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25 May 2017

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[1] Batabyal acknowledges financial support from the Gosnell endowment at RIT. The usual disclaimer applies.

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Abstract

We study aspects of economic growth in a region that is creative in the sense of Richard Florida. We model creativity by supposing that the region under study has two sectors. The first sector uses physical capital $\{K(t)\}$ and trained workers $\{A(t)W(t)\}$ to produce creative capital $\{R(t)\}$. The second sector uses physical and creative capital to produce a final consumption good $\{Q(t)\}$. In this setting, we accomplish four tasks. First, we derive the equations of motion for physical capital per trained worker (k) and creative capital per trained worker (r). Second, we find combinations of k and r for which $\dot{k} = \dot{r} = 0$. Third, we investigate whether the economy of our creative region has a balanced growth path (BGP). Finally, assuming that our region is initially on a BGP, we study the impact of a permanent increase in the savings rate (s) on the trajectory of output per worker.

Keywords: Balanced Growth Path, Consumption Good, Creative Capital, Creative Region, Economic Growth

JEL Codes: R11, O41

1. Introduction

Richard Florida's two tomes titled *The Rise of the Creative Class* (2002) and the *Flight of the Creative Class* (2005) have successfully introduced the twin concepts of the *creative class* and *creative capital* to economists and regional scientists. According to Florida (2002, p. 68), the creative class "consists of people who add economic value through their creativity." This class consists of professionals such as doctors, lawyers, scientists, engineers, university professors, and, notably, bohemians such as artists, musicians, and sculptors. The distinguishing feature of these people is that they possess creative capital which is defined to be the "intrinsically human ability to create new ideas, new technologies, new business models, new cultural forms, and whole new industries that really [matter]" (Florida, 2005, p. 32).

Florida (2014) maintains that the creative class is significant as a driver of economic growth because this group of people gives rise to ideas, information, and technology, outputs that are very important for the growth of cities and regions. Therefore, cities and regions that want to succeed in the global arena need to make a concerted attempt to attract and retain members of this creative class who are, we are told, the primary drivers of economic growth.

In recent times, several papers have analyzed the nexuses between the creative capital possessed by a region's creative class and economic growth in this same region. For instance, one of the two sectors in the model studied by Batabyal and Nijkamp (2010) uses creative capital to produce a traded good and this paper provides a formal analysis of the creative capital accumulation decision faced by individuals in the region under study. Usman and Batabyal (2014) also analyze the impact that creative capital has on regional economic growth but the specific focus of their paper is on analyzing the effects of learning by doing.

Batabyal and Beladi (2015) analyze the accumulation of what they call acquired creative capital when the means for obtaining this acquired creative capital or the number of years of schooling is not constant but growing over time. Batabyal and Beladi (2016) focus on India's creative economy and point to the role that creative capital accumulation plays in enhancing the intertemporal prospects of this nation's creative economy.

Can the use of creative capital to produce one or more final consumption goods lead to income inequality of the sort seen in cities and regions in which the activities of the creative class constitute a large part of all economic activities? Batabyal and Nijkamp (2016) contend that there exist theoretical circumstances in which the answer to this question is yes.[4] Finally, Batabyal (2016) analyzes a creative capital using production process that exhibits increasing returns to scale. He shows that despite the presence of increasing returns, the regional economy being studied converges to a balanced growth path (BGP).

The studies discussed in the preceding three paragraphs have certainly advanced our understanding of the ways in which the use of creative capital affects economic growth in one or more creative regions. Even so, to the best of our knowledge, the existing literature has paid virtually *no* attention to theoretically analyzing economic growth in a region that is creative *a la* Richard Florida and where the creativity phenomenon is modeled with *two sectors*. The first sector produces creative capital. The second sector uses this produced creative capital to manufacture a final consumption good such as a smartphone.

Given this lacuna in the literature, in this paper we provide the *first* analysis of a two-sector model of regional economic growth where this growth is driven primarily by the production and use of creative capital to manufacture a final consumption good. The remainder

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4 See Florida and Mellander (2016) for empirical evidence on this point.

of this paper is organized as follows. Section 2 delineates a dynamic model of economic growth in a region that is creative in the sense of Richard Florida. Specifically, creativity is modeled by supposing that the region under study has two sectors. At any time t, the first sector uses physical capital $\{K(t)\}$ and trained workers $\{A(t)W(t)\}$ to produce creative capital $\{R(t)\}$. The second sector uses physical and creative capital to produce a final consumption good $\{Q(t)\}$ such as a smartphone. Section 3 derives the equations of motion for physical capital per trained worker (k) and creative capital per trained worker (r). Section 4 finds combinations of k and r for which $\dot{k} = \dot{r} = 0$. Section 5 investigates whether the economy of our creative region has a balanced growth path (BGP). On the assumption that our region is initially on a BGP, Section 6 studies the impact of a permanent increase in the savings rate (s) on the time path of output per worker. Section 7 concludes and then suggests two ways in which the research described in this paper might be extended.

2. The Theoretical Framework

Consider a dynamic regional economy that is creative *a la* Richard Florida and that has two sectors. In the first sector, at any time t, creative capital $R(t)$ is produced with its own production function. To grasp this production process, let us first understand the basic features of this creative region. The region itself is populated by a large number of individuals who we shall refer to as workers and denote by $W(t)$. In order for these workers to be effective in producing creative capital, they will need to receive knowledge or training which we denote by $A(t)$. So, the product $A(t)W(t)$ refers to knowledgeable or trained workers at time t. Physical capital at time t is denoted by $K(t)$. Let $a_K \in (0,1)$ and $a_R \in (0,1)$ denote the proportions of the existing stocks of physical and creative capital that are used in the creative capital production sector.

Then, the differential equation describing the temporal evolution of the stock of creative capital is given by

$$\frac{dR(t)}{dt} = \dot{R}(t) = B\{a_K K(t)\}^{\beta}\{a_R R(t)\}^{\lambda}\{A(t)W(t)\}^{1-\beta-\lambda} - \delta_R R(t), \tag{1}$$

where $B > 0$ is a shift parameter, $\delta_R > 0$ is the creative capital depreciation parameter, and we assume that $\beta > 0, \lambda > 0$, and that $\beta + \lambda < 1$.

The dynamics of the stock of knowledge and workers are described by

$$\frac{dA(t)}{dt} = \dot{A}(t) = gA(t),\ g > 0, \tag{2}$$

and

$$\frac{W(t)}{dt} = \dot{W}(t) = nW(t),\ n > 0, \tag{3}$$

respectively. Output of the final consumption good at any time t or $Q(t)$ is produced in the second sector of our region in accordance with the production function

$$Q(t) = \{(1 - a_K)K(t)\}^{\alpha}\{(1 - a_R)R(t)\}^{1-\alpha}, \tag{4}$$

where $\alpha \in (0,1)$. We suppose that the price of the final consumption is normalized to unity at all points in time. Finally, the temporal evolution of the stock of physical capital is given by

$$\frac{dK(t)}{dt} = \dot{K}(t) = sQ(t) - \delta_K K(t), \tag{5}$$

where $s \in (0,1)$ is the savings parameter and $\delta_K > 0$ is the physical capital depreciation parameter.

The reader should note the way in which we are modeling the notion of creativity in the region under study. An arbitrary worker in this region can become a member of the creative class by acquiring creative capital. This creative capital is produced in its own sector and with its own production function. In this regard, observe that workers (W) are useful only as vehicles for the acquisition of creative capital. They do *not* contribute directly to the manufacture of the final consumption good. Similarly, knowledge or training (A) is useful only as something that can be conveyed to the acquirers of creative capital. This training does *not* affect the manufacture of the final consumption good as a direct input. This completes the description of our theoretical framework. Our next task is to derive the equations of motion for physical capital per trained worker (k) and creative capital per trained worker (r).

3. Two Equations of Motion

3.1. Physical capital per trained worker

Let us define physical and creative capital per trained worker to be the ratios $k(t) \equiv K(t)/A(t)W(t)$ and $r(t) \equiv R(t)/A(t)W(t)$, respectively. Now, differentiating both sides of the defining equation for $k(t)$ with respect to time t gives us

$$\dot{k}(t) = \frac{A(t)W(t)\dot{K}(t) - K(t)\{\dot{A}(t)W(t) + A(t)\dot{W}(t)\}}{\{A(t)W(t)\}^2}. \tag{6}$$

Using the above defining relationship for $k(t)$, equation (6) can be rewritten as

$$\dot{k}(t) = \frac{\dot{K}(t)}{A(t)W(t)} - \left\{\frac{\dot{A}(t)}{A(t)} + \frac{\dot{W}(t)}{W(t)}\right\} k(t). \tag{7}$$

Let us now use equation (5) and the conditions that the stocks of knowledge and workers grow at constant rates to simplify equation (7). This gives us

$$\dot{k}(t) = \frac{sQ(t) - \delta_K K(t)}{A(t)W(t)} - (g+n)k(t). \tag{8}$$

Now, substituting the production function from equation (4) in equation (8), we get

$$\dot{k}(t) = s\{\frac{(1-a_K)K(t)}{A(t)W(t)}\}^{\alpha}\{\frac{(1-a_R)R(t)}{A(t)W(t)}\}^{1-\alpha} - (g+n+\delta_K)k(t). \tag{9}$$

Let $b_K \equiv s(1-a_K)^{\alpha}(1-a_R)^{1-\alpha}$. Using this defining relationship for b_K along with the defining relationships for $k(t)$ and $r(t)$, we can simplify equation (9). This simplification yields the equation for $\dot{k}(t)$ that we seek. We get

$$\dot{k}(t) = b_K k(t)^{\alpha} r(t)^{1-\alpha} - (g+n+\delta_K)k(t). \tag{10}$$

We now proceed to derive the corresponding equation for creative capital per trained worker.

3.2. Creative capital per trained worker

As in section 3.1, we begin by differentiating both sides of the defining equation for $r(t)$ with respect to time t. This gives us

$$\dot{r}(t) = \frac{A(t)W(t)\dot{R}(t) - R(t)\{\dot{A}(t)W(t) + A(t)\dot{W}(t)\}}{\{A(t)W(t)\}^2}. \tag{11}$$

Using the defining equation for $r(t)$, equation (11) can be simplified to

$$\dot{r}(t) = \frac{\dot{R}(t)}{A(t)W(t)} - \left\{\frac{\dot{A}(t)}{A(t)} + \frac{\dot{W}(t)}{W(t)}\right\} r(t). \tag{12}$$

Substituting equation (1) and the conditions that the stocks of knowledge and workers grow at constant rates in equation (12) gives us

$$\dot{r}(t) = B\{\frac{a_K K(t)}{A(t)W(t)}\}^{\beta}\{\frac{a_R R(t)}{A(t)W(t)}\}^{\lambda}\{\frac{A(t)W(t)}{A(t)W(t)}\}^{1-\beta-\lambda} - (g + n + \delta_R)r(t). \tag{13}$$

Let $b_R = Ba_K^{\beta}a_R^{\lambda}$. Using this last expression to simplify equation (13), we get

$$\dot{r}(t) = b_R k(t)^{\beta} r(t)^{\lambda} - (g + n + \delta_R)r(t). \tag{14}$$

Equations (10) and (14) give us the two equations of motion for physical capital per trained worker (k) and creative capital per trained worker (r) that we seek. Our next task is to find combinations of k and r for which $\dot{k} = \dot{r} = 0$.

4. Combinations of Physical and Creative Capital per Trained Worker

4.1. Combinations of k and r for which $\dot{k} = 0$

To find the combinations of k and r for which $\dot{k} = 0$, we set the right-hand-side (RHS) of equation (10) equal to zero and then solve for k as a function of r. This gives us

$$b_K k(t)^{\alpha} r(t)^{1-\alpha} = (g + n + \delta_K)k(t). \tag{15}$$

After a few more steps of algebra, equation (15) can be simplified to

$$k(t) = \{\frac{b_K}{g+n+\delta_K}\}^{1/1-\alpha} r(t). \tag{16}$$

Inspecting equation (16), we see two things in $k(t) - r(t)$ space. First, the $\dot{k} = 0$ locus denotes a straight line with slope $\{b_K/(g + n + \delta_K)\}^{1/(1-\alpha)} > 0$. Second, this straight line passes through the origin. From equation (10) we can infer that $\dot{k}(t)$ is increasing in $r(t)$. Therefore, as shown in figure 1 below with the upward pointing arrow, to the right of the $\dot{k} = 0$

Figure 1 about here

locus, we have $\dot{k}$>0 and therefore we have $k(t)$ is rising. In contrast, to the left of the $\dot{k} = 0$ locus, we get $\dot{k} < 0$ and hence $k(t)$ is falling and this is shown with the downward pointing arrow.

4.2. Combinations of k and r for which $\dot{r} = 0$

To locate the combinations of k and r for which $\dot{r} = 0$, we set the RHS of equation (14) equal to zero and then solve for k as a function of r. We get

$$b_R k(t)^{\beta} r(t)^{\lambda} = (g + n + \delta_R) r(t). \tag{17}$$

Simplifying and then rearranging the individual terms in equation (17) gives us

$$k(t) = \{\frac{b_R}{g+n+\delta_R}\}^{\beta} r(t)^{(1-\lambda)/\beta}. \tag{18}$$

Inspecting equation (18), we can draw two conclusions about the $\dot{r} = 0$ locus in $k(t) - r(t)$ space. First, the $\dot{r} = 0$ locus is upward sloping with a positive second derivative, i.e., $d^2k(t)/dr(t)^2 > 0$. Second, this locus passes through the origin. From equation (14) we can tell that $\dot{r}(t)$ is increasing in $k(t)$. Therefore, as shown in figure 1, above the $\dot{r} = 0$ locus, we have $\dot{r}$>0 and hence $r(t)$ is rising. This is shown with the arrow pointing rightwards. In contrast, below the $\dot{r} = 0$ locus, we get $\dot{r} < 0$ and therefore $r(t)$ is falling. This is shown with the arrow pointing leftwards. We now proceed to discuss whether the economy of our creative region has a BGP.

5. The Balanced Growth Path

The reader will note that figure 1 brings the $\dot{k} = 0$ and the $\dot{r} = 0$ loci together. Given the properties of these two loci discussed in section 4, it is clear that the economy of our creative region will converge to a *stable* BGP at the point marked E. If we disregard the origin where $k = r = 0$, then this stable BGP is *unique*. Figure 1 also tells us that physical capital per trained worker or $k(t) = K(t)/A(t)W(t)$ is *constant* on the BGP. From this we can deduce that physical capital per worker or $K(t)/W(t) \equiv k(t)A(t)$ grows at the same rate as the stock of knowledge, which is $g > 0$. Similarly, we can tell that creative capital per trained worker or $r(t) = R(t)/A(t)W(t)$ is *constant* on the BGP. From this, we infer that creative capital per worker or $R(t)/W(t) \equiv r(t)A(t)$ is also growing at the same rate as the stock of knowledge, which is, as in the preceding case, $g > 0$.

Dividing the production function in equation (4) by $W(t)$ gives us an expression for the output of the final consumption good per worker. We get

$$\frac{Q(t)}{W(t)} = \left\{\frac{(1-a_K)K(t)}{W(t)}\right\}^{\alpha}\left\{\frac{(1-a_R)R(t)}{W(t)}\right\}^{1-\alpha}. \tag{19}$$

Now, we have already pointed out that the ratios $K(t)/W(t)$ and $R(t)/W(t)$ both grow at rate $g > 0$ on the BGP. In addition, note that the production function in equation (4) displays constant returns to scale. Therefore, we infer that the output of the final consumption good per worker also grows at rate $g > 0$ on the BGP. Now, suppose that the economy of the creative region under study is initially on a BGP. Our final task in this paper is to analyze the impact of a permanent increase in the savings rate (s) in this region on the time path of output per worker.

6. A Permanent Increase in the Savings Rate

We begin by pointing out that from equation (16), the slope of the $\dot{k} = 0$ locus is $\{b_K/(g + n + \delta_K)\}^{1/(1-\alpha)}$. Recall that $b_K = s(1 - a_K)^{\alpha}(1 - a_R)^{1-\alpha}$ in the preceding expression. This tells us that an increase in the savings rate s will make the $\dot{k} = 0$ locus *steeper*. Since s does not appear anywhere in equation (18), the $\dot{r} = 0$ locus is unaffected by an increase in s. As shown in figure 2, with an increase in s, the economy of our creative region moves from

Figure 2 about here

its old BGP at point E to a new BGP at point E'. The output of the final consumption good per worker grows at rate $g > 0$ until the time that s rises. This happens at time t_0 in figure 3. During

Figure 3 about here

the transition from the point E to the point E' in figure 2, both $k(t)$ and $r(t)$ are increasing. In particular, creative capital per worker and physical capital per worker are growing at a rate greater than $g > 0$ during the transition. From equation (19), this means that the output of the final consumption good per worker also grows at a rate *greater* than $g > 0$ during the transition.

The economy of our creative region reaches the new BGP at time t_1 in figure 3. When this happens, the ratios $k(t)$ and $r(t)$ are *constant* again. This means that creative capital per worker and physical capital per worker, once again, grow at rate $g > 0$. In turn, this implies that the output of the final consumption good per worker also grows at rate $g > 0$ on the new BGP. In sum, a permanent increase in our creative region's savings rate does *not* have a permanent growth effect. Instead, the rise in s leads only to a *level* effect on the output of the final consumption good per worker. This completes our discussion of a two-sector model of regional economic growth that is driven by creative capital.

7. Conclusions

In this paper we analyzed aspects of economic growth in a region that was creative in the sense of Richard Florida. We modeled creativity by supposing that the region under study had two sectors. The first sector used physical capital and trained workers to produce creative capital. The second sector used physical and creative capital to produce a final consumption good. In this setting, we completed four tasks. First, we derived the equations of motion for physical capital per trained worker (k) and creative capital per trained worker (r). Second, we found combinations of k and r for which $\dot{k} = \dot{r} = 0$. Third, we investigated whether the economy of our creative region had a BGP. Finally, on the assumption that our region was initially on a BGP, we studied the impact of a permanent increase in the savings rate on the trajectory of output per worker.

The analysis in this paper can be extended in a number of different directions. In what follows, we suggest two possible extensions. First, it would be useful to extend the analysis conducted here by letting the temporal evolution of the stock of creative capital in the region under study be augmented by interactions with creative capital units present in other, spatially distinct, regions. Second, it would also be instructive to embed the regional economy analyzed here in a stochastic environment and then analyze the impact that uncertainty either in the temporal evolution of the stock of creative capital or in the production of the final consumption good has on the growth prospects of the economy under study. Studies that analyze these aspects of the underlying problem will provide additional insights into the nexuses between the efficient utilization of the factors of production in a creative region and economic growth in this same region.

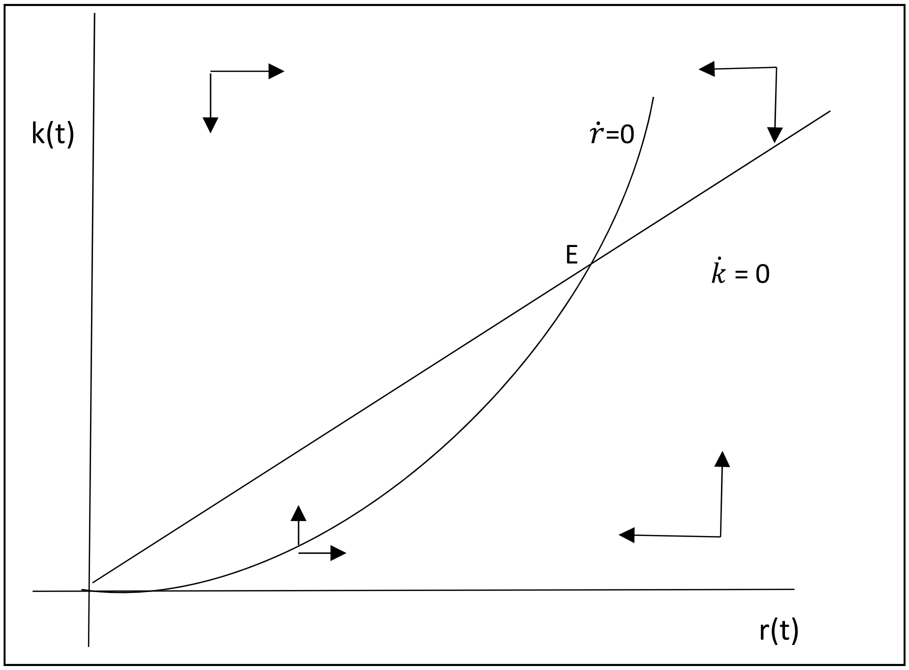

Figure 1: The balanced growth path (BGP) equilibrium

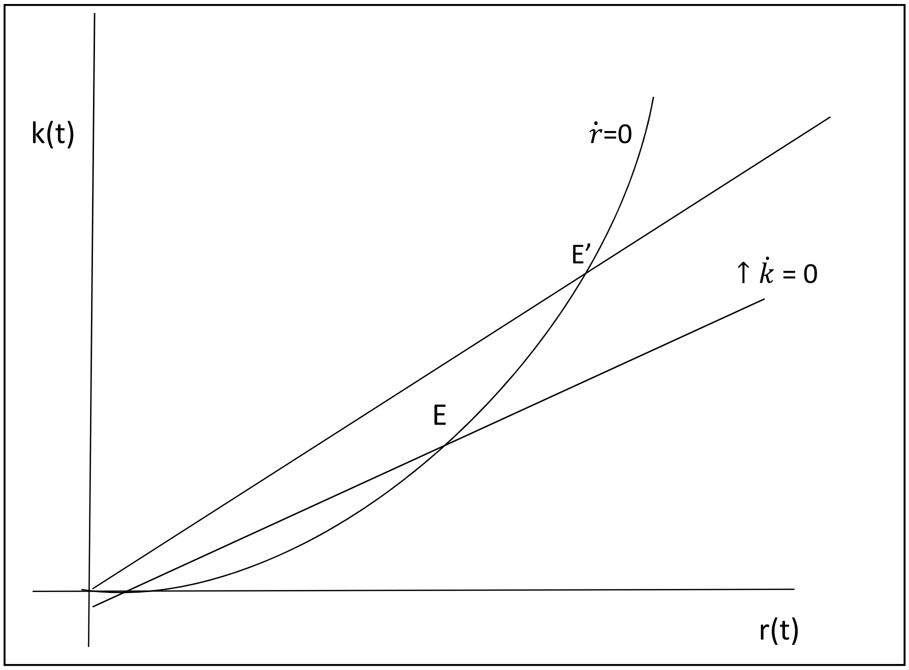

Figure 2: The impact of a rise in the savings rate on the BGP equilibrium

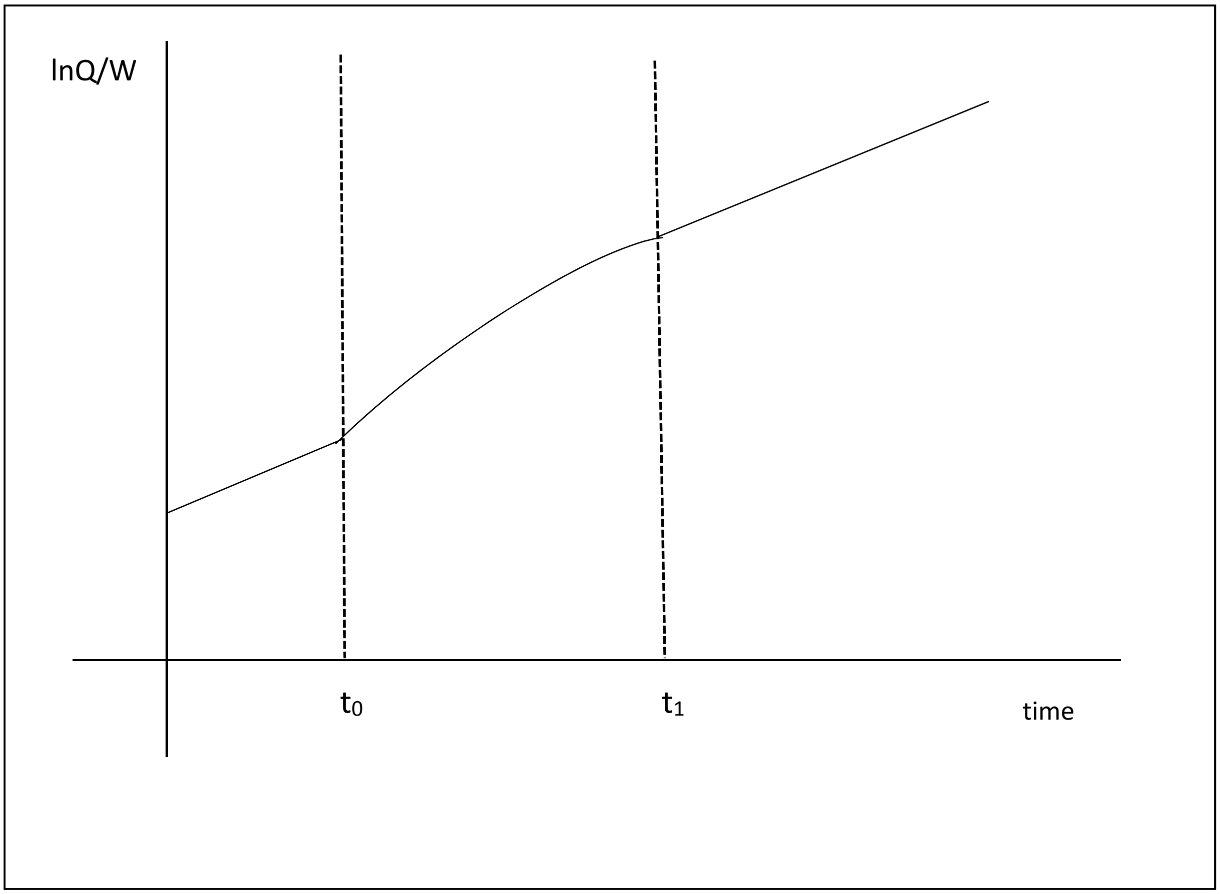

Figure 3: Output per worker before and after the rise in the savings rate

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