Share-Based Schemes, Efficiency Wages and Economic Growth

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This study establishes an endogenous growth model characterized by a revenue sharing scheme and two variable factor utilizations, namely, labor productivity and the capital utilization rate. The results indicate that if revenue sharing acts as an efficiency wage, performance pay seeking can be a driving force behind labor productivity and in turn economic growth without any factor externalities. However, a more intensive sharing scheme may not necessarily increase employment, capital utilization, or economic growth. The current analysis also shows that capital utilization and economic growth always exhibit a positive relationship with each other, whereas employment may be either pro-cyclical or countercyclical in relation to capital utilization and balanced growth rates, which crucially depend on different shocks.

Keywords: Revenue sharing, efficiency wages, capital utilization, economic growth
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1 Introduction

Since the mid-1980s, the so-called New Growth Theory has offered a new alternative approach. Economists have believed that perpetual growth is generated by endogenous technological progress, which is achieved by learning

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by doing and knowledge spillovers (Lucas, 1988; Romer, 1986), R&D expenditures (Aghion and Howitt, 1992; Romer, 1990), and human capital considerations (Mankiw et al., 1992).[1] In departing from these previous studies, this paper shows that a share-based scheme causes workers to engage in performance pay seeking and, as a result, become a driving force behind economic growth. In practice, labor is an important productive input in the modern capitalist economy. Mankiw (2000) noted that output elasticity with respect to labor has been very high — approximately 0.7 in the United States between 1960 and 1996. Using U.S. time-series data from 1960 to 1990, Jones (1998) adopted Solow (1957) "growth accounting equation" and showed that the GDP growth rate was equal to 3.1% per year, of which the labor growth rate accounted for 1.2% per year. The contribution of labor to economic growth depends on both the quantity of labor (employment) and the quality of labor (productivity of workers). According to wage contract theory, both are crucially related to the compensation scheme designed by firms. Despite its importance, the literature on endogenous growth still restricts its focus to a simple labor contract with a fixed wage; the role of alternative compensation schemes has been largely overlooked. Because of this neglect, we in effect have not been able to provide a good assessment of the role of labor in the explanation of growth. To address this question seriously, this paper provides a new attempt at investigating how a share-based scheme gives rise to an incentive-inducing work effort that in turn affects economic growth.[2]

The proposed model comprises some novel characteristics: the incentive of efficiency wages, a revenue sharing scheme, and two variable factor utilizations — labor productivity and capital utilization. These novel characteristics allow exploration of the following interesting issues. First, the efficiency wage argument indicates that employee productivity increases as the real wage they receive increases, and the firm can exert its market power in the wage-setting process. Under a revenue-sharing scheme, workers are

[1] In a different way from them, Corneo and Jeanne (2001) developed a growth model in which individuals care about their social status, which in turn is determined by their relative wealth. They indicated that the human desire for social status may also be an engine of growth.

[2] In a series of articles, Weitzman (1983, 1984, 1985) advocated the replacement of traditional fixed-wage payment schemes with profit (revenue)-sharing ones to stimulate work effort and increase employment.

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willing to exert more effort to receive more revenue-linked earnings. Such an activity of performance pay seeking not only stimulates the growth of labor productivity, but also becomes a driving force behind the growth of output without any factor externalities.

Second, RBC models (e.g., Greenwood et al. (1988); Burnside and Eichenbaum (1996); DeJong et al. (1996); Nakajima (2005)) indicate that a variable utilization rate of capital is important for understanding business cycles. Aznar-Márquez and Ruiz-Tamarit (2004) and Chatterjee (2005) recently explored the relationship between capital utilization and economic growth. Moving beyond these studies, this work incorporates not only capital utilization, but also labor utilization, into the growth model and uses it to investigate (i) how the economy allocates its resources between employment, capital, and, more importantly, their utilization rates; and (ii) how economic growth, employment, and capital utilization respond to various shocks. The activity of performance pay seeking can be a driving force behind labor productivity and economic growth, but a more intensive sharing scheme may not necessarily raise employment, capital utilization, or economic growth. This study shows that an income tax gives rise to a harmful effect on capital utilization and balanced-growth rates, whereas it does not unambiguously harm employment. This result contradicts the conventional employment effect of taxes, which commonly appears in the literature, such as Turnovsky (2000).

Third, and finally, this paper investigates the long-term relationship among the balanced-growth rate, employment, and capital utilization, and shows that capital utilization and economic growth always exhibit a positive relationship, whereas employment may be pro-cyclical or countercyclical in relation to the capital utilization and balanced-growth rates, which crucially depend on different shocks. In response to technological innovations, employment, capital utilization and the balanced-growth rate are all pro-cyclical. However, in response to changes in income taxes and wage incentive effectiveness, employment may be either pro-cyclical or countercyclical in relation to capital utilization and economic growth. The balanced-growth rate also appears to be positively related to the depreciation rate. Although this result contradicts the previous theoretical results in common endogenous growth models, it accords with observed facts concerning growth and depreciation.

The remainder of this paper is organized as follows: Section 2 details the analytic framework; Section 3 shows that a revenue-sharing scheme can serve

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as an engine of economic growth; Section 4 presents the relevant comparative statics results and describes the long-term relationship among employment, capital utilization, and the balanced-growth rate; and finally, Section 5 offers a summary of the main findings.

2 Analytic Framework

The economy consists of firms, households, and a government sector. Firms produce goods by providing capital and labor services. There are two variables utilized for capital and labor. Specifically, "effective" capital is defined as μk, where μ represents the capital utilization rate and k is the existing physical stock of capital. The "effective" labor force depends not only on the quantity of labor, i.e., working hours l, but also on the quality of labor, measured by a productivity index E.[3] To increase labor utilization, firms provide an incentive to their employees for inducing labor productivity E. Firms provide performance-related pay to induce higher labor productivity. Households derive utility from consumption, but incur disutility from providing labor productivity. Finally, the government levies an income tax on households and rebates the tax revenue collected to households as a lump-sum transfer to balance its budget.

2.1 Firms

The representative firm produces output y according to the Cobb-Douglas technology by the services provided by an effective capital stock and effective labor force as follows:

$$y = Z(\mu k)^{1-\alpha} E^{\varphi} l^{\nu}; \quad 0 < \alpha, \nu, \varphi < 1, \tag{1}$$

where Z is a technology parameter, μ is the rate of utilization, an intensity at which the available stock of capital is utilized, and $1 - \alpha$ measures the weight attached to capital services. In line with Taubman and Wilkinson (1970) and Calvo (1975), this study assumes that firms can choose the accumulation rate of new capital, or the intensity of use or speed of operation of existing capital. The term $E^{\varphi} l^{\nu}$ captures the generalized labor force, where ν and φ measure the importance of quantity l and quality E of the labor

[3] In this paper, "working hours" and "employment" are interchangeable.

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force, respectively. A particular emphasis is that, while the production function (1) exhibits decreasing returns to scale in capital, as we will see later, in the presence of a share-based scheme the economy generates perpetual growth through labor productivity if workers pursue performance-related pay.

Given that the price of the final good is normalized to unity, the before-tax compensation per worker is

$$w = w_m + s\frac{y}{l},$$

where w_m is a base component of the pay and s (with $0 \leq s < 1$) is the revenue-sharing offered by the firm, where sy/l is the revenue shared by the firm with its workers. This specification of revenue sharing is consistent with Weitzman (1983) observation that some form of revenue sharing by the firm is arguably the most practical scheme for linking wages to current performance in a modern capitalist economy. Many industrial gain-sharing plans augment wages by some fraction of the value of plant shipments per unit of labor; for example, in Japan and South Korea the bonus payment schemes are often related to firm revenue (Cin et al., 2003).[4]

Malcomson (1981) and Lindbeck and Snower (1989, pp. 62–63) claimed that the efficiency wage theory rests on a fundamental assumption: employee productivity increases as the real wage increases.[5] In line with this assumption, the level of work effort E in this model is positively related to the real (after-tax) share-based compensation the worker receives, and the firm can unilaterally determine the worker's share s to induce unobservable labor productivity. With this understanding, under a share-based system, the productivity function is given by[6]

$$E = E_0 \cdot \left[\frac{(1-\tau)sy}{l}\right]^{\phi}; \quad E_0 > 0 \text{ and } 0 < \phi < 1, \tag{2}$$

[4]As shown in Nordhaus (1986) and Michaelis (1997), profit and revenue sharing have a similar effect on economic performance. We then adopt a revenue-sharing scheme for analytical convenience.

[5]As surveyed by Akerlof and Yellen (1986) and Katz (1986), this is consistent with various versions of the efficiency wage argument, ranging from nutritional concerns to social norms.

[6]To shed light on the incentive effect of a share-based compensation scheme, we assume that the level of labor productivity depends on variable performance-related pay, rather than share-based wages.

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where τ is the rate of income tax, and the restriction $0 < \phi < 1$ is imposed to have a diminishing marginal effect in increasing the wage offer. Of importance, the term ϕ captures the effectiveness of efficiency wages: the higher ϕ is, the more effective the wage incentive is in inducing workers' productivity.

Because (2) is related to the firm's output y, by substituting (2) into (1), we can rewrite the production function as follows:

$$y = \left\{ Z(\mu k)^{1-\alpha} \left[E_0((1-\tau)s)^{\phi} \right]^{\varphi} l^{\nu-\phi\varphi} \right\}^{\frac{1}{1-\phi\varphi}}. \tag{1a}$$

Accordingly, the representative firm's profit π is

$$\pi = y - r\mu k - \left(w_m + s\frac{y}{l} \right) l. \tag{3}$$

Accordingly, subject to the production function (1a), the typical firm's optimization problem is to choose the capital k, labor l, and revenue share coefficient s to maximize its profit π; that is,

$$\max_{k,l,s} \pi = (1-s) \left\{ Z(\mu k)^{1-\alpha} \left[E_0((1-\tau)s)^{\phi} \right]^{\varphi} l^{\nu-\phi\varphi} \right\}^{\frac{1}{1-\phi\varphi}} - r\mu k - w_m l. \tag{4}$$

The corresponding first-order conditions are given by

$$r = (1-s) \cdot \frac{1-\alpha}{1-\phi\varphi} \cdot \frac{y}{\mu k}, \tag{5}$$

$$w_m = (1-s) \cdot \frac{\nu-\phi\varphi}{1-\phi\varphi} \cdot \frac{y}{l}, \tag{6}$$

$$s = \phi\varphi. \tag{7}$$

By combining (6) and (7), a simple manipulation yields the firm's demand for labor:[7]

$$l = \frac{(\nu-\phi\varphi)}{w_m} \cdot y. \tag{8}$$

2.2 Households

The economy is populated by a continuum of identical and infinitely lived households (of mass one). Each household has a simple instantaneous utility

[7] With (8), in the model we should assume $((1-\tau)\phi\varphi w_m/\nu - \phi\varphi) > 1$ to guarantee that labor productivity increases with revenue-related pay.

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function with respect to consumption c and suffers disutility from providing labor productivity. Thus, the objective of the representative household is to maximize the discounted sum of future instantaneous utilities:

$$\max \int_0^\infty \left\{ \frac{1}{1-\varepsilon} [c(1-l)]^{1-\varepsilon} - \xi E \right\} e^{-\rho t} dt, \tag{9}$$

where ρ denotes the subjective time preference rate. The representative household is bound by a flow budget constraint linking gross capital accumulation (inclusive of capital depreciation) to any difference between its after-tax incomes (including wage income, capital income, and lump-sum transfers T) and consumption expenditure. Accordingly, the household budget constraint can be described as

$$\dot{k} = (1-\tau)(wl + r\mu k + \pi) + T - c - \delta k. \tag{10}$$

For simplicity, we assume that labor and capital incomes are subject to the same income tax rate τ.[8]

Households are allowed to underuse the installed capital and, consequently, to vary the depreciation rate. As in Greenwood et al. (1988), we suppose that using capital more intensively increases the rate at which capital depreciates. Specifically, we assume that the depreciation rate of capital δ is an increasing function of the rate of capital utilization μ and takes the following form:

$$\delta = \beta \mu^\theta; \quad 0 < \beta < 1 \text{ and } \theta > 1. \tag{11}$$

The parameter θ measures the elasticity of depreciation related to capital utilization, that is, $(\partial\delta/\partial\mu \cdot (\mu/\delta)) = \theta$. The restriction $\theta > 1$ implies that the capital depreciation function (11) is convex and yields an interior solution in the steady state. Shapiro (1993, 1996) particularly stresses increasing costs for adjusting the utilization margin and argues that once variation in the capital workweek is considered, little cyclical movement in productivity remains to either provide evidence of increasing returns to scale or to drive real business cycle models. If $\theta \leq 1$, the optimal rate of capital utilization is always one. Because θ captures depreciation sensitivity to utilization, we further assume that $(\partial(\partial\delta/\partial\mu)/\partial\theta) < 0$, implying that the marginal cost of capital utilization is decreasing in θ.

[8]Relaxing this assumption does not alter our main results.

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With the household budget constraint (10) and the capital depreciation function (11), the corresponding optimal conditions necessary for this optimization problem, as expressed by (9), are as follows:

$$[c(1-l)]^{-\varepsilon}(1-l) = \lambda, \tag{12a}$$

$$\lambda\left[(1-\tau)r\mu - \beta\mu^{\theta}\right] = -\dot{\lambda} + \lambda\rho, \tag{12b}$$

$$[c(1-l)]^{-\varepsilon}(-c) = -\lambda(1-\tau)w, \tag{12c}$$

$$(1-\tau)r = \beta\theta\mu^{\theta-1}, \tag{12d}$$

together with the budget constraint (10) and the transversality condition $\lim_{t\to\infty} \lambda k e^{-\rho t} = 0$. The term λ is the co-state variable, which can be interpreted as the shadow value of the capital stock, measured in utility terms. By taking the log derivative of (12a) and combining it with (12b) and (12d), we have the modified Keynes-Ramsey rule in the share economy with capital utilization:

$$\frac{\dot{c}}{c} = \frac{1}{\varepsilon}\left[(1-\tau)r\mu - \beta\mu^{\theta} - \rho\right]. \tag{13}$$

2.3 Government

The government is assumed to balance its budget at any instant in time and levies taxes on incomes at a flat rate τ (imposed on households). It then rebates the tax revenues to households as a transfer payment, T, in a lump-sum fashion. Thus, the government budget constraint can be expressed as

$$T = \tau(wl + r\mu k + \pi). \tag{14}$$

In line with King and Rebelo (1990), this work assumes that tax revenue is used to finance lump-sum transfer payments T to isolate taxation effects because lump-sum transfers do not influence the household's behavior at the margin.

Combining the government's budget constraint (14), the household's budget constraint (10), and the firm's profit function (3) yields the aggregate resource constraint of the economy:

$$\dot{k} = y - c - \delta k. \tag{15}$$

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3 Revenue Sharing and Balanced Growth Path Equilibrium

Documentation shows that with the characteristic of diminishing returns to capital, an economy eventually converges to a steady state with zero per capita growth. To generate perpetual growth, the so-called New Growth Theory broadens the concept of capital by endogenizing technological progress that allows an escape from diminishing returns at the aggregate level. The potential driving force for endogenous growth includes learning by doing and knowledge spillovers (Lucas, 1988; Romer, 1986), R&D expenditures (Aghion and Howitt, 1992; Romer, 1990), public goods services (Barro, 1990), human capital (Mankiw et al., 1992), and the variety of goods (Devereux et al., 1996). This paper shows that the efficiency wage argument with revenue sharing could also generate the AK form of the *aggregate* production function, and hence, perpetual growth.

By substituting the employee's share ratio (7) and labor demand function (8) into the production function (1a) and assuming $\alpha = \phi\varphi$, we can obtain the aggregate production function as follows:

$$y = \left\{ Z \left[E_0((1-\tau)\phi\varphi)^{\phi} \right]^{\varphi} l^{\nu-\phi\varphi} \right\}^{\frac{1}{1-\phi\varphi}} \mu k. \tag{16}$$

Equation (16) shows that the efficiency wage argument with revenue sharing could result in the AK form of the *aggregate* production function, which generates perpetual growth. The firm's wage policy (particularly the parameter accounting for the effectiveness of the wage incentive ϕ) affects the balanced-growth rate. This enables us to highlight the distinctive implication of efficiency wages for the endogenous growth rate.

A competitive equilibrium is defined as a tuple of allocation paths $\{c, k, l\}$, factor prices $\{r, s\}$, government policies $\{\tau, T\}$, and two-factor utilization rates $\{E, \mu\}$, such that (i) the representative household maximizes its lifetime utility (9), that is, the optimizing conditions (12a) – (12d) (hence (13)), and the transversality conditions hold; (ii) the representative firm maximizes its profits (3), that is, the optimizing conditions (5) – (7) hold; (iii) the flow government budget constraint (14) is met; and (iv) the goods market clears, that is, (15) is met.

This paper discusses the equilibrium characteristics of these variables. To obtain a substantial growth rate, we define $x \equiv c/k$ and let the superscript "$*$" be the steady-state value for the relevant variables throughout the paper.

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From (7), the steady-state sharing coefficient s^* can be expressed as

$$s^* = \phi\varphi. \tag{17}$$

Equation (17) vividly conveys the essence of efficiency wage theory whereby, if higher wages can effectuate a better incentive effect for inducing worker productivity ($\phi > 0$), the firm raises the workers' share s to increase revenue-linked pay.

By substituting (5), (6), (12a), and (16) into (12c) and (12d), respectively, it is easy to derive the following capital utilization μ and working hours l:

$$(1-l)(1-\tau)\nu = \frac{x}{\left\{Z\left[E_0((1-\tau)\phi\varphi)^{\phi}\right]^{\varphi} l^{\nu-\phi\varphi}\right\}^{\frac{1}{1-\phi\varphi}} \mu} l, \tag{18}$$

$$\mu^{\theta-1} = \frac{(1-\tau)(1-\phi\varphi)}{\beta\theta} \left\{Z\left[E_0((1-\tau)\phi\varphi)^{\phi}\right]^{\varphi} l^{\nu-\phi\varphi}\right\}^{\frac{1}{1-\phi\varphi}}. \tag{19}$$

We also rewrite the aggregate resource constraint and the Keynes-Ramsey rule as follows:

$$\frac{\dot{k}}{k} = \left\{Z\left[E_0((1-\tau)\phi\varphi)^{\phi}\right]^{\varphi} l^{\nu-\phi\varphi}\right\}^{\frac{1}{1-\phi\varphi}} \cdot \mu - \frac{c}{k} - \delta, \tag{20}$$

$$\frac{\dot{c}}{c} = \frac{1}{\varepsilon}\left\{(1-\tau)(1-\phi\varphi)\left\{Z\left[E_0((1-\tau)\phi\varphi)^{\phi}\right]^{\varphi} l^{\nu-\phi\varphi}\right\}^{\frac{1}{1-\phi\varphi}} \mu - \beta\mu^{\theta} - \rho\right\}. \tag{13}$$

The equilibrium features and relationships enable us to arrive at the following proposition:

Proposition 1. Revenue sharing serves as an engine of economic growth, generating the BGP equilibrium, when efficiency wages can induce labor productivity.

Proof. From (20) and the definition of a BGP, c and k must grow at the same rate on the BGP when physical capital grows at a constant rate in the BGP equilibrium and the equilibrium rate of capital utilization μ^* is constant. The aggregate production function $y = \{Z[E_0((1-\tau)\phi\varphi)^{\phi}]^{\varphi} l^{\nu-\phi\varphi}\}^{1/1-\phi\varphi}$. μk also indicates that y and k have the same growth rate on the BGP. Labor-market equilibrium is characterized by the equality between the firms' demand for and the households' supply of labor, which determines the based

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wage and working hours. Following from (6), (8), and (17), (i) based wages w_m^* grow at the same rate as output y^* and (ii) the employment rate l^* and the share rate s^* are constant in the BGP equilibrium. Finally, we learn from (2) that E^* and k^* should also grow at a common rate on the BGP. In summary, a non-degenerate balanced-growth-path (BGP) equilibrium is a tuple of paths $\{c, k, l, w_m, r, s, E, \mu\}_{t=0}^{\infty}$, such that the growth rates of consumption, capital, output, based wages, and labor productivity are all equal, i.e., $\gamma^* = (\dot{c}/c)^* = (\dot{k}/k)^* = (\dot{y}/y)^* = (\dot{w}_m/w_m)^* = (\dot{E}/E)^*$; the employment, share, interest, and capital utilization rates are constant in the BGP equilibrium. □

In the proposed model, employee productivity increases as the real wage increases. Revenue sharing that serves as efficiency wages implies that workers are willing to exert more effort and productivity to receive greater revenue-linked earnings. Such an activity of performance pay seeking becomes a driving force behind labor productivity and, in turn, economic growth. In a departure from the existing literature, we do not need any factor externalities to obtain a sustained growth rate.[9]

Using the definition of $x \equiv c/k$ as well as (20) and (13), we derive the following differential equation of x:

$$\frac{\dot{x}}{x} = \left[\frac{(1-\tau)(1-\phi\varphi)}{\varepsilon} - 1\right]\left\{Z\left[E_0((1-\tau)\phi\varphi)^{\phi}\right]^{\varphi} l^{\nu-\phi\varphi}\right\}^{\frac{1}{1-\phi\varphi}} \mu + \frac{(\varepsilon-1)\delta}{\varepsilon} - \frac{\rho}{\varepsilon} + x. \tag{21}$$

Equations (18), (19), and (21) constitute the dynamic system of our model. Once x, μ, and l are determined, the balanced-growth rate can also be obtained by (13).

4 Employment, Capital Utilization, and Economic Growth

This section investigates two interesting and important questions. This study first explores how employment, capital utilization, and the balanced-growth rate respond to changes in the incentive parameter of efficiency wages ϕ, the government's tax policy τ, and the technology shock Z. Second, we

[9]We are grateful to an anonymous referee for offering insightful comments and suggestions on the characteristics of the BGP equilibrium.

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examine whether the balanced-growth rate is pro-cyclical or countercyclical to employment and capital utilization.

Based on (18), (19), and (21) with $\dot{x} = 0$, we establish the following proposition:

Proposition 2. In an economy where revenue sharing acts as an efficiency wage,

(i) effectiveness of the wage incentive ϕ has an ambiguous effect on working hours l^*, the capital utilization rate μ^*, and the balanced-growth rate γ^*;
(ii) technology innovation Z has a positive effect on working hours, the capital utilization rate, and the balanced-growth rate;
(iii) the income tax rate τ has a negative effect on the capital utilization rate and balanced-growth rate, while it has an ambiguous effect on working hours.

Proof. See Appendix 1. □

Following on from (17), when higher wages give rise to a better incentive effect for inducing workers' productivity ($\phi > 0$), the firm raises revenue-linked pay for its workers by increasing the workers' share s. More intensive performance pay induces workers' productivity and working hours increase as well. By contrast, a higher sharing ratio implies that the firm shares more of its investment reward with its employees. As a result, a more intensive sharing system discourages firms from accumulating capital; as shown in (5), a higher s decreases the rate of return for capital r. Because labor and capital are technical complements under a Cobb-Douglas production function, working hours fall in response. Due to these two opposite effects, the employment effect of an increase in ϕ is ambiguous. Because of this ambiguity, the efficacy of the wage incentive also has an uncertain effect on capital utilization and economic growth. This result conforms to Meade (1986) prediction whereby a sharing system may increase the firm's user cost of capital, which discourages the firm's investment and harms economic growth. Accordingly, Proposition 2(i) offers an important implication for policy-makers because a more intensive sharing scheme does not necessarily effectuate a favorable economic effect.

The effects of technology innovations are straightforward. A positive economic innovation increases the marginal product of capital *MPK*. This

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raises the equilibrium capital utilization and increases the level of working hours. With these beneficial effects, a rise in the economy's technology also has a positive effect on the balanced-growth rate.

Proposition 2(iii) provides an interesting result: Income tax effectuates a harmful effect on the capital utilization and balanced-growth rates, whereas it does not unambiguously harm employment. This result contradicts the conventional employment effect of taxes, which commonly appear in the literature, such as Turnovsky (2000). A factor tax decreases the marginal product of capital *MPK*, which not only deteriorates capital utilization and capital accumulation (hence economic growth), but also lowers the level of working hours. Thus, why might income taxes have a positive effect on employment in a share economy? The proposed model has an additional effect on employment through two variable factor utilizations (labor productivity and capital utilization). As already mentioned, a rise in income tax decreases not only labor productivity, but also capital utilization, of which both lower the level of output. In the face of a lower income level, the income effect leads households to decrease their consumption and leisure. This creates a positive effect on employment. Because the additional channel intensifies the income effect of taxes, employment may increase, rather than decrease, with a higher rate of income tax.

It is also interesting to further investigate the steady-state relationship between employment, capital utilization, and economic growth in the presence of various shocks consisting of the technology shock Z, the income tax rate τ, and the effectiveness of revenue sharing ϕ. Using the results of Proposition 2 leads to the following corollary:

Corollary 1. Along the BGP equilibrium,

(i) in response to a technological innovation, employment, capital utilization, and the balanced-growth rate are all pro-cyclical;

(ii) in response to a tax shock, capital utilization and economic growth are pro-cyclical, whereas they may be countercyclical in relation to employment;

(iii) in response to a change in the effectiveness of the wage incentive, the balanced-growth rate has either a positive or negative relationship with capital utilization and employment.

The source of shocks obviously plays a crucial role in affecting the long-term relationship among employment, capital utilization, and economic

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growth. Corollary 1(i) confirms the prediction of Real Business Cycle models: in response to technology-driven shocks Z, employment, capital utilization, and economic growth, all exhibit a positive relationship.

More interestingly, if the source of the shock stems from the change in income tax, employment can be countercyclical in relation to capital utilization and economic growth in a share economy, because a higher income tax τ is associated with a lower capital utilization rate and economic growth rate, but may be associated with higher employment, as shown in Proposition 2. Finally, because a sharing scheme that is more intensive may have a negative discouraging effect on the firms' investment, in response to a change in the effectiveness of the wage incentive, the balanced-growth rate has either a positive or negative relationship with capital utilization and employment. Capital utilization and economic growth always exhibit a positive relationship. This is confirmed by combining (12d) with (13) to yield $\gamma^* = (1/\varepsilon)[(\theta - 1)\beta\mu^\theta - \rho]$.[10]

Before ending this section, this study emphasizes that in a standard endogenous growth model the capital depreciation rate is regarded as an exogenous constant that negatively affects the long-term growth rate. However, in using data from the World Bank, Gylfason and Zoega (2001) recently found that, in a sample of 85 countries for the 1965–1998 period, there is a positive correlation between depreciation and the growth of per capita income. In our model, a more intensive utilization of the existing capital stock would cause higher wear and tear and, consequently, increase depreciation costs. Therefore, Corollary 1 provides evidence that the balanced-growth rate may appear to be positively correlated with not only capital utilization, but also the depreciation rate. This result accords with observed facts concerning growth and depreciation, but contradicts previous theoretical results in common endogenous growth models.[11]

5 Concluding Remarks

This paper shows that revenue sharing leads workers to engage in performance pay seeking and, as a result, becomes a driving force behind labor productivity and hence economic growth without any factor externalities.

[10] This point was raised by an anonymous referee, to whom I am very grateful.

[11] By incorporating adjustment costs and a technology for capital maintenance, Aznar-Márquez and Ruiz-Tamarit (2004) derived similar results.

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Interesting results of comparative statics are derived from our analysis. First, a more effective sharing scheme may not necessarily increase employment, or the capital utilization and balanced-growth rates. Second, income tax has a negative effect on the capital utilization rate and balanced-growth rate, whereas it has an ambiguous effect on working hours (employment). This result provides an important policy implication because, by contradicting the effect of income tax, income taxes may have a beneficial effect on employment in a sharing scheme economy.

This paper also discovers the relationship between the balanced-growth rate, employment, and capital utilization. Capital utilization and economic growth always exhibit a positive relationship, whereas employment may be pro-cyclical or countercyclical in relation to capital utilization and balanced-growth rates, which crucially depend on different shocks. The balanced-growth rate appears to be positively related to the depreciation rate. Although this result contradicts previous theoretical results in common endogenous growth models, it is in accordance with observed facts concerning growth and depreciation.

Appendix 1. (Proof of Proposition 2)

Using (18), (19) and (21), we can solve l and μ jointly and obtain the following comparative statics:

$$l_Z^* = \frac{1}{\Delta}\cdot\frac{1}{(1-\phi\varphi)Z}\cdot\frac{1}{\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}}\cdot\frac{1}{x}\cdot\frac{\rho}{\varepsilon}\cdot\frac{\theta}{\theta-1} > 0,$$

$$l_\tau^* = \frac{1}{\Delta}\cdot\frac{1}{\left(\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right)}\cdot\left\{\frac{1}{(1-\phi\varphi)(1-\tau)}\cdot\frac{\theta}{\theta-1},\right.$$
$$-\frac{x-\frac{(1-\varepsilon)\delta+\rho}{\varepsilon}}{x(1-\phi\varphi)(1-\tau)}\left[\frac{1}{1-\theta}\left(\frac{(1-\varepsilon)\beta\theta\mu^\theta}{\varepsilon x-((1-\varepsilon)\delta+\rho)}+1\right)\right.$$
$$\left.\left.+\frac{(1-\tau)(1-\phi\varphi)-\phi\varphi\varepsilon}{\varepsilon-(1-\tau)(1-\phi\varphi)}\right]\right\}\gtreqless 0,$$

$$l_\phi^* = -\frac{\Omega_1}{\Omega_2}\gtreqless 0,$$

$$\mu_Z^* = \frac{1}{\Delta}\cdot\frac{\mu}{(1-\phi\varphi)(\theta-1)Z}\cdot\left\{1+\frac{\nu-\phi\varphi}{\left[\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right](1-\phi\varphi)l}\right\} > 0,$$

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$$\mu_\tau^* = \frac{1}{\Delta}\cdot\frac{\mu}{(1-\theta)(1-\phi\varphi)}\cdot\left\{\frac{1}{1-\tau}+\frac{x-\frac{(1-\varepsilon)\delta+\rho}{\varepsilon}}{\left(\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right)x}\cdot\right.$$
$$\frac{\nu-\phi\varphi}{(1-\tau)l}\cdot\frac{\varepsilon}{\varepsilon-(1-\tau)(1-\phi\varphi)}$$
$$\left.+\frac{\nu-\phi\varphi}{l}\cdot\frac{1}{\left[\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right](1-\phi\varphi)(1-\tau)}\right\}<0,$$

$$\mu_\phi^* = \frac{1}{\Delta}\cdot\frac{1}{\left(\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right)}\cdot\frac{\mu}{(\theta-1)(1-\phi\varphi)}\cdot\left\{-\frac{1}{x}\right.$$
$$\left[x-\frac{(1-\varepsilon)\delta+\rho}{\varepsilon}\right]\frac{\varphi\varepsilon}{(1-\phi\varphi)[\varepsilon-(1-\tau)(1-\phi\varphi)]}\cdot$$
$$\frac{\nu-\phi\varphi}{l}+\varphi\left[\ln\left(\frac{y}{\mu k}\right)+\ln(1-\tau)\phi\varphi-\ln l\right]\frac{1}{l(1-l)}$$
$$\left.+\frac{\varphi(\nu-\phi\varphi)}{(1-\phi\varphi)l}\right\}\gtreqless 0,$$

where $\Delta = 1+\frac{1}{\left(\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right)}\cdot\frac{\nu-\phi\varphi}{(1-\phi\varphi)(\theta-1)l}\left[\frac{1}{x}\cdot\frac{-\rho\theta}{\varepsilon}+(\theta-1)\right]$,

$$\Omega_1 = -\frac{\rho\theta\varphi}{\varepsilon(\theta-1)(1-\phi\varphi)}\left[\ln\left(\frac{y}{\mu k}\right)+\ln(1-\tau)\phi\varphi-\ln l\right]$$
$$+\left[x-\frac{(1-\varepsilon)\delta+\rho}{\varepsilon}\right]\cdot\frac{\varphi}{1-\phi\varphi}\cdot\frac{\varphi(1-\tau)}{[\varepsilon-(1-\tau)(1-\phi\varphi)]}$$
$$-\frac{(1-\varepsilon)\delta+\rho}{\varepsilon}\cdot\frac{\varphi}{1-\phi\varphi},$$

$$\Omega_2 = \left(\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right)x+\left[x-\frac{(1-\varepsilon)\delta+\rho}{\varepsilon}\right]\cdot\frac{1}{1-\phi\varphi}\cdot$$
$$\frac{\nu-\phi\varphi}{l}+\frac{\nu-\phi\varphi}{(1-\phi\varphi)(\theta-1)l}\cdot\frac{1}{\varepsilon}\cdot[\delta(1-\varepsilon)(\theta-1)-\rho].$$

In addition, based on (13), (16) – (19), and (21), we can easily derive

$$\frac{\partial\gamma^*}{\partial Z} = \frac{1}{\varepsilon}(1-\tau)\frac{y}{k}\cdot\frac{1}{Z\Delta}\cdot\frac{1}{l(1-l)\left(\frac{1}{1-l}+\frac{1-\nu}{1-\phi\varphi}\cdot\frac{1}{l}\right)}>0,$$

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$$\frac{\partial \gamma^*}{\partial \tau} = \frac{1}{\varepsilon} \cdot \frac{y}{k} \cdot \frac{1}{l\Delta\left(\frac{1}{1-l} + \frac{1-\nu}{1-\phi\varphi} \cdot \frac{1}{l}\right)} \left[-\frac{l}{1-l} - (1-\phi\varphi) \right.$$
$$\left. +(\nu - \phi\varphi)\left(1 - \frac{y}{c}\right) - \nu \right] < 0,$$
$$\frac{\partial \gamma^*}{\partial \phi} = \frac{1}{\varepsilon}(1-\tau)\mu \frac{r}{1-\phi\varphi} \left\{ \varphi \ln\left(\frac{y}{\mu k}\right) + \left[\varphi \ln((1-\tau)\phi\varphi) \right.\right.$$
$$\left.\left. -\varphi \ln l + (\nu - \phi\varphi)\frac{l_\phi^*}{l} \right] \right\} \gtreqless 0.$$

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分紅制度、效率工資與經濟成長

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本文建立一個考慮收益分紅工資制度, 與勞動生產力及資本使用的內生成長模型。在不具任何生產的外部性之下, 若將收益分紅視爲一效率工資, 此種制度將可提高勞動生產力, 並進一步成爲經濟成長的動力。然而, 越積極的分紅工資制度並不必然能增進就業、資本使用或經濟成長。本研究也顯示, 資本使用與經濟成長存在一正向關係, 而就業與資本使用及經濟成長則是基於不同的衝擊, 可能呈現順循環或反循環。

關鍵詞: 收益分紅, 效率工資, 資本使用, 經濟成長
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