Entrepreneurs and Professionals: Their Relative Supplies and Returns – A Perspective from Economic Growth

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Abstract This paper analyzes a growth model in which the ratio of professional human capital return to entrepreneurial human capital return changes with the level of economic development. Empirically, few economies in today's world are near the ratio's optimal steady-state level though developed economies register a higher ratio on average than less developed economies. With the entrepreneur shortage, the required adjustment includes a transition of some professionals to entrepreneurs, and a decrease in the existing entrepreneurs' compensation relative to professionals'. In this process, entrepreneurs' average consumption rises in less developed economies whereas it falls in developed economies. Furthermore, it is shown that a decelerating growth is compatible with the optimal adjustment process and an accelerating growth isn't.

Keywords: entrepreneurs, professionals, human capital, economic growth

JEL Classification: J24, O11, O40

1. Introduction

Human capital, no matter whether it is acquired ability or genetic endowment, enhances productivity not only through upgrading educational level of labor force and work skills (professional type) but also through instilling and disseminating entrepreneurship (entrepreneurial type). However, entrepreneurs as an indispensable productive factor have not received their due in economic growth analysis.

Schumpeter (1934) represents the early work on the role of entrepreneurial human capital in economic growth. According to Schumpeter, entrepreneurs create technical and financial innovation in the face of competition and thus spurt investment activities and generate economic growth. In a later study, Schumpeter (1962) identifies the entrepreneur as the prime mover of various innovations in a growing economy. Phelps (1961) explores the steady-state level of per capita capital accumulation that maximizes the well-being of the individuals, which is well known as the golden rule level of capital, a yardstick that gauges the level of investment in economic growth. Unfortunately, no economy in the world today has saving
and investment rates that match the golden rule of capital accumulation, which, to a great extent, reflects the lack of entrepreneurship.

Schmitz (1989) presents a model in which endogenous entrepreneurial activity is a key factor in economic growth via imitating and implementing knowledge. The study emphasizes that imitating entrepreneurs’ act in transferring and implementing new technologies (product of professionals) drives economic growth, which in fact signals the role of an appropriate combination of professional and entrepreneurial human capital. It is also argued that economies with a larger proportion of entrepreneurs tend to grow persistently faster. Baumol (1990) finds that innovation and risk-taking characters of entrepreneurship can significantly strengthen the vigor of productivity growth, implying the importance of a right mixture of the two types of human capital. Oi (1999) discusses two types of human capital in economic growth by arguing that entrepreneurial human capital is attributable to a dynamic innovating economy whereas professional human capital is only a consequence but not an engine of growth.

Hellmann (2004) represents an interesting study on entrepreneurial human capital. According to Hellmann, entrepreneurs often get ideas from working as employees in established firms. Employees with ideas can at least become intrapreneurs and some of them leave their parent firm to launch the next entrant. No matter whether employees depart to become entrepreneurs or stay to develop their innovations internally and thus turn themselves into intrapreneurs, they are two natural equilibrium outcomes in the process of innovation, therefore representing a path from professionals to entrepreneurs in general.

Iyigun and Owen (1998, 1999) show that a skill-biased technological progress drives changes in the composition of aggregate human capital: the ratio of entrepreneurial human capital to professional human capital falls as technology improves. In particular, their study argues that entrepreneurial human capital plays a relatively more important role in relatively poorer countries, and economic development is associated with a decline in the number of entrepreneurs relative to professionals. The relative return of two types of human capital, nevertheless, is not the focus of their studies.

As far as entrepreneurs and professionals are concerned, which type of human capital is in a relative shortage? Is the answer sensitive to the stage of economic development? If so, how? And, furthermore, who are “overpaid” and who are “underpaid” with respect to their steady state in the long-term economic growth? This paper attempts to investigate these issues by exploring the relative returns to the two types of human capital in a dynamic optimization model. The analytical approach used in this paper appeals to the norm provided by the golden rule steady state in which entrepreneurial human capital, professional human capital, consumption, and output grow at the same constant rate. We first characterize the golden-rule steady state ratio of professionals’ return to entrepreneurs’ return as well as the golden-rule steady state ratio of entrepreneurial human-capital stock to professionals’ human-capital stock. We then compare the ratios with the norm and discuss the pertinent dynamics in the equilibrium adjustment process. In particular, we emphasize the implications to the relative human capital returns and to the associated growth of entrepreneurs’ average consumption. It turns out that the results are sensitive to the level of economic development. Our analysis will establish a relationship between output growth and the ratio of returns to the two types of
human capital, which allows us to draw a conclusion on what type of second-order change in output matches the optimal adjustment in human capital accumulation and their returns.

It is shown that at the steady state the human-capital return ratio equals one and the optimal ratio of entrepreneurial to professional human capital stock is negatively related to the output elasticity of professional human capital. If the ratio of professionals’ return to entrepreneurs’ is less than one at the initial state, transitional dynamics exhibits a positive relationship between entrepreneurs’ relative return and output growth: as entrepreneurial human capital rises relative to professional human capital, professional human capital relative return rises and economic growth decelerates; and meanwhile, there is a saddle path along which entrepreneurs’ average consumption rises for less developed economies but it falls for developed economies. An examination of the panel data with 45 countries suggests that the accumulation of entrepreneurial human capital in most economies, both the less developed and the developed, is inadequate and away from the optimal path that allows them to maximize the well-being of individuals. Unlike Iyigun and Owen (1998, 1999), we show that developed economies are not immune from an underdevelopment of entrepreneurial human capital relative to professional human capital and thus an overpayment to entrepreneurs relative to professionals. Our finding suggests that, in addition to further regulation of executive compensation\(^2\), a transition from some professionals to entrepreneurs can also help achieve a more balanced steady-state growth; in this regard, professional human capital is no longer merely a passive and non-causal force as in Oi (1999).

The paper proceeds as below. Section II presents the basic elements of the growth model that integrates professional and entrepreneurial human capital and focuses on the “golden-rule” steady state properties. Section III develops the theoretical results of transitional dynamics underlying the later empirical analysis. Section IV discusses some preliminary empirics and GLS regression results that are relevant to the model. Section V offers a brief set of conclusions.

2. Human-Capital Investment in the Steady State

In a competitive closed economy, it is assumed that households own both physical and human capital and carry out production directly. To focus on the dichotomy between professional human capital and entrepreneurial human capital, we hold the stock of physical capital constant and set it to unity for normalization. We can think of professional human capital as the number of professionals multiplied by their professional knowledge, and entrepreneurial human capital as the number of entrepreneurs multiplied by their entrepreneurship. Production technology exhibits constant returns to two human capitals and the economy maintains a positive output growth at the steady state, even though there is no exogenous technical progress and the total number of professionals and entrepreneurs is constant.

In such an economy, a benevolent social planner (government) chooses the paths of consumption and human-capital investment to maximize lifetime utility of the representative household. The optimization problem is subject to the resource constraint and the conditions that govern the evolution of the stock of human capital. Formally, we have
\[
\max U(0) = \int_0^\infty e^{-\rho t} u(C) dt \\
\text{s.t. } (a) \quad \dot{H}_p = I_p - \delta H_p \\
(b) \quad \dot{H}_e = I_e - \delta H_e \\
(c) \quad A(H_p)^\beta (H_e)^{1-\beta} = C + I_p + I_e \\
(d) \quad \lim_{t \to \infty} [\mu_p(t)H_p(t)] = \lim_{t \to \infty} [\mu_e(t)H_e(t)] = 0
\]

where \(U(0)\) is the value of the objective function as seen from the initial period, \(\rho\) is the discount rate, \(C\) is consumption at time \(t\) (for simplicity, the time element has been eliminated from all the relevant variables.), \(u(C)\) is a standard utility function which relates the flow of the household’s utility to the quantity of consumption, \(H_p\) and \(H_e\) are respectively the stocks of professional human capital and entrepreneurial human capital at time \(t\), \(I_p\) and \(I_e\) are respectively net investment in professional human capital and entrepreneurial human capital, and \(\delta\) is the depreciation rate for both types of human capital (due to the losses from unemployment and underemployment, skill and knowledge depreciation, and mortality, etc.). The LHS of (1c) is the Cobb-Douglas production function in which \(A\) is the productivity parameter, and \(\beta\) is the output elasticity of professional human capital. In short, (1a) and (1b) are dynamic equations for two types of human capital, (1c) is the resource constraint, and (1d) gives the transversality condition.

The associated Hamiltonian expression is
\[
J = u(C)e^{-\rho t} + \mu_p(I_p - \delta H_p) + \mu_e(I_e - \delta H_e) \\
+ \nu \left[ A(H_p)^\beta (H_e)^{1-\beta} - C - I_p - I_e \right]
\]

where \(\mu_p\) and \(\mu_e\) are respectively the present-valued shadow prices of investment in professional human capital and entrepreneurial human capital (i.e., the present value of an investment available at time \(t\) in units of utils); similarly, \(\nu\) is the present-valued shadow price of aggregate income. Applying the maximum principle produces a set of the optimum conditions:
\[
u u'(C)e^{-\rho t} = \nu \\
\mu_p = \mu_e = \nu
\]

The Euler equations require
\[
\dot{\mu}_p = \mu_p \delta - \nu A \beta (H_p)^{\beta-1} (H_e)^{1-\beta} \\
\dot{\mu}_e = \mu_e \delta - \nu A(1-\beta) (H_p)^\beta (H_e)^{-\beta}
\]
Substituting (4) into the Euler equations (5) and (6), and rearranging, yields the steady state human capital ratio:

$$\frac{H_e}{H_p} = \frac{1 - \beta}{\beta}$$

(7)

which is the optimum ratio of entrepreneurial human capital to professional human capital.

For both types of human capital, their marginal products determine marginal returns. Denote the marginal return to professional human capital by $w_p$ and the marginal return to entrepreneurial human capital by $w_e$. Then, the ratio of $w_p$ to $w_e$ is

$$\frac{w_p}{w_e} = \frac{\beta}{1 - \beta} \frac{H_e}{H_p}$$

(8)

Actually, at the steady state, the marginal return to professional human capital is equal to the marginal return to entrepreneurial human capital:

$$w_p = w_e = A \beta^{\beta}(1 - \beta)^{1-\beta}$$

(9)

In addition, professional human capital and entrepreneurial human capital share the same net rate of return at the steady state, which is given by

$$r^* = A \beta^{\beta}(1 - \beta)^{1-\beta} - \delta$$

(10)

The ratio of the two human capital’s marginal returns equals one at the steady state, less than one if entrepreneurial human capital is in shortage relative to professional human capital, and greater than one otherwise.

Using the constant elasticity of substitution utility function, $u(C) = (C^{1-\theta} - 1)/(1-\theta)$, ($0 > 0$), we can obtain a closed-form expression for the steady-state growth rate of consumption, $\gamma^*_C$:

$$\gamma^*_C(= \gamma^*) = \frac{1}{\theta} \left[ A \beta^{\beta}(1 - \beta)^{1-\beta} - \delta - \rho \right]$$

(11)

In the steady state, two types of human capital, consumption, and output all grow at the same constant rate, $\gamma^*$.

Theoretically, once the human-capital stock ratio deviates from its steady state value, $(1-\beta)/\beta$, a negative gross investment at a high rate in one of the two stocks appears to be necessary to restore the value instantaneously. However, it is rather unrealistic to have such a disinvestment in any type of human capital whereby the human capital derogates at a rate faster than its depreciation rate by a great margin. In this paper, we impose the restriction of non-negative net investment in any type of human capital.
3. Transitional Dynamics

Suppose that entrepreneurial human capital is initially in shortage relative to professional capital, and thus the ratio of professionals’ return to entrepreneurs’ falls short of the “golden-rule” level, i.e., \( \frac{w_p}{w_e} < 1 \). In response to the gap, a zero net investment in professional human capital is needed \( (I_p=0) \) so that \( H_p \) declines at its depreciation rate \( (\dot{H}_p/H_p=-\delta) \). With this constraint, we can find a dynamic system in the return ratio \( (w_p/w_e) \) and entrepreneurs’ average consumption \( (C/H_e) \) by resolving the social planner’s dynamic optimization problem formulated in (1) (see Appendix 1 for the mathematical results). As in Figure 1 below, the two demarkation loci, i.e., \( (\frac{\dot{w}_p}{w_e})=0 \) and \( (\frac{\dot{C}}{H_e})=0 \), divide the space into four regions and the arrows show the directions of motion in each region. The dynamic system exhibits the saddle-path stability. Depending upon the relative magnitude of the output elasticity of entrepreneurial human capital, \( 1-\beta \), and the elasticity of marginal utility, \( \theta \), the demarkation curve for \( C/H_e \) will have different shapes and associated dynamics. Figure 1a depicts the dynamics when \( (w_p/w_e)<1 \) and \( \theta<1-\beta \).

The case depicted in Figure 1a appears more likely in less developed economies due to their low consumption level, high marginal utility of consumption, and high output elasticity with respect to entrepreneurship. Although the dynamics in this case features a saddle-point equilibrium, \( Q \), the human-capital return ratio that begins at a level below one moves along the saddle path in the north-east direction and reaches the “golden-rule” level in finite time before it reaches \( Q \). Once arriving at the “golden-rule” level, the economy is no longer constrained by investment in professional human capital and then both human capitals can grow together at a positive and constant steady-state rate. During the transition in which \( H_p \) falls at the depreciation rate, \( H_e \) rises at a declining rate toward \( \gamma^* \):

\[
\gamma_e = \frac{\dot{H}_e}{H_e} = A \left( \frac{H_e}{H_p} \right)^{-\beta} - \delta - \frac{C}{H_e} \tag{12}
\]

On the other hand, if the economy starts with \( (w_p/w_e)<1 \) and \( \theta>1-\beta \), the initial state is literally what a developed economy looks like: high consumption level, relatively low marginal utility of consumption, and relatively low output elasticity with respect to entrepreneurship. As illustrated in Appendix 1, the demarkation curve for \( C/H_e \) in this case is downward sloping, and it crosses the other demarkation curve from below as \( w_p/w_e \) rises. Furthermore, in contrast to the earlier case for less developed economies, the present case features a downward-sloping converging saddle path along which entrepreneurs’ average consumption declines while their return relative to professionals’ falls, as depicted in Figure 1b. Again, once the economy reaches the “golden-rule” steady state before it converges to the hypothetical instantaneous equilibrium \( Q \), the investment constraint on professional human capital becomes unbinding and the two types of human capital will grow at the same rate.
Theoretically, when \((w_p/w_e)>1\), the social planners’ optimal response to the discrepancy from the steady state would be to adopt a zero net investment in \(H_e\), so that the stock of entrepreneurial human capital declines at its depreciation rate while \(H_p\) rises at the following declining rate:

\[
\gamma_p \equiv \frac{\dot{H}_p}{H_p} = A \left( \frac{H_e}{H_p} \right)^{1-\beta} - \frac{C}{H_p} - \delta
\]

(13)

where \(\gamma_p>0\). In this case, although we could similarly demonstrate the dynamics of the return ratio \((w_p/w_e)\) and entrepreneurs’ average consumption \((C/H_e)\), we have omitted the analysis of this case in view of the lack of empirical evidence in support of its relevance (see Section IV).

Now we investigate the relationship between the growth rate of output and the human-capital return ratio. Given the Cobb-Douglas production function specified in the previous section, the growth rate of output, denoted by \(\gamma_Y\), is determined by the growth rates of entrepreneurial and professional human capital, respectively, that is, \(\gamma_Y=\beta \gamma_p+(1-\beta)\gamma_e\). The relationship between output growth and human-capital return ratio is different with respect to whether the human-capital return ratio is below or above its golden-rule steady state level.

If \(w_p/w_e>1\), the growth rate of output is positively related to the human-capital ratio, \(H_e/H_p\), and thus the return ratio, \(w_p/w_e\). Using (13) and \(\gamma_e=-\delta\), we obtain

\[
\gamma_Y = \beta \left[ A \left( \frac{1-\beta}{\beta} \frac{w_p}{w_e} \right)^{1-\beta} - \frac{C}{H_p} - \delta \right] + (1-\beta)(-\delta)
\]

(14)

which has a positive slope term with respect to \(w_p/w_e\). Analogously, if \(w_p/w_e<1\), the growth rate of output is negatively related to the human-capital ratio, \(H_e/H_p\), and thus the return ratio, \(w_p/w_e\), because

\[
\gamma_Y = (1-\beta) \left[ A \left( \frac{1-\beta}{\beta} \frac{w_p}{w_e} \right)^{-\beta} - \frac{C}{H_e} + \delta \right] + \beta (-\delta).
\]

(15)

Noting that \(\gamma_Y\) approaches the same growth rate as \(w_p/w_e\) approaches one from either side, we can plot the growth rate of output against the return ratio between two types of human capital. The curve we obtain is of a U-shape as depicted in Figure 2: the further \(w_p/w_e\) deviates from its “golden-rule” steady state value, the higher the output growth rate is.

4. Further Thoughts from Empirics

As demonstrated above, the key findings in this paper suggest that the process of economic development will see a rising professional human capital return relative to entrepreneurial human capital return and a declining economic growth rate over time, though entrepreneurs’ average consumption tends to converge between developing and developed economies, i.e., rising (from a low level) in developing economies but falling (from a high level) in developed economies. The aim of this section is to investigate the international empirical evidence that
can support the findings. Specifically, we use the panel data and regression analysis to
demonstrate the following two empirical results: first, based on the present phase of the world
economic development in which the relative professional human-capital return ratio is less
than one, it is important to enhance entrepreneurial human capital in particular, especially for
middle- and high-income countries, and to implement some pertinent policy to support the
drive; and second, an optimal adjustment process in the human capital-return ratio toward its
golden-rule steady state will see a decelerating rather than an accelerating economic growth.

The data used in our analysis are taken from 1996-2003 volumes of *IMD World
Competitiveness Yearbook*. The grand panel data set includes 45 countries; among them are
22 high-income countries (per capita real income greater than $20,000), 9 middle-income
countries (per capita real income less than $20,000 but greater than $10,000), and 14 low-
income countries (per capita real income less than $10,000). The time range is from 1996 to
2003 inclusive. The variables investigated are the ratio of engineers’ annual total
remuneration to CEOs’ annual total remuneration (RATIO), which is the proxy variable for
the ratio of professional human capitals’ return to entrepreneurial human capitals’ return
\(w_p/w_e\) in the model, per capita real GDP (ARY) compiled according to purchasing power
parity measures, and real GDP growth rate (RGY). The total remuneration used to construct
the variable RATIO is based on the data from companies with the minimum turnover of
US$250 millions, and it includes annual base salary, annual short-term incentive bonus and
long term incentive components.

Unlike some existing business literature that distinguishes between managers and
entrepreneurs, we treat both managerial and entrepreneurial functions as the interrelated traits
of the entrepreneurship. Especially, as demonstrated by Hellmann (2004), the boundary
between intrapreneurs and entrepreneurs can be vague since the former can become the latter
after serving as employees and bearing managerial responsibilities. Hence, considering the
fact that chief executive officers (CEOs) are taking increasingly more responsibilities of
entrepreneurship in today’s business world, we use CEOs’ remuneration as a proxy variable
for the return to entrepreneurial effort.

Table 1 presents the mean human-capital return ratios for each country in different groups
(high-, middle-, and low-income countries) and their group means. All the countries’ human-
capital return ratios are less than one, with the global mean ratio as 0.398037, and in
particular, the low-income countries’ mean ratio registers 0.373021 whereas the middle- and
high-income country groups’ mean ratios register 0.414059 and 0.407033, respectively.
Although the return differential between the groups is limited, the data here suggest that the
professionals’ return relative to entrepreneurs’ has gone up from low-income countries to
middle-income countries but it remains at about the same level between middle-income
countries and high-income countries; the entrepreneurial human capital relative to
professional type, at least for high-income economies, has not grown into a desired quantity
that matches their GDP level. Given such a gap in high-income economies as well as the
overall global gap from the golden-rule steady state level, there is a great potential for all the
countries in the world to raise the professionals’ relative return, which is equivalent to
increased relative employment of entrepreneurial human capital globally.

Nevertheless, the existing literature such as Iyigun and Owen (1999) places emphasis only on
low-income or developing economies while explaining the importance of entrepreneurial
human capital. Indeed, when a country is at the low level of economic development with existing resources in abundance, the entrepreneurs’ effort in innovating to utilize the idle or uncultivated resources appears to be more indispensable and relevant than the professionals’ role; and once an economy reaches the developed stage, the professionals’ contributions naturally becomes increasingly complementary to entrepreneurship. That is why the ratio of professional human capital returns to entrepreneurial human capital returns is higher in developed economies than that in developing economies.

In a sharp contrast to the conventional view, however, our modeling of two types of human capital and analysis of the empirical evidence suggest that, for almost all the economies in today’s world, the existing gap in economic growth does not come from a relative shortage of professionals but rather from a relative shortage of entrepreneurship, even in highly developed economies like the United States. Given that many studies have noted the gap for developing economies, which is simply even larger than that for developed economies, the seemingly surprising but probably interesting findings in this paper will shed more light on the issue concerning the high-income and middle-income economies.

Where does entrepreneurial human capital come from? Just like education can transform entrepreneurs into professionals, well-trained professionals can also shoulder entrepreneurship in pushing highly technologically sophisticated modern economies forward through new rounds of innovations (Hellmann, 2004). In this regard, our model is in spirit consistent with the entrepreneurship-oriented growth literature starting from Schumpeter. A sustainable growth path must be entrepreneurship driven so that the path can stay on the trajectory that leads to the maximization of well-being of individuals; in this process moving toward the “golden-rule” steady state can professionals’ return increase relative to entrepreneurs’. Although few economies are even near the optimal steady state level of the human capital return ratio, our model, analogous to the golden rule of capital accumulation in growth models, provides a yardstick in gauging the ratio of professional human-capital returns relative to entrepreneurial returns.

Is there any empirical evidence that the relative return to professional human capital increases with the level of economic development? Furthermore, is the return ratio negatively related to the rate of economic growth if the ratio is less than one as depicted in Figure 2? Table 2 provides answers to the questions by presenting the Generalized Least Squares (GLS) regression results. Using cross-section weighting, the GLS method here uses estimated cross-section residual variances from a first-stage pooled OLS regression to correct for both cross-section heteroskedasticity and contemporaneous correlation. We regress the professionals’ relative return (RATIO) on the current real GDP growth rate (RYG), the one-year lagged real GDP growth rate (RYG(-1)), and the logarithm of the current per capita GDP level (LOGARY). We perform four GLS regressions: one on the grand data set with 45 countries, one on the group of 14 low-income countries, one on the group of 9 middle-income countries, and one on the group of 22 high-income countries.

The GLS regressions yield the uniformly robust results in support of our theoretical hypothesis on the relationship of GDP level, GDP growth, and the human-capital return ratio. All the four groups of GLS estimates exhibit statistically significant coefficients associated with RYG(-1) and LOGARY; all of them have passed the t-test and Wald coefficient test at the 5% significance level, as in Table 2. In contrast, the estimated coefficients for RYG in three cases are insignificant at the 5% level and in one case it is significantly negative.
Therefore, the evidence strongly suggests that the ratio of professionals’ return to entrepreneurs’ return is negatively related to the previous year’s GDP growth and positively related to the current year’s per capita GDP level. The catch-up effect, whereby countries with relatively low income tend to grow more rapidly than countries with relatively high income, can help explain why the growth rate is negatively related to the human-capital return ratio: as an economy gets more developed, it reaches a higher human-capital return ratio on the one hand, and the law of diminishing returns as modeled in this paper will lead to a lower growth rate, on the other hand. Our GLS regression results further demonstrate the one-period lagged “catch-up effect” on human capital returns: although growing less rapidly in the previous period than a period before, the resources accumulated through economic growth this way will attribute to a higher professional human capital return relative to entrepreneurs’ return in the current period.

5. Concluding Remarks

We have developed a growth model in which the ratio of professional human capital return relative to entrepreneurial human capital return changes with the level of economic development. Although the human-capital return ratio equals one at the well-being maximization steady state (a “golden-rule” state), few economies in today’s world are near the optimal steady-state level of the human-capital returns ratio. Developed economies, on average, register a higher ratio of professional’s return to entrepreneurs’ return than less developed economies. From the well-being maximization perspective, most economies (not just less developed economies) face the shortage gap in entrepreneurial human capital relative to professional human capital. Therefore, a transition of some professionals to entrepreneurs will help the economy grow in a more balanced way toward its “golden-rule” steady state; such a process involves a decrease in the returns to entrepreneurial human capital relative to the returns to professional human capital, with entrepreneurs’ average consumption increasing from a low level in less developed economies but declining from a high level in developed economies.

Some economies are already experiencing such an adjustment in which increasing number of professionals play the role of entrepreneurs and executives’ compensation tend to fall from excessively high level relative to professionals’. A balanced steady-state growth welcomes such an ongoing trend and hails the resulting relative decline in the executive compensations. Furthermore, our model implies that a decelerating growth that accompanies rising relative returns to professionals is compatible with the adjustment toward the “golden-rule” steady state but an accelerating economic growth deviates from the steady state.
**Appendix 1**

Taking logarithm of the both sides of (8) yields

\[
\log \left( \frac{w_p}{w_e} \right) = \log \left( \frac{\beta}{1 - \beta} \right) + \log H_e - \log H_p. \tag{A1}
\]

Now, by taking time derivative of (A1) and substituting (12) and \((\dot{H}_p/H_p)=-\delta\) into the time-derivative equation, we get the transition equation for \((w_p/w_e)\)

\[
\left( \begin{array}{c} \dot{w}_p \\ \dot{w}_e \end{array} \right) = \left( \begin{array}{c} w_p \left( 1 - \frac{\beta}{\beta} \right) - \frac{C}{H_e} \\ w_e \beta \left( 1 - \frac{\beta}{\beta} \right) \end{array} \right). \tag{A2}
\]

To get the transition equation for \((C/H_e)\), we need to find the growth rate of consumption, \(\gamma_C\), first. Substituting \(u(C)=(C^{1-\theta}-1)/(1-\theta)\) into (3) generates

\[
C^{-\theta}e^{-\rho t} = \nu. \tag{A3}
\]

Taking logarithm of (A3) and using Euler equation (6), we can get \(\gamma_C\) as a function of \((H_p/H_e)\):

\[
\gamma_C = \frac{1}{\theta} \left[ (1 - \beta) A \left( \frac{H_p}{H_e} \right)^{\frac{\beta}{1 - \theta}} - \delta - \rho \right]. \tag{A4}
\]

Since the time derivative of \((C/H_e)\) is

\[
\left( \frac{\dot{C}}{H_e} \right) = \frac{C}{H_e} \left( \frac{\dot{C}}{C} - \frac{\dot{H}_e}{H_e} \right), \tag{A5}
\]

then, by substituting (A4) and (12) into (A5), we can get the transition equation for \((C/H_e)\) as

\[
\left( \frac{\dot{C}}{H_e} \right) = \frac{C}{H_e} \left\{ \frac{1}{\theta} \left[ (1 - \beta - \theta) A \left( \frac{1 - \beta}{\beta} \frac{w_p}{w_e} \right)^{\frac{\beta}{1 - \theta}} - \delta (1 - \theta) - \rho \right] + \frac{C}{H_e} \right\}. \tag{A6}
\]

Based on the transition equation system formed by (A2) and (A6), it follows that the dynamics of the return ratio and entrepreneurs’ average consumption are respectively determined by two demarkation curves below:
\[
\left( \frac{w_p}{w_e} \right)_{>0} \Leftrightarrow \left( \frac{w_p}{w_e} \right)_{<1-\beta} \left[ \frac{A}{\left( \frac{C}{H_e} \right)} \right]^{1/\beta}
\]

\[
\left( \frac{C}{H_e} \right)_{>0} \Leftrightarrow \left( \frac{w_p}{w_e} \right)_{>1-\beta} \left[ \frac{(1-\beta-\theta)A}{\delta(1-\theta) + \rho - \theta \frac{C}{H_e}} \right]^{1/\beta}, \text{ if } 0<1-\beta;
\]

\[
\left( \frac{C}{H_e} \right)_{>0} \Leftrightarrow \left( \frac{w_p}{w_e} \right)_{<1-\beta} \left[ \frac{(1-\beta-\theta)A}{\delta(1-\theta) + \rho - \theta \frac{C}{H_e}} \right]^{1/\beta}, \text{ if } 0>1-\beta.
\]
Endnotes

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3. When $\theta \to 1$, $u(C) \to \log(C)$.

4. The human-capital depreciation here mainly refers to a transition from professionals to entrepreneurs, though it also includes human death and the obsolescence of knowledge and skills.

References


Figure 1a
Adjustment dynamics with $\frac{w_p}{w_e} < 1$ and $\theta < 1-\beta$
Figure 1b
Adjustment dynamics with $w_p/w_e < 1$

$$\frac{C}{H_e} \quad \theta > 1 - \beta$$

$$\frac{\delta(1-\theta) + \rho}{1-\beta}$$

$$1 \quad \frac{w_p}{w_e} = \beta \frac{(1-\beta)A}{\delta(1-\theta) + \rho}$$
Figure 2   The relationship of output growth and the human-capital return ratio

\[ \gamma_Y \]

\[ \frac{w_p}{w_e} \]

1
Table 1. The Mean Ratio of Professional Human Capital Return to Entrepreneurial Human Capital Return

<table>
<thead>
<tr>
<th>Low Income</th>
<th>Country</th>
<th>Mean Ratio</th>
<th>Middle Income</th>
<th>Country</th>
<th>Mean Ratio</th>
<th>High Income</th>
<th>Country</th>
<th>Mean Ratio</th>
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<tbody>
<tr>
<td>Brazil</td>
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<td>Greece</td>
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<td>Average</td>
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Table 2. GLS Regression with Cross Section Weights

<table>
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<tr>
<th>Dependent Variable</th>
<th>RATIO</th>
<th>Grand Total</th>
<th>Low income</th>
<th>Middle income</th>
<th>High income</th>
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<td>RYG</td>
<td>0.001</td>
<td>-0.002*</td>
<td>-0.003</td>
<td>0.002</td>
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<tr>
<td></td>
<td>(1.117)</td>
<td>(-2.906)</td>
<td>(-1.689)</td>
<td>(1.701)</td>
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<tr>
<td></td>
<td>(1.248, 0.26)</td>
<td>(8.445, 0.00)</td>
<td>(2.853, 0.09)</td>
<td>(2.894, 0.09)</td>
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<tr>
<td>RYG(-1)</td>
<td>-0.001*</td>
<td>-0.002*</td>
<td>-0.005*</td>
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<tr>
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<td>(-1.93)</td>
<td>(-3.100)</td>
<td>(-3.049)</td>
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<td></td>
<td>(3.734, 0.05)</td>
<td>(5.480, 0.02)</td>
<td>(9.301, 0.00)</td>
<td>(7.002, 0.01)</td>
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<tr>
<td>LOGARY</td>
<td>0.041*</td>
<td>0.030*</td>
<td>0.047*</td>
<td>0.039*</td>
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<td>(136.544)</td>
<td>(2.341)</td>
<td>(42.270)</td>
<td>(70.645)</td>
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<td>(9.610, 0.00)</td>
<td>(1786, 0.00)</td>
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<td>R-squared</td>
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<td>0.990</td>
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<td>Panel</td>
<td>Observations</td>
<td>405</td>
<td>198</td>
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</tbody>
</table>

Note: For each coefficient, the figure in the top parenthesis is the t-value; the first figure in the lower parenthesis is the F-value of the Wald test, and the second figure is the associated p-value.

* Significant at the 5% level.