The Role of the Education System and On-the-Job Training in Innovation: Evidence from the Slovenian Manufacturing and Service Sector

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Abstract

This paper contributes to the debate on the importance of education for sustainable economic growth. Following a recent contribution by Aghion (2009), we focus on the role of tertiary education in innovation at the company level using patent applications as a proxy. Rather than examining tertiary education spending or the share of the population with tertiary education, we make use of the Aghion Index, which measures the quality of tertiary education. Moreover, as innovation is only the first step in the value chain at the company level, we complement data on the quality of tertiary education with company-level data on human capital spending in large and medium-sized Slovenian firms. We report that not only a sound education system, but also on-the-job training is important for increased company-level invention and innovation. Firms with more on-the-job training reported a significantly higher number of patents in the period of 2007-2009.

Keywords: education, innovation, on-the-job training, Slovenia

JEL classification: O31,O43, J24

If you think in terms of a year, plant a seed; if in terms of 10 years, plant trees; if in terms of 100 years, teach the people.

(Confucius)

Education is the key to prosperity, and the top countries are striving hard to improve even more.

(Fullan, 2011)

1 Introduction

Identifying the most important parameters of innovation and growth on a national level has been an important issue for several decades. While early growth models emphasized capital accumulation as the most important source of growth, over the past two decades researchers have started emphasizing human capital as an important additional accumulating factor of production. According to a seminal paper by Nelson and Phelps (1966) growth is presumed to be driven by the stock of human capital, which in turn affects a country's ability to innovate or catch up with more advanced countries. The idea that human capital could generate long-term sustained growth was one of the critical features of the "new growth" literature initiated by Lucas (1988) and Romer (1990). Later on, a neo-classical revival evolved from Mankiw, Romer and Weil (1992) arguing that human capital is an ordinary input unable to generate sustainable growth. Although some contributions[1] argue that the role of human capital in economic growth

1 See, for example, Benhabib and Spiegel (1994), Pritchett (2001) and Bils and Klenow (2000).

has been vastly overstated, Cohen and Soto (2007) confirmed that these results are partly driven by poor data.

A significant body of literature analyzes the role of education in sustainable growth, especially regarding the organization of the education sector and its spending structure. An empirical study of individual states in the USA in the period of 1970-2000 estimated the impact of investment in higher education on economic growth. Generally, the closer a state gets to the technological frontier, the more growth-enhancing it becomes to invest in higher education and the less growth-enhancing it becomes to emphasize lower education (Aghion et al., 2007). This result is consistent with the findings of Krueger and Lindahl (2001) which show that the correlation between growth and education is significant when analysis is restricted to OECD countries. Krammer (2009), on the other hand, analyzed a panel of sixteen transitional Eastern European countries and confirmed the crucial role of universities and the existing national knowledge base complemented by R&D commitments from both public and private sources. The key role of universities and the existing national knowledge base are the result of a sound education system that equips people with human capital, i.e., cognitive and non-cognitive abilities. Finally, Kuhl Teles and Joizo (2011) report that there is a significant long-term relationship between the stock of human capital and the quantity of innovation, if the possibility of a structural break is considered.[2] Given that innovation is probably encouraged by several factors, in addition to human capital, the structural breaks should, if they happen, incorporate these factors as well as exogenous shocks.

This paper contributes to the debate on the importance of education for sustainable economic growth. Following a recent contribution by Aghion (2009), we focus on the influence of tertiary education on innovation at the company level using patent applications as a proxy. Rather than focusing on spending for tertiary education or the share of the population with tertiary education, we present the

2 This relationship is reflected on the cointegration between the number of patents and public spending in education and in the population's average years of education (Kuhl Teles and Joizo, 2011).

Aghion Index, which measures the quality of tertiary education. Moreover, as innovation is only the first step in the value chain at the company level, we complement data on the quality of tertiary education with company-level data on human capital spending in large and medium-sized Slovenian firms.

This paper is organized as follows: first we summarize the role of innovation and present some statistical findings on selected economies. Then we discuss the links between education and innovation and sustainable economic growth. We pay special attention to the quality of education. Further on we continue with a discussion about empirical findings on the employability of young graduates in Slovenia, as well as on-the-job training in Slovenian firms. We conclude with remarks on the importance of a sound education system for encouraging innovation.

2 Innovation Throughout the World

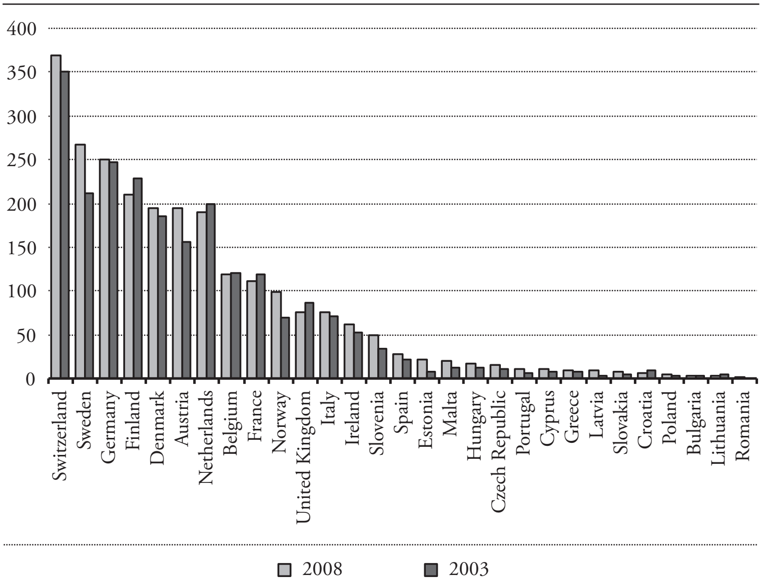
The importance of innovation for economic growth has been described in several research papers since the pioneering work of Nelson and Phelps (1966). There is a consistent gap between some groups of countries in terms of innovation activity, although some recent examples show that it is possible to substantially increase the measurable output of innovation in a relatively short five-year period. An examination of the number of patent applications[3] across countries reveals an amazing increase in the number of applications in South Korea and China in recent years. South Korea, for example, reported nearly one-third fewer patents than the average European Union country in 2003, measured in terms of patents per million inhabitants. However, due to astonishing growth from 2003 to

3 Some scholars have questioned the validity of measurements based on the number of patents for innovation as this focuses on a rather narrow aspect of innovation activity, excluding product modifications as well as process innovation or activities such as fashion design (Kalantaridis and Pheby, 1999). Moreover, some previous researchers have argued that patent statistics are more appropriate for measuring inventions rather than innovation, as many ideas patented never become viable products (Shane, 1992). However, we think that the number of patents is a valid measure for a country's innovative output because it reveals an important aspect of its level of technological activity, and because several fundamental conditions need to be fulfilled in order for an activity or invention to qualify for patent eligibility, e.g. the invention must be novel, useful, and exhibit an "inventive step" in that it is non-obvious to practitioners skilled in the given field of technology (Evenson, 1984).

2008, that amounted to an 80 percent increase in patent applications, South Korea on average reported 4 percent more patents per million inhabitants than the average EU-27 member country in 2008. China also witnessed a substantial 220 percent growth in the number of patent applications per million inhabitants in the period of 2003-2008 while, on the other hand, the growth of the average EU-27 member country amounted to 11.1 percent. Slovenia increased its number of patent applications by 60 percent in the same period.

Since innovation activity is closely related to institutional frameworks, developmental stages, and industrial structures, we should more closely examine innovativeness of countries that are more similar in terms of all the aforementioned factors. By analyzing the patent activity of European countries, we may observe a very interesting pattern (Figure 1).

Figure 1: *Patent Applications by Selected European Countries per Million Inhabitants, Average EU-27=100*



Source: Eurostat (2011).

Switzerland and Scandinavia, along with Germany and Austria, reported the highest innovation activity when measured according to a scale of the average number of EU-27 patent applications per country. For example, in 2008 Switzerland had nearly 4 times as many patents per million inhabitants as the average EU-27 country. In the same year Germany reported 2.5 times more patents than the average EU-27 country. Innovation in new member states, as well as the Mediterranean countries (Italy, Portugal, Spain, and Greece), was far below the European average. Slovenia, for example, reported 50 percent fewer patents than the average European country in 2008. The other former transitional countries also lagged well behind the best innovators.

Interestingly, the most innovative countries also performed extremely well in the perceptible quality of their education system, as reported by Aghion (2009).

3 Educate to Innovate: Does Education Really Matter?

Education, as such, plays a central role in most development strategies around the world. It is usually identified as the key factor for achieving sustainable growth in the long term, based on the large body of literature on human capital formation and in-depth surveys of its role in advanced economies. Growth equations usually include some kind of proxy for human capital as measured by the quantity of formal schooling (Barro and Lee, 1993) or resources allocated for education (Barro, 1991). However, as noted by Hanushek and Woessmann (2010) there are also some nagging uncertainties that exist alongside this evidence. First, developed and developing countries differ from one another in myriad ways besides education levels. Second, a number of countries – both on their own and with the assistance of others – have expanded education opportunities without seeing any dramatic evidence of catching up to developed countries in terms of economic well-being. Third, countries that do not function well in general might not be more able to mount effective education programs than they are to pursue other societal goals. Fourth, even when education policy is made a point of focus, many of the approaches undertaken do not seem very effective and do not lead to the anticipated student outcomes. To wit, is it obvious that education is the key driving force, or is it merely one of several factors that are correlated with more fundamental development forces? Is there a substantial difference in the effects caused by improved primary, secondary, or tertiary levels of education? Is it possible to measure quality of education in a consistent way, including hard and soft skills in adequate proportions?

Hanushek and Woessmann (2010) investigate long-term growth differences among OECD countries. Interestingly, they show that the key factors in growth equations, such as property rights and free trade institutions, as well as labor and product market regulations, do not play a significant role in explaining the growth differences in developed countries. On the contrary, they show that direct measures of educational outcomes, such as cognitive skills, on international achievement tests play a leading role in their understanding.[4] The most common international tests for measuring cognitive abilities are Trends in International Mathematics and Science Study (TIMSS) and PIRLS (Progress in International Reading Literacy Study) administered by TIMSS & PIRLS International Study Center and PISA (Program for International Student Assessment) conducted by the OECD. Hanushek and Woessmann (2010) estimate how much improvements in educational outcomes might contribute to growth in developed economies. Their projection analysis suggests that improved educational achievement is projected to have a large impact on the future economic well-being of OECD countries.[5] Moreover, they report that the gains from projected education reform far exceed gains from state funds helping firms in the current global recession.

4 The insignificance in the institutional measures does not mean that institutions are unimportant for long-term growth, but since OECD countries have similar institutions, the differences among them do not explain many of the variations in their growth.

5 A boost in average PISA scores by 25 points in all OECD countries (one-quarter standard deviation) implies an aggregate gain of OECD GDP of US$90-123 trillion. In addition, bringing all students to a level of minimal proficiency for the OECD or bringing all OECD countries to the level reached by Finland today would imply aggregate GDP increases beyond US$200 trillion according to historical growth relationships.

The most recent PISA test was implemented in 2009 and covered 34 OECD countries and 41 partner countries and economies. It focused on young people's ability to use their knowledge and skills to meet real-life challenges. It measured literacy, mathematics, and science knowledge. In the last PISA assessment, 15-year-old students from Shanghai, China scored the highest, with an average score of 600 points in mathematics, which is 104 points higher than the OECD average (OECD, 2010a). Students from Finland, followed by students from Korea and Hong Kong, China, achieved the second highest score. Slovenian students on average scored 501 points, which was significantly higher than the OECD average, and scored 22nd place after Germany, Belgium, and the United Kingdom, placing them ahead of Poland, Ireland, and the Slovakian Republic. Slovenian students scored above the OECD average in science and placed 19th after Switzerland, Hungary, and Latvia. Compared to 2006, Slovenian students scored above the OECD average of 500 points in all selected fields of testing (OECD, 2007).[6] Recently, much attention was focused on the statistically significant below-OECD-average score of students on the 2009 PISA reading proficiency test, which tells us that Slovenian students are below average in finding what they need in written texts, interpretation, and the use of information, and reflecting upon it critically in relation to their own experience and understanding. So far the situation is not that alarming. As suggested by Hanushek and Kimko (2000), the mathematics and science test results can be perceived as a proxy of labor force quality. Based on findings from 31 countries from 1965 until 1991, they learned that these direct measures of labor-force quality from international mathematics and science test scores are strongly correlated to growth.

Hanushek and Woessmann (2010) argue that improved educational achievement would have a significant effect on growth. To improve the quality of education,

6 The TIMSS test also confirmed the fair knowledge of Slovenian students. They tested the mathematical and science knowledge of fourth graders and eighth graders. In 2007, Slovenian students scored about average in mathematics and placed 19th after Italy, Austria, and Sweden, whereas the leading scores were achieved by Hong Kong, Singapore, Chinese Taipei, and Japan (Gonzales et al., 2008). Also, eighth graders scored above average on the examination. The TIMSS is administered by the USA, therefore they compared the results to their fourth and eighth graders and found that in both cases Slovenian students scored below their American counterparts. However, based on the TIMSS science examination, eighth graders scored ninth place, which is above average and above their American counterparts.

policy-makers must focus on the improvement of education policies, ensuring the quality of service provision, a more equitable distribution of learning opportunities, and stronger incentives for greater efficiency in schooling (OECD, 2010b). A comparison of international results achieved by 15-year-olds shows that the most successful school systems grant greater autonomy to individual schools to design curricula and establish assessment policies, but these school systems do not necessarily allow schools to compete for enrollment. Averagely successful school systems also spend large amounts of money on education. Between 2000 and 2008, expenditure on education institutions across all levels of education increased by an average of 32 percent in OECD countries (OECD, 2011). On average, OECD countries spent 6.1 percent of GDP on education in 2008. The countries that devoted the most resources to education in 2008 were Iceland, Korea, Israel, Norway, and the United States. Slovenia spent 5.4 percent of GDP for education (mostly for primary and secondary schools – 4.3 percent of GDP), which is below the OECD average. However, in addition to spending, the efficiency of education spending is highly important (Hanushek, 1996). The most current research on school input and students' achievement has also focused on teacher quality as an important factor determining student achievement, indicating that in some countries teacher quality has been declining (Hanushek and Woessmann, 2010).

While a sound lower level education system and investment in primary and secondary education are more likely to make a difference in a country's ability to implement existing technologies, higher (particularly graduate) level education investment has a greater impact on a country's ability to produce cutting-edge innovations (Acemoglu, Aghion and Zilibotti, 2006). An alternative measure of the quality of a tertiary school system's importance for a given country's innovation activity is to develop the country performance index as the sum of Shanghai scores[7] divided by the population (Aghion et al., 2007). In 2006, the performance of EU-25 universities averaged in the 10th percentile level when

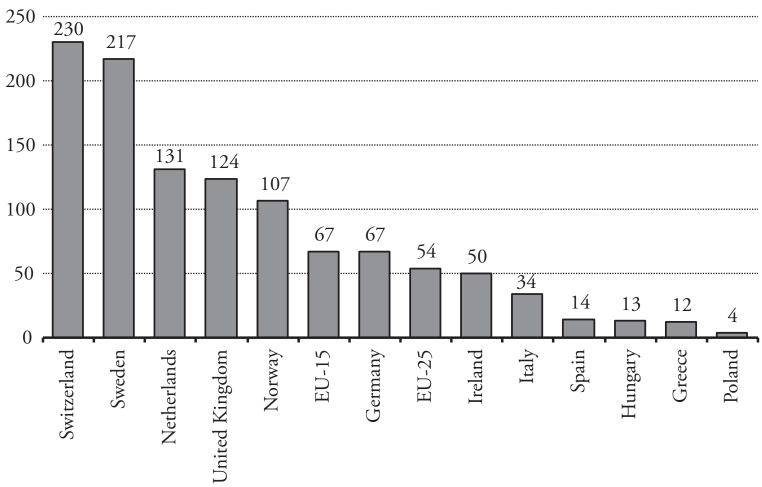
7 The Shanghai indicator aggregates information on both publications/citations and on honors (such as Nobel prizes) received by current or past faculty or alumni. Citations are thus one component of the overall Shanghai Index.

compared to the USA in terms of the top 50 universities in the world, based on Shanghai scores. Average European scores rose to the 50th percentile level of the USA when 500 universities were taken into account. Specifically, they found that both Anglo-American and Scandinavian countries (including Switzerland) performed relatively well, whereas continental countries (particularly France, Italy, and Spain) performed relatively poorly. Interestingly, unlike their Anglo-American counterparts, Swiss or Swedish universities are mostly public, charge low tuition fees, and are not very selective when accepting applicants at the undergraduate level. However, good performance always relies on high budgets per student combined with budget and hiring autonomy. Interestingly, the countries doing well, based on university performance indicators, are among the leading countries in the world according to the metric used for measuring innovation activity (number of patents per million inhabitants).[8]

An important insight of the academic research is that it is extremely difficult to measure the quality of education. Moreover, the OECD warns that focusing too much on test scores can have adverse effects such as “gaming” and “teaching to tests” and encourages an emphasis on skills that can be easily taught and easily measured, thereby reducing the time spent on non-cognitive skills. Heckman (2011) stressed the role of non-cognitive personal traits in the success of individuals. Research shows that cognitive abilities are just one, less important, part of individual productivity. Most education systems in developing and developed economies focused primarily on developing cognitive abilities as noted above. This kind of behavior was partly driven by the introduction of various international tests. However, none of these tests measure the sort of non-cognitive abilities that might prove even more important when discussing the quality of an education system. Employers measure these abilities indirectly, as potential employees are often tested before they are hired.

8 Aghion et al. (2007) do not present a calculation of the Aghion Index for Slovenia. Our calculations show that the index for Slovenia is 4.2, which is very similar to Poland’s value.

***Figure 2:** Aghion Index for Selected European Countries in 2006*



Source: Aghion et al. (2007).

4 From Invention to Innovation: Evidence from Company-Level On-the-Job Training in Slovenia

The concept of human capital pertains to individuals' knowledge and abilities that allow for changes in activity and economic growth (Coleman, 1988). Human capital may be developed through formal training and education aimed at updating and renewing one's capabilities in order to do well in society. In order to further investigate the role of the education system in sustainable growth, we complement state-level data on the quality of the education system with company-level data about on-the-job training. A good tertiary education system that equips individuals with the knowledge necessary to develop invention should be complemented with company-level practices that stimulate the next stage of applied invention – innovations. Due to data availability, we only explored the potential link between R&D and human capital at the company level in Slovenia.

Slovenia's education policy over the past two decades mainly focused on primary and secondary schools, for which the majority of resources were allocated (68.5 percent of all expenditures for education went toward primary and secondary levels of education, and the remaining 31.5 percent for tertiary education). Spending on tertiary education in Slovenia amounted to 1.1 percent of GDP in 2008. The majority was invested from public resources.

The first important indicator of the quality of tertiary education is found by analyzing the employability of graduates. Based on a unique matched employer-employee micro dataset for the complete cohort of Slovenian graduates from 2007 (provided by the Statistical Office of the Republic of Slovenia), Domadenik, Drame and Farčnik (2010) conducted an analysis to research the quality of education services by using a proxy not often used in the relevant literature: the employability of graduates. The results show that, on average, the probability of employment after graduation differs significantly among schools.[9] Some institutions exhibit a higher probability of employment, thereby revealing considerable differences in quality. These institutions provide their education services at a lower price per "employable" graduate compared to other higher education institutions. Newer private schools exhibited a significantly lower level of employability of their full- and part-time graduates, possibly indicating a lower innate ability of the students who enroll in these schools and/or the lower quality of the academic programs involved. When looking a bit more broadly, we investigated differences in the probability of employment of graduates of three consequent generations from 2007 to 2009 (Farčnik and Domadenik, 2012). We found that variations in employability are attributable to differences in the field of education, the university, and the study program.[10] This indicates that

9 In order to assess the impact of different schools on employability of graduates, Domadenik, Drame and Farčnik (2010) chose schools that provide business and administration education. The main reason for doing so was the representation of these programs in virtually all universities and other higher education institutions in Slovenia.

10 Regarding fields of study, we find that the highest probability of employment is held by health services graduates regardless of the year, followed by graduates from engineering, architecture and construction, as well as mathematics, statistics and computing, followed by business and administration graduates. The lowest probability of employment was exhibited by graduates from the humanities and arts, social sciences, and journalism and information. In terms of the time trend, the average probability decreased in 2009 when the economic crisis in Slovenia deepened.

investment in education has different payoffs for different fields of study, and also highlights certain aspects of the state of the Slovenian economy.

We could argue that formal education increases the individual human capital associated with knowledge that is applicable to a broad range of firms and industries and is related also to individuals' age, and total household income. Prior research has shown that an individual level of human capital has an impact on economic success, both at the business level and the macro level, when combined with company-specific human capital. Milkovich and Bloom (1998) consider investments made by firms in employee training an important source of creating company-specific human capital important for maintaining competitiveness in a globalized business environment. This is especially crucial for firms operating in countries hoping to catch up with the most developed economies, because they often need to carry out radical upgrades of their human resources.[11] Hausmann et al. (2011) stress the importance of tacit knowledge that constrains the process of growth and development, as knowledge can only be accumulated, transferred, and preserved if it is embedded in networks of individuals and organizations that put this knowledge into productive use. The importance of tacit knowledge is especially emphasized in firms that are aware of the importance of investing in employees and the effect it has on company productivity (Siebers et al., 2008). For example, firms that systematically train and develop their workers are more likely to enjoy the rewards of a more productive workforce than those that do not. A study conducted on 66 Slovenian manufacturing firms by Zupan et al. (2010) finds that there are significant variations in the ways and amounts Slovenian firms invest in people and organization.[12] The study also finds that there are no significant correlations between investment in human capital and productivity, or investment in management/human resource management (HRM) practices and productivity.

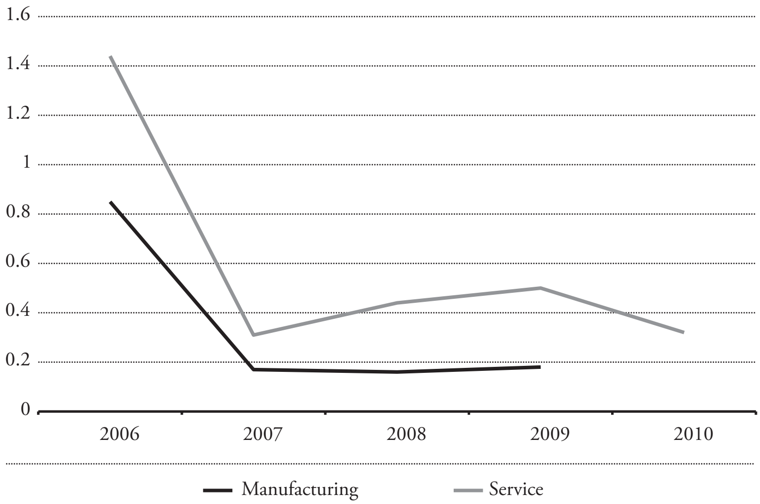
11 See, for example, Domadenik, Prašnikar and Svejnar (2008) for further discussion.

12 The data was collected as part of the project "The role of investment in intangible and tangible capital in Slovenian companies". Questionnaires were sent to large and medium-sized manufacturing firms. The sample then consisted of the 66 firms. The study examined the differences among firms regarding their investment activities based on characteristics such as size, ownership, capital intensity, and indebtedness.

Regarding investment in education, we analyzed the education and training expenditures of Slovenian manufacturing firms during the 2006 to 2009 period, and also for Slovenian firms in the service industry from 2006 to 2010 (Figure 3). We sampled 71 large manufacturing firms and 38 large service industry companies. The data on manufacturing firms was the same as in Zupan et al. (2010) and five additional data collections from the service industry were additionally gathered. A questionnaire was sent to all large and medium-sized manufacturing and service companies. Data from responding companies was further matched with financial reports from AJPES (Agency of the Republic of Slovenia for Public Legal Records and Related Services). In addition to 71 manufacturing companies, we collected 38 questionnaires from different service industry firms. The sample of 38 service industry firms was gathered from the tourism industry, transportation, trade, banking and insurance sectors, information technology, telecommunication, construction and the energy sector. The representativeness of the sample was not controlled for and is one of the limitations of the paper. However, with no possibility of acquiring extra data on companies, some exclusions were unavoidable.

For companies in the service industry, there is an obvious trend of decreasing expenditures for education and training in the observed period. In 2006 a subsample of firms spent an average of 1.44 percent of their total income (ranging from 0.05 to 7.74 percent). By 2007 average spending had dropped to 0.31 percent of total income and was around 0.32 percent in 2010 (ranging from 0.57 to 2.65 percent). A previous study by Domadenik, Prašnikar and Svejnar (2008) reports that average spending on employee training by the average manufacturing company amounted to 0.34 percent in 1996 and 0.26 percent of total income in 2000. An interesting but worrisome trend can be observed, as the average manufacturing company spent less in 2007-2009 than did similar firms almost a decade ago.

***Figure 3:** Share of On-the-Job Training Expenses in Total Revenues*

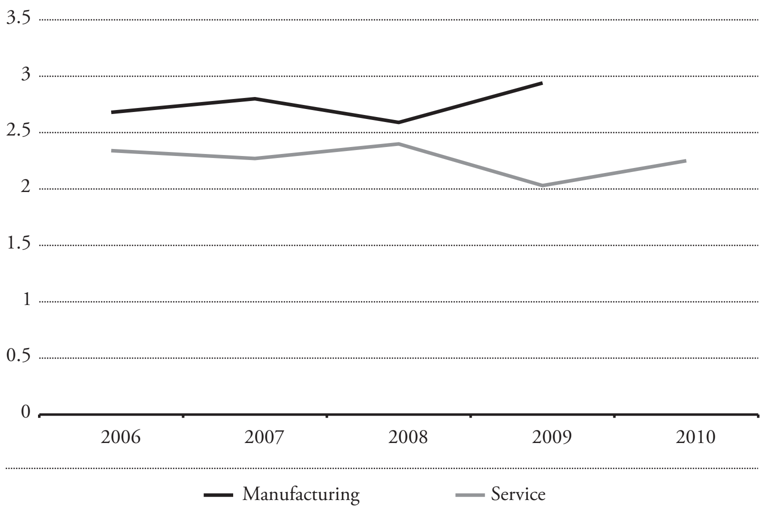


Source: Authors' calculations based on survey data.

When investigating the average number of days of education and training for the same subsample, we find a similar trend (Figure 4). The average number of days fell from 2.18 per year in 2006 to 1.66 in 2009, and slightly increased in 2010 to 1.81 days of education and training per year.[13] The trend in investment in education and training is quite similar for the sample of manufacturing firms. The average percentage of total income invested in education and training amounted to 0.85 in 2006, dropped to 0.17 in 2007, and settled at 0.19 in 2009. The average number of days of education and training also did not vary much over the observed four years (2.87 in 2006, 2.82 in 2007, 2.63 in 2008, and 2.98 in 2009).

13 However, these averages could be misleading, as we found a very low correlation (0.1346) between spending for education and average number of days of education and training.

Figure 4: *Average Number of On-the-Job Training Days*



Source: Authors' calculations based on survey data.

Analyzing investment in education or so-called on-the-job training in Slovenian firms, we find that 94.7 percent of the firms in the service industry and 97.2 percent in manufacturing provide regular on-the-job training, with the most common forms being seminars, conferences, and workshops, as well as the transfer of knowledge either laterally among fellow employees or in a top-down fashion from supervisors to subordinates. Mentoring and supervision systems are quite popular, as evidenced by the fact that half of the firms interviewed said they educate workers by assigning them mentors and supervisors. Out of those, 86.8 percent of service industry firms and 81.7 percent of manufacturing companies systematically utilize knowledge transfer among employees. Further on we find that 89.5 percent and 87.2 percent of the firms in service industries and manufacturing, respectively, invest in organized training of their employees based on the specifically identified needs of their companies. Of those, 73.5 percent of service industry firms and 62.3 percent of manufacturing companies reportedly involved more than half of their employees in training programs annually. Most of the firms analyzed conducted regular on-the-job training. One very interesting finding is that half of the firms in the service sector and 38 percent of manufacturing companies believed they could find successors for most of their key employees who would be capable of effectively taking over their new positions in a short period of time.

Further, we matched data on investment in education with data on innovation from Redek et al. (2010), with sample matching decreased to 66 firms. A statistical analysis of the 2006-2010 period shows that companies which systematically introduced knowledge transfer among employees for on-the-job training performed significantly better than their competition at introducing new products and developing more products that were not primarily created simply by imitation. In addition, the majority of those products were developed only in the company (with no outside cooperation). Furthermore, those companies are statistically significantly more likely to have an in-house R&D department which is also more advanced. The more advanced R&D departments also systematically support solving problems that arise on the shop floor, all the while building the absorption capacity of the company. Results and t-statistics are reported in Table 1.

Investigations revealed that companies which annually involved more than half of their employees in training programs reported a statistically higher number of patents in all observed years than did firms that included less than half of employees in their training programs. Furthermore, these new products were primarily developed in-company. Thus, the more employees receive on-the-job training, the more their companies tend to outperform the competition. Higher performing companies are also more likely to have a strategically important R&D department that helps to solve problems on the shop floor. Their R&D expenditures are of tactical importance. Additional critical sources of information for support and/or stimulation of innovation activity used by these companies include universities and other institutions of higher learning, as well as scientific, commercial and technical journals.

***Table 1:** T-statistics for Independent Variable: Systematically Utilized Knowledge Transfer*

Dependent variable	Number of observations	Mean difference	T-test	Probability
Performed better than competition at introducing new products	63	0.1984	1.3097	0.0976
Introduction of new product not primarily developed by imitation	65	0.1876	1.8190	0.0368
Development of new products primarily within the company	65	0.1358	1.4538	0.0755
R&D department	60	0.2995	2.8045	0.0034
R&D department systematically supports problem solving	59	0.2594	2.2111	0.0155
R&D department builds the absorption capacity of the company	59	0.2594	2.2111	0.0155
Advancement of R&D in the firm	64	0.4494	1.6299	0.0541

Source: Redek et al. (2010) and authors' calculations based on survey data.

***Table 2:** T-statistics for Independent Variable: More Than Half of Employees are Included in On-the-Job Training*

Dependent variable	Number of observations	Mean difference	T-test	Probability
Introduction of novelty in the global market	66	0.1635	-1.4736	0.0724
New product lines	61	0.2614	-1.4710	0.0733
Development of new products primarily in-company	65	0.1325	-1.7109	0.0460
Introduction of process innovation	65	0.1598	-1.4194	0.0804
Development of a new product that was not an imitation	62	0.1474	-1.6350	0.0536
Universities and other higher learning institutions as information sources	63	0.4800	-1.9767	0.0236
Scientific, commercial and technical journals information sources	63	0.0426	-1.8222	0.0367
R&D department	60	0.1542	-1.6604	0.0511
R&D department helps solve problems	59	0.1775	-1.8733	0.0331
Strategic importance of R&D expenditures	61	0.2792	-2.2506	0.0141
Number of patents in 2006	41	2.7794	-1.6240	0.0562
Number of patents in 2007	41	3.4779	-1.7389	0.0450
Number of patents in 2008	46	3.4642	-1.8866	0.0329
Number of patents in 2009	47	1.9398	-1.5909	0.0593

Source: Redek et al. (2010) and authors' calculations based on survey data.

The recently released Atlas of Economic Complexity (Hausmann et al., 2011) was a joint project carried out by two prestigious universities, Harvard and MIT. It assigns an Economic Complexity Index (ECI) in an attempt to measure the amount of productive knowledge in each country. It is expressed as the composition of a country's productive output and reflects the structures that emerge for maintaining and synthesizing knowledge. This index actually measures the amount of knowledge that a country has, expressed in terms of the diversity and ubiquity of the products that it creates, measured against all other countries that make similar products. Diversity and ubiquity are, respectively, crude approximations of the variety of capabilities available in a country or required by a product. Economic complexity helps to explain differences in the level of income of countries, and, more importantly, is a predictor of future economic growth. Optimal economic complexity might not be a simple goal to attain, but the countries that do achieve it tend to reap significant rewards. Based on ECI, countries are sorted according to the amount of productive knowledge that is implied in their export structures. Slovenia ranks in the top ten, together with Japan, Germany, Switzerland, Sweden, Austria, Finland, Singapore, the Czech Republic, and the UK. In summary, the education system, along with investment in education and training by firms, has equipped workers with productive knowledge, which is essential to developing diverse products. In this critical period, there should be even more attention allocated toward increasing the efficiency of education systems, supported by increased on-the-job training and education.

5 Conclusion

This paper provides evidence that a sound education system is very important for outstanding research performance when measured according to invention and innovation activity at the company level. General education has an important impact on individually specific levels of human capital. Although we do not argue that it is not important to increase public investment in education, we think that the focus should turn toward the quality of the investments made in a given education system. Higher quality can be achieved by various means. In times of crisis and indebted public budgets, increased private funding is necessary. On the other hand, public administrations will need to put more effort into observing the performance of each particular institution at every level of the education system. Decreased funding for low performing institutions (schools and universities) could lead to possibilities for rewarding the best schools. The newly created Slovenian Quality Assurance Agency for Higher Education can play a crucial role in accomplishing these ends. Over the past two years since its formation, not one single action has been taken in this direction. However, empirical research shows that this is the path we must follow in order to become a more innovative society.

Another important factor to be considered is company-specific human capital. As we have access to a rich database on Slovenian company-level investment in R&D and on-the-job training, we used Slovenia as a case study example. Observing the varieties of training practices and level of firms' expenses for training gives us some insight on how firms invest in company-specific human capital. Slovenian firms on average recognize that it is important to invest in firm-specific human capital in order to encourage innovation in the first phase and invention in the second (applying innovation in business). While these investments are not substantial in monetary terms, they are vital to the constant improvement of existing products and processes. Nevertheless, the economic crisis has forced firms to cut training expenses to levels even lower than ten years ago.

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