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Abstract

We propose a new microeconomic explanation for the divergent experiences of economies in forming human capital. We suggest that the positive effect of a longer life expectancy on human capital formation arises from two separate effects: a life expectancy effect and a prolonged intergenerational overlap effect. We argue that the duration of the overlap between generations and the associated parental support can affect the marginal cost of human capital formation and hence its level: parental support is cheaper than market financing. We thus attribute the strong correlation between the formation of human capital and life expectancy not merely to a higher marginal benefit arising from a longer payback period but also to a lower marginal cost arising from a prolonged intergenerational overlap. We provide conditions under which a longer overlap results in a higher level of per capita output.

Kurzfassung

Wir schlagen eine neue mikroökonomische Erklärung für die voneinander abweichenden Erfahrungen von Wirtschaftssystemen bei der Bildung von Humankapital vor. Die positive Wirkung einer längeren Lebenserwartung deutet darauf hin, dass Humankapitalbildung durch zwei getrennte Wirkungen entsteht: eine Lebenserwartungswirkung und eine anhaltende Wirkung der Intergenerationsüberlappung. Wir argumentieren, dass die Zeitdauer der Überlappung zwischen Generationen und die damit verbundene elterliche Unterstützung die Grenzkosten der Bildung von Humankapital beeinflussen können und somit auch deren Höhe: Elterliche Unterstützung ist billiger als Marktfinanzierung. Wir schreiben daher die hohe Korrelation zwischen der Bildung von Humankapital und der Lebenserwartung nicht nur einem höheren Grenznutzen zu, der durch eine längere Rückzahlungsdauer entsteht, sondern auch den niedrigeren Grenzkosten, die durch eine verlängerte Intergenerationsüberlappung entstehen. Wir liefern Bedingungen, unter denen eine längere Überlappung ein höheres Ertragsniveau pro Kopf ergibt.

1 The idea

It has been long recognized that the stock of human capital affects the level of per capita output in an economy. Whether the effect arises because human capital is an ordinary input in the economy's production function or because the effect manifests itself through enhancement of total factor productivity (in that it leads to the creation, adoption, implementation, and diffusion of new technologies) are largely empirical issues. The notion that an economy that forms a large quantity of human capital will have a higher per capita output than an economy that forms a small quantity of human capital can safely be taken as given, requiring little, if any, additional inquiry. But why is it that one economy has, or forms, abundant per capita human capital, while another has, or forms, little per capita human capital? Why does the per capita human capital gap between economies not close? Much – though not all – of the human capital in an economy is the result of decisions made by individuals. Clearly, several factors are involved and one of them is life expectancy: a longer life expectancy entails a longer payback period that in turn encourages larger investments in human capital. An economy consisting of individuals with a long life expectancy will then form more human capital than an economy consisting of individuals with a short life span.

The impact of a lengthened life expectancy comes from the returns side of the human capital investment calculus: the marginal benefit is higher. We argue, however, that typically, imbedded in a lengthened life expectancy is a lowered marginal cost of forming human capital. We seek to unearth this effect and study its role in accounting for the divergent experiences of economies in the formation of human capital. We suggest that the lowered marginal cost effect arises from a correlate of extended life expectancy: prolonged duration of the overlap between generations. Suppose that as long as they are alive, parents support the human capital formation of their children, and that the parental support is cheaper than market financing. An extended life expectancy that results in a prolonged overlap entails more parental support, which in turn can foster the formation of more human capital. An example will serve to illustrate.

Suppose that life expectancy is 45. An individual gives birth to one child when the individual is 20 years of age. The child is cared for in his infancy and for as long as he engages in acquiring human capital, conditional on the individual being alive. The age at which the child makes the human capital formation decision is 15. At this age, if the child were to engage in human capital formation, the child could expect parental support for up to 10 years. If the child finds it optimal to devote more than 10 years to human capital formation, he can do so by borrowing at a fixed market interest rate. When the child reaches the age of 20, he gives birth to a child whom he, in turn, will support in the same manner in which he was supported. Suppose that the child finds it optimal to acquire human capital for a little more than 10 years, say for τ

years in excess of 10. During these years the child has to bear the entire cost of forming human capital, which includes the market rate of interest.

Suppose now that life expectancy is 55. Retaining all other assumptions as before, the child can now expect parental support for up to 20 years. To see the implications of this assumption for human capital formation, consider the case $0 < \tau < 10$. All of the years of human capital formation previously financed by commercial loans now become parentally supported, interest-free years. Since the marginal cost of forming human capital goes down, more human capital will be formed. This effect is separate from the *returns* to human capital, a marginal benefit that arises from the addition of years during which returns to the human capital investment can be reaped.

In section 2 we present our analytical framework. In section 3 we investigate formally the effect of extended overlapping on the formation of human capital by optimizing individuals. To this end we decompose the "gross" life expectancy effect into a "net" life expectancy effect and an overlapping effect. In section 4 we trace the welfare implication of extended overlapping for an economy that is subjected to such a change. In section 5 we further explain the rationale underlying our idea and offer a suggestion as to how to differentiate empirically between the overlapping model of human capital formation and the received model of human capital formation.

2 The analytical framework

Consider an overlapping-generations economy. In every period t a generation is born. A generation consists of a continuum of individuals of measure N. Each member of generation t has a single parent in generation t-1, and each parent of generation t-1 has a single offspring in generation t. The economy consists, therefore, of a continuum of dynasties of measure N.

Individuals live for two periods. In the first period of their lives, individuals work and form human capital. In the second and last period of their lives individuals work and procreate. Let the duration of the first period be normalized at 1, and let the duration of the second period be $0 < l < 1$. Thus, the individual's lifespan is 1+l. An individual gives birth to a child after l^c (≥0) of l has elapsed. Thus, $l^p \equiv l - l^c$ measures the duration of the overlap between the individual and his child.[1]

Let s_t represent the proportion of the first period that an individual chooses to allocate to human capital formation. Hence $(1-s_t)$ of the first period is allocated to work. The first period earnings of a member of generation t thus become $(1-s_t)w_t$ where w_t is the prevailing wage at time t. Investment in human capital is costly. Let the cost be a proportion λ of the individual's wage. The cost of forming human capital is born by the individual's parent as long as the parent is alive, and by the individual himself through borrowing at the market interest rate if additional human capital is formed past the parent's death. When the child reaches the point l^c of the second period of his life he has a child. That child too is faced with a choice of allocating the first period of his life between work and human capital formation, drawing on his parent's support in a manner akin to that described above, that is, up to a duration of l^p. The amount of human capital (measured in efficiency units of labor) that is available in the second period of the individual's life, generated by investment of the time proportion s_t in human capital formation in the first period, is given by $\varphi(s_t)$ where $\varphi(0)=1$; $\varphi(s_t)>1$, $\varphi'(s_t)>0$, $\varphi''(s_t)<0$ for all $s_t \in (0,1)$; $\lim_{s_t \to 0} \varphi'(s_t) = \infty$, and $\lim_{s_t \to 1} \varphi'(s_t) = 0$.[2]

[1] Alternatively, it can be assumed that the individual gives birth to a child during the first period of his life and that the child reaches the human capital formation age only at a point in time that is 1+l^c into the individual's life. The years prior to that point in time are immaterial since they do not affect the child's human capital formation decision.

[2] The assumption that the human capital investment has a lagged effect on productivity, affecting the efficiency units of labor in the second period of the individual's lifetime, is expositionally convenient but is not essential. Our analysis also applies in the case in which the human capital investment affects the individual's productivity in the first period of his lifetime.

Let c_{t+1} be consumption in the second period of the individual's life. The individual's preferences are represented by the utility function $u(c_{t+1})$ where $u'(c_{t+1}) > 0$ and $u''(c_{t+1}) \leq 0$ for all $c_t \geq 0$; $u(0) > -\infty$. Thus, $u(c_{t+1})$ is strictly increasing, concave, and bounded from below. For simplicity's sake we have assumed a preference for consumption only in the second period of life.

Given r_t, w_t, w_{t+1}, the human capital formation decision of the individual's child, and recalling $\varphi(s_t)$, the individual chooses the proportion of time allocated to human capital formation so as to maximize his utility. Namely,

$$s_t = \arg\max u(c_{t+1}) \qquad (1)$$

where

$$c_{t+1} = (1+r_t)[(1-s_t)w_t - \lambda \max(s_t - l^p, 0)w_t] + \varphi(s_t) l w_{t+1} - \lambda \min(s_{t+1}, l^p)w_{t+1}.$$

Given the assumptions concerning the utility function and the production function of human capital, the solution to (1) is unique and interior (that is, the proportion of time allocated to human capital formation maintains $s_t \in (0,1)$) and is given by the first-order condition

$$(1+r_t)[1+\lambda\delta(s_t - l^p)]w_t = \varphi'(s_t) l w_{t+1} \qquad (2)$$

where $\delta(x) = 1$ for $x > 0$, and $\delta(x) = 0$ for $x \leq 0$.[3]

We now describe briefly the economy. We have in mind a small overlapping-generations economy that operates in a perfectly competitive world in which economic activity extends over an infinite discrete time. In every period the economy produces a single consumption good using perfectly durable capital and labor measured in efficiency units in the production process. The supply of capital in every period consists of the resources that were not consumed in the preceding period in addition to net international borrowing. Capital is perfectly mobile across countries and the rate of return to capital is at a stationary positive level, $\bar{r}$, in terms of the consumption good. The supply of labor in every period is the sum of the aggregate supply of "raw" labor by the current generation and the aggregate supply of human-capital-augmented labor by the preceding generation. Production occurs within a period according to a constant returns to scale production function which is invariant across time. Therefore, the output produced at time t, Y_t, is

$$Y_t = F(K_t, L_t) \equiv L_t f(k_t); \qquad k_t = K_t / L_t, \qquad (3)$$

[3] The second-order condition for a maximum, $\varphi''(s_t) l w_{t+1} < 0$, holds.

where K_t and L_t = $(1-s_t)N + \mathbf{j}(s_{t-1})lN$ are the capital and labor employed at time t, respectively. The production function $f(k)$ is strictly concave and strictly monotonic increasing. Producers operate in a perfectly competitive environment. The inverse demand for factors of production is therefore given by the first order conditions for profit maximization

$$r_t = f'(k_t)\,; \tag{4}$$

$$w_t = f(k) - f'(k_t)k_t\,, \tag{5}$$

where r_t and w_t are the interest rate and wage at time t, respectively, and output is the numeraire. Given the unrestricted nature of the international capital markets, the economy's interest rate is exogenously given at the world level $\bar{r}$. Consequently, the capital-labor ratio employed in production is stationary at a level $\bar{k}$,

$$\bar{k} = f'^{-1}(\bar{r}), \tag{6}$$

and the wage is stationary at a level $\bar{w}$,

$$\bar{w} = f(\bar{k}) - f'(\bar{k})\bar{k}\ . \tag{7}$$

Since the economic environment in which the individual optimizes is stationary, we can ignore time subscripts and rewrite (2) as

$$(1+\bar{r})[1+\mathbf{l}\,\mathbf{d}(s-l^p)] = \mathbf{j}'(s)l. \tag{8}$$

The right-hand side of (8) measures the marginal benefit of human capital formation. The marginal cost of human capital formation is measured by the left-hand side of (8), which has two components. The first component is the usual opportunity cost of forgone earnings (plus interest) and the second component reflects the impact of the overlap between parents and children. When the duration of the period of human capital formation chosen by the child is shorter than the duration of the overlap, $\mathbf{d}(s-l^p)=0$; the entire cost of human capital formation is born by the parent and the second component vanishes. However, when the child chooses to form human capital for a time span that is longer than the duration of the overlap with his parent, $\mathbf{d}(s-l^p)=1$; the marginal cost of forming human capital incorporates the extra cost of financing human capital formation through the marketplace.

3 The effect of an extended overlapping on human capital formation

Although in this paper we are interested in investigating the consequences of the duration of the overlap between parents and children as measured by l^p, typically an increase in l^p arises from the prolongation of life expectancy l. Therefore, a change in l affects the endogenous variables through two channels: changing the life expectancy, and varying the duration of the overlap between parents and children. We are able though to separate the effects of a change in l on the investment in human capital that arises from these two channels. While there are many interesting models that focus on the link between human capital formation and life expectancy (recent examples include Stark 1999, chapter 2; Kalemli-Ozcan, Ryder, and Weil, 2000; and Leung and Wang, 2001), our investigation of the overlapping-duration channel is novel.

Suppose that there is an increase in l. The right-hand side of (8), as a function of s, shifts upward: the conventional life expectancy channel is at work. As a result of the increase in l, individuals live longer and hence are able to reap the returns to human capital formation over a longer period, raising the marginal benefit of human capital formation. But the increase in l also increases l^p by the same amount (keeping l^c constant), which in turn affects the marginal cost of human capital in the left-hand side of (8) in a more subtle way. The left-hand side of (8), as a function of s, is essentially a step function with the jump occurring at $s = l^p$. Upon an increase in l^p, the jump in the marginal cost function occurs at a later point in time, thereby extending the range within which the marginal cost of human capital formation is low. This is due to the overlapping-duration channel: a larger l^p implies a longer overlap between parents and children, which in turn allows children to enjoy parental support for forming human capital for a longer period of time. To the extent that the extra parental support lowers the cost of forming human capital at the margin, the overlapping-duration channel is operative as it encourages additional human capital formation that would not have been possible had the intergenerational overlap remained the same. In short, while the life expectancy channel operates from the benefit side, the overlapping-duration channel operates from the cost side. The following figures illustrate circumstances in which the overlapping-duration channel is fully operative.

Suppose that l rises from l_1 to l_2, and hence l^p rises from l_1^p to l_2^p. Figure 1 shows that individuals initially choose $s_1^* < l_1^p$ for engaging in human capital formation so that their entire investment is paid for by the parents and no market finance takes place. Following the increase of l from l_1 to l_2, the marginal benefit curve shifts up due to the life expectancy effect, and the marginal cost curve extends the range (the darkened segment between l_1^p and l_2^p) within which

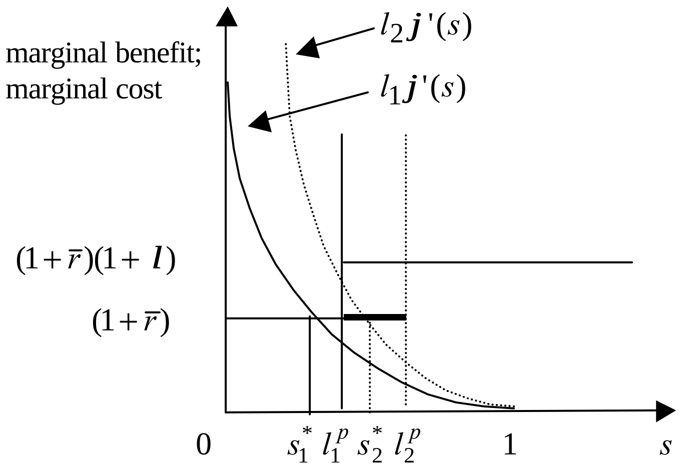

Figure 1

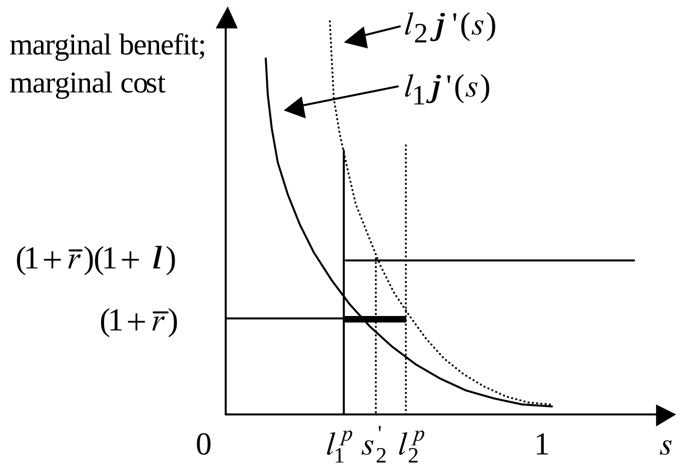

Figure 2

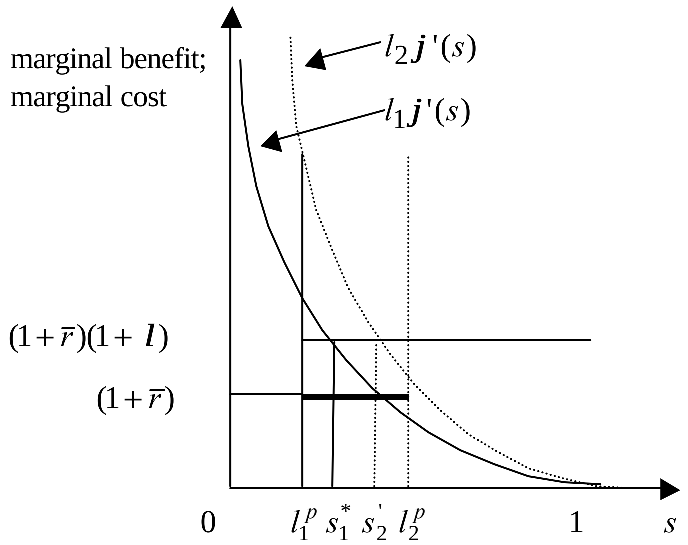

Figure 3

human capital formation is family financed (the overlapping-duration effect). Consequently, individuals choose s_2^*. Had the cost structure of human capital formation been the same as before (that is, without the overlapping-duration effect), the life expectancy effect alone would have resulted in a duration of human capital formation equal to l_1^p, which is less than s_2^*. Hence the additional period of human capital formation of $s_2^* - l_1^p$ can be attributed to the pure effect of the overlapping duration. In Figure 2, individuals initially choose $s_1^* = l_1^p$ for human capital formation so that the constraint of parental supported human capital formation just binds. Following an increase of l from l_1 to l_2, and of l^p from l_1^p to l_2^p, individuals choose l_2^p. In this case the life expectancy effect results in a duration of human capital formation that is equal to only $s_2^{'}$, and the overlapping-duration effect contributes to the additional increase of $l_2^p - s_2^{'}$ in the duration of human capital formation. Similarly, Figure 3 illustrates the case in which individuals initially choose $s_1^* > l_1^p$, relying on market financing above and beyond the overlapping period with their parents. Following the increases in l and l^p, they choose l_2^p, wherein the overlapping-duration effect again contributes to the additional increase of $l_2^p - s_2^{'}$ in the duration of human capital formation.

Having provided a non-exhaustive list of cases in which the overlapping-duration channel is operative in human capital formation decisions, we should add that, of course, the overlapping-duration channel is not always operative. Nonetheless, the combined effect of the life expectancy channel and the overlapping duration channel is always positive.

Proposition 1: An increase in l will increase human capital formation, that is, $\frac{\partial s}{\partial l} > 0$, for all $l \in (0,1)$.

Proof: See appendix.

Our argument so far amounts to a statement that the positive effect of a longer life expectancy on human capital formation arises from two distinct effects: a pure life expectancy effect and a prolonged intergenerational overlapping effect. Yet decomposing an effect into its constituent parts falls short of demonstrating that each part has a life of its own. Thus, we next investigate the pure overlapping-duration effect, studying its role in isolation from, and independently of, the conventional life expectancy effect.

Suppose that individuals give birth to their children at a somewhat earlier age while their life expectancy remains intact. This change entails an increase in l^p that is not associated with a change in l. While, by construction, the right-hand side of (8) remains unaltered so that the life expectancy channel is not operative, the change in l^p affects the left-hand side of (8) through the overlapping-duration channel. To illustrate the pure effect of the overlapping duration on human capital formation, suppose that l^p increases from l_1^p to l_2^p (keeping l constant). To facilitate comparison we consider once again three cases. In Figure 4, individuals initially choose to form human capital for a period that is shorter than the duration of the overlap with their parents, $s_1^* < l_1^p$. In this case a prolonged overlapping has no impact on the individuals' decision as to how much human capital to form. In Figure 5, the initial decision is to set the period of human capital formation equal to the duration of the overlap, that is, $s_1^* = l_1^p$. In this case, the extended overlap has a clear and positive effect – it increases the individuals' human capital formation period to s_2^*. Lastly, Figure 6 presents the case where individuals initially choose a duration of human capital formation, s_1^*, that exceeds the duration of the overlap with their parents. The extended overlap prompts additional human capital formation, provided that the increase in the duration of the overlap is large enough (that is, as large as $l_2^p > s_1^*$). We summarize these results on the pure effect of overlapping in the following proposition.

Proposition 2: An increase in l^p from l_1^p to l_2^p without any change in l leads to a strict increase in human capital formation by the young, that is, $s_2^* > s_1^*$, if $s_1^* = l_1^p$ or if $l_1^p < s_1^* < l_2^p$.

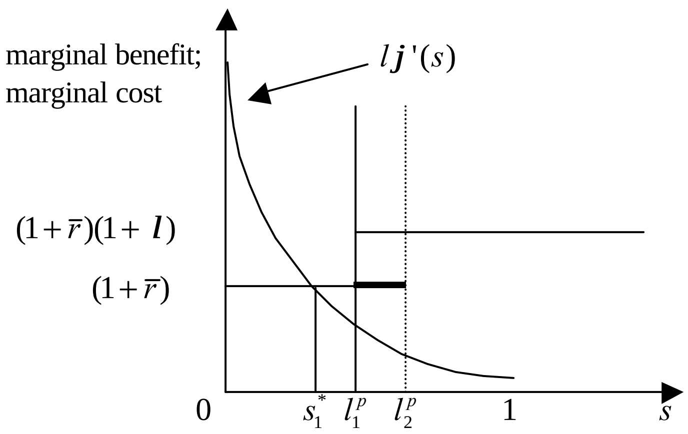

Figure 4

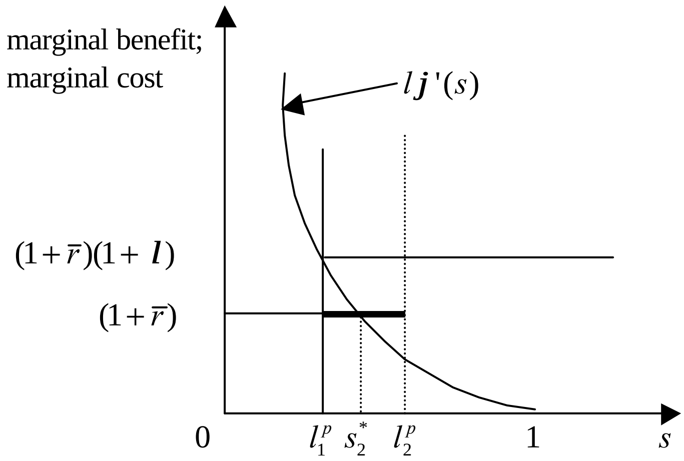

Figure 5

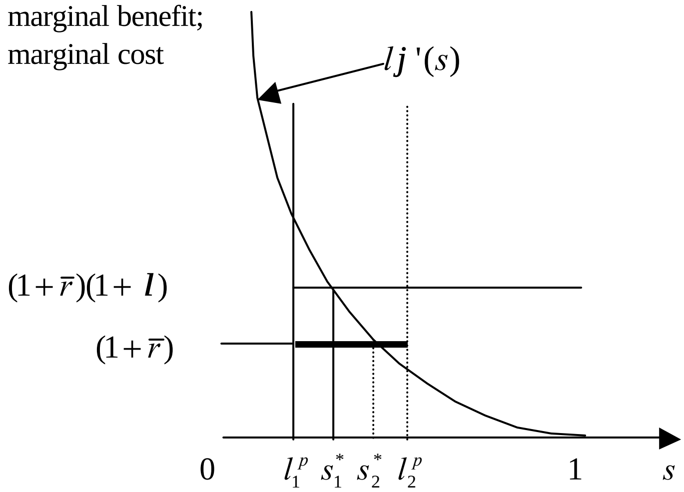

Figure 6

4 The welfare effect of an extended overlapping

We have shown that the duration of the intergenerational overlap of individuals with their parents can impact positively on an individual's formation of human capital. This channel of influence is independent from the usual repercussion of the life expectancy channel.

To analyze the welfare effect of extended overlapping both when it operates in conjunction with the life expectancy effect and when it operates independently of the life expectancy effect, we first calculate the per capita output. Since the economy's labor input measured in efficiency units is $L = [(1-s) + \boldsymbol{j}(s)l]N$, the economy's total output (given (6)) is $Y = Lf(\bar{k})$, and population size is $N + lN = (1+l)N$, per capita output is:

$$y = \frac{Y}{(1+l)N} = \frac{[1 - s + \boldsymbol{j}(s)l]f(\bar{k})}{1+l}. \qquad (9)$$

We present our results regarding the welfare implication of an extended overlapping in the two cases, that is, with and without a simultaneous change in life expectancy, in the following proposition.

Proposition 3: (i) For a given $\Delta l = \Delta l^{p}$ >0, Δy >0 holds; and (ii) for a given Δl^{p} >0 but $\Delta l = 0$, Δy >0 holds as long as Δs >0. In both cases, Δy is larger the larger is Δs.

Proof: (i) Denoting $s \equiv s(l)$ and differentiating both sides of (9) with respect to *l*, we have

$$\frac{dy}{dl} = \frac{[-s'(l) + \boldsymbol{j}(s) + \boldsymbol{j}'(s)s'(l)l](1+l) - [1 - s + l\boldsymbol{j}(s)]}{(1+l)^2} f(\bar{k})$$

$$= \frac{f(\bar{k})}{(1+l)}\left([\boldsymbol{j}'(s)l - 1]s'(l) + \frac{\boldsymbol{j}(s) - 1 + s}{(1+l)}\right).$$

Hence, for a given $\Delta l > 0$, we obtain

$$Dy = \int_{l}^{l+Dl} \frac{f(\bar{k})}{(1+l)}\left([\boldsymbol{j}'(s)l - 1]s'(l) + \frac{\boldsymbol{j}(s) - 1 + s}{(1+l)}\right)dl.$$

Since $\boldsymbol{j}'(s)l > 1$ from (8), $s'(l) > 0$ from Proposition 1, and $\boldsymbol{j}(s) > 1$, it follows that $\Delta y > 0$.

(ii) Since l is constant in this case, denoting $s \equiv s(l^p)$ and differentiating both sides of (9) with respect to l^p, we have

$$\frac{dy}{dl^p} = \frac{f(\bar{k})}{(1+l)}\left[\boldsymbol{j}'(s)l - 1\right]s'(l^p) \; .$$

Hence, for a given $\Delta l^p > 0$, we obtain

$$\boldsymbol{D}y = \frac{\mathrm{f}(\bar{k})}{(1+l)}\int_{l^p}^{l^p+\boldsymbol{D}l^p}\left[\boldsymbol{j}'(s)l - 1\right]s'(l^p)dl^p = \frac{\mathrm{f}(\bar{k})}{(1+l)}\int_{s}^{s+\boldsymbol{D}s}\left[\boldsymbol{j}'(s)l - 1\right]ds.$$

Again, since $\boldsymbol{j}'(s)l > 1$ from (8), it follows that $\Delta y > 0$ as long as $\Delta s > 0$.

In both cases, it is easy to see from (9) that $\frac{\partial y}{\partial s} > 0$, since $\boldsymbol{j}'(s)l > 1$. Hence, the larger the increase in *s* that arises from a given increase in *l* or l^p, the larger the increase in *y*.

When an extended overlapping, resulting from prolonged life expectancy, brings about additional human capital formation as illustrated in Figures 1-3, it also raises the per capita output. Similarly, when an extended overlapping that is not accompanied by a change in life expectancy induces additional human capital formation as illustrated in Figures 5 and 6, it also raises the per capita output. Therefore, whenever the overlapping duration channel is operative, either in conjunction with the life expectancy effect or independently of it, an increase in the intergenerational overlap is welfare improving. By the same token, a shortening of the overlap between parents and their children can have an adverse impact on human capital formation, and hence on welfare.

Corollary: Consider two identical economies in which the overlapping duration channel is operative. The economy that experiences an increase in the duration of the overlap will enjoy a higher per capita output than the economy in which the duration of the overlap remains unchanged.

5 Complementary reflections

In a highly stylized economy in which material capital is the only production input, the production function is concave, and the cost of acquiring capital is linear, a lengthening of the lifespan of capital prompts the optimal acquisition of more capital. The pioneers some four decades ago of the modern theory of human capital, notably Jacob Mincer, Theodore W. Schultz, and Gary S. Becker, were duly aware of the powerful analogy between the effect of the lifespan of material capital and the effect of longevity, as a proxy of the length of the period during which human capital renders a return. Yet, while the acquisition of more material capital (machinery) today in response to a lengthened lifespan would presumably crowd out the acquisition of material capital tomorrow, a lengthened life expectancy could crowd in human capital formation by the next generation. Here, the direct analogy between the two types of capital apparently breaks down.

The positive effect on human capital formation of overlapping with a parent arises from the parent's provision of support for the child's formation of human capital. In the absence of any reverse transfer from the child to the parent, the motive for the parental support is altruism. In this paper we *assume* parental altruism within dynasties rather than explain why and how it evolves – an issue that we address in related work (Falk and Stark, 2001).[4,5]

While assuming that the parent provides somewhat less than full support for the child in the child's pursuit of human capital will affect the absolute size of the effects in our model, it will not change its qualitative predictions.

A widely held view maintains that in developing economies, delayed marriage and postponed childbearing will hasten the pace of economic development and entail a higher per capita output. The rationale is that as a consequence of delay and postponement, the denominator in the output per capita ratio will be smaller, and the nominator will be larger since adults (young women) will be spending more of their productive time producing in the economy rather than tending to home production (rearing children). Yet if the economic environment in which such changes occur is characterized by a fixed (or little-changed) life expectancy, the intergenerational overlap will be reduced, possibly impinging *negatively* on human capital formation (Proposition 2), and on per capita output (Proposition 3).

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[4] The extended overlap is tantamount to enhanced altruism, an effect studied in Stark, 1999 chapter 1. There, as here, the effect on the child's wellbeing is positive.

[5] We further assume that parental altruism takes the form of sharing a meal, not imposing a will; parents do not decide for their children how much human capital the children should form.

To discriminate between the received model of human capital formation and the overlapping model, consider a setting in which the life expectancy of the individual's parent is rising (the intergenerational overlap is lengthened), the individual's life expectancy is declining, yet the individual invests *more* in human capital formation. Such as outcome can only arise from the operation of the overlapping effect since the individual's negative life expectancy effect (the shortened duration of the payback period to an investment in human capital) implies reduced investment in human capital by the individual. The same discriminating test applies if the life expectancy of the individual's parent is rising, and the individual's life expectancy remains unchanged.

If the poor in an economy overlap with their children for a shorter time span than do the rich, the children of the poor will run out of parental support earlier than the children of the rich, and could therefore acquire less human capital even if all children have access to equally priced market finance. Thus, rendering the terms under which children from poor families can borrow in order to pay for their acquisition of human capital equal to the terms under which children from rich families can so borrow may not equalize the investment in human capital environment for the two types of children under differential overlapping.

A low likelihood that a costly human capital formation today will be rewarded by a flow of returns tomorrow dampens investment in human capital. Among the considerations that impinge on his likelihood is the risk to life emanating from civil strife. It is less appreciated though that the probability that civil strife will occur is negatively affected by the level of investment in human capital: people who stand to lose a large quantity of human capital are less inclined to resort to violent means of settling disputes and resolving conflicts than people who risk only meager quantities of human capital. To the extent that an extended overlap entails the formation of a larger quantity of human capital, the duration of the overlap will be correlated negatively with the likelihood of civil strife or with the likelihood of brutality.

Appendix

Proof of Proposition 1: For both $s < l^p$ and $s > l^p$, that is, the marginal benefit curve intercepts one of the two horizontal portions of the marginal cost curve, the left hand side of (8) is constant and hence we obtain from differentiating both sides of (8) with respect to *l*:

$$\varphi'(s) + \varphi''(s) l \frac{\partial s}{\partial l} = 0.$$

Thus, for both $s<l^p$ and $s>l^p$, $\frac{\partial s}{\partial l} = -\frac{\varphi'(s)}{\varphi''(s)l} > 0$. When $s = l^p$, there are three possibilities: the marginal benefit curve intercepts the marginal cost curve i. at the interior of its vertical portion; ii. at the lower corner of its vertical portion; and iii. at the upper corner of its vertical portion. Suppose $s = l^p$ and case i. is true, that is, $(1+\bar{r}) < \varphi'(l^p)l < (1+\bar{r})(1+\lambda)$. By continuity $(1+\bar{r}) < \varphi'(l^p + \Delta l^p)(l + \Delta l) < (1+\bar{r})(1+\lambda)$ holds for sufficiently small $\Delta l = \Delta l^p$. This implies that the new marginal benefit curve passes through the new marginal cost curve in the interior of the vertical portion, in other words $\Delta s = \Delta l = \Delta l^p$ for sufficiently small Δl, implying $\partial s / \partial l = 1$. Suppose $s = l^p$ and case ii. is true, that is, $(1+\bar{r}) = \varphi'(l^p)l$. Then $\partial s / \partial l$ will be equal to either 1 or $-\frac{\varphi'(l^p)}{\varphi''(l^p)l}$, whichever is smaller. If $-\frac{\varphi'(l^p)}{\varphi''(l^p)l} < 1$, $\varphi'(l^p)l = \varphi'(l - l^c)l$ is decreasing in l and hence $\varphi'(l^p + \Delta l^p)(l + \Delta l) < \varphi'(l^p)l = 1 + \bar{r}$ for sufficiently small $\Delta l = \Delta l^p$ (>0). It then follows that the new marginal benefit curve will intercept the new marginal cost curve at its lower horizontal portion for small increases in *l*, implying $\varphi'(s + \Delta s)(l + \Delta l) = 1 + \bar{r} = \varphi'(s)l$, or $\frac{\Delta s}{\Delta l} \cdot \frac{\varphi'(s+\Delta s) - \varphi'(s)}{\Delta s} l = -\varphi'(s + \Delta s)$. Letting Δl tend to zero, we have $\frac{\partial s}{\partial l} = -\frac{\varphi'(s)}{\varphi''(s)l} > 0$. If, on the other hand, $1 \le -\frac{\varphi'(l^p)}{\varphi''(l^p)l}$, $1 + \bar{r} = \varphi'(l^p)l \le \varphi'(l^p + \Delta l^p)(l + \Delta l)$ holds for sufficiently small $\Delta l = \Delta l^p$ (>0). Since by continuity $\varphi'(l^p + \Delta l^p)(l + \Delta l) < (1+\bar{r})(1+\lambda)$ also holds for small $\Delta l = \Delta l^p$ (>0), the two curves must intercept at the vertical portion of the new marginal cost curve for small $\Delta l = \Delta l^p$ (>0), implying $\partial s / \partial l$ =1. Alternatively, suppose $s = l^p$ and case iii. is true, that is, $(1+\bar{r})(1+\lambda) = \varphi'(l)l$. Once again, $\partial s / \partial l$ will be equal to either 1 or $-\frac{\varphi'(l^p)}{\varphi''(l^p)l}$, whichever is smaller, In any event we have $\partial s / \partial l$ >0 at $s = l^p$. This completes the proof.

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