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## MONTHLY REVIEW OF ACADEMIC LITERATURE ON ASPECTS OF HUMAN CAPITAL AND SKILLS IN RESEARCH AND INNOVATION POLICY

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The present special issue focuses on the impact of human capital and skills on productivity and innovation as well as sketching a rough picture of changes in the demand for skills against the backdrop of deep technological disruptions. The first paper sets the scene and provides a positive outlook on the future of the demand for labour. The second paper provides some insights on possible productivity enhancements by foreign human capital. The remaining seven empirical studies explore the effects of human capital and skill on productivity and innovation outcomes. Most research papers are country-specific and make use of micro-level data.

### 1. Why Are There Still So Many Jobs? The History and Future of Workplace Automation

Autor D (2015). Why Are There Still So Many Jobs? The History and Future of Workplace automation. *Journal of Economic Perspective* 29(3): 3-30.

- During the past two centuries of automation and technological progress human labour was not made obsolete.
- Although employment polarisation is observed and many middle-skill jobs are susceptible to automation, many middle-skill jobs will continue to demand a unique combination of routine and non-routine tasks.
- These non-routine tasks include interpersonal interaction, flexibility, adaptability and problem solving skills.
- From a policy perspective this implies that education systems should focus on human capital investments that produce skills that are complemented by technological change.

This paper addresses the widely held fear of machines substituting for human labour and highlights the strong complementarities between automation and labour. According to the author these complementarities can lead to increases in productivity, earnings and the demand for labour. Whilst new technologies have the capacity to substitute for workers in performing routine tasks, the comparative advantage of workers lies in supplying problem-solving skills, adaptability, and creativity. Hence, unique tasks that cannot be substituted by automation are usually complemented by it, and productivity gains in one set of tasks almost increase the economic value of the remaining tasks. However, the author also notes that technological change does not necessarily lead to increases in employment. Only if workers supply tasks that are complemented by automation does this occur, but not if the tasks supplied can be substituted. Further, the output elasticity of demand combined with income elasticity of demand can either dampen or amplify the gains from automation. The phenomenon of 'job polarisation' describes the situation where computerization of routine tasks may lead to the growth of high-education, high-wage jobs at one end and low-education, low-wage jobs at the other end of the wage spectrum, both at the expense of middle-wage, middle education jobs. The prediction of the author is that this polarisation will not continue indefinitely as many middle-skill jobs will continue to demand a mixture of tasks.

## 2. Human Resources and Innovation: Total Factor Productivity and Foreign Human Capital

Fassio C, Kalantaryan S & Venturini A (2015). Human Resources and Innovation: Total Factor Productivity and Foreign Human Capital. IZA Discussion Paper Series No 9422.

- Migrants in Germany, France and the UK with tertiary-level education have a positive effect on productivity growth in high-tech sectors and to a lesser extent in services.
- Migrants with lower levels of education display a weak positive effect in manufacturing.
- The authors conclude that migration policy intended to boost innovative performances ought to be demand-driven taking into account the needs of firms in different sectors.

Within the framework of a simple model in which innovation is proxied by TFP, the impact of migration on the innovative performances in different sectors is analysed between 1994 and 2007. Specific characteristics such as ethnicity, education and age are accounted for in the study. The measure of TFP stems from the EU KLEMS Growth and Productivity Accounts database, whereas human capital variables of the labour force are extracted from national microdata. The initial specification focuses on the impact of migrants on TFP within sectors taking into account education, average age and the diversity of migrants. Thereafter variables to distinguish between migrants with and without tertiary education are introduced. The impact of higher levels of formal education on innovation is more pronounced in manufacturing and much stronger in the high-tech sectors, relative to services.

## 3. The Effect of Human Capital and Networks on Knowledge and Innovation in SMEs

Farace S, Mazzotta F (2015). The Effect of Human Capital and Networks on Knowledge and Innovation in SMEs. *Journal of Innovation Economics and Management* 1(16): 39-71.

- Innovation propensity in Southern Italian SMEs is increased by human capital characteristics.
- Positive effects on innovation propensity are also found for network variables such as participating in a production chain and the presence of competitors.
- These results advocate policies aimed at promoting training at all levels to increase worker participation in strategic decision making and to improve external networks.

In order to understand knowledge creation and innovation mechanisms in SMEs in traditional sectors in Southern Italy, this research draws on a theoretical model to test the hypothesis of whether human capital of entrepreneurs and employees as well as the internal and external networks are important sources of knowledge for SMEs that do not undertake R&D activities. Human capital characteristics include the entrepreneur's education level, previous entrepreneurship experience and professional training. The relationship between innovation, human capital and internal and external networks is empirically tested by making use of survey data of SMEs in the province of Salerno, where innovation intensity is measured in terms of number of innovations.

## 4. Study on Human Capital Gaps for Effective Innovation Strategies in the Knowledge Era

Cabrilo S, Laposava Grubic N & Slavica M (2016). Study on human capital gaps for effective innovation strategies in the knowledge era. *Journal of Intellectual Capital* 15(3): 411-429.

- This research paper identifies gaps in human capital related to innovation performance in Serbian companies in order to design more effective innovation strategies.
- The smallest gaps related to innovation capacity are found in media and services, while the biggest gaps are in industry.
- To fill these gaps, the national innovation system in Serbia should focus on improving skills related to basic analysis and problem solving, creativity, imagination, resourcefulness and flexibility.

In order to transform an economy in transition with an industry-based mind-set into one with a knowledge mind-set, the link between human capital value drivers and innovation strategies has to be understood and the role of intangible drivers of innovation acknowledged. The developed methodology contains four steps: A survey, an assessment of human capital value drivers, the identification of gaps related to human capital value drivers and recommendations for an updated innovation strategy. The human capital survey includes 554 managers from Serbian companies within seven different industries. The analysis reveals gaps in human capital value drivers in almost all observed industries that are crucial to innovation performance. These are innovativeness, education and knowledge sharing and social skills.

## 5. Measuring the Impact of Innovative Human Capital on Small Firms' Propensity to Innovate

McGuirk H, Lenihan H & Hart M (2015). Measuring the impact of innovative human capital on small firms' propensity to innovate. *Research Policy* 44(2015): 965-976.

- This research paper introduces a new and multi-dimensional concept of Innovative Human Capital (IHC) to investigate its impact on the probability of firms to engage in innovation activity.
- The Irish empirical evidence shows an increased likelihood of engaging in either service, product and/or process innovation of small firms whose managers have IHC.
- Larger firms are found to be more likely to engage in process innovation if managers participate in training.
- These findings can guide the design of public support programmes for small firms.

The paper addresses two central questions: does IHC contribute to firm-level innovation? And does IHC have differing outcomes in small and larger-sized firms? Small firms are defined as those with less than 50 employees, whereas large firms have more than 50 employees. An extensive firm-level dataset of employees in Ireland surveyed in 2009 is used to retrieve respondents' characteristics at senior and middle management and supervisor level. IHC incorporates traditional measure of human capital such as education and/or training, as well as intangible characteristics such as job satisfaction and the willingness to accept change. A model provides estimates on the probability of introducing product, service or process innovations. Interaction effects between the location of a firm and the four IHC elements were also explored; no significant effects across regions were observed.

## 6. Allocation of Human Capital and Innovation at the Frontier: Firm Level Evidence on Germany and the Netherlands

Bartelsman E, Dobbelaere S & Peters B (2015). Allocation of human capital and innovation at the frontier: firm level evidence on Germany and the Netherlands. *Industrial and Corporate Change* 24(5): 875-949.

- The role of human capital and innovation in increasing productivity is studied across two selected countries, namely Germany and the Netherlands, as well as across industries.
- Frontier firms receive the highest returns to product innovation in the majority of industries.
- The most negative returns to process innovation are observed in the best-performing enterprises of most industries in both countries.
- The authors conclude that the best strategy for frontier firms is to invest in product rather than in process innovation.

For Germany, the study uses an unbalanced panel of 11,699 observations corresponding to 6634 firms over the period 2000–2008 and for the Netherlands an unbalanced panel of 24,586 observations corresponding to 14,841 enterprises for the same period of observation. Samples are split into five industries: high-, medium- and low-technology manufacturing, knowledge-intensive-services and other services. The empirical strategy consists of two parts. Firstly, the returns to human capital and innovation at the firm level are estimated. Following firm-level results, the second part of the analysis focuses on how these heterogeneous productivity effects of human capital and innovation change the productivity distribution at the industry level. Descriptive

statistics show the magnitude of the observed heterogeneity: for example, industries in the Netherlands are characterised by a larger average proportion of employees with a college or university degree irrespective of their level of technological intensity, whereas in German industries a more unequal distribution of human capital intensity prevails. Further, average innovation performance is higher in all industries in Germany, except for low-tech manufacturing. Innovation performance appears to follow a wider distribution in the Netherlands than in Germany.

## 7. Test Scores, Noncognitive Skills and Economic Growth

Balart P, Oosterveen M & Webbink D (2015). *Test Scores, Noncognitive Skills and Economic Growth*. IZA Discussion Paper Series No 9559.

- The impact of human capital and skills on economic growth is analysed by using a novel approach to associate noncognitive skills and productivity at the macroeconomic level for numerous countries.
- Cognitive test scores are decomposed into two components: the starting level and the decline in performance during the test.
- The latter observed effect can be attributed to noncognitive skills, whereas the former to cognitive skills.
- Noncognitive skills are an important explanatory factor for capturing the link between test scores and economic growth.

In basic cross-country growth specifications, the relationship between average economic growth of a country for a specific period and measures of human capital, GDP per capita and other variables such as years of schooling and population growth is explored. In these endogenous models, growth is attributed to the stock of human capital which induces innovations and/or the adoption and imitation of newly introduced technologies. More recent research introducing cognitive test scores (PISA) also shows a strong causal association with economic growth. The present paper adds to the literature by exploiting the random allocation of test booklets and the variation in question numbers to estimate the decline in performance during the test. Due to the random allocation of booklets to students, the decline in performance during the test or noncognitive skills, such as perseverance is captured. The test scores can then be decomposed into the starting level and the performance decline. Both test score components are related to economic growth. The estimated effects are of equal size.

## 8. Educational Mismatch and Firm Productivity: Do Skills, Technology and Uncertainty Matter?

Mahy B, Rycx F & Vermeulen G (2015). *Educational Mismatch and Firm Productivity: Do Skills, Technology and Uncertainty Matter?* IZA Discussion Paper Series No 8885.

- In this empirical research paper, mean years of over- and under-education within Belgian firms is calculated to understand the relationship with productivity across different working environments.
- Working environments are differentiated by the level of skills required by jobs, the degree of technological/knowledge intensity and the uncertainty of the economic context.
- Results contradict the hypothesis that over-educated workers are less productive due to frustration and less job satisfaction.

According to the literature, an educational mismatch appears if an increasing/decreasing level of education is not matched by jobs which require these increasing/decreasing skills. To understand how average years of over- and under-education within firms affect the productivity across different working environments, this paper uses Belgian linked employer-employee data covering the period 1999-2010. Estimates of firm-level productivity are provided for the two groups within each working environment and take into account a rich set of worker and firm characteristics. Results related to firm-level productivity show that over-education has a positive and significant impact on productivity regardless of the required type of skills and contributes to firm value added. Conversely, higher levels of under-education hamper firm productivity. Over-educated workers are more flexible, more adaptable and thus more productive under conditions of uncertainty and the returns to over-education are higher in firms which are technology/knowledge intensive.

## 9. Does Founders' Human Capital Matter for Innovation? Evidence from Japanese Start-ups

Kato M, Hiroyuki O & Honjo Y (2015). Does Founders' Human Capital Matter for Innovation? Evidence from Japanese Start-ups. *Journal of Small Business Management* 53(1): 114-128.

- The objective of this analysis is to explore the effect of human capital characteristics of founders of start-up enterprises in Japan on innovation outcomes.
- Specific human capital can be directly associated with innovation outcomes; on the other hand, general or generic human capital, such as educational attainment, indirectly affects innovation outcomes through R&D investment.
- Particularly for enterprises which undertake R&D activities at the start-up stage, human capital of the founder(s) significantly affects the post-entry performance of their enterprises.
- From a policy perspective, the authors conclude that developing entrepreneurial human capital is vital in countries with low start-up ratios.

By means of a survey questionnaire, this research examines whether and how the human capital of founders of start-ups impacts on innovations in Japan. Together with the direct effect of human capital on innovation outcomes the indirect effect through R&D investment is explored by testing a set of three hypothesis. The first hypothesis postulates that founders with higher levels of human capital are more likely to generate innovation outcomes, whereas the second differentiates between firm-specific and generic or general human capital; it is tested whether the former is associated with innovation activity more strongly than the latter. The third hypothesis tests whether generic human capital is more likely to boost R&D investment as opposed to innovation outcomes. Innovation outcomes are defined as the patent applications filed by the firm after foundation. The post-entry performance of start-up firms is recognised to contribute to economic growth as small enterprises undertake a large fraction of innovation activity. The authors argue that knowledge and skills are key components of human capital and of innovation capacity, hence human capital is of fundamental importance for research and development (R&D). Prior work or industry experience increases production efficiency and facilitates access to finance for R&D.