6-2010

Human Capital, Education, and Entrepreneurs: Evidence from the Yangtze River Delta

Zhining Hu
Gettysburg College

Jianghuai Zheng
Nanjing University

Jialing Wang
Slippery Rock University of Pennsylvania

Hu, Zhining, J. Zheng and J. Wang. "Human Capital, Education, and Entrepreneurs: Evidence from the Yangtze River Delta." Scientific Inquiry 11.1 (2010), 35 – 48.

Human Capital, Education, and Entrepreneurs: Evidence from the Yangtze River Delta

Abstract
This paper seeks to examine the relationship between education demand and entrepreneurs in the process of enhancing the growth of human capital in China. We develop a theoretical model that incorporates the important roles played by human capital, education and entrepreneurs. Then, we derive an immigration condition under which the demand for education depends on the existence of entrepreneurs. Finally, we test whether this condition holds true in China, using a panel data set from the Yangtze River Delta which is considered a key barometer of Chinese economy. The empirical results reveal a significant positive relationship between entrepreneurs and education demand in the Yangtze River Delta, suggesting that if we can find ways to promote the growth of entrepreneurial endeavors, we could spur the growth of education demand and further drive human capital accumulation in China.

Keywords
Entrepreneurs, Human Capital, Education

Disciplines
Asian Studies | Chinese Studies | Economics

Scientific Inquiry, vol. 11, no. 1, June, 2010, pp. 35 – 48 *IIGSS Academic Publisher*

HUMAN CAPITAL, EDUCATION, AND NTREPRENEURS: EVIDENCE FROM THE YANGTZE RIVER DELTA

ZHINING HU[a*#], JIANGHUAI ZHENG[b] and JIALING WANG[c]

[a]*Department of Economics, Gettysburg College, Gettysburg, PA 17325, USA;* [b]*Department of Industrial Economics, Nanjing University, Nanjing, 210093, P.R. China;* [c]*Department of Geography, Geology, and the Environment, Slippery Rock University, Slippery Rock, PA 16057, USA.*

(Received February 16, 2009; In final form April 27, 2009)

This paper seeks to examine the relationship between education demand and entrepreneurs in the process of enhancing the growth of human capital in China. We develop a theoretical model that incorporates the important roles played by human capital, education and entrepreneurs. Then, we derive an immigration condition under which the demand for education depends on the existence of entrepreneurs. Finally, we test whether this condition holds true in China, using a panel data set from the Yangtze River Delta which is considered a key barometer of Chinese economy. The empirical results reveal a significant positive relationship between entrepreneurs and education demand in the Yangtze River Delta, suggesting that if we can find ways to promote the growth of entrepreneurial endeavors, we could spur the growth of education demand and further drive human capital accumulation in China.

Keywords: Entrepreneurs, Human Capital, and Education.

1. INTRODUCTION

In the last two decades of the twentieth century, the world has witnessed great revolutions and changes in the global economy and technological landscapes. Of remarkable significance are: (1) internationalization as a result of increasingly inter-dependent and integrated global markets through free-trade and democratization, (2) the emergence of a technology-intensive and knowledge-based global economy driven predominately by technology and innovation, and (3) the rise of the so-called newly industrialized economies (NIEs), such as Korea, Taiwan, Hong Kong, and Singapore, and the late industrializing economies (LIEs) which are mainly represented by India and China. Because these influencing phenomena have had profound impacts on both developing economies and the developed world alike and will continue shaping the new world economic order, many world-wide scholars, politicians, and business executives are engaged in holding heated debates with regard to what driving forces are behind globalization, what roles developing countries, especially NIEs and LIEs, can (and/or should) play in international markets, and whether and how these rising latecomers may catch up, leapfrog, and even surpass early starters. Although interpretations drawn from a variety of theoretical and empirical studies are often controversial and different methodologies adopted by individual scholars tend to lead them to make different conclusions, one common ground for various arguments is the recognition of the factor of human capital as an increasingly critical element and

* Corresponding Author: zhu@gettyburg.edu

This research project was funded by the Research and Professional Development Grant of Gettysburg College.

growth engine for the development of technology-led or knowledge-based industries in both developed and developing countries.

A considerable amount of research has been devoted to what human capital is really about and what its role is in economic and industrial development; however, many theories or models-in-progress lack either real operational details or country/industry-level implications. Against this background, there are a large number of scholars involved in debating how to invest in and accumulate human capital in today's economy. This study aims to provide a better understanding of the relationship between human capital, education, and entrepreneurs in the globalization of world business and technology, with a particular focus on China. Our choice mainly arises from the fact that China is still lagging behind other countries in some dimensions of human capital growth and educational progress, despite China's economic growth over the past twenty years, which has been nothing short of astonishing. In our paper, we directly recognize the important roles played by education, technological advances, and entrepreneurship in accumulating human capital. We further strive to address a central issue of how entrepreneurs are able to drive workers to increase their demand for education, and thus, effectively promote human capital development in China. By doing so, we attempt to provide significant insights to both Chinese entrepreneurs and policy makers and enable them to carry out more appropriate technological and governmental strategies in the right place and at the right time. To achieve our goals, we construct a conceptual framework of human capital and transform it into a testable hypothesis. Then we examine this hypothesis with data from the Yangtze River Delta (the Delta for short). Through our empirical study, we find that the greater number of entrepreneurs leads to higher demand for education in the Delta. Since the Delta is the most flourishing economic region in China, our case study has a high level of implications for China's economy. One of the clearest implications rests on the role of entrepreneurs which contributes to changes in education demand. More specifically, when a firm or a country strives for an enhancement in technological innovation and human capital stock, a high priority should be given to the growth of entrepreneurial efforts.

We organize the rest of our paper as follows. Section 2 presents the relevant theories and concepts used for analyzing human capital. Section 3 shows the basic set-up of our model under which we derive an important migration condition where workers find it worthwhile to accumulate their human capital. Section 4 discusses the empirical evidence from the Yangtze River Delta in order to gain greater insights on the Chinese economy. The last section offers some conclusions.

2. LITERATURE REVIEW

As Krugman (1994) points out, if the major source of economic development is the growth of tangible capital, then given the diminishing marginal productivity of tangible capital, as more and more tangible capital is accumulated, each additional unit of tangible capital will be less productive than the unit preceding it. As a result, economic growth will slow down and eventually stop altogether. Kim and Lau (1994) further suggest that investment in intangible capital can increase the productivity of tangible capital because of its complementarities with tangible capital, and thus, prevent the decline in the marginal productivity of tangible capital, efficiently counteracting the "Krugman effect". More recently, a greater emphasis has been placed on the importance of human capital. At an individual level, human capital is an influential factor in determining a person's income, employment status, and labor mobility (Heckman *et al*., 1998). At a firm level, human capital is an important asset of the firm, and the empowerment of human capital is related to an increase in international competition (Martimort and Verdier, 2003). At an aggregate level, macroeconomists have identified human capital's crucial role in enhancing a country's overall economic performance (e.g., Lucas, 1988; Romer, 1990; Barro, 1991; Young 1995). In the above studies, human capital is not just a narrowly quantitative input or indicator for production or investment, but also a profoundly technological and economic factor that drives the ultimate success or failure of a firm, an industry, or a nation alike in the international competitive landscape.

Since skilled and adaptable human capital is important in taking advantage of the potential offered by the explosion of new knowledge and accelerating technological changes, there are substantial gains in addressing the issue of how to foster an investment in human capital. In fact, many researchers have already studied a variety of major determinants for human capital in order to seek feasible investment strategies. Since the microelectronics revolution in the 1980s, the new technological wave has caused a considerable increase in the share of skilled labor in the total labor force, over time and among industrialized countries. The interaction between human capital and R&D, hence, has largely been left out in previous work, such as Berman *et al.* (1994), Mishel and Bernstein (1998), Machin and Van Reenen (1998), and Piva *et al.* (2005). The role of entrepreneurship also deserves particular attention in facilitating the growth of human capital. A few works have stressed that, when the number of knowledge-intensive firms increases, individuals attempt to accumulate human capital to make their labor attractive to employers both through formal training prior to career employment and through on-the-job experience (e.g., Appold, 2001). Additionally, as argued by Romer (1990), Mankiw et al. (1992), Barro and Lee (1996), and others, there exists a close relationship between human capital and education. Based on their research, the commonly used measures of human capital are associated with such educational indicators as years of formal schooling, educational attainment rates at different levels (primary, secondary, or tertiary), or the adult literacy/illiteracy rate of a nation. Moreover, Heckman and Klenow (1997) study the contribution of human capital policies and find that government policies, to the extent that they are warranted, could promote private schooling and provide incentives for investments in human capital.

This paper is related to recent trends in the current economic literature of human capital. In our study, we directly incorporate these aforementioned theories and concepts into our theoretical and empirical models. Furthermore, we are interested in examining the interplay between human capital, education, and entrepreneurs in an economy. Dias and McDermott (2006) have found that entrepreneurs are instrumental for structural transformation, and thus, workers migrate and get educated in response to the number of entrepreneurs. Inspired by their research, we take one step forward to discuss whether this would also be the case in China.

Over the past twenty years, China has been making impressive achievements in economic growth. At the same time, China has been facing tremendous challenges. For instance, China still has such problems as weak supplier network, narrowly focused R&D, poor brand development, limited marketing capability, and low ability to compete in the international playing field. To overcome these challenges, we should take into account one of the most crucial factors - human capital- which is behind and beyond the abundant and "cheap" labor in China. Recently, many accounts have noted the distinctive role of Chinese human capital (e.g., Li and Florida, 2006; Fleisher *et al*., 2007). However, little effort has been devoted towards the research on how to promote its development so far. Some scholars have been performing a series of studies on the evolution of human resource management from business management perspectives (e.g., Warner, 1986, 1995, and 1999, etc.). These studies, in fact, are mainly focused on the general and micro-level management of human resources, such as recruitment, employment contracts, reward and benefit system, labor turnover, and trade union and labor relations, etc. What remains debated or unexplored are such fundamental and macro-level questions as to how China can accumulate human capital and enhance technological capabilities to meet its development goals, what factors in China's human capital stock will highlight the successes or opportunities of the catch-up, what factors will bear information about the potential obstacles or challenges in the development of human capital, and what industrial or governmental policies should be adopted to encourage investments in human capital.

A few researchers have tried hard to shed light on these above issues (e.g., Xiao and Lo, 2003; Zhang, 2008). We join their debates with an attempt to investigate the relationship between human capital, education, and entrepreneurs. We develop a theoretical model as a starting point. Through our analysis, we derive an important condition under which more workers desire to get educated and migrate to R&D-intensive industries when the number of entrepreneurs rises. Then, we test whether this migration condition holds true in China in our empirical work. Due to the difficulty in collecting a large sample of annual data for the whole country, we choose a panel data set available from the Yangtze River Delta as an alternative. Since no other region has played so vital a role in China's growth as this economic region, the Delta serves as a key barometer of the Chinese economy. Hence, we consider it an appropriate case which can be highly generalized to investigate the impact of entrepreneurs on the investment of human capital in China. Our findings have certain of policy implications for Chinese economic growth.

3. THEORETICAL FRAMEWORK

In our model[1], there are two sectors in an economy: the traditional manufacturing and the R&D-intensive. In each sector, there are two groups: workers and managers, who cannot switch between categories later in life. However, within each class, agents can choose. Specifically, workers can choose to be unskilled workers in the traditional sector or educated workers in the R&D-intensive sector. If a worker decides to migrate from the traditional sector to the R&D-intensive sector, he/she must acquire a minimum amount of human capital through education. Managers make up a managerial class that includes not only productive managers (i.e. entrepreneurs) but also unproductive managers (rent seekers) who have the ability to divert income from the rest of society without directly producing anything of value. An individual of the managerial class faces a choice: either a rent seeker or an entrepreneur. Capital can be divided into manufacturing capital and R&D capital. Without loss of generality, we assume that the capital market is perfectly competitive without any constraints on capital acquisition. For the convenience of analysis, we also assume that manufacturing capital and R&D capital are non-transferable.

In the traditional manufacturing sector, the production function is given by:

$$Y_P = AK_P^{1-\alpha} L_P^{\alpha} \, , \tag{1}$$

where we denote the technological level as A, manufacturing capital as K_P, and labor as L_P. We assume that the increase in human capital stock in the R&D-intensive sector will enhance the level of manufacturing technology, and thus, lead to higher demand for capital and labor in the traditional sector. Under this assumption, technology takes the following form:

$$A = \phi h^{\gamma} \, , \tag{2}$$

where ϕ is a constant, and $0 < \gamma < 1$ is a parameter[2].

We also assume that there is a positive external effect from the number of entrepreneurs (denoted by E) on the growth of human capital in the R&D-intensive sector. Given this assumption, the human capital-accumulation equation is represented by:

$$\dot{h} = f(E)h \, , \tag{3}$$

where h denotes the amount of human capital possessed by each worker and $\dot{h}$ is the growth rate of human capital. The inclusion of human capital h has become standard in the growth literature (e.g., Lucas, 1988). Function $f(E)$ shows that a greater number of entrepreneurs in an economy would facilitate the accumulation of human capital by workers. The justification for such a setup comes from what Dias and McDermott (2006) believe in their work, which includes the factors of urban environment, diversity of firms, opportunities and requirements, and international contacts. We follow their ideas, and thus, assume that $f'(E) > 0$ and $f''(E) \le 0$ because of decreasing returns to human capital.

In the R&D-intensive sector, the production function is given by:

[1] We are motivated to set up our theoretical model, based on the model developed in Dias and McDermott (2006).

[2] Assuming $0 < \gamma < 1$ means human capital has a decreasing return to scale with respect to output in the manufacturing sector. This assumption fits the practical situation in the Delta where the resources of current direct investment mainly come from international manufacturing capital. Although human capital stock is highly valued, workers with human capital still are treated as senior labor in the process of manufacturing. They do not participate in technological innovation.

$$Y_R = \theta K_R^{\beta} + A_R z^{\varepsilon}, \tag{4}$$

where θ is a constant, $0 < \beta < 1$ and $\varepsilon > 1$ are parameters[3]. We do not employ the basic framework of the Cobb-Douglas production function, with a belief that R&D capital and human capital are complements as justified on both theoretical and empirical grounds (e.g., Redding, 1996; Goldin and Katz, 1998). We also believe that technological progress reduces the amount of human capital needed to achieve a given amount of output, thus the production function depends on R&D capital and on human capital multiplied by the state of technology. In Equation (4), we denote R&D capital by K_R, technology by A_R, the number of workers in the R&D sector by L_R, and the aggregate demand for human capital by each enterprise, denoted by z , is given by:

$$z = L_R h. \tag{5}$$

Following a similar fashion as we set up the human capital-accumulation equation, we assume that there is another positive external effect from the number of entrepreneurs in the R&D-intensive sector, summarized by:

$$\dot{K}_R = g(E) K_R, \tag{6}$$

where $g(E)$ indicates that a larger number of entrepreneurs would facilitate the accumulation of R&D capital, with $g'(E) > 0$, $g''(E) \le 0$. As in Sjögren (1998), the incentive to do R&D comes from the monopoly rents the entrepreneur can extract due to the monopoly power an entrepreneur enjoys in the sale of his/her products. Under this scenario, we believe that the greater the number of entrepreneurs, the larger the number of workers to accumulate their human capital, and the higher the demand for the accumulation of R&D capital, due to the complementarities between human capital and R&D capital.

In the R&D-intensive sector, the net income or profit of the representative firm is given by:

$$\pi_R = \theta K_R^{\beta} + A_R z^{\varepsilon} - w_R z - \rho_R K_R, \tag{7}$$

where w_R is the wage per unit of human capital, and ρ_R is the rate of return to R&D capital. In the traditional manufacturing sector, the profit is defined as follows:

$$\pi_P = A K_P^{1-\alpha} L_P^{\alpha} - w_P L_P - \rho_P K_P . \tag{8}$$

Workers are more likely to leave the traditional manufacturing sector and migrate to the R&D-intensive sector if the wage earning is higher in the latter sector. This condition can be derived in detail as follows. In the traditional manufacturing sector, solving the first order condition

$$\frac{d\pi_p}{dL_p} = 0$$

gives

$$w_P = \alpha A \left(\frac{K_P}{L_P}\right)^{1-\alpha} = \alpha A k^{1-\alpha} .$$

[3] If a team consists of workers having strong scientific and research abilities, its impact will be imponderable. Hence, assuming $\varepsilon > 1$ means human capital has increasing returns to scale with respect to the R&D-intensive output.

Similarly, in the R&D-intensive sector, solving the first order condition

$$\frac{d\pi_R}{dz} = 0$$

provides

$$w_R = \varepsilon A_R z^{\varepsilon-1}.$$

If a worker decides to work in the R&D-intensive sector, however, he/she must pay a one-time cost to acquire the human capital of the representative worker in the R&D-intensive sector. This cost can be thought of as payment for moving, for direct education costs to obtain the minimum level of human capital, and for forgone income during the period of training. To incorporate this cost, we assume that the cost function of education investment is $C_M = \psi h^\sigma$ where $\sigma > 1$. Under these assumptions, the migration of workers from the traditional manufacturing sector to the R&D-intensive sector will occur, if the following condition holds:

$$\int_t^{+\infty} w_R h e^{-r(x-t)} dx - C_M > \int_t^{+\infty} w_P e^{-r(x-t)} dx. \tag{12}$$

Integrating Equation (12), we get (see the detailed derivation in appendix):

$$\frac{\varepsilon A_R L_R^{\varepsilon-1} h^\varepsilon}{r - \varepsilon f(E)} > \frac{\alpha \phi k^{1-\alpha} h^\gamma}{r - \gamma f(E)} + \psi h^\sigma. \tag{17}$$

In Equation (17) with $\varepsilon > 1$, $0 < \gamma < 1$, holding all other variables constant, when the number of entrepreneurs (i.e., *E*) increases, the left-hand side will be greater than the right-hand side. Given that a larger number of entrepreneurs can facilitate human capital accumulation and the acquisition of human capital is through education, we can infer that workers will have to acquire their human capital through education in order to migrate to the R&D-intensive sector, when the number of entrepreneurs increases. In other words, the demand for education will rise in response to the increasing number of entrepreneurs.

4. EMPIRICAL ANALYSIS

The above result derived from the model provides a theoretical basis for our empirical research and then can be transformed into a testable hypothesis which states that the demand for education is positively related to the number of entrepreneurs in China. Instead of using country-level data, we examine the hypothesis with panel data from the Yangtze River Delta, due to the difficulty to collect a large sample of data for the whole country. We believe that the Delta serves as an appropriate case and its potential findings can be generalized and applicable to the whole country. Before we start our estimation, it is worthwhile discussing where our belief comes from.

4.1. Background on the Yangtze River Delta

The Yangtze River Delta is home to Shanghai, Jiangsu, and Zhejiang provinces. While the Delta covers less than 1% of the total area of China and houses 5.8 % of the nation's population, it is actually an economic/geographic area far greater than may be inferred from its name. According to

Xinhua News Agency (*Peopledaily.com, 2008*), this economic region accounts for about 22.5 percent of the country's GDP, 31.5 percent of tax revenue, and holds 35 percent of the country's foreign investment. Being a strategic leader of China's economic centers and a key barometer of the Chinese economy, the Delta has always been brought to the forefront of China's reform and opening-up and become a driving force for Chinese economy. Over the past ten years, the economic breakthrough in the Yangtze River Delta region has been mostly prompted by market force and technological advances. As such, the economic resources and essential production factors' flow among different areas in the Delta have relaxed administrative controls and made economic activities link more closely. Such close economic ties have boosted regional economic integration and made the economy become more vigorous. Because of economic integration and its economic power in China, the Delta is a locomotive of Chinese economy, making our study meaningful far beyond its regional limitations and applicable to other regions and even the whole country.

In the echo of globalization of world business and technology, the Delta, as the most important manufacturing base in China, has strived for a knowledge-led development strategy. This strategy attaches importance to the enhancement of human capital, as one of the driving forces for internationalization and technological innovation. However, the development of human capital in the Delta is not very optimistic. The following Table 1 reports the composition of local population by the level of education (measured in percentages).

Province/City	People that have attained Higher Education	People that have attained Senior Secondary Education	People that have attained Junior Secondary Education	People that have attained Primary Education
Shanghai	11.4	23.8	38.2	19.6
Jiangsu	3.92	13.04	36.37	32.88
Zhejiang	3.19	10.76	33.34	36.62

Data Source: From Jiangsu Bureau of Statistics, Zhejiang Bureau of Statistics, and Shanghai Bureau of Statistics, the reports on the fifth national census in 2000.

Clearly, from the above table, we can find that the overall level of education in Shanghai, as a core of the Delta, is the highest as compared with Jiangsu and Zhejiang provinces. However, the percentage of Shanghai's population with junior secondary schooling and lower still exceeds 50%. According to Liu *et al.* (2003), the percentage of the employed with higher education was about 24% on average among twenty-nine OECD countries in 2000, while the average percentage was just about 6% in the Delta. This comparison displays a striking educational disparity between the Delta and industrialized countries. Furthermore, illiteracy rates are much higher among the rural population in China, with relatively few rural residents having completed senior school or college. These laborers have no specific set of skills but now become the largest concentrations of migrants in the Delta. Although the Delta has attracted a large amount of labor from west-central China, it is still short of skillful and educated workers. For instance, among 1,200,000 enterprises in 16 cities of the Delta (known as the most advanced manufacturing cities), the gap between the desired and actual percentages of senior mechanics and engineers is as high as 68%.

Against these scenes, the improvement of the Delta's technological capabilities has lagged behind its economic development. Notably, enterprises in the Delta are far from being the leaders in innovation. They still rely on foreign supply of advanced industrial technologies, and the lack of domestic progress has further increased reliance on foreign technology. In addition, poor domestic technological capability might have led to a serious structural weakness in the Delta's economy. Therefore, building technological capabilities is one of the areas in which the Delta will encounter great challenges in the short- to medium-term. Given this situation, we are concerned about how the Delta will be able to not only increase its R&D and strengthen its current innovation system, but also effectively foster the accumulation of human capital. To seek answers and provide greater insights on Chinese economic growth, we move to the next step by constructing an empirical model which is then estimated to test the derived hypothesis that the number of entrepreneurs is positively related to education demand.

4.2. Data and Empirical Evidence

Our regression model is set up as follows:

$$ED_{it} = c_1 + c_2 \sum_{j=1}^{n} ED_{it-j} + c_3 \sum_{j=0}^{n} ENTR_{it-j} + c_4 \sum_{j=0}^{n} ETD_{it-j} + c_5 \sum_{j=0}^{n} X_{it-j} + \varepsilon_{it}.$$

Here, ED_{it} denotes the amount of education demand in area *i* at time *t*, while $ENTR_{it-j}$ represents the current and/or past number of entrepreneurs in area i at time t-j, where j stands for the length of lags. According to Appold (2001), as already mentioned, we expect that the number of entrepreneurs is positively related to human capital development. ETD_{it-j} stands for the expenditures on R&D as a leading indicator of R&D activities. Its inclusion is consistent with the relevant literature indicating a positive relationship between human capital and R&D (e.g., Sjögren, 1998). X_{it-j} (current and/or lagged) is a set of controls including the average per capita spending on education (*EHPC*) and the expenditure on culture, education, science, and public health (*CECHC*)[4]. These two variables are added to minimize the problem of omitted variable bias. More importantly, they are used to measure how public educational expenses contribute to the accumulation of human capital. The lagged variable for education demand is considered to test for the presence of inertia or persistence.

The data are collected from Statistical Yearbook of Jiangsu Province, Statistical Yearbook of Zhejiang Province, Statistical Yearbook of Shanghai and Statistical Yearbook of China. We construct a panel data set for three sub-regions in the Delta, including Jiangsu, Zhejiang, and Shanghai. The sample size includes the annual data from 1990 until 2006, yielding a total of 48 observations. If we simply collect annual data at country level, we will encounter the problem of a small sample which might fail to give a statistical test enough power (sensitivity), therefore causing our interpretation on empirical results to be plausible and ambiguous.

Variable		Mean	Std. Dev.	Min	Max
ED	Overall	.0258055	.0186603	.0049124	.0684662
	Between		.0167042	.0129611	.0446895
	Within		.0125883	.0040161	.05071
ENTR	Overall	.0013896	.0007646	.0004091	.0033507
	Between		.0007519	.0007709	.0022264
	Within		.0004474	.0006793	.0025139
EHPC	Overall	.0425888	.0102763	.0210988	.0639427
	Between		.0068311	.0351264	.0485332
	Within		.0085948	.0285612	.0581928
CECHC	Overall	.0226828	.0074226	.0077004	.0334924
	Between		.0044126	.0192519	.0276606
	Within		.0064695	.0111313	.0369234
ETD	Overall	.018782	.0091252	.0055986	.0423622
	Between		.0092077	.0088039	.0269506
	Within		.0050614	.0107316	.0405526

In our collected data set, education demand (ED) is measured as the proportion of total students receiving senior secondary education or above in each sub-region. The number of entrepreneurs (ENTR) is measured as the percentage of total local population. R&D expenditures (ETD) are measured as the percentage of local GDP. All of the other variables, including EHPC and CECHC, are

[4] The expense on culture, education, science and public health refers to the funds appropriated from the government budget to promote culture, publication, cultural relics, education, public health, traditional Chinese medical science, free medical services, sports, communications, broadcasting, film and television, etc.

measured as the percentages of local GDP as well. The following Table 2 gives summary statistics of all of our variables in terms of the mean, standard deviation, minimum, and maximum, both within groups, between groups, and overall.

To estimate the above dynamic panel equation, we start with pooled OLS regression as a benchmark that makes no allowance for any of the potential pitfalls. However, many researchers, such as Audretsch *et al.* (2006), have noticed that entrepreneurial activity is an endogenous response to higher investments in new knowledge since greater entrepreneurial opportunities are generated by knowledge investments. Thus, the inclusion of entrepreneurs in a linear regression will cause inconsistent estimates if it happens to be correlated with the error term. It is very likely that this correlation will be non-zero because unobservable factors may determine human capital development. Another endogeneity problem may arise from the complementarities between R&D and investments in human capital, as discussed in Redding (1996) and Scicchitano (2006). In order to solve these endogeneity issues, we employ an instrumental variables (IV) approach and a Generalized Method of Moments (GMM) approach to quantify the dynamic relationships between education demand and the number of entrepreneurs. This study strategy allows us to compare different estimation specifications and verify the robustness of regression results regarding the role of entrepreneurs in determining the change of education demand.

Prior to estimation, we first-difference each variable under our study to control for the problem of non-stationarity and the omitted variable bias that occurs when some unmeasured area-specific characteristics are likely to be correlated with the explanatory variables. In our implementation of estimation, we include one lag of the dependent variable, which allows us to determine how long it takes for adjustments to happen. Furthermore, we lag all of the independent variables to rule out potential reverse causation and allow for measuring the dynamic impacts of independent variables. To avoid the problem of hetereskedasticity, we compute robust standard errors. The following Table 3 provides the panel regression results using different estimation methods.

Dependent Variable (ΔED_t)	**Pooled OLS Estimation**	**IV Estimation**	**GMM Estimation**
Independent Variable			
ΔED_{t-1}	.5052249*** (3.76)	.5348279*** (2.97)	.4188123*** (.1402894)
$\Delta EHPC_t$	-.0257023 (-0.40)	-.0216999 (-0.25)	-.0193263 (.0242194)
$\Delta EHPC_{t-1}$	.051381 (1.12)	.0463948 (0.60)	.0648887 (.0664493)
$\Delta CECHC_t$	.0095013 (0.14)	.0034932 (0.02)	.0289185 (.045097)
$\Delta \mathrm{CECHC}_{t-1}$	-.0316769 (-0.41)	-.0515835 (-0.29)	-.0101403 (.0382474)
$\Delta ENTR_t$	.8181117 (1.19)	1.45325 (0.46)	.5521353 (.6096045)
$\Delta \mathrm{ENTR}_{t-1}$	3.197656*** (2.21)	3.117827*** (2.64)	3.203886*** (1.126887)
ΔETD_t	-.006013 (-0.19)	-.02181 (-0.09)	-.0070499 (.0103222)
ΔETD_{t-1}	.0298306 (0.87)	.0257588 (0.28)	.027925 (.0566467)

Note: Figures in brackets are t test statistics. *, **, *** represent the statistics under the levels 10%, 5%, 1%, respectively.

In Table 3, the first column shows the pooled-OLS results, the second presents the IV model by choosing local fiscal revenue (LFR), expense on science and technology promotion (STP), and innovation funds of enterprises (TUTE) as instruments for the number of entrepreneurs and R&D expenditures, and the third reports the GMM method designed by Arellano and Bond (1991) using moment conditions in which lags of the dependent variable and first differences of the exogenous variables are chosen as instruments. As Arellano and Bond (1991) point out, the GMM estimator incorporates the strong assumption that lagged values of the dependent variable and the error terms are uncorrelated. We examine the appropriateness of this assumption by conducting a series of diagnostic tests which enable us to conclude that the instruments used in the regression are not correlated with the error term and the equation is reasonably specified.

It is likely that the pooled OLS and IV approaches might result in the estimation biasedness, due to the problem of endogeneity and inappropriate instruments, respectively. However, when comparing the regression results in these three estimation specifications, we find no substantial differences. Therefore, the estimated results highlight the existence of robustness. The worthwhile interpretations on the regression estimates are as follows.

Although the contemporaneous coefficient on the change in the number of entrepreneurs is insignificantly different from zero, the impact of this change is significant with a time of one lagged period. This indicates that, despite the delay effect, there still exists a crucial role of entrepreneurs in spurring the change of education demand. This finding, therefore, implies that with the number of knowledge-intensive firms increasing, more and more workers in the Delta will desire to get educated as a means to acquire or accumulate their human capital.

The regression results also show that neither the change in the expenditure on culture, education, science, and public health (CECHC) nor the change in the average per capita spending on education (EHCH) is statistically significant. This indicates that educational expenditures and the subsidies offered by local governments in the Delta have little short-term influence on the change of education demand. This finding is consistent with Heckman (2005) who discusses that China's current policies favor physical capital investment over schooling, suggesting that funding for education should be encouraged and can supplement government funding.

Another point worth noting is the insignificant impact of the change in R&D expenditures on the change of education demand. It implies that the Delta might not have been successful in transferring education results through the channel of R&D expenditures and applying them to the production of human capital. Hence, the Delta fails to create a strong incentive for migrant workers to invest in their human capital by getting more education, despite that it is a hub of lots of universities and research institutions with a substantial pool of talents.

4.3. Discussion

Since the Delta’s economy is a good representative of Chinese economic performance, our empirical findings on the Delta have a high level of generalization, and thus, enable us to draw implications for the whole country. Through our empirical analysis, we find that education depends on the existence of entrepreneurs in China. Behind this finding is the common traditional convention that education is a propeller for the growth of human capital and entrepreneurship is a catalyst for carrying out an innovation-based growth strategy. When the number of entrepreneurs increases, it results in a higher demand for education, and thus, facilitates the accumulation of high-quality human capital and promotes R&D activities, which in turn further contributes to economic growth.

In addition, we look closely at the impact of R&D expenditures on education. In the Delta, the overall R&D expenditures are still much too low, at about 1.8% of local GDP on average during the given period. Comparatively, in the whole country, the average percentage is even lower, around 1.4% in 2007, which was only a quarter of the U.S. level (Boroush, 2008). These figures demonstrate that the research and development activities in China haven’t become dominant yet, and consequently, they do not generate a stimulus to generate higher growth of education demand. Furthermore, this regression result implies that whether China can emerge as a high-tech powerhouse will depend on its appropriate technological strategies among which the strategy of how to mitigate the risk and cost of R&D investments and promote R&D activities deserves a further consideration.

Finally, we use our empirical model to provide a quantitative assessment of the effect of public education expenditures on education demand and find the lack of significance on the public expenditure coefficients. This evidence implies that governments in China have been facing the problem of maintaining public funding level of higher education. In China, the development of the country's educational infrastructure has been an on-going priority for the governments at local and central levels. Much has been achieved, particularly since the 1990's, however, the ever-increasing demand for education means that the number of students – especially those eager to go beyond nine years of compulsory schooling – outstrips the supply of places and resources. Additionally, since the late 1970's, the central government has gradually decreased its influence over local economies and given local governments greater say on how to spend their revenues. However, local governments are prone to use their financial resources in sectors more profitable than education, such as transportation or communications infrastructure. To address the problems and issues of funding higher education, we recommend that the central government as well as local governments should offer further incentives to encourage localities to spend more money on higher education, carry out educational reforms, and search funding alternatives to finance more of higher education institutes, etc.

5. CONCLUSIONS

This paper mainly studies the relationship between entrepreneurs and education demand, with a motivation that education fosters the development of human capital, and in turn, stimulates knowledge-based economic growth. We consider an economy with two sectors: the traditional manufacturing sector hiring unskilled workers and the R&D-based sector hiring educated and skilled workers. In the economy, we also consider two types of managers- rent seekers who are unproductive and entrepreneurs who are productive and engaged in innovative activities. We derive an important migration condition under which the larger number of entrepreneurs spurs higher demand for education and leads more workers to migrate into an innovation-based enterprise after developing their human capital. Our theoretical finding highlights the importance of entrepreneurs in enhancing the growth of the demand for education in the process of improving investments in human capital. Our empirical work further confirms that this relationship between entrepreneurs and education is valid in China by choosing the Yangtze River Delta as a case study.

The implications from our study on the Delta can be applied to other regions and even the whole country, as the Delta is a good representative of Chinese economy. As illustrated previously, China is short on skilled labor. Increasing education and greater understanding about the role of entrepreneurs will hopefully alleviate this problem. Furthermore, this paper concludes, as the main policy implication, that policy makers in China should continue encouraging more managers to become productive entrepreneurs and extending help to innovating enterprises to raise their profiles in the global competition. The supportive strategies which should be further intensified by governments involve the provision of enterprise and entrepreneurship education, the provision of facilities to the high-tech development zones and technology development areas, such as the Delta, and governmental subsidies including favorable tax credits. With continued governmental support, the growing number of entrepreneurs would further drive human capital accumulation and lead to economic growth by spurring the growth of education demand in China.

Acknowledgement

The authors are grateful for helpful suggestions from the participants at the 82nd annual conference of Western Economic Association International in 2007. All errors are ours.

References

Acemoglu, D., (1997) "Training and Innovation in an Imperfect Labor Market". *Review of Economic Studies*, vol.64, no.3, pp.445 – 64.

Appold, S.J., (2001) "The Control of High-skill Labor and Entrepreneurship in the Early US Semiconductor industry". *Environment and Planning* A, vol. 33, pp. 2133 – 2160.

Arellano, M., and Bond, S., (1991) "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations". *Review of Economic Studies*, vol. 58, no.2, pp. 277 – 297.

Audretsch, D.B., Keilbach, M.C., and Lehmann, E.E., (2006) *Entrepreneurship and Economic Growth*, Oxford University Press, New York, NY.

Barro, R.J., (1991) "Economic Growth in a Cross Section of Countries". *Quarterly Journal of. Economics*, vol. 106, no. 2, pp.407 – 443

Barro, R.J., and Lee, J.W., (1996) "International Measures of Schooling Years and Schooling Quality", *American Economic Review, Papers and Proceedings*, vol.86, no.2, pp. 218 – 223.

Berman, E., Bound, J., and Griliches, Z., (1994) "Changes in the Demand for Skilled Labor within U.S. Manufacturing Industries: Evidence from the Annual Survey of Manufacturing", *Quarterly Journal of Economics*, vol. 109, no. 2, pp. 367 – 397.

Boroush, M., (2008) "New Estimates of National Research and Development Expenditures Show 5.8% Growth in 2007", Science Resource Statistics (NSF 08-317), National Science Foundation.

Dias, J., and McDermott, J., (2006) "Institutions, Education, and Development: The Role of Entrepreneurs". *Journal of Development Economics*, vol. 80, pp. 299 – 328.

Fleisher, B., Li, H., and Zhao, M.Q., (2007) "Human Capital, Economic Growth, and Regional Inequality in China". Working paper: No. 857, The William Davidson Institute, University of Michigan.

Goldin, C., and Katz, L.F., (1998) "The Origins of Technology-skill Complementarity". *Quarterly Journal of Economics*, vol. 113, no. 3, pp. 693 – 732.

Heckman, J., and Klenow, P., (1997) *Human Capital Policy*. University of Chicago, mimeo.

Heckman, J., Lochner, L., and Taber, C., (1998) "Explaining Rising Wage Inequality: Explorations with A Dynamic General Equilibrium Model of Earnings with Heterogeneous Agents". *Review of Economic Dynamics*, vol. 1, No. 1.

Heckman, J., (2005) "China's Human Capital Investment". *China Economic Review*, vol. 16, no. 1, pp. 50 – 70.

Kim, J., and Lau L.J., (1994) 'The Sources of Economic Growth of the East Asian Newly Industrialized Countries'. *Journal of the Japanese and International Economies*, vol. 8, no. 3, pp. 235 – 271.

Krugman, P., (1994) "The Myth of Asia's Miracle". *Foreign Affairs*, vol. 73, no. 6, pp. 62 – 78.

Li, T., and Florida, R., (2006), "Talent, Technological Innovation and Economic Growth in China". Working paper, Joseph L. Rotman School of Management, University of Toronto.

Liu, Z., (2005) *Chinese Manufacturing Industrial Base: the Yangtze River Delta*. In Chinese, China Renmin University Press, Beijing, China.

Lucas, R.E., Jr., (1988) "On the Mechanics of Economic Development". *Journal of Monetary Economics,* vol. 22, no. 1, pp. 3 – 42.

Machin, S., and Van Reneen, J., (1998) "Technology and Changes in the Skill Structure: Evidence from Seven OECD Countries". *Quarterly Journal of Economics*, vol. 113, no. 4, pp. 1215 – 1244.

Mankiw, G.N., Romer, D., and Weil, D., (1992) "A Contribution to the Empirics of Economic Growth". *Quarterly Journal of Economics*, vol. 105, no. 2, pp. 407 – 437.

Martimort, D., and Verdier, T., (2003) "From Inside the Firm to the Growth Process". *Journal of the European Economic Association*, vol. 1-2-3, April – May, pp. 621 – 629.

Mishel, L. and Bernstein, J., (1998) "Technology and the Wage Structure: Has Technology Impact Accelerated Since the 1970s?". *Research in Labor Economics*, vol. 17, pp. 305 – 355.

Peopledaily.com, (2008) "China's Yangtze River Delta to Attain Modernization by 2020, Says Official". 17 October, available at: http://english.peopledaily.com.cn/90001/90776/90884/6516590.html.

Piva, M.C., Santarelli, E., and Vivarelli, M., (2005) "The skill Bias Effect of Technological and Organisational Change: Evidence and Policy Implications". *Research Policy*, vol. 34, no. 2, pp. 141 – 157.

Redding S.,(1996) "The Low-Skill, Low-Quality Trap: Strategic Complementarities between Human Capital and R&D". *The Economic Journal*, vol. 106, no. 435, pp. 458 – 470.

Romer, P.M., (1990) "Ednogenous Technological Change". *Journal of Political Economy*, vol. 98, no. 5, Part 2, pp. S71 – S102.

Scicchitano, S., (2006) "Complementarity Between Heterogeneous Human Capital and R&D: Can Job-training Avoid Low Development Traps?". Working paper, University of Calabria and Ministry for Economic Development, Italy, September 2006.

Sjögren, A., (1998) "*Human Capital, R&D and Economic Growth"*. Working paper series in Economics and Finance: no. 238, Department of Economics, Stockholm School of Economics.

Warner, M., (1986) "Managing Human Resources in China: an Empirical Study". *Organization Studies*, vol. 7, no. 4, pp. 353 – 366.

Warner, M., (1995) "Managing China's Human Resources". *Human Systems Management*, vol. 14, no. 3, pp. 239 – 248.

Warner, M.., (1999) "Human Resources and Management in China's Hi-tech Revolution: a Study of Selected Computer Hardware, Software and Related Firms in the PRC". *International Journal of Human Resource Management*, vol. 10, no. 1, pp. 1 – 20.

Xiao, J., and Lo, L.N.K., (2003) "Human Capital Development in Shanghai: Lessons and Prospects". *International Journal of Education Development*, vol. 23, pp. 411 - 427.

Young, A., (1995) "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience". *Quarterly Journal of Economics,* vol. 110, no. 3, pp. 641 – 680.
Zhong, H., (2008) "Foreign Direct Investment and Human Capital Accumulation in China". *International Research Journal of Finance and Economics*, vol. 19, pp. 205 – 215.

APPENDIX

The profit in the R&D sector can be expressed as:

$$\pi_R = \theta K_R^{\beta} + A_R z^{\varepsilon} - w_R z - \rho_R K_R \cdot \tag{1}$$

The profit in the manufacturing sector is given by:

$$\pi_P = A K_P^{1-\alpha} L_P^{\alpha} - w_P L_P - \rho_P K_P \cdot \tag{4}$$

In Equations (1) and (4), we set $\frac{d\pi_R}{dz} = 0$ and $\frac{d\pi_P}{dL_P} = 0$. Based on $\frac{d\pi_R}{dz} = 0$, we can derive

$$w_R = \varepsilon A_R z^{\varepsilon-1} \cdot \tag{9}$$

Based on $\frac{d\pi_P}{dL_P} = 0$, we can derive

$$w_P = \alpha A \left(\frac{K_P}{L_P}\right)^{(1-\alpha)} = \alpha A k^{1-\alpha} \cdot \tag{10}$$

If a worker decides to work in the R&D sector, however, he/she must pay a one-time cost to acquire the human capital of the representative worker in the R&D sector. To incorporate this cost, we assume that the cost function of education investment is:

$$C_M = \psi h^{\sigma}, \sigma > 1. \tag{11}$$

Thus, the migration of workers from the manufacturing sector to the R&D sector will occur, if the following condition holds:

$$\int_t^{+\infty} w_R h e^{-r(x-t)} dx - C_M > \int_t^{+\infty} w_P e^{-r(x-t)} dx \tag{12}$$

Substituting Equations (9), (10), (11) into Equation (12), we have:

$$\int_t^{+\infty} \varepsilon A_R z^{\varepsilon-1} h e^{-r(x-t)} dx - \psi h^{\sigma} > \int_t^{+\infty} \alpha A k^{1-\alpha} e^{-r(x-t)} dx \tag{13}$$

On the left hand side of Equation (13), the first item becomes:

$$\int_t^{+\infty} \varepsilon A_R z^{\varepsilon-1} h e^{-r(x-t)} dx = \varepsilon A_R \int_t^{+\infty} L_R^{\varepsilon-1} h^{\varepsilon} e^{-r(x-t)} dx = \varepsilon A_R L_R^{\varepsilon-1} \int_t^{+\infty} h^{\varepsilon} e^{-r(x-t)} dx$$

Since,

$$\int_t^{+\infty} h^{\varepsilon} e^{-r(x-t)} dx = (-\frac{1}{r}) \int_t^{+\infty} h^{\varepsilon} d e^{-r(x-t)} = (-\frac{1}{r}) h^{\varepsilon} e^{-r(x-t)} \Big|_t^{+\infty} + \frac{1}{r} \int_t^{+\infty} e^{-r(x-t)} \varepsilon f(E) h^{\varepsilon} dx = \frac{1}{r} h^{\varepsilon} + \frac{1}{r} \varepsilon f(E) \int_t^{+\infty} h^{\varepsilon} e^{-r(x-t)} dx,$$

We have

$$\int_t^{+\infty} h^{\varepsilon} e^{-r(x-t)} dx = \frac{h^{\varepsilon}}{r - \varepsilon f(E)}.$$

This indicates that the first item on the left hand side of Equation (12) becomes

$$\int_t^{+\infty} w_R h e^{-r(x-t)} dx = \frac{\varepsilon A_R L_R^{\varepsilon-1} h^{\varepsilon}}{r - \varepsilon f(E)} \; ; \tag{15}$$

The right hand side of Equation (12) becomes:

$$\int_t^{+\infty} w_P e^{-r(x-t)} dx = \int_t^{+\infty} \alpha A k^{1-\alpha} e^{-r(x-t)} dx = \alpha k^{1-\alpha} \phi \int_t^{+\infty} h^{\gamma} e^{-r(x-t)} dx = \frac{\alpha \phi k^{1-\alpha} h^{\gamma}}{r - \gamma f(E)} \tag{16}$$

Combining Equations (15) and (16) into Equation (13), we get:

$$\frac{\varepsilon A_R L_R^{\varepsilon-1} h^{\varepsilon}}{r - \varepsilon f(E)} > \frac{\alpha \phi k^{1-\alpha} h^{\gamma}}{r - \gamma f(E)} + \psi h^{\sigma} \tag{17}$$