we use the same methodology as FiBS and Cedefop study on adult learning (CEDEFOP, 2012). The choice of variables are discussed in previous part of the paper. Our base model is 5-year interval panel data regressions with country random effects and different framework controls:

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + \beta_7 X_{7it} + u_{it} + \varepsilon_{it}$$

Y_{it} = innovation index for country, where i=country, t=time;

X_{2it} = Human capital formation;

X_{3it} = Discretionary learning work organization;

X_{4it} = Lean production work organization;

X_{5it} = Taylorist work organization;

X_{6it} = Traditional or simple work organization;

X_{7it} = GPD per capita per country;

u_{it} = between-country error;

ε_{it} = within-country error;

β = coefficients for the variables.

With the available variables, we conduct panel data analysis, where innovation index is dependent variable and organization of work variables, Human capital formation, GDP per capita, and share of tertiary educated adults, R&D expenditure, and PISA scores are independent variables. The descriptions concerning the data and methodology used throughout the empirical analyses are the following.

FiBS

	Variable name	Source
Innovation performance	Innovation index	Own calculations on basis of IUS
Forms of work organisation	Discretionary learning	Own calculations on basis of EWCS data
	Lean production	Own calculations on basis of EWCS data
	Taylorist	Own calculations on basis of EWCS data
	Traditional or simple	Own calculations on basis of EWCS data
Human Capital Formation	Share of training providing enterprises as % of total (2005-2010)	CVTS
	Employee participation in CVT courses (2005-2010)	CVTS
	Costs of CVT as % of total labour cost (2005-2010)	CVTS
	Hours in CVT courses per employee (all enterprises)	CVTS
	Participation in training	Own calculations on basis of EWCS data
Framework variables	Share of tertiary educated adults	Eurostat
	GDP per capita	Eurostat
	PISA numerical scores	OECD
	R&D expenditure	Eurostat

Table 2 Variables used and statistical data sources for analysis Measures

Dependent Variable

Innovation index is our calculation based on European Innovation Scoreboard (EIS), We propose the way of its use as it was done in the research of FiBS and CEDEFOP (2012) (CEDEFOP, 2012). Therefore, in that way we can present objective values for innovation performance.

The Summary Innovation Index (SI) from the EIS is frequently used as a catch-all indicator of innovation. This is, however, a problem that the SI includes input, throughput, and output indicators of innovation. In the context of this project, innovation input (e.g. public R&D expenditure) is not relevant, the focus is rather on actual innovation activities and results in companies. Therefore, only throughput and output parameters were included in the analysis. This choice of underlying indicators avoids the predominance of factors that are related to the innovation potential of a country but do not necessarily measure the innovative performance of enterprises. This leads to the following set of indicators: linkages and entrepreneurship, intellectual assets, innovators and economic effects. These four indices, composed of multiple underlying categories, were then averaged to calculate the innovation index used in this study:

- firm activities:

  - linkages & entrepreneurship:
  - SMEs innovating in-house;
  - innovative SMEs collaborating with others;
  - public-private co-publications.

- intellectual assets:

FiBS

- PCT (Patent Cooperation Treaty) patent applications;
- PCT patent applications in societal challenges;
- community trademarks;
- community designs.

- outputs:
- innovators:

  - SMEs introducing product or process innovations;
  - SMEs introducing marketing/organisational innovations.

- economic effects:

  - employment in knowledge-intensive activities;
  - medium and high-tech product exports;
  - knowledge-intensive services exports;
  - sales of new-to-market and new-to-firm innovations;
  - licence and patent revenues from abroad.

Our independent variable is Innovation index, which is derived from the UIS, yearly publishing statistical data of different aspects to measure and benchmark innovation of European countries. Here we are based on previous FiBS applied methodology to extract only core of indicators (see Figure 1) that are related to innovation output, that are namely – Linkages and entrepreneurship, Intellectual assests, Innovators, and Economic effects. We exclude the part of enablers, namely, Human resources, Research systems, Finance and support, and Firm investments as these are slightly distorting the geography of actual output. As an example, when we look for the coutry rankings in 2016 by these two indicators (see Figure 2), we see that by Innovation index proposed, which is a real output indicators, Norway, Sweden, UK, France and East European countries score even low low while Germany, Austria, Netherland, Denmark, Ireland, Luxembourg, Italy, Cyprys and Malta score even higher.
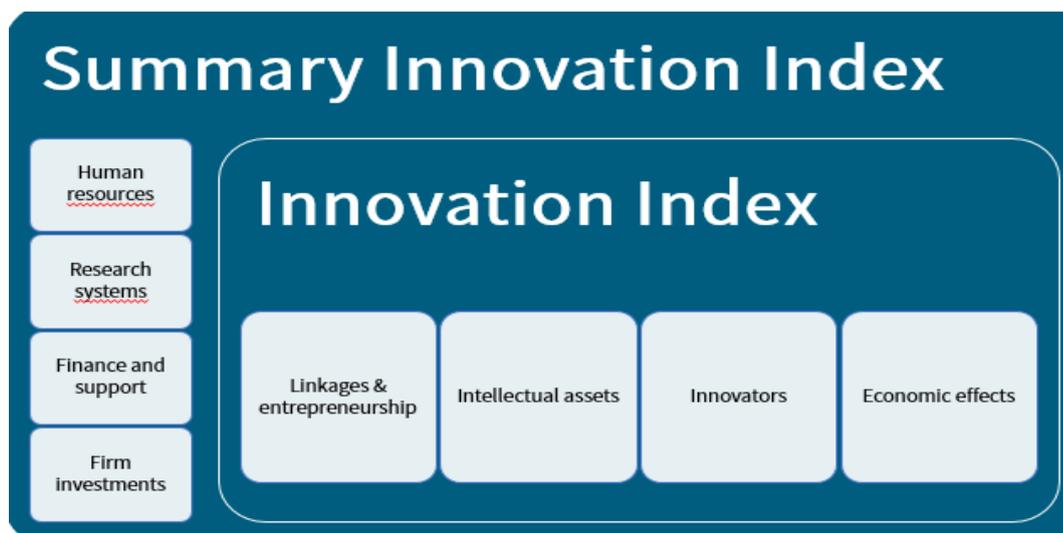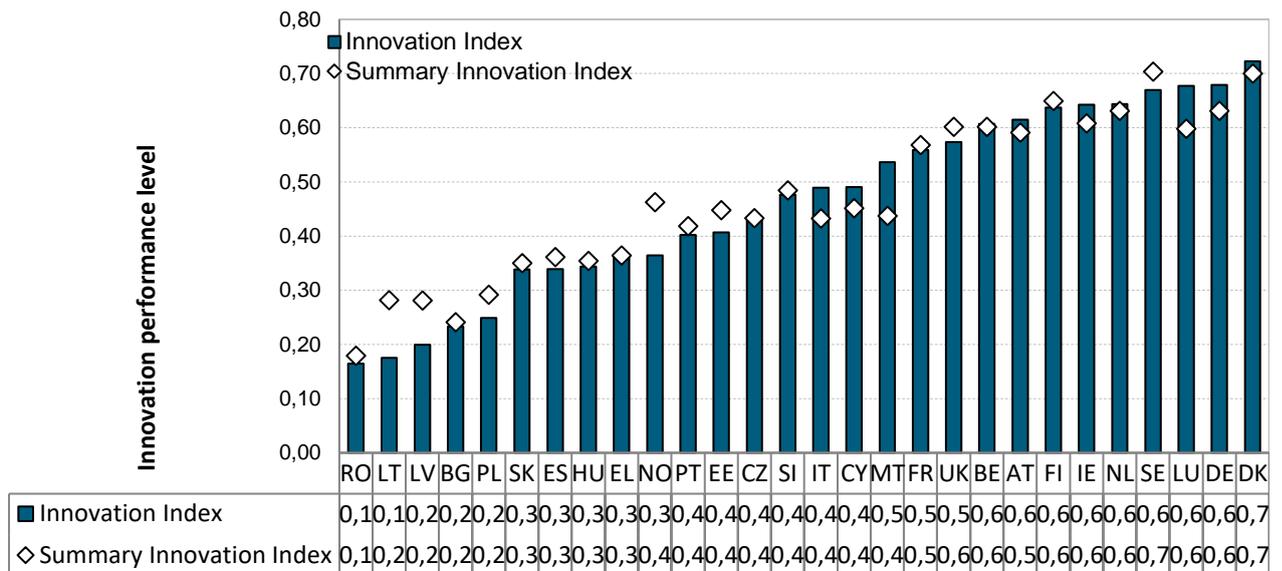

Figure 1 SII and Innovation index clusters

Figure 2 The country rankings by Innovation index and Summary innovation index

FiBS

	RO	LT	LV	BG	PL	SK	ES	HU	EL	NO	PT	EE	CZ	SI	IT	CY	MT	FR	UK	BE	AT	FI	IE	NL	SE	LU	DE	DK
■ Innovation Index	0,1	0,1	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,3	0,3	0,4	0,4	0,4	0,4	0,4	0,4	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,7
◇ Summary Innovation Index	0,1	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,3	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,5	0,6	0,6	0,5	0,6	0,6	0,6	0,7	0,6	0,6	0,7

Independent Variable.

Human capital development has been measured by variety of proxy measures ranging from formal education till informal and non-formal learning, through which skills can be learnt. Here as the main emphasis is laid on further education we take measures of participation in various trainings. Human Capital Formation consists of five variables – Employee participation in training, Hours in CVT courses per employee (all enterprises), Employee participation in CVT courses, Costs of CVT as % of total labour cost, share of training providing enterprises as % of all enterprises.

The variable Participation in training was derived from the EWCS based on average of these three answers: Over the past 12 months, have you undergone any of the following types of training to improve your skills? (1) Training paid for or provided by your employer; (2) Training paid by yourself; (3) On-the-job training.

Work organization refers to autonomy related items. Nevertheless, since these indicators are based on indices from publicly available studies such as OECD study, we rely on the official names to ensure better comparability and uniformity. The empirical work and methodology were provided by Lorenz and Valeyre. The indicators of work organization are derived from individual level study of the European Working Conditions Survey (EWCS) waves 2005, 2010 and 2015 with the weighting for country level. On the basis of 17 binary variables derived from the 2005, 2010 and 2015 waves of the EWCS data, principal component analysis were carried out to identify types of work organisation. These types of work organisation represent different environments regarding learning opportunities and necessities. In methodology of Lorenz and Valeyre, 15 binary variables were used, we extended our variables to consider aspect related to presence of difference skills in tasks and delegation of tasks.

The selected variables were:

- Learning new things in work
- Problem-solving activities
- Complexity of tasks
- Discretion in fixing work methods
- Discretion in setting work rate
- Horizontal constraints on work rate
- Hierarchical constraints on work rate

FiBS

- Norm-based constraints on work rate
- Automatic constraints on work rate
- Team work
- Job rotation
- Quality norms
- Responsibility for quality control
- Monotony of tasks
- Repetitiveness of tasks
- Tasks requiring different skills
- Autonomy in division of tasks

Control Variables.

R&D expenditure. Organizational learning and macro level studies do emphasis on R&D investment, therefore recognizing that we control for this variable. Data is taken from Eurostat - Total intramural R&D expenditure (GERD) by all sectors of performance as a percentage of gross domestic product (GDP). We include R&D as a separate variable as we have excluded it from the SII and separated from dependent variable.

Share of tertiary educated adults. This variable presents data (percentage share) on the highest level of education successfully completed by the individuals of a given population. This variable was derived from Eurostat database on Percentage of population aged 25-64 by tertiary educational attainment level (level 5-8).

PISA numerical scores. We as a control variable include the PISA results to see the impact of skill level of 15-year old students on macroeconomic outcomes. However, for the analysis, we keep taking the matching data on PISA for the years we are taking, as if we take the earliest cohorts we would need to substantially decrease the number of observations. To control for PISA results, depending on availability we take PISA results of 2006 for 2005 year panel data, for 2010 we take PISA results 2009, for 2015 year we take PISA results of 2012 year.

4.1.2   Results

Results from descriptive and pre-regression analyses

To derive Human capital formation and types of organization of work, principal component analysis, which is more robust to different distributions of the data, was therefore preferred. This method is based on idea that indicators referring to the same dimension are likely to be strongly correlated, and that we may use this insight to reduce the complexity of a large data set into small number of composite variables, each reflecting a specific dimension of variance in the data. Then the loadings of the various indicators on the retained factors are adjusted through so-called "rotation" to maximize the differences between them, we used "varimax normalized" rotation, that have often been used in applied work.

Derived factor score - Human capital formation have the following loadings, higher loads on Hours in CVT courses per employee, with weakest load in Employee participation in CVT courses. There are no extreme correlations within a factor score, which indicates the absence of multicollinearity problems, since the correlations are less than 0,90 (see Appendix 4). Also for the multi-item measures, we calculated Cronbach's alpha to establish their internal consistency. For HCF we have value of 0,48 (see Appendix 3), that is below acceptable 0,7 by Acock (Alan C. Acock, 2016), however, as argued by Lance et al. (2006) for

FiBS

newly developed constructs the lower levels are acceptable - item-total correlations can be ranged between .30 and .70 for a good scale (Lance, Butts, & Michels, 2006).

Variables	Component 1
Participation in training	0.4043
Hours in CVT courses per employee (all enterprises)	0.5370
Share of training providing enterprises as % of total	0.4854
Employee participation in CVT courses	0.3231
Costs of CVT as % of total labour cost	0.4563

Table 3 Factor score - Human capital formation

Derived factor scores on Organization typology have the following loadings.

Variable	Component 1 - 'Discretionary learning' working environment	Component 2 - 'Lean production' working environment	Component 3 - Taylorist working environment	Component 4 - 'traditional' or 'simple' working environment
Work depends … the work done by colleagues	0.3791	-0.3314	0.1221	0.2249
Work depends … numerical production targets or performance targets	-0.2395	0.5162	-0.1359	0.3681
Work depends … automatic speed of a machine or movement of a product	-0.1322	-0.0275	-0.0698	0.5063
Work depends … the direct control of your boss	-0.0498	-0.3438	-0.0220	0.1888
Work involves … meeting precise quality standards	-0.0129	0.0601	0.3036	0.3181
Work involves … assessing yourself the quality of your own work	0.0538	0.1481	0.4401	0.1459
Work involves … solving unforeseen problems on your own	0.1597	0.2977	0.0988	0.0979
Work involves … non-monotonous tasks	0.2200	-0.2282	-0.2200	0.2871
Work involves … complex tasks	0.3820	0.1618	-0.4378	-0.0332
Work involves … learning new things	0.2914	0.2129	0.0951	-0.0105
Work involves … short repetitive tasks of less than 1 minute and 10 minutes	0.0860	-0.0311	0.0599	0.5324
Able to choose … methods of work	0.0692	0.1966	0.3762	-0.1046
Able to choose … speed or rate of work	0.1031	-0.1414	0.4802	-0.0820
Work in a group or team that has common tasks and can plan its work	0.4057	-0.0093	0.0909	-0.0417
Work involves rotating tasks between yourself and colleagues	0.3554	0.0195	0.0301	-0.0327
Tasks require different skills	0.3859	0.1585	-0.1755	0.0359
The division of tasks are decided by people who are rotating tasks	0.0926	0.4263	0.0294	-0.0313

Table 4 Factor scores on Organisation of work

Looking at the scoring coefficients, we can differentiate the types of working environments. The analysis of the matrix of bivariate correlations shows low correlation between the independent variables (see Appendix 4), which indicates the absence of multicolinearity problems, therefore we can proceed with the analysis. Before the main analysis, principal component analysis (PCA), unidimensionality and

FiBS

internal consistency were assessed by calculation of reliability coefficients and inter-item correlations. The reliability of measurement was assessed by Cronbach's alpha to see whether these seventeen manifest variables could construct four performance latent variable. As shown in the appendix, the result shows good reliability and validity, and the constructed latent variables show high levels (see Appendix 3).

The results of the principal component analysis of the 17 EWCS variables yielded four categories, described as below:

We can call the first factor score as 'Discretionary learning' working environment, which is characterized with high levels of discretion in work, that provides scope for exploring new knowledge, and adhocracies tend to show a superior capacity for radical innovation. This type of organization of work is characterised by the overrepresentation of the variables measuring task complexity (0,38), non-monotonous tasks (0,22), learning (0,29) and problem solving (0,16). The complexity of tasks in this working environment can be also seen from the variable – tasks require different skills – which shows high load in this working type (0,38). The variables reflecting monotony, repetitiveness and work rate constrains are underrepresented. This type is characterized with less dependency on control from boss (-0,05), meeting precise quality standards (-0,01), dependency on machine (-0,13). In this type we also can see positive presence of the abilities to choose methods of work (0,06) and speed of work (0,41).

Regarding 'Lean production' or the J-form organization, which is in theory characterized as having a relatively bureaucratic form that relies on formal team structures and rules of job rotation to embed knowledge within collective organization, tuned towards incremental innovation. However, according to loading describing this working environment we cannot clearly see the distinct features. Yet compared to the first type, presence of complex tasks (0,16) and learning new things (0,21) are relatively low and tight quantitative production norms (0,51) and inability to choose rate of work (-0,14) are used to control employee effort. Here we can also see strong employees' problem solving (0,29) and division of tasks decided by people (0,43).

Regarding the third type, hierarchically structured Taylorist form, we see the work situation is somehow opposite to the first type 'Discretionary learning'. It is characterized by low levels of complexity (-0,44), minimal learning dynamics (0,09), monotonous tasks (-0,22) and overrepresentation of the variables measuring precise quality standards (0,30), assessing quality of work (0,44).

Regarding the fourth group, it can be called the 'traditional' organization based on a simple management structure, where methods are presumably informal and non-codified. We can see overrepresentation of the variables measuring constrains of work – colleagues (0,22), numerical targets (0,36), dependence on machine (0,50) and control from boss (0,19). In this type, there is little learning (-0,01) and problem solving (0,09), minimal presence of complex tasks (-0,03) and less tasks requiring different skills (0,04).

Results from regression analyses – panel data

To decide between fixed or random effects we run a Hausman test where the null hypothesis is that the preferred model is random effects vs. the alternative the fixed effects (see Green, 2008). By looking at the results (see Appendix 5), we see that p value is not significant, therefore we assume that the use of Random effect is preferred.

Regarding to other diagnostics, we perform Breusch-Pagan Lagrange multiplier (LM) test to decide between a random effects regression and a simple OLS regression. The null hypothesis in the LM test is that variances across countries is zero, i.e.no significant difference across units (i.e. no panel effect). From results (see Appendix 5) we see that p value is significant, therefore we assume that there is an evidence of significant differences across countries, and use of Random effects is appropriate.

FiBS

Then we also perform tests for panel-level heteroskedasticity and autocorrelation (see Appendix), and see that our models are homoscedastic and do not have autocorrelation issues. Therefore we state that our models give grounded consistent results.

The all model results are present in Table 5, and all models show high global significance, that make these regressions interpret. Table 5 also presents the results of a robustness analysis in which estimations were repeated with the same set of countries with the basic set of independent variables and adding one control variable.

The base model - Model 1 explains 79,9% of the variation shown in R-square value. Here, the working environments, except the second type are significant. The working environment, which is characterized as discretionary learning shows positive significance, while the Taylorism and simple forms of working environment present negative impact on innovation level of a country. GDP per capita is positively associated with innovation.

Further we can see in the Model 2 the interaction of Discretionary working environment and Human capital formation, i.e. their joint effect. The model 2 is sound, and variables used explain 79,9% of the variation of innovation output. In this model, the Discretionary learning environment has highly significant positive effect, and when treated with discretionary learning context human capital formation is highly positively significant as well. Coming to working environments that constrains learning and complex problem solving, shows negative significant impact on innovation. That suggests that there is negative correlation of these working environment types and innovation level of a country. Control variable – GDP per capita is significant and positive. The second type of working environment, that we hardly described as Lean, remains insignificant. Working environments Taylorism and simple forms have negative impact on innovation.

In the Model 3 we added another control variable - R&D expenditure as it was vastly discussed in the literature and by many authors were relating its volume to innovation performance. Here in the Model 3 R&D expenditure is insignificant, however, in the further models (Models 5,6,7) when other control variables included shows positive significant impact. The explanatory power of the model 3 is 80,9% confirmed by R-square of the model. Here we can see that Human capital formation, which gives us the level of formalized training at the workplace, is significant and positive when combined with the discretionary working environment. Regarding the types of working environment, our base model results are consistent and discretionary learning environment has significant positive impact, while the Taylorism and simple form of working environment are significant and negatively associated with innovation level.

The model 4 has control variable share of adults with tertiary education, which shows no significance and the overall model explains 79,9% of variation of the value of dependent variable. The results stay consistent with the base model.

In Model 5, when having as control variables share of tertiary educated adults and R&D expenditure, we see that increase of tertiary educated people has decreasing marginal rate on innovation. R&D expenditure is positive and significant. Other assumptions in line with base model hold true.

In Model 6 and Model 7, we control for the PISA numeracy scores and this variable turned to be insignificant. Increase of share of adults with tertiary education in Model 7 shows significant decreasing correlation with innovation. Our base model assumptions remain in these models.

To conclude, the combined evidence presented in the models consistently points to the conclusion that differences in discretionary working environment, and combined context of discretionary learning environment with human capital formation lead to significant differences in innovation output. The

FiBS

estimation results suggest that task complexity and learning aspects of work organization and its presence with formalized provision of trainings contribute to innovation performance in our countries of interest. As such, it can be said that firms that establish discretionary working environment have a superior advantage to grasp the benefits of adult education. Discretionary work organization hereby represent the most crucial factor for innovation performance. These findings are also in accordance to some studies, where it is argued that learning acquired while working, through informal processes, need to be combined with more structured, systematic and formal learning pathways to enable employees make a significant improvement in terms of knowledge and performance in a particular field (Cedefop, 2010). However, the working environments that are characterized with low levels of task complexity, learning and problem solving, less autonomy and dependence show significant negative impact for innovation. These relationships are very stable when other measures of country attributes are added, including GDP per capita, R&D expenditure, Share of adults with tertiary education and PISA scores. The importance of work-based learning highlights the fact that skills acquisition is a lifelong process. In addition to formal education through the secondary and tertiary levels, the learning that takes place on the job is a crucial component and helps shape innovation outcomes.

Additionally, we can see the time lag effect of Human capital formation – still this variable impact innovation over the years. As we take five year intervals, the lag is five years. By introducing lag coefficient we decrease the number of observation, but this treatment can reveal additional findings and track the impact of the variable over the years. Four models are presented with lag effect for HCF.

From these models 8-11 from Table 6, we see that time lag of HCF combined with Discretionary learning work organization are positively significant. Discretionary learning work organization itself shows no significance as Lean production work organization and Traditional or simple work organization do. Taylorist work organization presents negative impact on innovation. Control variables - GDP per capita and R&D expenditure as %of GDP are highly positively associated with innovation, while Share of adults with tertiary education and PISA numeracy scores show no significance where included. Time lag of Human capital formation (HCF) itself showed high positive significance in Model 8 and Model 9, but turned to be insignificant when more control variables added. In general, analysis with time lag can present opportunity to study the impact of certain variables over time, and here in our case the joint effect of HCF even after five-year period combined with the discretionary learning environment still positively impact on innovation index. The findings could mean that over years the impact of training sustain when it is within certain working environment. However, this topic is open for further research.

FiBS

VARIABLES	(Model 1) Innovation Index	(Model 2) Innovation Index	(Model 3) Innovation Index	(Model 4) Innovation Index	(Model 5) Innovation Index	(Model 6) Innovation Index	(Model 7) Innovation Index
Discretionary learning work organisation	0.0143**	0.0158**	0.0141**	0.0176***	0.0160**	0.0165**	0.0184***
Human capital formation (HCF)	0.00111	0.00680	0.00198	0.0126	0.00769	-0.00830	-0.00316
Discretionary learning work organisation #HCF		0.00633**	0.00610*	0.00717**	0.00702**	0.00456	0.00582*
Lean production work organisation	0.0145	0.0132	0.00878	0.0128	0.00745	0.00897	0.00774
Taylorist work organisation	-0.0224**	-0.0240**	-0.0190*	-0.0242**	-0.0179*	-0.0300**	-0.0266**
Traditional or simple work organisation	-0.0162**	-0.0153**	-0.0134**	-0.0133**	-0.0105	-0.0157**	-0.0137**
ln_ GDP per capita	0.158***	0.151***	0.140***	0.155***	0.142***	0.137***	0.139***
R&D expenditure as %of GDP			0.0326		0.0405*	0.0445**	0.0530**
Share of adults with tertiary education				-0.00209	-0.00261*		-0.00246*
ln_PISA numeracy score						0.440	0.387
Constant	0.0115	0.0258	0.00657	0.0702	0.0598	-2.739	-2.364
Observations	79	79	79	79	79	70	70
Number of countries	28	28	28	28	28	25	25
R-square	0,7995	0,7998	0,8097	0,7991	0,8109	0,8667	0,8693

Table 5 Results from regression analyses – panel data

FiBS

VARIABLES	(Model 8) Innovation Index	(Model 9) Innovation Index	(Model 10) Innovation Index	(Model 11) Innovation Index
Discretionary learning work organisation	0.0131*	0.00844	0.0117	0.0108
Time lag of Human capital formation (HCF)	0.0203**	0.0176**	0.00543	0.00473
Discretionary learning work organization #time lag of HCF	0.00915***	0.00897***	0.00650**	0.00648*
Lean production work organisation	0.0132	0.00384	0.0116	0.0118
Taylorist work organisation	-0.0195*	-0.00708	-0.0264*	-0.0272*
Traditional or simple work organization	-0.00641	-0.00298	-0.00354	-0.00386
ln_GDP per capita	0.152***	0.119***	0.122***	0.120***
R&D expenditure as %of GDP		0.0605**	0.0705***	0.0702***
ln_PISA			0.228	0.225
Share of adults with tertiary education				0.000584
Constant	0.0178	0.0106	-1.438	-1.432
Observations	53	53	47	47
Number of countrynum	28	28	25	25
R-square	0,7958	0,8249	0,8835	0,8831

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 Panel data models with Human capital formation time lag

4.1.3 Limitations and recommendations for further research

In our study, we can highlight several limitations. However, these limitations serve the recommendations for further improvement and do not bias our findings.

Firstly, there are some critiques over the use of survey itself as there are some authors doubting data validity (criticques of EWCS, IUS, LFS, CVTS – differences in sample selectivity, quality assurance, etc.) and general survey data disadvantages (Mairesse & Mohnen, 2010). Another delimitation of this study relates to the fact of not having carried out a qualitative study, particularly through case studies, in order to be able to further deepen of knowledge about the phenomenon of organizational innovation, as well as contact with other factors that could to be included in the analysis model.

Then, conceptually, there has not been a clear-cut definition on how human capital should be represented. This issue is open for discussion.

Then, the study frame was not restricted to an industry. Further at regional level, we suggest that provision of training have prevalence in knowledge-intensive sectors and certain industries; R&D expenditures also greatly vary across industries.

FiBS

Then, we do not consider types of innovation – product, process, organizational, marketing. These types are defined by Oslo Manual and can serve as a basis for further distinctions of interactions and outcomes. Then, our approach on embracing multiple levels of innovation, the choice of variables for microfoundations of it opens important avenues for future research.

Then, in methods, we can also introduce dummy variables – to see the changes before and after the certain policy measures if data would be available.

The detailded case studies can also be helpful in defining other variables that can impact innovativeness. For example, in-depth studies of Denmark, Finland, The Netherlands and Norway, revealed that probability of being an innovative strategic learner at work is found largely to be moderated by the person's work profile. (Støren, 2015).

As regards the geographical scope for the study – it could be also extended to further European countries and other non-European countries.

Another point of extension of research can be integration of the presented ideas in the innovation system and taking institutional approach. As it argued that innovation is affected by the institutional framework players and social capital (Soete, Verspagen, & ter Weel, 2010). Therefore, it is important to see the interactions among organizational actors, political and socio-economic culture.

The raising issue is also not only about the provision of adult education, but also the change of educational practices - curriculum, teaching ways and methods (Earl & Timperley, 2015; "The OECD Handbook for Innovative Learning Environments Educational Research and Innovation," 2017; Zitter & Hoeve, 2012). Additonally enhancing the development of Open Education Resources and digital tools of ICT for adult learning the current scene of participation can be altered (European Commission, 2015).

Finally, we also suggest using clustering of countries to investigate the relationship of the considered variables in the regional similarity. Here, it would be recommendable to separately consider learders and followers in innovation, as for the latter the policies and strategies to fill the gap could be different (Stiglitz, 2015). Another differentiation criterium could be country's systems of social protection as better ones increases the willingness and ability for innovative risk taking (Stiglitz, 2015).

FIBS

5 Conclusion

This study contributes to the development of existing theory of endogenous theory to analyze the internal capacity / relationships of companies and breakthrough performance at innovation level. After literure review, what appears to be missing in this area are empirical works that examine the macroeconomic benefits of adult learning. Research questions and hypothesis were developed that connected aspects of adult education with working environment and further innovation technologican and organizational alike. This paper identifies the impact of adult education on innovation, that then helps to put effective strategies for turning qualitative and quantitative information on adult education into relevant policy actions to strengthen innovation. Worth mentioning is that adult education challenges are common to several policy domains such as skills needs, training provision, investment and funding issues. Therefore combining various policy dimensions (education, finance, employment and migration) can help contribute to developing a systematic and comprehensive policy response. This paper would serve as a justification of government interference, because we know that due to market failure, government bears responsibility to educate. However, if government expenses are justified by economic benefits – that turns the vision toward market efficiency: adult education brings benefits in the form of innovation. So, if economic returns to government is reasonable, we further in the research project of VoREFFi-WB go into discussion of other topics – financing/investment in adult education and role of institutions. Moreover, innovation itself can have spillovers to other economic benefits - GDP growth, employment, and competitiveness, etc., which also need further research.

In the paper we attempted to reveal determinants, dimensions, and outcomes of firm capacity to innovate. We attempted to make this concept of innovation to educational concepts by creating a connection to the terms dynamic capability and absorbtive capacity.

We argue that realizing the potential of the absorptive capacity concept, dynamic capabilities view, knowledge based view require more research to show how macrobenefits result in outcomes such as innovation. In particular, we identified conceptual gaps that may guide future research to fully exploit these concepts in the organizational field and to explore future fruitful extensions of the concepts. This study integrated various concepts such as dynamic capabilities (Eisenhardt & Martin, 2000; Teece et al., 1997) and absorptive capacity (Cohen & Levinthal, 1989) in developing and testing a model of organizational learning resulting in higher innovation output.

We examined the process by which acquired knowledge (individual's and embedded in routines) is utilized through organization of work and further formalized education to create innovation, which then impacts on country level innovation performance. In doing so, we obtained a more systematic understanding of the innovation creation process. Here it is important to acknowledge that concepts such as innovation and organizational learning are inevitably complex and more contextual frames needs to be applied.

We selected indicators to assess the extent to which workers can broaden their competences at work; while taking the concerns of quality standards in the work process (meeting precise quality standards and assessing the quality of own work) and the complexity of work and the need to acquire new knowledge for work performance (solving unforeseen problems, carrying out complex tasks and learning new things). In contrast, a working environment that hinders workers in developing their skills while working is one that imposes low cognitive demands and comprises monotonous tasks tend to present negative correlation with innovation index.

The potential role of learning and interaction within organizations has been highlighted as a way to strengthen firm performance and via our quantitative analysis, we confirm that it has positive impact on

FiBS

innovation. Panel data offered a powerful way to improve the quality and validity of findings because we control for "country-specific" effects to find the "pure" relationship among adult education and organization of work to innovation performance. Since our regressions have control variables, the estimated effect of adult education and work environment on innovation is independent from the impact of R&D expenditures, higher education attainment, skills level tested by PISA. The key results as well as the limitations of the analysis are presented in the subsequent paragraphs. Drawing on longitudinal and cross-country data, we found Human capital formation and Discretionary organization of work to be most effective at driving innovation, when firms are characterized by strong incentive systems for innovation, substantial in learning capacity and effective freedom and complexity of tasks. In contrast, a strong focus on HCF on its own did not seem sufficient to increase firm and country innovativeness – adult education payoffs from suitable working environment that favors learning in any notable way. Only joint effect of Discretionary working environment and HCF is positive and significant. In light of these findings, decision-makers might be well advised not to take positive returns from adult education for granted. Rather, they need to achieve balance in organizational management practices to fully harness the potential value of further education. Also in our regression Models, via analyzing the marginal effects associated with the explanatory variables, it follows also that contexts not favoring learning through embedded complex tasks and problem solving and provision of adult education endows the disadvantages of innovation.

We finally conclude with the with a suggestion of further research to improve our understanding of effects of adult education and working environment on innovation. We should not overlooke working environment as it is the integral component of human capital development in its discussion of the role of adult learning benefits and in the construction of innovation.

6 Bibliography

3 GLOBAL REPORT ON ADULT LEARNING AND EDUCATION The Impact of Adult Learning and Education on Health and Well-Being; Employment and the Labour Market; and Social, Civic and Community Life. (2016). *UNESCO Institute for Lifelong Learning.* Hamburg, Germany. Retrieved from http://uil.unesco.org/system/files/grale-3.pdf

A. Snell, S., & S. Morris, S. (2014). Building dynamic capabilities around organizational learning challenges. *Journal of Organizational Effectiveness: People and Performance*, *1*(3), 214–239. https://doi.org/10.1108/JOEPP-07-2014-0033

Aghion, P., & Howitt, P. (1990). A Model of Growth Through Creative Destruction. https://doi.org/10.3386/w3223

Alan C. Acock. (2016). *A Gentle Introduction to Stata, Fifth Edition.* Stata Press. Retrieved from http://www.stata-press.com/books/gentle-introduction-to-stata/

Ambrosini, V., Bowman, C., & Collier, N. (2009). Dynamic capabilities: An exploration of how firms renew their resource base. *British Journal of Management*, *20*(SUPP. 1), 1–41. https://doi.org/10.1111/j.1467-8551.2008.00610.x

Arrow, K. J. (1973). Higher education as a filter. *Journal of Public Economics*, *2*(3), 193–216. Retrieved from http://econ.arts.ubc.ca/nfortin/econ560/arrow73.pdf

Arundel, A., & Lorenz, E. (2007). The Organization of Work and Innovative Performance: A comparison of the EU-15. *Blue Sky II Indicators …*, 36. https://doi.org/10.1300/J147v14n03_08

Arundel, A., Lorenz, E., Ke Lundvall, B.-Å., & Valeyre, A. (2007). How Europe's economies learn: a comparison of work organization and innovation mode for the EU-15. *Industrial and Corporate Change*, *16*(6), 1175–1210. https://doi.org/10.1093/icc/dtm035

Bhasin, S. (2015). *Lean management beyond manufacturing: a holistic approach.* Retrieved from https://books.google.de/books?id=xp1wCAAAQBAJ&dq=Liker,+J.+and+Franz,+J.+2011&hl=de&source=gbs_navlinks_s

Bonnafous, L. (2014). Trans-nationalization of educational policy making: from European innovation projects in adult education to an emerging European space for lifelong learning: what model for the European vocational education and training policy? *International Journal of Lifelong Education*, *33*(3), 393–410. https://doi.org/10.1080/02601370.2014.891888

Borras, S., & Edquist, C. (2015). Education, training and skills in innovation policy. *Science and Public Policy*, *42*(2), 215–227. https://doi.org/10.1093/scipol/scu043

Bourdieu, P., & Passeron, J.-C. (1977). Reproduction in Education, Society and Culture. *Sage Publications*. Retrieved from http://www.public.iastate.edu/~carlos/607/readings/bourdieu1.pdf

Buhr, D., & Stehnken, T. (2018). INDUSTRY 4.0 AND EUROPEAN INNOVATION POLICY Big plans, small steps. *WISO Diskurs*, (12). Retrieved from http://library.fes.de/pdf-files/wiso/14455.pdf

Cedefop. (2010). *Employer-provided vocational training in Europe: Evaluation and interpretation of the third continuing vocational training survey. Cedefop Research papers.* Retrieved from http://www.cedefop.europa.eu/en/publications/15390.aspx%5Cnhttp://www.cedefop.europa.eu/EN/Files/5502_en.pdf

Cedefop. (2011). *The benefits of vocational education and training. Director* (Vol. VI). https://doi.org/10.2801/43027

Cedefop. (2017). Investing in skills pays off: the economic and social cost of low-skilled adults in the EU. *Luxembourg: Publications Office of the European Union.* https://doi.org/10.2801/23250

CEDEFOP. (2012). *Learning and innovation in enterprises. Cedefop Research Papers.* https://doi.org/10.2801/94281

FiBS

Chaminade, C., Intarakumnerd, P., & Sapprasert, K. (2008). Measuring systemic failures in innovation systems in developing countries using innovation survey data: The case of Thailand. Retrieved from https://smartech.gatech.edu/bitstream/handle/1853/39415/Cristina_Chaminade_measuring_systems.pdf

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: The two faces of R&D. *The Economic Journal, 99*(397), 569–596. https://doi.org/10.2307/2233763

Collins, R. (1979). *The Credential society : an historical sociology of education and stratification.* Academic Press. Retrieved from https://books.google.de/books/about/The_Credential_society.html?id=e0edAAAAMAAJ

Dierkes, M. (2001). *Handbook of organizational learning and knowledge.* Oxford University Press. Retrieved from https://books.google.de/books/about/Handbook_of_Organizational_Learning_and.html?id=JRd7RZzzw_wC&redir_esc=y

Dohmen, D. (2016). Further Education for Vulnerable Groups: Barriers and the Role of Funding. Dublin: EAN-Conference. Retrieved from http://www.fibs.eu/en/sites/_wgData/Dohmen_EAN_Vulnerable Groups_160530_final.pdf

Dosi, G., & Nelson, R. R. (2013). The Evolution of Technologies: An Assessment of the State-of-the-art. *Eurasian Business Review, 3*(1), 3–46. Retrieved from https://www.ebesweb.org/pdf/ebr/EBR-3(1)_Dosi and Nelson.pdf

E. Ployhart, R., & Hale, Jr., D. (2014). The Fascinating Psychological Microfoundations of Strategy and Competitive Advantage. *Annual Review of Organizational Psychology and Organizational Behavior*, (1), 145–172. https://doi.org/10.1146/annurev-orgpsych-031413-091312

Earl, L., & Timperley, H. (2015). EVALUATIVE THINKING FOR SUCCESSFUL EDUCATIONAL INNOVATION. *OECD Education Working Paper*, (122). Retrieved from http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=edu/wkp

Edquist, C., Vonortas, N. S., Zabala-Iturriagagoitia, J. M., & Edler, J. (Ed.). (2015). *Public Procurement for Innovation.* Cheltenham: Edward Elgar Publishing. Retrieved from https://charlesedquist.com/2015/01/27/public-procurement-for-innovation/

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? *Strategic Management Journal Strat. Mgmt. J, 21*, 1105–1121. Retrieved from http://mail.tku.edu.tw/myday/teaching/992/SEC/S/992SEC_T3_Paper_20100415_Eisenhardt Martin (2000) - Dynamic capabilities what are they.pdf

Ekvall, G. (1997). Organizational Conditions and Levels of Creativity. *Creativity and Innovation Management, 6*(4), 195–205. https://doi.org/10.1111/1467-8691.00070

ERA Progress Report 2016. (2016). Brussels. Retrieved from http://ec.europa.eu/research/era/pdf/era_progress_report2016/era_progress_report_2016_technical_report.pdf

Eurofound. (2017). *Sixth European Working Conditions Survey – Overview report (2017 update).* https://doi.org/10.2806/422172

European Commission. (2015). *Adult learners in digital learning environments.*

European Commission. (2016). European Innovation Union Scoreboard 2016.

European Commission, Directorate General for Employment, S. A. and I. (2015). *An in-depth analysis of adult learning policies and their effectiveness in Europe.* Retrieved from https://ec.europa.eu/epale/sites/epale/files/all_in-depth_analysis_of_adult_learning_policies_and_their_effectiveness_in_europe_12.11.2015_pdf.pdf

European Commission/EACEA/Eurydice. (2015). *Adult Education and Training in Europe: Widening Access to Learning Opportunities.* Eurydice Report. Retrieved from http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/179EN.pdf

FiBS

Fagerberg, J., Mowery, D. C., & Nelson, R. R. (Eds.). (2006). *The Oxford Handbook of Innovation.* Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199286805.001.0001

Fagerberg, J., Srholec, M., & Verspagen, B. (2010). Chapter 20 – Innovation and Economic Development. In *Handbook of the Economics of Innovation* (Vol. 2, pp. 833–872). https://doi.org/10.1016/S0169-7218(10)02004-6

FiBS/DIE. (2013). *Financing the Adult Learning Sector.* Berlin.

Fischer, M., & Boreham, N. (2004). *Work process knowledge: origins of the concept and current developments. European Perspectives on Learning at Work: the acquisition of work process knowledge* (Vol. 115). https://doi.org/10.1161/CIRCULATIONAHA.107.183168

Foray, D., & Hollanders, H. (2015). An assessment of the Innovation Union Scoreboard as a tool to analyse national innovation capacities: The case of Switzerland. *Research Evaluation, 24*(2), 213–228. https://doi.org/10.1093/reseval/rvu036

Genkova, P., & Ringeisen, T. (2017). *Handbuch Diversity Kompetenz Band 2: Gegenstandsbereiche.* Springer Fachmedien Wiesbaden. Retrieved from https://play.google.com/store/books/details?id=oRg9DgAAQBAJ&rdid=book-oRg9DgAAQBAJ&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport

Green, L., Jones, B., & Miles, I. (2007). Skills for Innovation. *Inno Grips,* (Mini Study 02).

Grubb, W. N., & Ryan, P. (1999). *The roles of evaluation for vocational education and training: plain talk on the field of dreams.* Kogan Page. Retrieved from http://www.voced.edu.au/content/ngv%3A3991

Hanushek, E. A., & Woessmann, L. (2012). Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. *Journal of Economic Growth, 17*(4), 267–321. https://doi.org/10.1007/s10887-012-9081-x

Helfat, C. E., & Winter, S. G. (2011). Untangling Dynamic and Operational Capabilities: Strategy for the (N)ever-Changing World. *Strategic Management Journal, 32*(11), 1243–1250. https://doi.org/10.1002/smj.955

Hulten, C. R. (2010). Chapter 23 – Growth Accounting*. In *Handbook of the Economics of Innovation* (Vol. 2, pp. 987–1031). https://doi.org/10.1016/S0169-7218(10)02007-1

Johnes, G., & Johnes, J. (2004). *International handbook on the economics of education.* Edward Elgar.

Jovanovic, B., & Nyarko, Y. (1995). Journal of economic dynamics & control. *Journal of Economic Dynamics and Control, 19*(5–7), 1033–1064. Retrieved from https://econpapers.repec.org/article/eeedyncon/v_3a19_3ay_3a1995_3ai_3a5-7_3ap_3a1033-1064.htm

Kochan, T. A., Lansbury, R. D., & Macduffie, J. P. (1997). *After lean production: evolving employment practices in the world auto industry.* Cornell University Press. Retrieved from https://books.google.de/books?id=D758A49TcWQC&dq=MacDuffie+and+Pil,+1997&hl=de&source=gbs_navlinks_s

Krueger, A. B., & Lindahl, M. (2001). Education for Growth: Why and For Whom? *Journal of Economic Literature Growth Journal of Economic Literature, XXXIX XXXIX,* 1101–1136. Retrieved from http://www00.unibg.it/dati/corsi/91015/49249-jel 2000_kruegerlindahl.pdf

Lam, A. (2006). *The Oxford Handbook of Innovation, Chapter 5 Organizational Innovation.* (J. Fagerberg & D. C. Mowery, Eds.). Oxford: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199286805.003.0005

Lance, C. E., Butts, M. M., & Michels, L. C. (2006). The Sources of Four Commonly Reported Cutoff Criteria What Did They Really Say? *Organizational Research Methods, 9*(2), 202–220. https://doi.org/10.1177/1094428105284919

Leahy, D., & Neary, J. P. (2007). Absorptive Capacity, R&D Spillovers, and Public Policy*, *44*(0).

Leih, Sohvi; Linden, Greg; J. Teece, D. (2015). BUSINESS MODEL INNOVATION AND ORGANIZATIONAL DESIGN: A DYNAMIC CAPABILIIES PERSPECTIVE* Sohvi Leih,. In N. F. and T. Saebi (Ed.), *BUSINESS MODEL INNOVATION AND ORGANIZATIONAL DESIGN: A DYNAMIC CAPABILIIES PERSPECTIVE* (pp. 1–24). Oxford

FiBS

University Press.

Lorenz, Edward, Valeyre, A. (2005). Organisational innovation, Human ressource management and labour market structure : a comparaison of the EU15. *The Journal of Industrial Relations*.

Lorenz, E., Lundvall, B. ??ke, Kraemer-Mbula, E., & Rasmussen, P. (2016). Work Organisation, Forms of Employee Learning and National Systems of Education and Training. *European Journal of Education*, *51*(2), 154–175. https://doi.org/10.1111/ejed.12177

Lorenz edward, V. A. (2005). Organisational innovation, Human ressource management and labour market structure : a comparaison of the EU15. *The Journal of Industrial Relations*.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7

Lynch, L. M. (2007). The Adoption and Diffusion of Organizational Innovation: Evidence for the U.S. Economy. *IZA Discussion Papers, No. 2819*. Retrieved from http://nbn-resolving.de/urn:nbn:de:101:1-20080401119

Mairesse, J., & Mohnen, P. (2010). Chapter 26 – Using Innovation Surveys for Econometric Analysis. In *Handbook of the Economics of Innovation* (Vol. 2, pp. 1129–1155). https://doi.org/10.1016/S0169-7218(10)02010-1

Makkonen, T., & Lin, B. (2012). Continuing vocational training and innovation in Europe. *International Journal of Innovation and Learning*, *4*(4), 325–338. https://doi.org/10.1504/IJIL.2012.047135

OECD. (2017). *Education at a Glance 2017: OECD Indicators*. OECD. https://doi.org/10.1787/eag-2017-en

OECD, & Eurostat. (2005). Oslo manual, 1–113. https://doi.org/10.1787/9789264013100-en

Orr, D., & Cristóbal López, V. (2016). Weiterbildung in Deutschland im internationalen Vergleich. *FiBS - Forum*, (58). Retrieved from http://fibs.eu/de/sites/_wgData/FiBS-Forum_058_Infobrief_WB_final.pdf

Patterson, M. G., West, M. A., Shackleton, V. J., Dawson, J. F., Lawthom, R., Maitlis, S., … Wallace, A. M. (2005). Validating the organizational climate measure: links to managerial practices, productivity and innovation. *Journal of Organizational Behavior J. Organiz. Behav*, *26*, 379–408. https://doi.org/10.1002/job.312

Payne, J. (2017). The Oxford handbook of skills and training. In: C. Warhurst, K. Mayhew, D. Finegold and J. Buchanan (eds) (p. 737). Oxford University Press. Retrieved from https://www.dora.dmu.ac.uk/xmlui/handle/2086/13541

Reilly, E. T. (2007). How to build a high-performance organization. *American Management Organisation*, 1–80. Retrieved from http://www.amajapan.co.jp/j/pdf/HRI_HIGH-PERFORMANCE_Organization.pdf

RIGA CONCLUSIONS 2015. (2015). Retrieved from http://ec.europa.eu/dgs/education_culture/repository/education/policy/vocational-policy/doc/2015-riga-conclusions_en.pdf

Romer, P. M. (1989). Endogenous Technological Change. Retrieved from http://www.nber.org/papers/w3210.pdf

Russo, G. (2016). Job Design and Skill Developments in the Workplace. *IZA Discussion Paper* , (10207). Retrieved from http://ftp.iza.org/dp10207.pdf

Schmidt, T. (2005). Absorptive Capacity – One Size Fits All ? A Firm-level Analysis of Absorptive Capacity for Different Kinds of Knowledge Absorptive Capacity – One Size Fits All ? A Firm-level Analysis of Absorptive Capacity for Different Kinds of Knowledge. *39th Annual Meeting of the Canadian Economics Association*, (5), 37. https://doi.org/10.1002/mde

Schumpeter, J. A., Opie, R., & Elliott, J. E. (n.d.). *The theory of economic development : an inquiry into profits, capital, credit, interest, and the business cycle*. Retrieved from https://books.google.de/books/about/The_Theory_of_Economic_Development.html?id=-OZwWcOGeOwC&redir_esc=y

Soete, L., Verspagen, B., & ter Weel, B. (2010). Chapter 27 – Systems of Innovation. In *Handbook of the Economics of Innovation* (Vol. 2, pp. 1159–1180). https://doi.org/10.1016/S0169-7218(10)02011-3

FiBS

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics*, *87*(3), 355–374. Retrieved from http://links.jstor.org/sici?sici=0033-5533%28197308%2987%3A3%3C355%3AJMS%3E2.0.CO%3B2-3

Stiglitz, J. E. (2015). Leaders and followers: Perspectives on the Nordic model and the economics of innovation ☆. *Journal of Public Economics*, *127*, 3–16. https://doi.org/10.1016/j.jpubeco.2014.09.005

Stiglitz, J. E., & Greenwald, B. C. (2014). *Creating a learning society: a new approach to growth, development, and social progress*. Columbia University Press.

Støren, L. A. (2015). *Innovative learners at work*.

Stuart, T. E. (2000). INTERORGANIZATIONAL ALLIANCES AND THE PERFORMANCE OF FIRMS: A STUDY OF GROWTH AND INNOVATION RATES IN A HIGH- TECHNOLOGY INDUSTRY. *Strategic Management Journal Strat. Mgmt. J, 21*, 791–811. Retrieved from http://faculty.haas.berkeley.edu/tstuart/publications/2000/Interorganizational alliances.pdf

Teece, D. J. (2007). EXPLICATING DYNAMIC CAPABILITIES: THE NATURE AND MICROFOUNDATIONS OF (SUSTAINABLE) ENTERPRISE PERFORMANCE. *Strategic Management Journal Strat. Mgmt. J, 28*, 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J. (2010). Chapter 16 – Technological Innovation and the Theory of the Firm: The Role of Enterprise-Level Knowledge, Complementarities, and (Dynamic) Capabilities. In *Handbook of the Economics of Innovation* (Vol. 1, pp. 679–730). https://doi.org/10.1016/S0169-7218(10)01016-6

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, *18*(7), 509–533. Retrieved from http://links.jstor.org/sici?sici=0143-2095%28199708%2918%3A7%3C509%3ADCASM%3E2.0.CO%3B2-%23

Terence T. Burton. (2015). *Global Kata: Success Through the Lean Business System*. McGraw-Hill Education.

The Boston Consulting Group inc. (2011). High-Performance Organizations - The Secrets of Their Success. *The Boston Consulting Group Online Publications*, *September*, 14. https://doi.org/10.1108/EUM0000000004500

The OECD Handbook for Innovative Learning Environments Educational Research and Innovation. (2017). *OECD, Publishing, Paris*. Retrieved from http://espas.eu/orbis/sites/default/files/generated/document/en/9617031e.pdf

Tikkanen, T., & Nyhan, B. (Eds.). (2006). Promoting lifelong learning for older workers. An international overview. *Cedefop Reference Series*, (65), 1–277. https://doi.org/10.1017/CBO9781107415324.004

Toner, P. (2011). WORKFORCE SKILLS AND INNOVATION: AN OVERVIEW OF MAJOR THEMES IN THE LITERATURE. *OECD Working Paper*, *1*. Retrieved from https://www.oecd.org/innovation/inno/46970941.pdf

Tsai, W. (2001). Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *Journal*, *44*(5), 996–1004. Retrieved from http://links.jstor.org/sici?sici=0001-4273%28200110%2944%3A5%3C996%3AKTIINE%3E2.0.CO%3B2-8

Tsoukas, H., & Mylonopoulos, N. (2004). *Organizations as knowledge systems: knowledge, learning, and dynamic capabilities*. Palgrave Macmillan. Retrieved from https://play.google.com/store/books/details?id=FEWHDAAAQBAJ&rdid=book-FEWHDAAAQBAJ&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport

United Nations Millennium Development Goals. (2000). Retrieved from http://www.un.org/millenniumgoals/news.shtml

Van Den Bosch, F. A. J., Van Wijk, R., Volberda, H. W. (2003). Absorptive capacity: antecedents, models and outcomes. *Handbook of Organizational Learning and Knowledge Management*, 278–301. Retrieved from https://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwicmLe5rszVAhXGwBQKHRVmAgEQFggpMAA&url=https%3A%2F%2Frepub.eur.nl%2Fpub%2F334%2FERS-2003-035-STR.pdf&usg=AFQjCNEoSgQTY4IegLWtvBFyybA9aVQcXw

Volberda, H. W., Foss, N. J., & Lyles, M. A. (2010). *PERSPECTIVE—Absorbing the Concept of Absorptive Capacity:*

FiBS

How to Realize Its Potential in the Organization Field. Organization Science (Vol. 21). https://doi.org/10.1287/orsc.1090.0503

Wolfe, B., & Haveman, R. (1997). ACCOUNTING FOR THE SOCIAL AND NON-MARKET BENEFITS OF EDUCATION. *International Journal of Educational Research, , 27*(6), 491–501. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.645.8432&rep=rep1&type=pdf

Zahra, S. A., & George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension. *Academy of Management Review, 27*(2), 185–203. https://doi.org/10.5465/AMR.2002.6587995

Zitter, I., & Hoeve, A. (2012). Hybrid Learning Environments: Merging Learning and Work Processes to Facilitate Knowledge Integration and Transitions. *OECD Education Working Papers*, (81). https://doi.org/10.1787/5k97785xwdvf-en

FiBS

7 Annex

Appendix 1 The list of countries in the analysis

country

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia

FiBS

SK   Slovakia
UK   United Kingdom

Appendix 2 Measurement framework of Summary innovation index and our calculated Innovation index

FiBS

Innovation performance level, 2011

Legend: ■ SII   ◇ Innovation index

	LV	BG	RS	LT	RO	HR	PL	SK	MT	HU	EL	ES	PT	IT	CZ	SI	EE	NO	CY	EU average	UK	FR	IS	NL	BE	AT	IE	LU	DK	DE	FI	SE	CH
■ SII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
◇ Innovation index	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
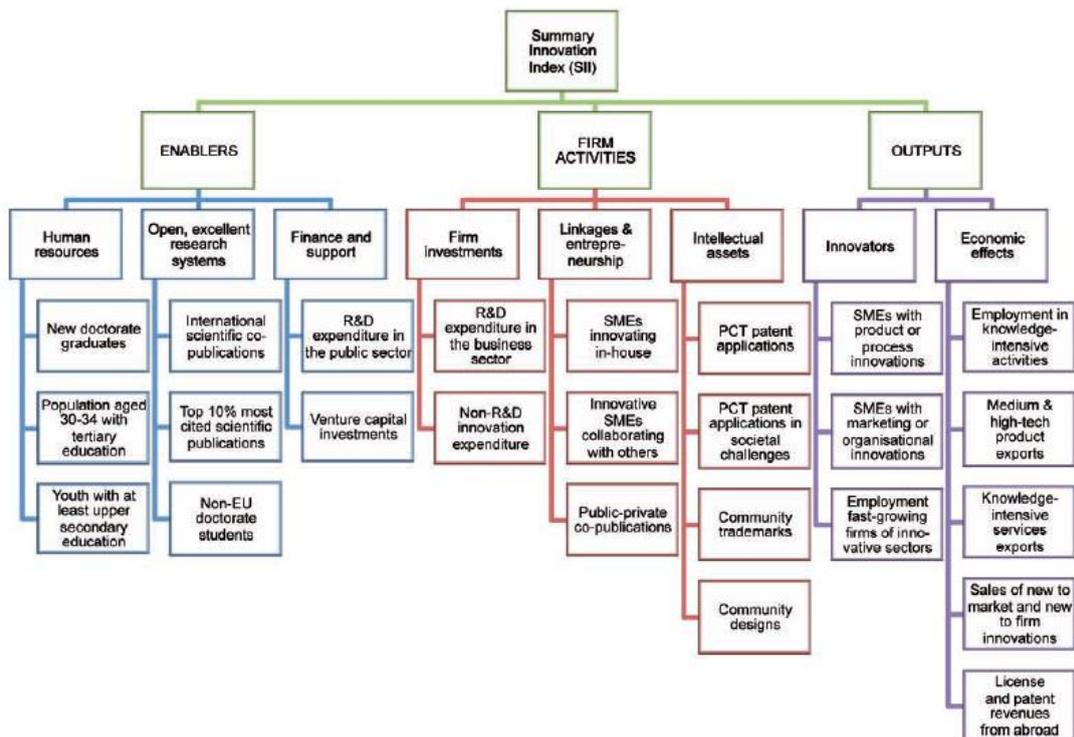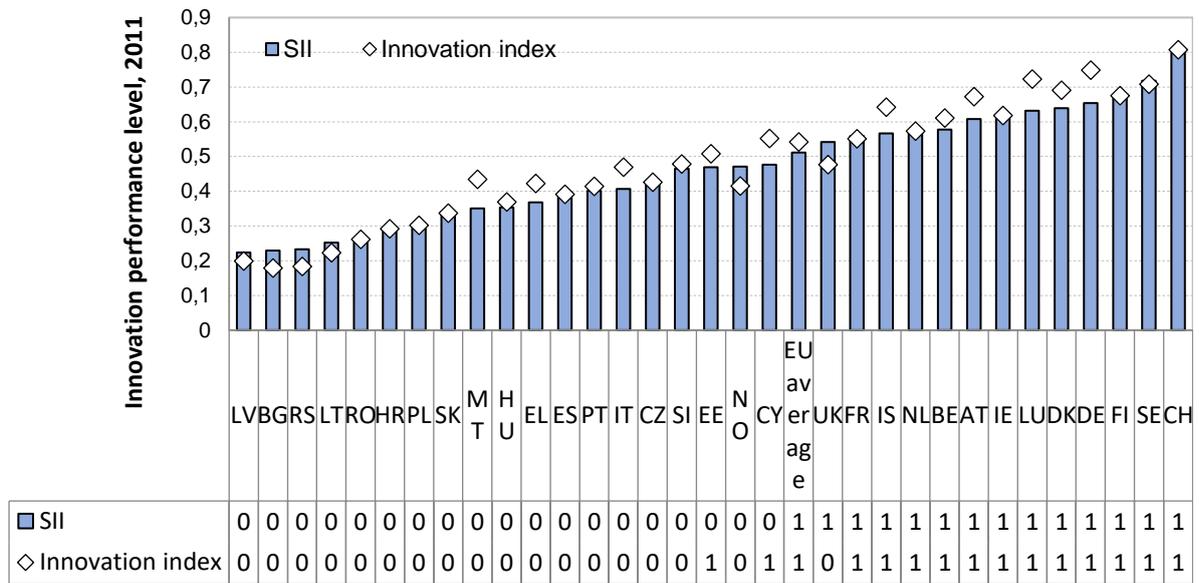
Appendix 3 Cronbach's alpha test for variables of work organization and human capital formation

FiBS

```
. alpha q50a q50c q50d q50e q53a q53b q53c q53d q53e q53f q48avr q54b q54c q58
> q55 q56 q57b, item

Test scale = mean(unstandardized items)
```

| | | | | | average | |
| | | | item-test | item-rest | interitem | |
Item	Obs	Sign	correlation	correlation	covariance	alpha
q50a	84	+	0.1717	0.0912	.0027861	0.8536
q50c	84	+	0.1664	0.0642	.0027919	0.8574
q50d	84	−	0.3980	0.3562	.002718	0.8456
q50e	84	−	0.7089	0.6304	.0022838	0.8295
q53a	84	+	0.3344	0.2492	.0026799	0.8485
q53b	84	+	0.6662	0.5967	.0023982	0.8325
q53c	84	+	0.7354	0.6931	.0024498	0.8312
q53d	84	−	0.4492	0.3413	.0025505	0.8464
q53e	84	+	0.4888	0.4010	.0025477	0.8424
q53f	84	+	0.9052	0.8791	.0021613	0.8153
q48avr	84	+	0.1229	0.0381	.0028155	0.8559
q54b	84	+	0.7793	0.7349	.0023544	0.8267
q54c	84	+	0.4059	0.3287	.0026396	0.8452
q58	84	+	0.4695	0.3629	.0025309	0.8453
q55	84	+	0.6573	0.5751	.0023576	0.8331
q56	84	+	0.6489	0.5625	.0023553	0.8338
q57b	84	+	0.8194	0.7635	.0021555	0.8202
Test scale					.0025045	0.8478

```
. alpha ewcstraining HoursinCVTcourses trng_cvts02 trng_cvts14 trng_cvts16, ite
> m

Test scale = mean(unstandardized items)
```

| | | | | | average | |
| | | | item-test | item-rest | interitem | |
Item	Obs	Sign	correlation	correlation	covariance	alpha
ewcstraining	84	+	0.5047	0.6983	31.28988	0.5099
HoursinCVT~s	80	+	0.8006	0.7428	17.08885	0.3474
trng_cvts02	82	+	0.8880	0.4688	6.195482	0.3646
trng_cvts14	82	+	0.7191	0.4034	9.857987	0.2915
trng_cvts16	82	+	0.5866	0.5680	30.11423	0.4999
Test scale					18.9048	0.4819

Appendix 4 Correlation matrices for factor variables and scores

FiBS

```
. correlate q50a q50c q50d q50e q53a q53b q53c q53d q53e q53f q48avr q54b q54c
> q58 q55 q56 q57b
(obs=84)
```

	q50a	q50c	q50d	q50e	q53a	q53b	q53c
q50a	1.0000						
q50c	-0.3670	1.0000					
q50d	0.1591	0.1980	1.0000				
q50e	0.3202	-0.1691	0.3585	1.0000			
q53a	0.0551	0.1572	0.0030	-0.0019	1.0000		
q53b	0.0539	0.0525	-0.2814	-0.5007	0.2756	1.0000	
q53c	0.0234	0.0534	-0.3576	-0.5043	0.3238	0.5389	1.0000
q53d	0.1874	-0.1546	0.3748	0.3020	-0.2181	-0.1807	-0.3526
q53e	0.0926	0.1031	-0.1338	-0.2791	0.2040	0.0264	0.3313
q53f	0.2350	0.0661	-0.4138	-0.6184	0.3590	0.6081	0.7545
q48avr	0.1853	0.0779	0.3448	-0.1234	-0.0268	0.1268	0.1080
q54b	0.1202	0.0323	-0.4673	-0.5319	0.2443	0.6536	0.6885
q54c	0.2524	-0.1909	-0.1336	-0.2168	0.1631	0.4738	0.2183
q58	0.3921	-0.0989	-0.1465	-0.1970	-0.0504	0.1799	0.1593
q55	0.3218	-0.1538	-0.3203	-0.4127	-0.0239	0.3769	0.4142
q56	0.0916	0.0865	-0.1780	-0.5198	0.0487	0.2938	0.3698
q57b	-0.0081	0.3134	-0.3527	-0.6689	0.2660	0.4677	0.5554

	q53d	q53e	q53f	q48avr	q54b	q54c	q58
q53d	1.0000						
q53e	-0.0923	1.0000					
q53f	-0.3358	0.4186	1.0000				
q48avr	0.3600	-0.0510	0.0582	1.0000			
q54b	-0.5109	0.1436	0.7207	-0.0187	1.0000		
q54c	-0.1162	-0.0266	0.3685	-0.1003	0.5800	1.0000	
q58	-0.1281	0.2876	0.3923	-0.0478	0.2488	0.1599	1.0000
q55	-0.2459	0.3473	0.5783	0.1038	0.3371	0.1653	0.4428
q56	-0.1195	0.4287	0.5239	0.2197	0.3172	0.2009	0.2554
q57b	-0.3546	0.4452	0.7172	0.0836	0.6074	0.1523	0.2830

	q55	q56	q57b
q55	1.0000		
q56	0.4687	1.0000	
q57b	0.4294	0.4897	1.0000

```
. correlate HoursinCVTcourses ewcstraining trng_cvts02 trng_cvts14 trng_cvts16
(obs=80)

                  │ Hoursi~s ewcstr~g trng_~02 trng_~14 trng_~16
       ───────────┼──────────────────────────────────────────────
       HoursinCVT~s │  1.0000
       ewcstraining │  0.4682    1.0000
        trng_cvts02 │  0.6290    0.6751    1.0000
        trng_cvts14 │  0.5806    0.4308    0.3440    1.0000
        trng_cvts16 │  0.7421    0.2687    0.5271    0.3539    1.0000


. correlate Fs1 Fs2 Fs3 Fs4 HCF5
(obs=80)

             │       Fs1       Fs2       Fs3       Fs4      HCF5
       ──────┼──────────────────────────────────────────────────
          Fs1 │   1.0000
          Fs2 │   0.4001    1.0000
          Fs3 │   0.4080    0.3949    1.0000
          Fs4 │  -0.1060   -0.1816   -0.1860    1.0000
         HCF5 │   0.4142    0.5173    0.3511   -0.1652    1.0000
```

Hausman test

```
. hausman fe re

                ──── Coefficients ────
                  (b)           (B)           (b-B)      sqrt(diag(V_b-V_B))
                  fe            re          Difference          S.E.
        ─────────────────────────────────────────────────────────────────────
            Fs1 │  .0121548      .014326      -.0021713        .0045459
            Fs2 │   .006518     .0144876      -.0079696        .0093448
            Fs3 │ -.0140377    -.0224474       .0084098         .013323
            Fs4 │ -.0141482    -.0161552        .002007        .0029214
           HCF5 │ -.0010592       .00111      -.0021692        .0044588
    ln_GDPperc~a│ -.0338586     .1575373      -.1913959        .0779148
        ─────────────────────────────────────────────────────────────────────

                    b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

            chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                    =        10.89
         Prob>chi2 =       0.0917
```

Breusch and Pagan test

```
Breusch and Pagan Lagrangian multiplier test for random effects

        Inno_Index[countrynum,t] = Xb + u[countrynum] + e[countrynum,t]

        Estimated results:
                         │       Var       sd = sqrt(Var)
                ─────────┼────────────────────────────────
            Inno_In~x    │    .0303313          .1741588
                    e    │    .0017171          .0414374
                    u    │    .0066013          .0812483

        Test:   Var(u) = 0
                        chibar2(01) =    20.47
                     Prob > chibar2 =   0.0000
```

FiBS

ENHANCING LIFELONG LEARNING FOR ALL

———

Research Institute · Consulting · Think Tank
Germany · Europe · Worldwide

www.fibs.eu

FiBS, Michaelkirchstr. 17/18, D-10179 Berlin, Germany
Tel: +49 (0)30 8471 223-0 · Fax: +49 (0)30 8471 223-29