Persons

Human capital of managerial leadership is related to innovativeness of the enterprise

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Persons

IMPRESSUM

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HUMAN CAPITAL OF MANAGERIAL LEADERSHIP IS RELATED TO INNOVATIVENESS OF THE ENTERPRISE

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Tingting Tong received her Master's degree in Agricultural Economics from the University of Tennessee. She is currently a doctoral candidate in the School of Economics at Georgia Tech. Her research interests include labor economics, education economics, and applied econometrics. Currently she is studying the relationship between cognitive and noncognitive abilities and leadership. She is also conducting research about massive online open courses (i.e., MOOC). She has two journal publications and has presented her work at several international conferences. She teaches undergraduate Microeconomics.

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Dr Xiuli Sun received her Ph.D. degree in economics from Georgia Institute of Technology in 2015 summer. She will be an Associate Professor in School of Statistics in Southwestern University of Finance and Economics in China in 2015 fall. Her research interests include labor economics, industry organization, environmental economics, and applied econometrics. Her current focus is on studying the relationship between firm-level human capital and innovation in China. She is studying patents, product innovation and productivity in China from human capital perspective. She has presented her research at several international conferences.

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While many studies have looked at R&D spending as the key element to assess the innovation abilities (and success) of an enterprise, R&D spending is able to capture only part of the innovative process and outcomes happening in an enterprise (and conceptualized as number of patents filed). Imitative innovation (e.g. reverse engineering), incremental innovation and innovation through design and process optimization, rather than technological improvements, are not considered. In our study, based on two Chinese datasets, we looked at a proxy able to capture more of the innovation-related processes and abilities: the human capital of the skilled workers and general management in a company. Results show that the human capital endowment in a firm has a good explanatory power for the stock of patents produced. A particularly significant contribution is given by the general management and its ability to both develop innovative ideas and manage innovation in a successful manner.

If this is the case, then what makes a good manager? An integral characteristic of managers or supervisors is leadership. In another research, we looked at the skills, which characterize individuals in lead. This study thus estimates factors such as cognitive and noncognitive abilities affecting the probability of being a leader. Data come from the Programme for the International Assessment of Adult Competencies (PIAAC) survey for the United States. The results indicate that both cognitive and noncognitive abilities are significant determinants of being a leader, with the most important predictors of leadership being problem-solving ability and perseverance. We also find college education is important in determining leadership and a significant proportion of the impact from education attributes to cognitive and noncognitive abilities.

Introduction

R&D spending is not able to fully capture the abilities contribution to innovation in a company

Traditionally, the most important explanatory factor of innovation is R&D spending because it is believed that R&D is the input in producing innovation. However, in essence, those studies are deficient. Most of them simply regard R&D as the most important input of innovation without going deeper into the details of R&D and the mechanisms of R&D in affecting innovation. They fail to take other firm resources, mainly a firm's skilled human capital, into consideration. Second, they ignore the non-R&D innovation, which is usually important to firm innovation.

In addition, innovation includes not only R&D innovation but also non-R&D innovation. Generally, there are three types of creative activities that do not require R&D.

Looking at the human capital endowment of skilled workers and management team can provide more complete insights into the innovativeness of a company

First, many imitative activities, including reverse engineering, do not require R&D, and the imitation is mainly dependent on the firm's technical personnel and engineers. Second, firms can make minor modifications or incremental changes to products and processes, relying on engineering human capital. Moreover, the innovation process in low- and medium-technology sectors is more related to adaptation and learning by doing, based on design and process optimization, rather than from R&D. Third, firms can combine existing knowledge in new ways, for example in industrial design and engineering projects. Due to the large share of firms that innovate without performing R&D, we can conclude that studies that only focus on R&D should not be enough to fully explain innovation differences across firms. Therefore, a study based on human capital should give us a better understanding of firm innovation.

What exactly forms the human capital of leaders and managers?

The results from this first study (displayed in more detail below) provide the backdrop to dwell more into human capital and skills and their connection with leadership and management abilities. Since the human capital of the general management will prove to be a good driver of innovativeness, we made use of another dataset to understand more fully what is behind this human capital and which skills exactly characterize individuals who reach managerial positions.

Why is important to study leadership?

An integral characteristic of managers or supervisors is leadership, which is essential to the development of business, governments, and numerous other groups and organizations. Therefore, firms are investing more and more to develop their employees' leadership skills. Similarly, colleges are starting to use leadership as an important admission criterion. Despite the importance of leadership, very few studies have looked into the impact of various human capital measures on leadership. This study fills this gap by focusing on factors such as cognitive and noncognitive abilities that affect leadership.

Important factors determing leadership

The importance of cognitive ability, commonly measured by the intelligence quotient (IQ), on individuals' future development has been widely recognized (Cawley et al. 2001; Heckman et al. 2006). However, noncognitive abilities, which represent personalities, behaviors, and attitudes such as perseverance and self-discipline, are often ignored in economic studies.

Noncognitive abilities are as important as, if not more important than cognitive skills in determining academic and career outcomes. It is common that individuals with high IQs cannot achieve success in life because of a lack of self-discipline whereas those with low IQs succeed by virtue of persistence, reliability, and self-discipline (Heckman and Rubinstein 2001).

Cognitive and noncognitive ability measures

Based on the data from the Programme for the International Assessment of Adult Competencies (PIAAC) survey, which collects information about proficiency skills of adults aged 16 to 65 in 24 OECD member countries from August 1, 2011 to March 31, 2012, we construct three measures of the cognitive ability—numeracy, literacy, and problem-solving abilities—and three measures of the noncognitive ability, perseverance, like to learn new things, and social trust.

Leadership and background measures

We identify leaders as individuals that supervise more than five employees. Education is measured by whether an individual has a college degree. We also construct other variables such as years of experience, parental education, marital status, and number of children.

Key observations

The relationship between innovation ability and human capital endowment is positive and significant

In our first study, we looked at the relationship between innovation ability of a company and the human capital endowment of its workforce (skilled workers and general management). We find that a firm's innovation is not only determined by its human capital level, firm characteristics, and its market share, but also might be affected by market environment.

In this empirical study, we use two firm-level datasets from China, one from metropolitan cities and one from provincial middle cites. We use the number of patent applications as dependent variable, and it is regressed on human capital indicators, R&D, and firm characteristics. Human capital indicators are skilled human capital (number of highly educated workers), general manager's education and experience, and management team's education and age. We take skilled human capital, general manager's education as endogenous variables.[1]

Our study involved two surveys. The first is "The Study of Competitiveness, Technology & Firm Linkage" conducted by the World Bank in China in 2002. The second is "Investment climate survey" conducted also by the World Bank in 2003.[2]

We use the number of patents applied for in China as our dependent variable. Skilled human capital, GM's tenure and education, and the average age and education of management team are used as our human capital indicators. We use number of highly educated workers or skilled workers to measure a firm's skilled human capital. Another important variable in the patent production function is R&D spending by the firm. To better capture a firm's effort in R&D, an average R&D over years rather than R&D of a certain year is a better innovation input measure for the firm.[3]

[1] For skilled human capital, we use number of applicants for skilled position, number of weeks the positions are vacant, and city and its industry average excluding firm itself as instruments; for general manager's education, we use its city and industry excluding firm itself as instruments. The basic model is estimated using poisson model. Control function model is used in IV estimation.

[2] The first dataset was carried out in 2001-2002, covering firms in five big cities, Beijing, Chengdu, Guangzhou, Shanghai, and Tianjin. Most quantitative questions covered the period 1998-2000; most qualitative questions covered only the time of the survey, 2000. The second dataset was conducted in 2003 and covered firms in 18 cities, which were smaller than the cities

[3] We exclude current R&D from the averages to lessen endogeneity. Firm size is measured by the log of total assets. We also include market share of each firm to account for a firm's market position. In addition, firm age, ownership, city fixed effect, industry fixed effect are also included as control variables.

Skilled human capital has a positive effect in both datasets and it is important in determining firm innovation. Specifically, we find that other things equal, when highly educated workers increase 100 people, for firms with mean values the number of patents will increase 0.0808 in Data 2000 and 0.0144 in Data 2002, respectively.

GM's education and tenure have positive and significant effects on innovation. Our results indicate that for an average GM in an average firm, when its GM has a postgraduate degree, its number of patents will increase 0.0859 than having a GM without postgraduate degree. Also, we show that for an average general manager in an average firm, when general manager holds the position for one additional year, the number of patent applications will increase 0.0458.

Management team's education has a positive effect on innovation while the team's average age has a negative and significant effect on firm innovation.

R&D has a positive and significant effect on innovation in Data 2002 while it is insignificant in Data 2000. This might imply that R&D might be not enough in less developed areas while it is enough and might be too much in developed areas.

What does this tell us about the role of leaders and managers?

The fact that GM's education and management team's education is important to firm innovation implies that GM and management team's Lifelong Learning is important to firm innovation. Executives with Lifelong Learning can master the most advanced knowledge and also have greater cognitive complexity. Those provide executives greater ability to absorb new ideas, and therefore increase the tendency toward accepting innovations, and also make better innovation decision. In the following sections, we look in greater detail at which ability exactly characterize individuals who have reached leadership positions.

Relationship among human capital measures

To better understand the impacts human capital measures on leadership, we first explore the relationship between cognitive and noncognitive abilities, then the relationship between ability and education.

Table 1: Correlations among abilities

	Numeracy	Literacy	Problem solving	Perseverance	Like to learn new things
Numeracy	1.000				
Literacy	0.886	1.000			
Problem solving	0.824	0.858	1.000		
Perseverance	0.097	0.061	0.065	1.000	
Like to learn new things	0.043	0.057	0.066	0.354	1.000

Relationship between cognitive and noncognitive abilities

- Correlations among cognitive ability measures are very high, all above 82%. The high correlation indicates that the three cognitive measurements, although they measure different aspects of cognitive abilities, overlap with each other.
- Perseverance is more closely related to numeracy, as solving mathematical problems need strong perseverance.
- Problem solving is positively related to both perseverance and likeness to learn new things.

Relationship between abilities and education

Cognitive ability and education are positively related, as shown in Figure 1.

- As education level increases, the mean ability level increases for all cognitive ability measures. Individuals with master's or Ph.D. degrees have the highest abilities and those with no high school diploma the lowest.
- The largest increase happens for social trust. Among those with college degrees or higher, the proportion with good social trust is more than doubled compared to those with below high school education.

- Perseverance and likeness to learn new things also increase significantly with education, which is easy to understand as steadfastness and the eager for new knowledge will help individuals achieve higher education levels.

Figure 1: Kernel distribution of cognitive ability by schooling levels

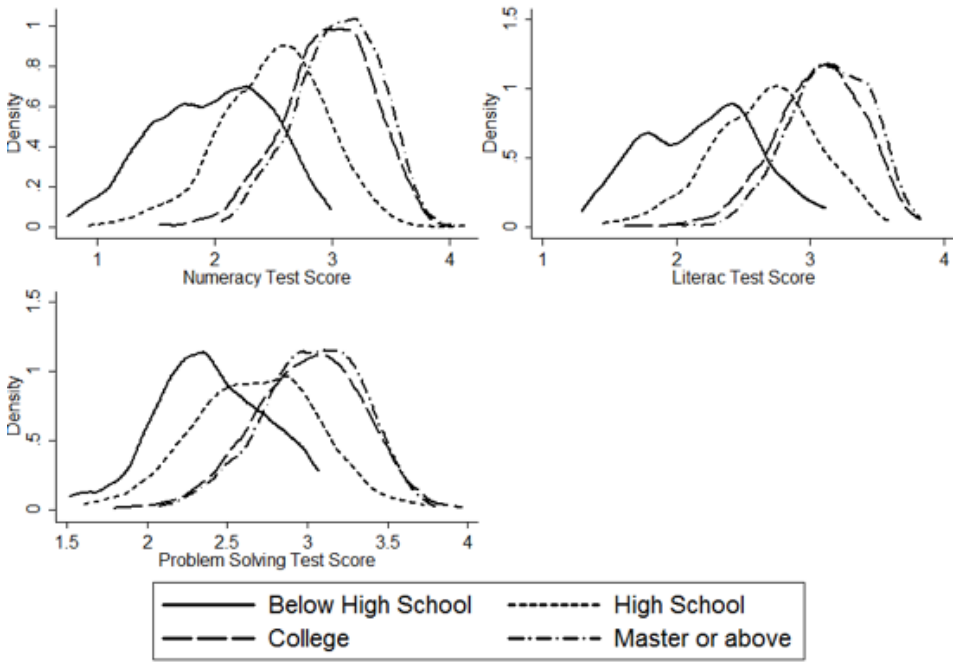

Table 2: Noncognitive ability and education level

Education	Perseverance	Likeness to learn	Social trust
Below High School	15.1%	33.0%	17.0%
High School	21.2%	40.2%	20.5%
College	31.6%	52.1%	36.5%
Master or Ph.D.	31.6%	55.4%	39.8%

Cognitive ability and leadership

We find cognitive abilities, especially problem solving ability, is important in determining leadership. College education is always important in determining leadership.

- Without other cognitive ability measures, if an individual has a college degree, the probability of being a leader will increase by 10.2 percentage points (column 1).

- College education is always important in determining leadership, whether controlling for other abilities or not.

However, the magnitudes of college coefficients drop by 30% to 40% after we control for numeracy and problem solving, which indicates that approximately a third of the impact of education can be attributed to cognitive abilities.

- The impact from literacy is non-linear. People too literate are not likely to become leaders.
- Only Problem-solving ability is positively significant if we control for cognitive abilities together (column 5). The importance of problem-solving ability, especially under technology-rich environment, has been emphasized by literature (Connelly et al. 2000).

Table 3: Cognitive ability and leader

	(1)	(2)	(3)	(4)	(5)
	lead5	lead5	lead5	lead5	lead5
Numeracy		0.081**			-0.031
Literacy			0.784***		0.153
Literacy2			-0.134***		-0.068
Problem solving				0.099**	0.306***
College	0.102***	0.068*	0.091**	0.064*	0.093**
Male	0.087***	0.074**	0.090***	0.096***	0.097***
Experience	0.003*	0.003*	0.003*	0.005***	0.006***
Married	0.066**	0.053	0.058*	0.051	0.057
Either parents has college degree	0.004	-0.01	-0.005	-0.018	0.002
Number of kids	0.018	0.021*	0.019	0.024*	0.021
Cons	0.018	-0.176**	-1.098***	-0.262**	-0.667
Industry dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	853	853	853	758	758
R^2	0.046	0.052	0.058	0.062	0.075
Adjusted R^2	0.037	0.042	0.046	0.051	0.06
F-statistics	5.34	5.691	6.263	6.034	5.248

Note: 1. Estimation results are based on linear probability model with robust standard error.

*2. *** denotes significance at 1%, ** denotes significance at 5%, and * denotes significance at 10%.*

Noncognitive ability and leadership

We find the most important noncognitive ability measure dertermining leadership is perseverance.

- Individuals with strong perseverance are more likely to become leaders.
- Problem solving ability remains significant after we control for noncognitive abilities but with a smaller magnitude.
- After controlling for cognitive and noncognitive abilities, the impact of education drops further but remains significant. A significant amount of the impact from education should be attributed to abilities.
- The estimation results of Probit and WLS are consistent with LPM estimation.

Table 4: Noncognitive ability and leader

	lead5			
	(1)	(2)	(3)	(4)
	LPM	LPM	Probit	WLS
Numeracy		-0.04	-0.046	-0.033
Literacy		0.166	0.177	0.145
Literacy2		-0.068	-0.068	-0.053
Problem solving		0.295***	0.300***	0.273***
College	0.088**	0.085**	0.083**	0.072**
Perseverance	0.099***	0.090**	0.090**	0.084**
Like to learn new things	-0.015	-0.027	-0.028	-0.032
Social trust	0.043	0.034	0.035	0.038
Male	0.080**	0.093**	0.098***	0.090***
Experience	0.003	0.006***	0.006***	0.005**
Married	0.063*	0.057	0.067	0.048
Either parents has college degree	0.003	0.001	-0.004	-0.012
Number of kids	0.019	0.022	0.02	0.022*
Cons	0.002	-0.658	-3.644*	-0.639
Industry dummies	Yes	Yes	Yes	Yes
Number of observations	853	758		758
R^2	0.056	0.083		0.106
Adjusted R^2	0.044	0.064		0.088
F-statistics	4.689	4.752		5.862
Pseudo R^2			0.072	

Note: 1. Estimation results are based on linear probability model with robust standard error.

*2. *** denotes significance at 1%, ** denotes significance at 5%, and * denotes significance at 10%.*

Policy Implications

This study provides evidence that congnitive and noncognitive skills, along with eductation, can significantly affect one's leadership and thus individuals' career outcomes. Policy implications for this study are as follows:

- Our study shows individuals with good problem solving skills and strong perseverance have more potential for leadership. Government and companies need to build mechanisms to identify individuals with strong leadership and put them in key positions in a competitive market.

- Government policies and company strategies in providing training in both cognitive and noncognitive skills, including early childhood education and lifelong learning opportunities, would improve individuals' leadership potentials.

Literature

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Project Identity

LLLight'in'Europe is an FP7 research project supported by the European Union, which has investigated the relevance and impact of lifelong learning and 21st century skills on innovation, productivity and employability. Against the background of increasingly complex tasks and jobs, understanding which skills impact individuals and organizations, and how such skills can be supported, has important policy implications. LLLight'in'Europe pioneered the use of an instrument to test complex problem solving skills of adults in their work environment. This allowed for the first time insights into the development of professional and learning paths of employed individuals and entrepreneurs and the role that problem solving skills play. Additionally, LLLight'in'Europe draws on a series of databases on adult competences from across the world to conduct rich analyses of skills and their impact.

These analyses were conducted in concert with different disciplines. Economists have been analyzing the impact of cognitive skills on wages and growth; sociologists have been investigating how public policies can support the development of such skills and lifelong learning; innovation researchers have been tracking the relationships between problem solving skills, lifelong learning and entrepreneurship at the organizational level;. educational scientists have investigated how successful enterprises support their workforce's competences; cognitive psychologists have researched on the development and implications of cognitive skills relevant for modern occupations and tasks; and an analysis from the perspective of business ethics has clarified the role and scope of employers' responsibility in fostering skills acquisition in their workforce. The team has carried out its research and analyses on the value of skills and lifelong learning in EU countries, USA, China, Latin America and Africa.

The result is a multi-disciplinary analysis of the process of adult learning and problem solving in its different nuances, and of the levers which can support the development of these skills for both those who are already in jobs, and for those who are (re)entering the labor market, as well as the development of effective HR strategies and public policy schemes to support them.

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Persons

This policy brief is part of the publication suite of the FP7 Project LLLight'in'Europe. The publication suite consists of 21 policy briefs, 6 thematic reports and 1 synthesis report. The 21 policy briefs discuss findings and policy implications proceeding from the project's research; they are organized along three level of analyses (persons; enterprise; country) and seven topics.

01 **Resources of society for learning**

02 Institutions of learning

03 Circumstances of learning

04 Role of transversal skills

05 Role of job-specific skills

06 Productivity of skills

07 Outcomes of skills

This policy brief discusses findings related to **Resources of society for learning** at the analysis level **persons**. For further publications and multimedia material related to the project, please visit www.lllightineurope.com