Income Distribution and Growth under A Synthesis Model of Endogenous and Neoclassical Growth

KIM Se-Jik

This paper develops a growth model which can explain the change in the balanced growth path from a sustained growth to a zero growth path as a regime shift from endogenous growth to Neoclassical growth regime, and that from zero to sustained growth path as a regime shift in the opposite direction. Based on the growth model, we show that government policies that affect labor income share (e.g., changes in income tax rates and regulations on monopoly or monopsony) may induce such a shift in growth regime and subsequent change in the long-run growth rate. For example, the government’s raising wage rates in monopsonistic labor markets may trigger human capital accumulation, which induces a shift to the path of sustained growth.
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Income Distribution and Growth under A Synthesis Model of Endogenous and Neoclassical Growth

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Executive Summary

This paper develops a model which allows us to analyze the effect of policies that influence income distribution between capitalists and workers (such as taxes and market imperfections) on the log-run growth path of an economy. More specifically, we present a heterogeneous agent model where some agents choose to be capitalists to specialize in accumulating physical capital and others become workers accumulating human capital. An important feature of this model is that it can be reduced to either an endogenous growth model or Neoclassical growth model. For a range of the parameters of technology and policy variables, the model generates a balanced growth path where capitalists continue to accumulate physical capital and workers human capital, as in AK model of endogenous growth. For a different range of parameters, the model generates a steady state along which both capitalists and workers do not increase physical or human capital any longer as in Neoclassical growth models. This model, therefore, can be viewed as a synthesis model of endogenous and neoclassical growth.

An advantage of this synthesis growth model is that it allows us to explain the shift in the growth path in response to policy shocks that affect the capital-labor income distribution. This growth model explains the change in the path from sustained growth to zero growth as a regime change from endogenous growth to Neoclassical growth regime, and that from zero to sustained growth as a regime shift of the other way around. Based on the synthesis growth model, we show that changes in labor income share or government policies that make such changes may induce a shift in the growth regime and subsequent change in the balanced growth path. The policies of capital-labor income distribution include those of changing labor and capital income tax rates and regulations on monopoly or monopsony. The monopolist firms which have monopsony power in labor
market can choose the wage rate rather than take it as given. Thus they may drive the wage rate down below labor productivity, which would induce a decline in labor income share and zero growth. We show that in this situation the government policy of regulating monopoly/monopsony or raising wage rates may raise labor income share, and by doing so, trigger human capital accumulation and an ensuing shift to a path of sustained growth.

Key words: income distribution policy, synthesis growth model, labor income share

JEL classification: D9, E2, E6, O4
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1 Introduction

This paper explores the effect of policies that influence income distribution between capitalists and workers (such as taxes and market imperfections) on the growth path of an economy. Some recent studies (e.g., Berg, Ostry and Tsangarides (2011, 2014)) provide evidence that income equality and the government’s redistribution policies may foster economic growth. Another strand of recent studies (including Karabarbounis and Neiman (2014a, 2014b) find that labor income share has significantly declined for the last four decades for the majority of advanced countries including the United States, unlike the standard assumption of constant labor income share. These findings lead to a question on whether government can raise economic growth by changing income distribution between workers and capitalists.

In this paper, we develop a theoretical framework to analyze the role of the policies that affect capital-labor income distribution in reshaping the log-run growth path of economies. To this end, this paper presents a synthesis growth model that comprises both Neoclassical and endogenous growth models. More specifically, we construct a stylized model with two types of heterogenous agents: the type of agents who have comparative advantage in production and choose to become entrepreneurs, and the other type who have comparative advantage in accumulating human capital to become workers. Under financial friction, the first type becoming entrepreneurs specialize in accumulating physical capital while the second type becoming workers in accumulating human capital. The separation of investment type between capitalists and workers arises because financial frictions make a discrepancy between the internal rate of return for entrepreneurs from investing in physical capital and the rate of return for workers. Workers, whose rate of return from investing in physical capital is far lower than that for entrepreneurs, prefer accumulating human capital to accumulating and lending physical capital.

The heterogenous agent model can be viewed as a synthesis growth model that is reduced to either an endogenous growth model or Neoclassical growth model, depending on the parameters of technology and policy variables. For a range of parameters, the model generates a balanced growth path where the entrepreneurs continue to save to accumulate physical capital and workers to accumulate human capital. The standard constant returns to scale production function then generates sustained positive growth as in AK type endogenous growth models based on the representative agent (see Stokey and
Rebelo (1995)). For a different range of parameters, however, the model can generate a steady state and transitional dynamics as in Neoclassical growth models (see Solow (1956), Cass (1965)) in which human capital and hence effective labor stays constant. Given diminishing marginal product of physical capital, entrepreneurs do not accumulate physical capital any longer once the economy reaches the steady state.

The synthesis growth model may explain the change in the growth path from sustained growth to zero growth or vice versa. Within our synthesis growth model, we can explain such change as a regime change, from endogenous growth regime to Neoclassical growth regime or the other way around in response to policy shocks that affect the share of labor income. We show that changes in labor income share due to changes in tax rates, distortions in labor market and income distribution policies may induce such a change in the growth regime and the subsequent change in the balanced growth path. Labor income share might be obviously affected by government policies on tax rates on labor income and capital income. It may also be affected by the change in the market structure. For example, as firms grow large to become monopolists in the product market, they might also have monopsony power in the labor market as well and choose the wage rate rather than take it as given, which leads the decline in the wage income share. The government policy of regulating monopoly or monopsony also affects the labor income share. Our synthesis model allows us to address the effect of such factors including policies that affect labor income share on the dynamic growth path of the economy.

An advantage of having a growth model that can nest both endogenous and neoclassical growth models is that it may explain by far more diverse growth experiences in terms of time and space than any of the existing two types of growth models can. There have been empirical research that investigate which of the two competing growth models better explains growth experiences under the assumption that the two types of models are incompatible with each other. But the results of the studies have been so far inconclusive. For example, Jones (1995) presents evidence in favor of the Neoclassical growth model for the US and OECD countries, while Kocherlakota and Yi (1996) find evidence supporting endogenous growth models, particularly those that emphasize public capital, based on the US data. The mixed results may suggest that there are times and countries that may be better explained by each of endogenous and Neoclassical growth models, and therefore our synthesis growth model nesting both models may better explain
growth experiences of longer periods and more countries than sticking to one of the two existing growth models.

This synthesis growth model may account well particularly for the growth paths of four Asian growth miracle NIES (South Korea, Singapore, Taiwan, and Hong Kong) for the last half century. In the early 1960s, for example, South Korea jumped to remarkable 8% growth path from almost zero growth of the previous decades. The country’s growth rate then had stayed constant around 8% for four decades, as if it follows the prediction of endogenous growth models. Since late 1990s, however, the growth rate has kept declining over more than a decade as if it now moves along the transitional dynamics path of Neoclassical growth models. The other Asian NIES experienced a similar pattern of growth path characterized by a long period of high and stable growth followed by a period of persistently falling growth. Therefore, adopting the endogenous growth models alone is not sufficient, nor resorting to only the Neoclassical growth models is not enough to explain the growth experience of the Asian NIES. Our synthesis growth model may explain the countries’ growth experience for the last five decades better, compared to any of the two types of existing growth models.

This paper is closely related to the endogenous growth models with taxes on human and physical capital (Stokey and Rebelo (1995), Lucas (1988, 1990), Jones and Manuelli (1990), King and Rebelo (1990), Rebelo (1991), Kim (1998), and Yuen (1991)). These existing studies, like our paper, show how government tax policies may affect the accumulation of both human and physical capital and the long-run growth rate of an economy, while our paper extends the policy analysis to include the effect of non-tax policies, particularly those that affect income distribution. Our paper also differs from the existing growth models based on a representative agent framework in that we introduce heterogenous agents, which allows for us to analyze the role of income distribution between capitalists and workers in determining long-run growth. Within our heterogenous agent framework, we can address the effect of labor and capital income taxes on income distribution (unlike most existing growth models with taxes based on the representative agent framework).

This paper is also related to the existing overlapping generations models on income inequality and economic development such as Galor and Zeira (1993) and Galor and Moav (2004). In the studies, the equality of income may alleviate credit constraint for human capital education and, by doing so, enhance economic growth. Galor and Moav (2004) present a growth
model which may also explain the positive effect of income inequality on the accumulation of physical capital and economic growth, which may occur in the early stages of the Industrial Revolution, as well as the negative effect of income inequality during the later stages of growth driven by human capital accumulation. While the studies analyze the income distribution among the identical agents except family wealth, our paper focuses on the income distribution between capitalists and workers (who differ in their access to technology).

2 Benchmark Model

We present a benchmark heterogenous agent model where agents differ in two types of abilities: abilities as entrepreneur and abilities to accumulate human capital.

2.1 Preferences

All the agents seek to maximize the same intertemporal utility

$$\sum_{t=0}^{\infty} \beta^t u(c_t),$$

where $\beta (< 1)$ is the subjective discount factor and $c_t$ is her consumption at time $t$. The per-period utility function takes a standard CRRA form:

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}.$$  

2.2 Production and Learning Technology

A single consumption good is produced through the constant returns to scale production function of physical capital and human capital. For simplicity, we assume Cobb-Douglas production function:

$$y_t = f(k_t, z_t) = \theta k_t^\alpha z_t^{1-\alpha}$$

where $\theta$ is an agent’s entrepreneurial ability which takes $\theta^l$ or $\theta^h$ ($\theta^l < \theta^h$), $k_t$ the input of physical capital and $z_t$ input of human capital.
Physical capital evolves following the law of motion

\[ k_{t+1} = (1 - \delta)k_t + i_{t+1} \quad (3) \]

where \( i_{t+1} \) is investment in physical capital and \( \delta \) is the depreciation rate of physical capital.

The agent may raise her effective labor by raising her level of human capital (or the skill level of labor), denoted by \( h_t \). When an agent spends one unit of time on working, she supplies effective labor amounting to \( h_t \). As in AK models of endogenous growth, assume that an agent’s accumulation of human capital is a linear function of her expenditures to raise human capital:

\[ h_{t+1} = (1 - \delta_h)h_t + \gamma_i h_{t,t} \quad (4) \]

where \( i_{h,t} \) is investment in human capital (e.g. through schooling), \( \gamma \) is how efficiently human capital is accumulated, and \( \delta_h \) is the rate of human capital depreciation. An agent’s education ability takes \( \gamma^l \) or \( \gamma^h \) (\( \gamma^l < \gamma^h \)).

There are two types of agents, each with measure one, depending on \( \theta \) and \( \gamma \). The first type of agents are those with \( \{\theta^h, \gamma^j\} \), while the second type are those with \( \{\theta^l, \gamma^h\} \).

There may potentially be a large number of banks that can intermediate financial resources from depositors to firms. An agent who has her own firm may raise capital from her own savings. But if she raises funds from others, she should do that through banks. Banks incur monitoring costs for their financial intermediation. A bank’s profit from intermediating one unit of capital is given by

\[ r_t - r_t^d - s_t \]

where \( r_t \) is the bank lending rate to firms, \( r_t^d \) the bank’s deposit rate and \( s_t \) the bank’s expenditures for monitoring for a unit of capital intermediated.

The banking sector is perfectly competitive. The ensuing zero profit condition gives

\[ r_t = r_t^d + s_t \]

Each agent is endowed with one unit of time each period. The agent may spend the one unit of time either on her entrepreneurial activity or her working as wage earner. The occupational choice between becoming an entrepreneur or a worker depends on whether the utility of becoming an entrepreneur exceeds that of becoming a worker.
2.3 Entrepreneur

If an agent becomes an entrepreneur, she, as an entrepreneur of her own firm, may finance physical capital \( k_t \) from herself (in the form of equity) or from other savers through banks (in the form of debt). Let \( a_t \) her own physical capital (equity) and \( d_t \) external borrowing of physical capital through banks. A firm’s physical capital input may be met by the entrepreneur’s supply and the other savers’ supply:

\[
k_t = a_t + d_t
\]

At the beginning of each period, given her own physical capital carried over from the previous period \( a_t \), the entrepreneur chooses her demand for physical capital \( k_t \) (or \( d_t \)), taking the rental rate of physical capital \( r_t \) and the wage rate for a unit of effective labor \( w_t \) and equiy \( a_t \) as given, so as to maximize the profit

\[
\pi_t = y_t - r_t d_t - w_t z_t
\]

\[
= \theta(a_t + d_t)^{1-\alpha} - r_t d_t - w_t z_t
\]  

The first-order conditions for the firm’s profit maximization with respect to external borrowing \( d_t \) and effective labor \( z_t \) give

\[
\alpha \theta k_t^{\alpha - 1} z_t^{1-\alpha} = r_t
\]

and

\[
(1 - \alpha) \theta k_t^{\alpha} z_t^{-\alpha} = w_t
\]

The maximized profit for given \( a_t \) can be expressed as

\[
\pi_t(a_t) = y_t - r_t d_t - (1 - \alpha) y_t
\]

\[
= \alpha y_t - r_t d_t
\]

\[
= r_t (k_t - d_t)
\]

\[
= r_t a_t
\]

An agent may save her income in the form of equity physical capital \( a_t \), deposit of physical capital to banks \( b_{c,t} \) or human capital \( h_t \). But if an agent becomes an entrepreneur, she cannot work as wage earner and consequently she will not invest in human capital to raise her skill level as a worker. Thus, the income of the agent who becomes an entrepreneur consists
of her profit and the interest income from deposit to banks. Using (8), the
agent’s budget constraint is given by
\[ c_{e,t} + (a_{t+1} - (1 - \delta)a_t) + (b_{e,t+1} - (1 - \delta)b_{e,t}) = (1 - t_k)[\pi_t + r_t^d b_{e,t}] \] (9)
= (1 - t_k)[r_t a_t + r_t^d b_{e,t}]
where \( c_{e,t} \) is the consumption of an agent as an entrepreneur, and \( t_k \) is the
tax rate on the return on physical capital (which is the same regardless of
equity or interest).

As an entrepreneur, the agent maximizes her intertemporal utility (1)
subject to the budget constraint, the law of motion for physical capital,
transversality condition \( \lim_{t \to \infty} \beta^t u'(c_{e,t})k_{t+1} = 0 \), and non-negativity con-
straints \((k_t, c_{e,t} \geq 0)\).

For the time being, suppose that the banks’ financial intermediation re-
quires large monitoring/enforcement cost \( s \) enough to exceed the bank lend-
ing rate \( (r_t) \) over any period in analysis (more simply we may assume that
\( s \) goes to infinity). Here \( s \) represents the difference between the internal and
external rates of return. In this simple case, the agent chooses not to deposit
but to save all her assets in the form of equity:
\[ b_{e,t+1} = 0 \quad \text{and} \quad k_{t+1} = a_{t+1} \] (10)
while Section 4 considers the case where this assumption is relaxed.

The first order condition with respect to \( a_{t+1} \) gives the Euler equation for
entrepreneurs:
\[ u'(c_{e,t}) = \beta u'(c_{e,t+1})(1 - \delta + (1 - t_k)r_{t+1}) \] (11)

### 2.4 Worker

If an agent becomes a worker, she provides her effective labor (amounting
to \( h_t \)) to a firm to earn wage income. She may invest her income on human
capital or on physical capital to deposit in a bank. The agent as a worker
faces the budget constraint
\[ c_{w,t} + i_{h,t} + (b_{w,t+1} - (1 - \delta)b_{w,t}) = (1 - t_h)w_t h_t + (1 - t_k)r_t^d b_{w,t} \]
which can be rewritten as
\[ c_{w,t} + \frac{1}{\gamma} (h_{t+1} - (1 - \delta_h)h_t) + (b_{w,t+1} - (1 - \delta)b_{w,t}) = (1 - t_h)w_t h_t + (1 - t_k)r_t^d b_{w,t} \]
where $c_{w,t}$ is the consumption by the worker, and $t_h$ is the tax rate on labor income. Whether she invests in human capital or physical capital depends on the rates of return from two types of capital. The rate of return on human capital is $(1-t_h)\gamma w_{t+1} - \delta_h$, and that of physical capital is $(1-t_k)(r_t-s) - \delta$.

In a simple case with large (say infinity) monitoring cost, the bank deposit rate should be negative. In this situation, workers accumulate only human capital and do not invest in physical capital:

$$b_{w,t+1} = 0$$  \hspace{1cm} (12)

So the budget constraint can be rewritten as

$$c_{w,t} + \frac{1}{\gamma}(h_{t+1} - (1-\delta_h)h_t) = (1-t_h)w_th_t$$  \hspace{1cm} (13)

The agent as a worker maximizes her intertemporal utility subject to the budget constraint (13), the law of motion for human capital, non-negativity constraints ($h_t, c_{w,t} \geq 0$) and transversality condition $\lim_{t\to\infty} \beta^t u'(c_{w,t})h_{t+1} = 0$.

The Euler equation for the worker’s dynamic optimization problem gives

$$u'(c_{w,t}) = \beta u'(c_{w,t+1})(1-\delta_h + (1-t_h)\gamma w_{t+1})$$  \hspace{1cm} (14)

### 2.5 Occupational Choice

Agents intrinsically differ in entrepreneurial ability and education ability, and thus are also heterogenous in the stock of physical capital and human capital each period. At the beginning of each period, an agent’s state can be characterized by eight variables: $\theta^i$, $\gamma^i$, $k_t$, $h_t$, $a_t$, $b_{e,t}$, $b_{w,t}$, $d_t$. Consider the simple case where $s$ is large enough. Then if we take a recursive representation, the value of her being an entrepreneur, denoted by $V_E(k, h, a, b_e, b_w, d; \theta, \gamma)$, is

$$V^E(k, h, a, b_e, b_w, d; \theta, \gamma) = \max_{k', h', a', b_e', b_w', d'} u(c) + \beta V^E(k', h', a', b_e', b_w', d'; \theta, \gamma)$$

s.t.  \hspace{0.5cm} c + (a' - (1-\delta)a) = (1-t_k)r a$$  \hspace{1cm} (15)$$

\footnote{We may relax this assumption. Then there are two cases: the case where $r_t > s$ and where $r_t < s$. If $r_t > s$, workers may invest in physical capital together with human capital. If $r_t < s$, the deposit rate of interest would be negative and thus workers would not invest in physical capital (through bank deposit) but human capital.}
The value of being a worker, denoted by $V^W(k, h, a, b_e, b_w, d; \theta, \gamma)$, is

$$V^W(k, h, a, b_e, b_w, d; \theta, \gamma) = \max_{k', h', a', b'_e, b'_w, d'} u(c) + \beta V^W(k', h', a', b'_e, b'_w, d'; \theta, \gamma)$$

s.t. $c + \frac{1}{\gamma}(ht - (1 - \delta_h)h) = (1 - t_h)wh$ \hspace{1cm} (16)

The agents choose whether to become an entrepreneur or a worker, depending on whether $V^E$ is greater than $V^W$. If $V^E(k, h, a, b_e, b_w, d; \theta, \gamma) > V^W(k, h, a, b_e, b_w, d; \theta, \gamma)$, the agent will choose to be an entrepreneur. If $V^E(k, h, a, b_e, b_w, d; \theta, \gamma) < V^W(k, h, a, b_e, b_w, d; \theta, \gamma)$, she will choose to be a worker.

2.6 Competitive Equilibrium

The competitive equilibrium allocations, rates of returns, occupational choices and growth rates are obtained by putting together the optimal solutions above and market clearing conditions. In a simple case where $s$ is large enough (say, it goes to infinity), labor market equilibrium implies $z_t = h_t$, and capital market equilibrium implies $a_t = k_t$ and $b_{e,t} = b_{w,t} = d_t = 0$ (we will discuss the case where this assumption is relaxed in Section 4).

Recall that the measure of the agents with $\{\theta^h, \gamma^l\}$ is one, and that of those with $\{\theta^l, \gamma^h\}$ is also one. The agents with $\{\theta^h, \gamma^l\}$ have comparative advantage in entrepreneurial activity, while those with $\{\theta^l, \gamma^h\}$ have comparative advantage in human capital accumulation. For simplicity, assume that $\theta^l = \gamma^l = 0$ and that for the agents with $\{\theta^h, \gamma^l\}$, the initial human capital $h_0$ is sufficiently small, say, close to zero.

Obviously, given $\theta^l = 0$, the agents with $\{\theta^l, \gamma^h\}$ would make no income if they spend one unit of time on working as entrepreneur, while they will earn positive wage income if they choose to be a worker instead of entrepreneurs. Therefore we have

$$V^E(k, h, a, b_e, b_w, d; \theta^l, \gamma^h) < V^W(k, h, a, b_e, b_w, d; \theta^l, \gamma^h)$$ \hspace{1cm} (17)

which suggests that the agents having comparative advantage in human capital accumulation choose to be workers for the whole periods.

For these agents, the net rate of return from investing in human capital is $(1 - t_h)\gamma^h w_{t+1} - \delta_h$, while that from investing in physical capital is $(1 - t_k)(r_{t+1} - s) - \delta$. Given $s$ goes to infinity, the former is always greater than the latter, so they do not invest in physical capital.
Given that $h_0$ is close to zero for the agents with $\{\theta^h, \gamma^l\}$, we have $(1 - t_k)\gamma_0 > (1 - t_d)\gamma_0 h_0 \approx 0$. So an agent with $\{\theta^h, \gamma^l\}$ earns a higher income if she becomes an entrepreneur-capitalist compared to becoming a worker at the initial period. With $\gamma^l = 0$, this type of agents with $\{\theta^h, \gamma^l\}$ would not invest in human capital. So their human capital will remain at the low initial level, which is close to zero. We then have

$$V^E(k, h, a, b_e, b_w, d; \theta^h, \gamma^l) > V^W(k, h, a, b_e, b_w, d; \theta^h, \gamma^l)$$

which suggests that the agents having comparative advantage in entrepreneurial talent always choose to be entrepreneurs.

For this type of agents, the net rate of return from investing in human capital is $(1 - t_k)\gamma^l w_{t+1} - \delta_h$, while that from investing in physical capital is $(1 - t_k)\gamma^l t_{t+1} - \delta$. Given $\gamma^l = 0$, the former is always lower than the latter, so they may invest in physical capital but never in human capital.

Note that in this equilibrium entrepreneurs become capitalists (who accumulate and own physical capital) while workers do not invest in physical capital.

For notational convenience, we below use $\gamma$ for $\gamma^h$ and $\theta$ for $\theta^h$ because all the agents who accumulate human capital in this economy are those with $\gamma = \gamma^h$ and the agents who become entrepreneurs are only those with $\theta = \theta^h$.

### 2.7 Accumulation Thresholds

In the competitive equilibrium, how much physical capital entrepreneurs accumulate and how much human capital workers accumulate depend on the physical-human capital ratio. Let $x_t$ denote the physical-human capital ratio $(= \frac{k_t}{h_t})$.

Note that in equilibrium the dynamic path of entrepreneurs’ consumption and physical capital can be summarized by the Euler equation

$$u'(c_{e,t}) = \beta u'(c_{e,t+1})(1 - \delta + (1 - t_k)\alpha \theta k_{t+1}^{\gamma^h} h_{t+1}^{1-\gamma^h})$$

and the budget constraint combined with the law of motion for physical capital

$$k_{t+1} - k_t = (1 - t_k)\alpha y_t - \delta k_t - c_{e,t}$$

and the transversality condition $\lim_{t \to \infty} \beta^t u'(c_{e,t+1}) k_{t+1} = 0$. 

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Using $x_t = \frac{k_t}{h_t}$, the Euler condition (19) can be rewritten as

$$u'(c_{e,t}) = \beta u'(c_{e,t+1})(1 - \delta + (1 - t_k)\alpha \theta x_{t+1}^{\alpha-1})$$

which, under CRRA utility function, gives

$$\left(\frac{c_{e,t+1}}{c_{e,t}}\right)^\sigma = \beta(1 - \delta + (1 - t_k)\alpha \theta x_{t+1}^{\alpha-1})$$

or

$$(1 + g_{e,t+1})^\sigma = \beta(1 - \delta + (1 - t_k)\alpha \theta x_{t+1}^{\alpha-1})$$

where $g_{e,t+1}$ is the growth rate of consumption by the entrepreneur. So the equation depicts the evolution of entrepreneurs’ consumption.

Suppose that human capital stays constant at a certain level. Consider a state where the entrepreneurs’ consumption and physical capital stay constant ($c_{e,t+1} = c_{e,t}$, $k_{t+1} = k_t$ and hence $x_{t+1} = x_t$) on the the condition that human capital level does not change. We call such state a quasi-steady state (or conditional steady state) for entrepreneurs. In this quasi steady state for entrepreneurs, the Euler equation is

$$1 = \beta(1 - \delta + (1 - t_k)\alpha \theta x_{t+1}^{\alpha-1})$$

Let $x^k$ denote the quasi-steady state value of $x_{t+1}$ that satisfies the above Euler equation conditional on any level of human capital. That is,

$$x^k = \left(\frac{(1 - t_k)\alpha \theta}{\beta - 1 + \delta}\right)^{\frac{1}{1 - \alpha}}$$

This quasi-steady state for entrepreneurs is stable as in the case of the steady state of Neoclassical growth models. Therefore, the threshold level of physical-human capital ratio ($x^k$) determines whether entrepreneurs accumulate physical capital or not. If $x_t > x^k$, the entrepreneur’s optimal choice implies that as long as workers’ human capital stays constant, her physical capital and consumption evolve along the saddle path where

$$k_{t+1} - k_t < 0 \quad \text{and} \quad g_{e,t+1} < 0$$

That is, the entrepreneur decumulates her physical capital and reduces the consumption until $x_t$ hits $x^k$. 

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Now suppose that \( x_{t+1} < x^k \). With constant human capital of workers, we then have
\[
kt+1 - kt > 0 \quad \text{and} \quad ge,t+1 > 0
\]
(27)
So the entrepreneur accumulates physical capital until \( x_t \) hits \( x^k \).

In the competitive equilibrium, the evolution of workers’ human capital and consumption can be represented by the Euler equation
\[
u'(cw,t) = \beta u'(cw,t+1)(1 - \delta_h + (1 - t_h)\gamma(1 - \alpha)\theta x^\alpha_{t+1})
\]
(28)
which, under CRRA utility function, gives
\[
(1 + gw,t+1)^\sigma = \beta(1 - \delta_h + (1 - t_h)\gamma(1 - \alpha)\theta x^\alpha_{t+1})
\]
(29)
and the worker’s budget constraint combined with human capital accumulation
\[
h_{t+1} - h_t = \gamma(1 - t_h)(1 - \alpha)y_t - \delta_h h_t - \gamma cw,t
\]
(30)
and the transversality condition \( \lim_{t \to \infty} \beta^t u'(cw,t+1)h_{t+1} = 0 \).

For any level of physical capital, we can think of a quasi-steady state for workers, by which we denote the state where the workers’ human capital and consumption stay constant \( (cw,t+1 = cw,t, \ h_{t+1} = h_t, \ \text{and hence} \ x_{t+1} = x_t) \) if physical capital does not change. In the quasi steady state for workers, we have
\[
1 = \beta(1 - \delta_h + (1 - t_h)\gamma(1 - \alpha)\theta x^\alpha_{t+1})
\]
(31)
from which we derive the quasi steady state level of \( x_{t+1} \), denoted by \( x^h \), as
\[
x^h = \left[ \frac{1}{(1 - t_h)\gamma(1 - \alpha)\theta} \left[ \frac{1}{\beta} - 1 + \delta_h \right] \right]^\frac{1}{\alpha}
\]
(32)
Analogously to the case of entrepreneur, this quasi-steady state for workers \( (x^h) \) is also saddle-path stable. Thus, this \( x^h \) works as the threshold level of physical-human capital ratio that determines whether workers accumulate human capital or not. Suppose \( x_{t+1} < x^h \). Then as long as physical capital of the economy stays constant, the worker’s optimal choices for her human capital and consumption evolve along the saddle path where
\[
h_{t+1} - h_t < 0 \quad \text{and} \quad gw,t+1 < 0
\]
(33)
So the workers decumulate human capital, which would raise $x_{t+1}$ if $k_t$ stays constant.

If $x_{t+1} > x^h$, we have

$$h_{t+1} - h_t > 0 \quad \text{and} \quad g_{w,t+1} > 0$$

(34)

So the workers accumulate human capital, which will reduce $x_{t+1}$ with $k_t$ staying constant.

Note that both thresholds for entrepreneur’ accumulation (alternatively, net investment) in physical capital and workers’ investment in human capital ($x^k$ and $x^h$) are functions of preference, technology and policy parameters. For example, a rise in the rate of capital income taxes will reduce the threshold ratio $x^k$. A rise in the labor income tax rate or frictions in labor market will increase the threshold ratio $x^h$.

### 3 Two Regimes of Growth Paths

In this heterogenous agent growth model, we have two totally different types of growth paths, depending on whether $x^h$ is greater than $x^k$ or the other way around. If the threshold physical-human capital ratio for workers’ human capital accumulation ($x^h$) is lower than that for entrepreneurs’ physical capital accumulation ($x^k$), the economy follows a balanced growth path of AK type endogenous growth models. If the former is greater than the latter, the economy follows the growth path of Neoclassical growth model.

#### 3.1 Endogenous growth regime

We call *endogenous growth regime* when preference, technology and policy parameters are such that

$$x^h < x^k$$

(35)

which can be explicitly expressed in terms of parameters as

$$\left[\frac{1}{(1 - t_h)\gamma(1 - \alpha)\theta}\left[\frac{1}{\beta} - 1 + \delta_h\right]\right]^{\frac{1}{\delta}} < \left[\frac{(1 - t_k)\alpha\theta}{\frac{1}{\beta} - 1 + \delta}\right]^{\frac{1}{\delta}}.$$  

(36)

If the initial physical-human capital ratio $x_0$ is between $x^h$ and $x^k$, that is,

$$x^h < x_0 < x^k$$

(37)
we have

\[ k_{t+1} - k_t > 0 \quad \text{and} \quad g_{e,t+1} > 0 \]  \hspace{1cm} (38)

\[ h_{t+1} - h_t > 0 \quad \text{and} \quad g_{w,t+1} > 0 \]  \hspace{1cm} (39)

Thus entrepreneurs accumulate physical capital \((k_{t+1} - k_t > 0)\) and workers accumulate human capital \((h_{t+1} - h_t > 0)\). Simultaneous accumulation of physical and human capital may allow the marginal products of both capital not to decline. So the growth rate is positive, and we have positive and sustained growth, as suggested by endogenous growth models.

There is a balanced growth path where the growth rates of consumption of entrepreneurs, that of workers, physical and human capital, and GDP are all the same at \(g^*\). Under CRRA utility function, the balanced-path growth rate \(g^*\) in this endogenous growth regime is determined from

\[ (1 + g^*)^\sigma = \beta (1 - \delta + (1 - t_k) \alpha \theta x^{\alpha - 1}) \]  \hspace{1cm} (40)

\[ (1 + g^*)^\sigma = \beta (1 - \delta_h + (1 - t_h) \gamma (1 - \alpha) \theta x^\alpha) \]  \hspace{1cm} (41)

which can be solved for \(g^*\) and \(x^*\), where \(x^*\) is the steady state physical-human capital ratio in this endogenous growth regime. Given eq. (37), the balanced path growth rate is positive

\[ g^* > 0 \]  \hspace{1cm} (42)

and the steady state physical-human capital ratio is between the two thresholds, that is,

\[ x^h < x^* < x^k \]  \hspace{1cm} (43)

To understand the dynamics in this regime intuitively, note that under this balanced growth path, for a given human capital \(h_t\), the entrepreneurs raise physical capital to get closer to a quasi-steady state \(x^k\) since \(x_t < x^k\). But human capital also rises as workers raise human capital so as to move towards their quasi-steady state \(x^h\) since \(x^h < x_t\). As the rise in human capital drives the physical-human capital ratio down from \(x^k\), the entrepreneurs raise physical capital again to raise the ratio closer to \(x^k\). But workers also raise human capital again. This process repeats forever with the ratio remaining between the two quasi-steady state values.
In case where $\delta = \delta_h$, the steady-state physical-human capital ratio ($x^*$) is calculated in a closed form solution as

$$x^* = \frac{(1 - t_h)\gamma(1 - \alpha)}{(1 - t_k)\alpha}$$  \hspace{1cm} (44)$$

and the growth rate is

$$g^* = [\beta(1 - \delta + (1 - t_k)\alpha(1 - t_h)\gamma(1 - \alpha)\alpha^\alpha(1 - \alpha)^{1 - \alpha}\theta)]^{\frac{1}{\beta}} - 1$$  \hspace{1cm} (45)$$

which can be easily shown to be positive.

So under this regime the balanced growth path in our heterogenous agent model is similar to that of AK type endogenous growth models that are based on the representative agent model. Along the balanced growth path, the physical-human capital ratio is constant at $x^*$, which gives a positive and constant marginal product of both physical and human capital. This brings a positive and sustained growth. The resulting growth rate $g^*$ is a function of the tax parameters and hence a change in tax rate $t_h$ or $t_k$ always induces changes in the growth rates.

The balanced growth path in this regime is stable. Suppose that the initial physical-human capital ratio $x_0$ is less than $x^h$ so we have

$$x_0 < x^h < x^k$$  \hspace{1cm} (46)$$

In this case, workers decumulate human capital because $x_0 < x^h$. Given $x_0 < x^k$, however, entrepreneurs accumulate physical capital. Therefore, the physical-human capital ratio $x_t$ rises. Once the physical-human capital ratio rises above $x^h$, workers also accumulate human capital. During the period where

$$x^h \leq x_t < x^*$$  \hspace{1cm} (47)$$

we have

$$1 - \delta + (1 - t_k)\alpha\theta x^{1 - \alpha} > 1 - \delta_h + (1 - t_h)\gamma(1 - \alpha)\theta x^\alpha$$  \hspace{1cm} (48)$$

Hence in this transitional period both physical and human capital grow but physical capital grows faster, which leads to increases in $x_t$ until it hits the steady state $x^*$.  

Now suppose that the initial physical-human capital ratio $x_0$ is greater than $x^k$, that is,

$$x^h < x^k < x_0$$  \hspace{1cm} (49)$$

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In this case, entrepreneurs do not accumulate physical capital, given that $x^k < x_0$. But because $x^h < x_0$, workers accumulate human capital. As a result, the physical-human capital ratio declines. Once the physical-human capital ratio is lowered below $x^k$, entrepreneurs begin to invest in physical capital. During the period where

$$x^* < x_t < x^k$$

(50)

the human capital grows faster than physical capital and hence $x_t$ declines until it hits the steady state $x^*$.

In sum, if

$$x^h < x^k$$

(51)

the economy always moves to the above path of balanced growth path where human and physical capital grow at the same rate, regardless of the initial ratio of physical-human capital ratio.

This condition for the endogenous growth regime is intuitively clear. Note that $x^h$ is the physical-human capital ratio when workers do not accumulate nor decumulate human capital, while $x^k$ is the capital ratio when entrepreneurs do not accumulate nor decumulate physical capital. Thus the condition suggests that when human capital of the economy does not change (that is, when $x_t = x^h$), entrepreneurs invest in physical capital since $x_t < x^k$. So under the condition, the physical-human capital ratio rises and in response to the resulting rise in the rate of return on human capital, then workers also accumulate human capital. The simultaneous accumulation of both types of capital induces sustained positive growth.

Alternatively, the condition suggests that when physical capital of the economy does not change (that is, when $x_t = x^k$) workers accumulate human capital since $x_t > x^h$. So the physical-human capital ratio falls. This raises the rate of return on physical capital, which induces entrepreneurs to accumulate physical capital. With investment in both human and physical capital, positive growth is achieved under the condition.

### 3.2 Neoclassical growth regime

We call *Neoclassical growth regime* when preference, technology and policy parameters make the two threshold physical-human capital ratios satisfy

$$x^k < x^h$$

(52)
That is, the threshold physical-human capital ratio for workers’ human capital accumulation \((x^h)\) is greater than that for entrepreneurs’ physical capital accumulation \((x^k)\).

We assume that there is a lower bound on the level of human capital of the agents with \(\{\theta^k, \gamma^h\}\), who become workers, given that any worker would have some intellectual abilities even without having received any education. We denote the lower bound of human capital of the agents with \(\{\theta^l, \gamma^h\}\) by \(h_{\min}\), and assume that any of the agents with \(\{\theta^l, \gamma^h\}\) who has not received any education is endowed with effective labor of \(h_{\min}\).

In this case, with a lower bound on human capital for workers, the economy converges to a steady state whose physical-human capital ratio is the quasi-steady state value for entrepreneurs when the workers’ human capital stays at its lower bound \(h_{\min}\), denoted by \(x^k(h_{\min})\):

\[
x^* = x^k(h_{\min}).
\]

To see this, consider first the case where the initial physical-human capital ratio \(x_0\) is less than \(x^k\)

\[
x_0 < x^k < x^h
\]
and for simplicity suppose \(\delta < \delta_h\).

Then we have

\[
\begin{align*}
k_{t+1} - k_t &> 0 \quad \text{and} \quad g_e, t+1 > 0 \\
h_{t+1} - h_t &< 0 \quad \text{and} \quad g_w, t+1 < 0
\end{align*}
\]

Thus workers decumulate human capital by allowing for natural depreciation at the rate of \(\delta_h\) since \(x_0 < x^h\), while entrepreneurs accumulate physical capital since \(x_0 < x^k\). This raises the physical-human capital ratio until it hits \(x^k\). After \(x_t\) hits \(x^k\), workers keep decumulating human capital, which would raise \(x_t\) over \(x^k\). In response to the rise of \(x_t\) over \(x^k\), however, entrepreneurs decumulate physical capital at the rate of \(\delta\). As human capital decumulates at a higher rate, \(x_t\) keeps exceeding \(x^k\) and rising toward \(x^h\). And such a simultaneous decline in both physical and human capital leads to the period of negative output growth.

But human capital cannot be reduced below \(h_{\min}\). Once it hits its lower bound, it should stay constant at the level. As \(x_t\) has exceeded \(x^k(h_{\min})\),

\[\text{Without loss of generality, we may also assume that the lower bound of human capital of the agents with } \{\theta^h, \gamma^l\} \text{ is close to zero and thus lower than that of the agents with } \{\theta^l, \gamma^h\}.\]
entrepreneurs’ consumption and physical capital now evolve along the stable saddle path where $g_{e,t+1} < 0$ and $k_{t+1} - k_t < 0$. Once $x_t$ hits $x^k(h_{\text{min}})$, entrepreneurs do not accumulate nor decumulate physical capital any more. So the steady state physical-human capital ratio is determined to be $x^k(h_{\text{min}})$.

Under the steady state physical-human capital ratio, the worker’s consumption, equal to her wage income, is determined to be

$$c_{w,t} = (1 - t_h)w_t h_t = (1 - t_h)(1 - \alpha)\theta(x^k(h_{\text{min}}))^\alpha h_{\text{min}}$$

and the entrepreneur’s consumption, the same as her rental income subtracted by replacement investment, is also determined to be

$$c_{e,t} = (1 - t_k)r_t k_t - \delta k_t = (1 - t_k)\alpha \theta(x^k(h_{\text{min}}))^\alpha - 1 x^k(h_{\text{min}})h_{\text{min}} - \delta x^k(h_{\text{min}})h_{\text{min}}$$

which implies that the steady state consumption growth rates of workers and entrepreneurs are also zero.

Consider now the case where the initial physical-human capital ratio $x_0$ is greater than $x^h$

$$x^k < x^h < x_0$$

In this case, entrepreneurs decumulate physical capital by allowing for depreciation at the rate of $\delta$, but workers accumulate human capital. As a result, $x_t$ is declining as long as $x_t$ exceeds $x^h$. After $x$ hits $x^h$, workers also decumulate human capital by allowing for natural depreciation. The simultaneous decumulation of physical and human capital continues until human capital hits its lower bound. Once human capital reaches its lower bound, $x_t$ moves toward $x^k(h_{\text{min}})$ along the saddle path for given $h_{\text{min}}$. So the steady state physical-human capital ratio is determined to be $x^k(h_{\text{min}})$.

This suggests that the steady state and transitional dynamics in this case of $x^k < x^h$ are similar to those of the Neoclassical growth models. The steady state is stable, and the steady state growth rates of output, physical capital and consumption are zero. The growth rate of consumption can be positive during the transitional period when $x_t$ is below $x^k(h_{\text{min}})$ and negative when $x_t$ exceeds $x^k(h_{\text{min}})$ once human capital hits its lower bound $h_{\text{min}}$.\(^3\)

\(^3\)Our model may explain even an extended period of negative growth with declines in human and physical capital, which might have been the case of some African countries for the latter half of the last century. An extended period of negative growth cannot be explained by AK type endogenous growth models, where an economy moves to a balanced growth path within a period. The absence of transitional dynamics in the AK type en-
The intuition behind this condition for the Neoclassical growth regime \((x^k < x^h)\) is clear. This condition tells us that when human capital of the economy does not change (that is, when \(x_t = x^h\)), entrepreneurs decumulate physical capital since \(x_t > x^k\). So the physical-human capital ratio decreases, which induces a reduction in the rate of return on human capital. Then workers do not accumulate human capital. As both entrepreneurs and workers do not invest in any type of capital, there is no positive growth under the condition.

### 3.3 Tax Policies for Regime Change

Our unified model is reduced to a Neoclassical growth model, where the steady state growth is zero, in case of \(x^k < x^h\). In case of \(x^h < x^k\), however, our unified model is reduced to an endogenous growth model, where the balanced-path growth rate is positive without technological progress.

This suggests that tax policy may have a crucial impact on whether an economy follows the growth path of endogenous growth models or Neoclassical growth models. To have sustained economic growth, it is particularly important for tax policies to ensure \(x^h < x^k\).

Suppose that an economy is in the Neoclassical growth regime because the parameters of the model induce \(x^k < x^h\), and the economy is in the steady state of zero growth with \(x_t = x^* = x^k(h_{\text{min}})\).

To move the economy from the Neoclassical growth region to the endogenous growth region, the government might pursue tax policies that reduce \(x^h\) and raise \(x^k\). Note that \(x^h\) and \(x^k\) are given by

\[
 x^k = \left[ \frac{1 - t_k}{ \frac{1}{\beta} - 1 + \delta } \right]^{1/\alpha}
\]

\[
 x^h = \left[ \frac{1}{ (1 - t_h)(1 - \alpha)\theta} \left[ \frac{1}{\beta} - 1 + \delta_h \right] \right]^{\frac{1}{\gamma}}
\]

Thus the policy of reducing tax rate on labor (human capital), by reducing \(x^h\), helps the economy to move from a zero growth steady state equilibrium.

Endogenous growth models stems from their assumption of the representative agent, who makes a decision on the accumulation of both human and physical capital together. Our heterogenous agent model, which separates between workers and capitalists, allows the separation of agents’ decisions on the accumulation of human and physical capital, which generates a transitional dynamics characterized by an extended period of negative growth.
to a positive growth equilibrium. The policy of reducing tax rates on capital income also helps by raising $x^k$.

Suppose that the government makes a substantial change in the labor tax rate enough to reduce $x^h$ to the level that induces the reversal of the size of $x^h$ and $x^k$. Then the workers start to invest in human capital. As human capital rises, the physical-human capital ratio $x_t$ is lowered below $x^k$. As it becomes that $x_t < x^k$, the entrepreneurs start to invest in physical capital. As the two types of capital simultaneously accumulate, the marginal products of both types of capital remain high, and a positive rate of balanced growth can be achieved. In this way, the economy moves to the endogenous growth regime.

This suggests that the relation between the tax rates and the growth rate is nonlinear. The reduction in tax rates does not always induce the rise in the growth rate. The reduction of tax rates to any levels which are still higher than a certain threshold level would not affect the growth rate. The threshold level of labor tax rates can be calculated by equating $x^h$ and $x^k$.

Let $\tilde{t}_h$ denote the threshold labor tax rate. Then the balanced path growth rate is given by

$$g = \begin{cases} 
0 & \text{if } t_h > \tilde{t}_h \\
[\beta(1 - \delta + ((1 - t_h)\alpha)((1 - t_h)(1 - \alpha)B)^{1-\alpha}B)]^{1/\alpha} - 1 & \text{if } t_h \leq \tilde{t}_h
\end{cases}$$

Thus only a substantial reduction in tax rates may induce a rise in the growth rate. Any size of reduction in the labor tax rate, until the rate hits $\tilde{t}_h$, would not affect the growth rate. But if it hits $\tilde{t}_h$, there is a jump in the growth rate, and after it hits $\tilde{t}_h$, a larger cut in the labor tax rate induces a greater increase in the growth rate.

Now consider the effect of a rise in labor tax rate in an economy which is in the endogenous growth regime as the parameters of the model induce $x^h < x^k$. The economy used to have a positive growth with $x^h < x_t = x^* < x^k$. Suppose that the tax rates on labor income rises substantially, leading to the rise of $x^h$ over $x^k$, which induces $x_t < x^k < x^h$. Then workers do not accumulate human capital any more, which raises the physical-human capital ratio $x_t$. Then the economy moves to the Neoclassical growth regime, as explained in the previous section, where along the steady state there is no growth.
4 Small Monitoring Costs

So far we have considered a simple case where the monitoring cost $s$ is so large (say, infinite) that nobody may never deposit in banks and entrepreneurs may use only external financing any time. If we relax this assumption, the transitional dynamics of the economy changes, and the model can explain more diverse cases, for example, where workers accumulate physical capital as well and where agents having entrepreneurial abilities serve as worker rather than becoming an entrepreneur.

4.1 Worker-Capitalists

Now consider the case where the monitoring cost $s$ is small. In this case, workers also may accumulate physical capital during the transitional period to get to a steady state unlike the benchmark model.

The agents with $\{\theta^h, \gamma^h\}$ make decisions on whether to invest in human capital or physical capital, depending on which is greater between the rates of return on their investing in human capital $((1 - t_h)\gamma^h w_{t+1} - \delta_h)$ and physical capital $((1 - t_k)(r_{t+1} - s) - \delta)$. With positive but small $s$, there may be a period when $(1 - t_k)(r_{t+1} - s) - \delta > (1 - t_h)\gamma^h w_{t+1} - \delta_h$ during the transitional period. In this period, the physical-human capital ratio $x_t$ will satisfy

\[ 1 - \delta + (1 - t_k)(\alpha t^{1-\alpha}_t - s) > 1 - \delta_h + (1 - t_h)\gamma(1 - \alpha)t^{\alpha}_t \]  \hspace{1cm} (60)

and

\[ 1 - \delta + (1 - t_k)(\alpha t^{1-\alpha}_t - s) > 0 \]  \hspace{1cm} (61)

In this case, the agents with $\{\theta^h, \gamma^h\}$ serve as workers using the human capital they have already acquired, but do not newly invest in human capital. They instead invest in physical capital, which gives a higher rate of return. During this period, given $r_{t+1} > r_{t+1} - s$, the entrepreneurs also invest in physical capital.

During this transitional period, capital market equilibrium implies

\[ b_{w,t} = d_t > 0 \quad \text{and} \quad a_t + b_{w,t} = k_t \]  \hspace{1cm} (62)

which suggests that during the period workers also become capitalists and firms use external financing. The bank lending rate and deposit rate of
interest are given by

\[ r_t = \alpha \theta \left( \frac{a_t + b_w t}{h_t} \right)^{1-\alpha} \]

and

\[ r^d_t = \alpha \theta \left( \frac{a_t + b_w t}{h_t} \right)^{1-\alpha} - s \]

This period does not persist for ever. As physical capital increases (while workers do not invest in human capital), the physical-human capital ratio \(x_t\) rises, which reduces the rate of return on the workers’ investing in physical capital \(((1 - t_k)(r_{t+1} - s) - \delta)\). As a result, there comes a time when the workers receive lower rate of return on investing in physical capital than human capital, or \(x_t\) is high enough to satisfy

\[ 1 - \delta + (1 - t_k)(\alpha \theta x_t^{1-\alpha} - s) < 1 - \delta_h + (1 - t_h)\gamma (1 - \alpha) \theta x_t^\alpha \]

Under the condition, workers start to invest in human capital but decumulate physical capital. Now physical capital is accumulated only by entrepreneurs. Hence this case goes back to the benchmark case where we for simplicity assume \(s\) is so large.

The steady state is also the same as that in the benchmark case. Regardless of the assumption on the size of positive \(s\), there is a separation of investment between entrepreneur-capitalists and workers in the steady state. In the steady state, workers continue to accumulate human capital and entrepreneurs physical capital when the economy is in the endogenous growth regime. In the Neoclassical growth regime, workers and entrepreneurs maintain the same levels of human capital and physical capital, respectively.

In the previous sections, we also assumed that the tax rate on profit (equity) is equal to the tax rate on deposit (or lending) as \(t_k\).\(^4\) Now we allow the difference in the tax rates on internal fund and external fund. Let \(t_{ke}\) and

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\(^4\)In the benchmark case, we also assumed that there are two types of agents; those with \(\{\theta^h, \gamma^l\}\) who have advantage in entrepreneurial activity and those with \(\{\theta^l, \gamma^h\}\) who have advantage in human capital accumulation. We may introduce a third type of agents who are inferior in both entrepreneurial activities and human capital accumulation, those with \(\{\theta^d, \gamma^f\}\).

This type of agents would not invest in human capital because of low education abilities. They could not serve as entrepreneur given their low entrepreneurial abilities. So they may become pure capitalists, who raise their income by accumulating physical capital and lending it to entrepreneurs, during the transitional period, but the introduction of this type of agents would not qualitatively affect the main results of the paper.
$t_{kb}$ denote the tax rate on internal fund and external fund, respectively. The government may induce workers to accumulate physical capital by setting tax rates such that

$$1 - \delta + (1 - t_{ke})\alpha x_t^{1-\alpha} \leq 1 - \delta + (1 - t_{kb})(\alpha x_t^{1-\alpha} - s)$$

(64)

### 4.2 Occupational Choice

The assumption of small monitoring costs also affects occupational decisions by the agents with $\{\theta^h, \gamma^i\}$, that is, those who have comparative advantage in entrepreneurial activities.

Suppose that monitoring cost $s$ is small. In this case, the difference between the internal and external rates of return on investing in physical capital is small. The return on physical capital when the agents work as entrepreneur is $r_t k_t$, while the return when they work as worker and lend physical capital through banks is $r^d k_t$. So if the agent decides to be an entrepreneur instead of being a worker, she would earn a higher return from investing her physical capital by $sk_t$. By deciding to be an entrepreneur, however, she needs to spend one unit of time on entrepreneurial activity, and hence she needs to give up wages $w_t$.

Therefore, the occupational choice of the agents with $\{\theta^h, \gamma^i\}$ depends on the product of monitoring costs and physical capital ($sk_t$) and wage rates. If $w_t > sk_t$, the return from becoming a worker is greater than that from being an entrepreneur. So in this case, the agents with $\{\theta^h, \gamma^i\}$ will choose to be a worker rather than an entrepreneur, even though their human capital is lower than those agents with $\{\theta^l, \gamma^h\}$. If $w_t < sk_t$, the agents with $\{\theta^h, \gamma^i\}$ will choose to be an entrepreneur.

This implies that the agents’ occupational choice may change during the transitional period when the wage rate $w_t$ changes over time. Suppose that some of the agents who have advantage in entrepreneurial abilities have high level of physical capital while others have low level of physical capital. If the wage rate rises substantially enough to induce $w_t > sk_t$ for those agents with low physical capital, then those agents having low level of physical capital, who used to work as entrepreneur, may choose to become workers.

\[\text{\textsuperscript{5}}\text{In addition, the labor supply will be greater compared to the benchmark case.}\]
5 Income Distribution Policy and Growth

We now extend the benchmark model to explore the impact of labor market imperfection and government policy of income distribution on the dynamic path of the economy. If the labor market is perfectly competitive, the firms would not have any bargaining power to decide the wage, and the wage rate is determined in the market. But if firms have monopsony power, they would affect the wage rate, which would result in the decline of labor income share. In this situation, the government may perhaps impose regulations to alleviate market imperfection and to restrict monopsony, which would raise the income share of workers.

5.1 Model with Imperfect Competition

5.1.1 Entrepreneur-capitalists

To address the role of income distribution between capitalists and workers in a simple way, notice that labor supply is fixed each period in our model where the utility does not depend on leisure. If the labor market is perfectly competitive, the equilibrium wage is determined to be equal to the marginal product of labor when the vertical aggregate labor supply curve meets the downward sloping aggregate labor demand curve.

In the equilibrium in this case as well as the benchmark case, the agents with \( \Theta, \gamma \) become entrepreneur-capitalists, and those with \( \Theta', \gamma' \) workers. Suppose that those agents with \( \Theta, \gamma' \) who become entrepreneurs are allowed to establish a coalition firm to raise their profits by becoming a monopsony in the labor market. If the labor market is monopsonistic, the monopsonist can choose the wage rate so as to maximize its profits. Given the vertical supply curve, the monopsonistic firm would set the wage as low as possible.

Allowing for the deviation of the wage rate from the marginal product of labor, we express the actual wage, denoted by \( \tilde{w}_t \), as

\[
\tilde{w}_t = q m_t
\]

where \( m_t \) denotes the marginal product of labor, and \( q \) the actual wage rate as a fraction of the marginal product of labor.

If the labor market is perfectly competitive, the equilibrium wage rate is equal to the marginal product of labor, and hence \( q \) is equal to one. But if
the market is imperfect, the firm coalitions that have some monopsony power set the wage rate below the marginal product of labor, making \( q \) below one.

The extent to which the firms can cut \( q \) down depends first on their bargaining power, which in turn depends on the degree of market imperfections. The degree of market imperfection can be captured by the maximum portion of the marginal product of labor that the firm coalitions can take as monopolistic rent, which we denote by \( \phi \in (0, 1] \). So we have

\[
q \geq \phi
\]

that is, the firm coalition can choose any \( q \) which is greater than or equal to \( \phi \).

The actual wage rate as a fraction of the marginal product of labor \( q \) is affected by the government policy as well. The government can raise it by imposing regulations on monopsony in the labor market as

\[
\phi = \phi(\lambda), \quad \phi'(\lambda) > 0
\]

where \( \lambda \) captures how strong the government’s policy of fair competition is. In this way, we take \( \lambda \) as a policy variable that can be raised by the government policy of fair competition in the markets.

The policy of fair competition can be interpreted as a policy of income distribution between capitalists and workers. The government policy of raising \( \lambda \) raises the income share of workers against that of capitalist-entrepreneurs. The income distribution policy includes the policy of minimum wage required by the law (see Picketty (2014)). Further, this policy affects the dynamic path of the growth rate by affecting the growth regime.

At the beginning of each period, the firm coalition (joined by entrepreneurs) chooses its demand for physical capital \( k_t \) (which is equal to \( a_t \)) and \( q \), taking the rental rate of physical capital \( r_t \) and the labor supply curve which is vertical at \( z_t \) as given, so as to maximize its profit

\[
\max \pi_t = y_t - r_t d_t - \tilde{w}_t z_t
\]

\[
= y_t - r_t d_t - q m_t z_t
\]  \tag{65}

The first-order condition with respect to \( k_t \) (or \( d_t \)) gives

\[
\alpha \theta k_t^{\alpha - 1} z_t^{1-\alpha} = r_t
\]  \tag{66}
Given vertical aggregate labor supply curve and \( q \geq \phi \), the firm coalition’s optimal \( q \) is obviously given by

\[
q^* = \phi
\]

That is, the profit-maximising firms would try to decide \( q \) as low as possible, and hence the optimal \( q \) is decided at its minimum, \( \phi \). This also implies that the firm’s profit-maximizing wage rate is

\[
\bar{w}_t = \phi m_t = \phi (1 - \alpha) \theta k_t^\alpha z_t^{-\alpha}
\]

With \( d_t = 0 \), the profit in equilibrium can be expressed as

\[
\pi_t = y_t - q m_t z_t = (r_t k_t + m_t z_t) - q m_t z_t = r_t k_t + (1 - q) m_t z_t = r_t a_t + (1 - q) m_t z_t
\]

This expression tells us that the entrepreneur’s profit consists of two components: the return on capital \( r_t a_t = r_t k_t \) and monopoly rent \((1 - q) m_t z_t\). So \( q \) does not affect the return on capital accumulated by the entrepreneur. It affects only the monopoly rent.

Given that the return on capital is \( r_t a_t \), the entrepreneur’s maximization problem gives the Euler condition

\[
u'(c_{e,t}) = \beta u'(c_{e,t+1})(1 - \delta + (1 - t_k) r_{t+1}) = \beta u'(c_{e,t+1})(1 - \delta + (1 - t_k) \alpha \theta k_{t+1}^{\alpha - 1} z_{t+1}^{1 - \alpha})
\]

which, under CRRA utility function, gives

\[(1 + g_{e,t+1})^\sigma = \beta (1 - \delta + (1 - t_k) \alpha \theta x_{t+1}^{\alpha - 1})\]

Along the quasi-steady state for entrepreneurs, we have

\[1 = \beta (1 - \delta + (1 - t_k) \alpha \theta x_{t+1}^{\alpha - 1})\]

The threshold level of physical-human capital ratio which determines whether the entrepreneurs accumulate physical capital or not, denoted by \( x^k \), is given by

\[x^k = \left[ \frac{(1 - t_k) \alpha \theta}{1 - 1 + \delta} \right]^{\frac{1}{\alpha - 1}}\]

which is the same as the benchmark case in the previous sections.
5.1.2 Workers

The agent with \( \{ \theta^i, \gamma \} \) who becomes a wage worker receives wage at the rate of \( \bar{w}_t = q^* m_t = \phi m_t \). Therefore, her budget constraint can be rewritten as

\[
c_{w,t} + \frac{1}{\gamma} (h_{t+1} - (1 - \delta_h) h_t) = (1 - t_h) \phi m_t h_t
\]

She seeks to maximize her utility taking \( \bar{w}_t (= \phi m_t) \) as given. The first-order condition with respect to \( h_{t+1} \) gives the Euler equation for the worker

\[
u'(c_{w,t}) = \beta u'(c_{w,t+1})(1 - \delta_h + \phi(1 - t_h) \gamma m_{t+1})
\]

(72)

In equilibrium, the Euler equation is

\[
u'(c_{w,t}) = \beta u'(c_{w,t+1})(1 - \delta_h + \phi(1 - t_h) \gamma x_{t+1}^\alpha)
\]

(73)

which, under CRRA utility function, gives

\[(1 + g_{w,t+1})^\sigma = \beta(1 - \delta_h + \phi(1 - t_h) \gamma (1 - \alpha) x_{t+1}^\alpha))
\]

(74)

Along the quasi-steady state, we have

\[1 = \beta(1 - \delta_h + \phi(1 - t_h) \gamma (1 - \alpha) x_{t+1}^\alpha)
\]

(75)

Then, \( x^h \), the threshold level of physical-human capital ratio which determines whether the workers accumulate human capital or not, is given by

\[x^h = \left[ \frac{1}{\phi(1 - t_h) \gamma (1 - \alpha) \theta} \left[ \frac{1}{\beta} - 1 + \delta_h \right] \right]^{\frac{1}{\gamma}}
\]

(76)

which differs from the threshold in the benchmark case. In particular, \( \phi \) affects the threshold \( x^h \). An increase in market imperfection (expressed as a decline in \( \phi \)) raises \( x^h \), while an increase in the government’s income distribution policy, by raising \( \phi \), reduces \( x^h \).

5.2 Market distortion and income distribution policy

In this setup, a change in the degree of market imperfection affects the threshold level of physical-human capital ratio for workers’ human capital accumulation \( x^h \), and hence it might affect which growth regime an economy will follow.
Consider an economy where initially $\phi$ is large enough to ensure
\[ x^h < x^k \]  
(77)
Then this economy is in the endogenous growth regime and the economy’s physical-human capital ratio converges to $x^*$ where
\[ x^h < x^* < x^k \]  
(78)
regardless of the initial condition and thus the balanced growth path is characterized by a sustained positive growth.

Now suppose that due to some factors such as technology or globalization shock, the bargaining power of firms in the labor market is raised by a large extent enough to induce the reversal of the two thresholds as
\[ x^k < x^h \]  
(79)
Such an increase in the bargaining power of the firms in the labor market shifts the economy from the endogenous growth regime to the Neoclassical growth regime. This suggests that shocks in market imperfection in the labor market may critically affect the growth path of an economy, whether an economy enjoys a sustained growth or remains with zero growth.

This also suggests that if an economy is in the Neoclassical growth region due to imperfections in the labor market, the government policy of fair competition in the labor market or income distribution policy (such as the raise of the minimum wage) may help the economy to move to the endogenous growth regime with sustained growth.

Suppose that an economy initially is in the Neoclassical growth region because parameters induce $x^k < x^h$, which leads to the steady state of zero growth with $x_t = x = x^k$. To shift the economy from the Neoclassical growth regime to the endogenous growth regime, the government might pursue some policies that raise $\phi$ and hence reduce $x^h$. Suppose that the government policy raises $\phi$ large enough to reduce $x^h$ that induce the reversal of the size of $x^h$ and $x^k$. This induces workers’ investment in human capital. The rise in human capital makes the physical-human capital ratio $x_t$ to go below $x^h$, which leads the entrepreneurs to invest in physical capital. With the simultaneous accumulation of human and physical capital, the marginal product of capital remain high, and the positive growth rate is sustained.

This also suggests that the relation between government income distribution policy and the growth rate is nonlinear. The government income
distribution policy may not always raise the growth rate. When the rise in $\phi$ is below a certain threshold level, the growth rate remains unchanged. We can calculate the threshold level of $\phi$ by equating $x^h$ and $x^k$. If we denote the threshold of $\phi$ by $\hat{\phi}$, the growth rate is given by

$$g = \begin{cases} 0 & \text{if } \phi \leq \hat{\phi} \\ \beta(1-\delta + ((1-t_k)\alpha^\alpha((1-t_h)(1-\alpha\phi\gamma)^1-\alpha\hat{\theta})^{\frac{1}{1-\alpha}})\phi^\alpha - 1 & \text{if } \phi > \hat{\phi} \end{cases}$$  \tag{80}$$

This suggests that the income distribution policy should be substantial enough if it is to induce a change from a zero growth to a positive growth.

6 Conclusion

In this paper, we develop a growth model which allows us to analyze the growth effect of policies that affect income distribution between capitalists and workers. The model is a heterogenous agent model with entrepreneurs and workers, who specialize in investment in physical capital and human capital, respectively. In the model, the decision on investment in physical capital is made by entrepreneurs, and that on human capital by workers. Because of the separation of the decisions on the two different types of capital, the rates of return on human capital and physical capital may deviate from each other.

We show that this heterogenous agent model can be reduced to either an endogenous growth model or Neoclassical growth model, depending on the parameters of technology and policy variables. In this sense, our model is a synthesis growth model that comprises both Neoclassical and endogenous growth models. Using the synthesis growth model, we can explain the change in the growth path from a sustained growth to zero growth as a regime change from the endogenous growth regime to the Neoclassical growth regime or from zero growth to a sustained growth as a reverse regime change. We then use the model to show how tax or non-tax policies that affect the labor income share induces a change in the growth regime and the growth rate.
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본 논문은 자본-노동 간의 소득분배에 영향을 미치는 정부의 소득분배정책이 경제성장에 미치는 영향을 분석한다. 이를 위해 자족을 통해 기계와 같은 물적자본을 축적하는 자본가와 교육을 통해 인적자본을 축적하는 근로자의 최적 투자가 상호 영향을 주고받으며 경제의 장기성장 경로를 결정하는 경제성장모형을 개발·제시한다. 이 모형하에서는 자본가나 근로자가 동시에 각각 물적자본과 인적자본에 투자해야 지속적인 경제성장을 이룰 수 있다. 그러나 두 가지 유형의 경제주체 중 한쪽만 투자해서는 한계 생산성감으로 인하여 결국 경제성장이 멈춰버리게 된다. 그리고 두 경제주체가 동시에 투자되도록 하기 위해서는 물적자본과 인적자본 각각에 대한 투자수익이 모두 일정 수준 이상이 되어야 한다. 결국 본 논문의 모형하에서는, 물적자본과 인적자본 각각에 대한 투자수익의 크기에 따라 신고전과 성장모형에서처럼 물적 및 인적 자본 축적이 모두 일어나야 하고, 장기적으로 경제성장이 일어나지 않은 경우도 존재하며, 또한 내생적 성장모형에서처럼 물적자본과 인적자본의 동시 축적을 통해 지속적 경제성장이 일어나는 경우도 존재한다. 이런 점에서 본 논문이 제시하는 모형은 신고전과 성장모형과 내생적 성장모형을 모두 포괄하는 종합모형(synthesis growth model)이라고 볼 수 있다.

이러한 성장모형에서, 임금과 자본수익의 상대적 비율에 영향을 미치는 정부의 경제정책에 따라 물적 및 인적 자본의 축적이 멈춰버리는 경향이 0이 될 수도 있고, 지속적인 양(陽)의 성장을 가져올 수도 있다. 자본-노동 소득분배에 영향을 미칠 수 있는 중요한 정책은 근로소득세율과 법인소득세율을 조정하는 조세정책뿐만 아니라, 시장의 독점제한 정책을 포함한다. 지속적으로 빠르게 성장하고 있던 경제에 생산물시장의 독점으로 노동시장에서 수요독점적 지위가 강화된 기업들이 등장하게 되면, 이들은 임금을 노동의 생산성 이하로 떨어뜨릴 수 있다. 그 결과 임금이 사회 전체적으로 낮아지게 되면, 인적자본에 대한 투자수익률이 낮아지므로 인적자본에 대한 투자가 거의 멈출 수 있다. 인적자본이 증가하지 않으면 자족을 통한 물적자본 투자 수익률도 낮아져 물적자본 투자도 제대로 이루어지지 않게 된다. 결국 물적 및 인적 자본 모두 축적되지 않아 경제가 성장을 멈출 수 있다. 이 경우 독점제한정책 등을 통해
근로자들의 임금을 근로자들의 생산성 수준으로 다시 증가시키는 정책은 인적자본 축적에 대한 수익률을 높여줌으로써 교육을 통한 인적자본 투자를 다시 불러일으키고, 그 결과 저축을 통한 물적자본 축적에 대한 투자수익률 역시 높여줌으로써 경제를 지속적 성장경로로 다시 회복시켜줄 수 있다.

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This paper develops a growth model which can explain the change in the balanced growth path from a sustained growth to a zero growth path as a regime shift from endogenous growth to Neoclassical growth regime, and that from zero to sustained growth path as a regime shift in the opposite direction. Based on the growth model, we show that government policies that affect labor income share (e.g., changes in income tax rates and regulations on monopoly or monopsony) may induce such a shift in growth regime and subsequent change in the long-run growth rate. For example, the government’s raising wage rates in monopsonistic labor markets may trigger human capital accumulation, which induces a shift to the path of sustained growth.