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Asymmetric Information, Government Fiscal Policies, and Financial Development

Fu-Sheng Hung[1] **and Chien-Chiang Lee**[2]

Abstract

Previous studies assert that the optimal share of public spending is equal to the output elasticity of public spending and that relying on capital income taxation to finance public spending is either beneficial or harmful to capital accumulation and economic growth. The authors incorporate asymmetric information into an endogenous growth model and reexamine how the presence of asymmetric information in financial markets affects the consequences of the government's expenditure and financing policies. With this asymmetric information, the authors find an optimal tax rate for capital income and an optimal share of government spending that maximize economic growth. These two optimal levels are more reasonable in comparison with recent empirical works. The authors find that financial development, measured by a decrease in the information cost, is positively correlated with the optimal share of government spending and the optimal tax rate for capital income. Some preliminary evidence in support of these implications is also found.

Keywords

capital income taxation, government fiscal policies, asymmetric information, endogenous growth, financial development

Economic growth theory has paid considerable attention to the relationship between government fiscal policies and economic growth. On one hand, government spending for public services may enhance the productivity of private capital and hence economic growth. On the other hand, government taxation that is required to finance spending may distort private capital investment and hence impede economic growth. By focusing on government spending policy, Barro (1990) incorporates these two effects in an endogenous growth model with a constant-returns technology and finds an optimal share of public spending in terms of maximizing economic growth. Various other studies, however, focus on government financing policies and examine the effects of government policies related to factor taxation for financing an exogenously given level of government spending. Disparate results, however, are found in this line of research. For example, Chamley (1986), Sinn (1987), Lucas (1990),[1] and Feldstein (1995) find that a government's taxation of capital income, which lowers the rates of return on capital investment, is likely to depress savings and hence impede capital investment and economic growth. Thus, these studies hold the view that the capital income tax rate should be kept low in the long term or even be zero.[2] In contrast, Uhlig and Yanagawa (1996) find that, under some plausible conditions, the capital income tax is likely to be positively correlated with economic growth, indicating that the optimal tax rate for capital income is equal to 1.

Although studies by Barro (1990) and Uhlig and Yanagawa (1996) are quite insightful, their results may not be consistent with the real world. Specifically, we usually observe that the tax rate for capital income is less than 1.[3] As reviewed below, Barro's (1990) conclusion that the optimal share of government spending is equal to the output elasticity of public spending is also inconsistent with the real world. The fact that the conclusions of Uhlig and Yanagawa and those of Barro are not consistent with the real world may be because some key, real-world phenomena are missing in the studies by Uhlig and Yanagawa and Barro. It is also worth noting that studies focusing on the optimal share of government spending usually ignore the optimal government financing policy and vice versa. In reality, both types of policies may be related. Thus, the purpose of this article is to reexamine the conclusions of Uhlig and Yanagawa (1996) and Barro (1990) in a single framework that is incorporated with the real world as a key feature. By so doing, the model developed in this article provides a better description of reality in capital investment and hence may be able to bring the conclusions of Barro and Uhlig and Yanagawa closer to the real world.

The key feature of the real world that we emphasize in this article is the presence of asymmetric information. It has

[1]National Taipei University, Taiwa
[2]National Sun Yat-Sen University, Taiwan

Corresponding Author:
Chien-Chiang Lee, Department of Finance, National Sun Yat-Sen University, Kaohsiung, Taiwan,
Email: cclee@cm.nsysu.edu.tw.

long been recognized that asymmetric information in capital markets places considerable strain on capital investment (e.g., McKinnon, 1973). Recent studies, such as Bencivenga and Smith (1993), Azariadis and Smith (1996), and Bose and Cothren (1996, 1997), have further highlighted the important roles played by asymmetric information in determining an economy's growth. In particular, the presence of asymmetric information leads to the result that lenders and financial institutions must monitor or screen borrowers (e.g., Bose & Cothren, 1996; Diamond & Dybvig, 1983). Screening is costly and such a cost constitutes a spread between the deposit and lending rates. It is well-recognized that financial development eases the problem of asymmetric information and thereby reduces this spread. Thus, incorporating asymmetric information into a framework similar to Uhlig and Yanagawa's (1996) enables us not only to check the robustness of Uhlig and Yanagawa's (1996) and Barro's (1990) conclusions but also to shed light on the effects of financial development on the government policies of public spending, factor taxation, and economic growth.

Our main findings are as follows. First, we find that an increase in the tax rate for capital income exacerbates borrowers' incentives. In response to this, lenders must screen borrowers with a larger probability, which absorbs more resources and, to a greater extent, distorts capital investment. Therefore, in addition to Uhlig and Yanagawa's (1996) findings of two opposite effects, capital income taxation in our model gives rise to more distortion than that of Uhlig and Yanagawa, implying that the optimal tax rate in relation to capital income should be less than 1, a result that is in accord with the real world. Second, a higher screening cost that leads to a higher spread between the deposit and lending rates would give rise to a larger distortion, all things being equal. Because financial development can reduce this spread, we find that the optimal tax rate for capital income should be negatively correlated with financial development. Third, the presence of asymmetric information intensifies the negative effects of government spending on economic growth, leading to the result that the optimal share of government spending in the presence of asymmetric information is less than the output elasticity of public spending. Moreover, financial development that eases the problem of asymmetric information leads to an increase in the optimal share of government spending. Finally, we find some preliminary evidence that countries with more developed financial markets should have a higher share of government spending and a higher tax rate for capital income than countries with less-developed financial markets.

The remainder of this article is organized as follows: The next section surveys the related literature and outlines the model, followed by a section that presents the model. Next, we derive the equilibrium contracts in the presence of asymmetric information, followed by a section in which we calculate the equilibrium growth rate under a balanced growth path. The optimal tax rate for capital income and the optimal share of government spending are determined and some preliminary evidence that supports our model is presented in the penultimate section. The last section presents our conclusions.

Related Studies and Outlining the Model

Our model is given its impetus by the corresponding models of Uhlig and Yanagawa (1996) and Barro (1990). In a model with two-period-lived overlapping generations, Uhlig and Yanagawa (1996) argue that capital income taxation creates distributional effects across generations, which further give rise to two opposite effects on savings.[4] The distributional effects emerge in the overlapping generations model because capital income accrues to the older generation whereas labor income accrues to the younger generation. By relying on taxation from both capital and labor incomes to finance an exogenously given level of government spending, Uhlig and Yanagawa demonstrate that a change in the tax rate for capital income leads to two opposite effects on private savings from two different channels. First, an increase in the tax rate on capital income reduces the net returns on savings and lowers the savings of the older generation, and second, such an increase relaxes the tax burden on the younger generation and leaves them with more labor income out of which to save. As a whole, an increase in the tax rate on capital income may increase or decrease the amount of total private savings, depending on the magnitudes of these two opposite effects. However, Uhlig and Yanagawa find that the former effect dominates the latter one if the interest elasticity of savings is sufficiently low, which seems plausible in the light of past empirical findings. Because capital investment relies on savings, an increase in the tax rate on capital income that leads to an increase in total private savings will stimulate capital investment and, under a model in which capital investment gives rise to externalities (e.g., Romer, 1986), will lead to an increase in the rate of economic growth. Consequently, Uhlig and Yanagawa's analysis implies that the optimal tax rate for capital income is equal to 1. Obviously, this is not consistent with the real world.

Note that Uhlig and Yanagawa (1996) focus on the government's optimal financing policy in relation to factor taxation, as government spending in their model is exogenously given and is useless to the economy. Barro (1990) proposes a model in which government spending can enhance the productivity of private capital. The issue related to factor taxation, however, is ignored by Barro, as government spending is fully financed by output taxation only. Under this setting, government spending gives rise to two opposite effects on capital investment and economic growth. First, an increase in government spending raises the productivity of private capital, which induces private capital investment and economic growth. Second, such an increase requires that the government increase the tax rate in relation to output, which depresses private investment and economic growth. Barro finds an optimal government share of spending, which is equal to the complementary share of income for private capital. As the income share of private capital lies between 0.3 and 0.5, Barro's model implies that the optimal share of government spending is between 0.5 and 0.7, which is also not consistent with the real world.[5]

The purpose of this article is to reexamine the conclusions of Uhlig and Yanagawa (1996) and Barro (1990) in a framework that incorporates asymmetric information. Economists have long recognized that asymmetric information in financial markets places considerable strain on capital accumulation. Recent studies, such as Bencivenga and Smith (1993), Azariadis and Smith (1996), and Bose and Cothren (1996, 1997), further integrate asymmetric information into endogenous growth models and show that the presence of asymmetric information gives rise to credit rationing, which impedes capital accumulation and economic growth. As asymmetric information is important to capital investment and government financing policy is likely to affect the problem of asymmetric information, it is interesting to further examine whether or not the conclusions of Uhlig and Yanagawa and Barro will hold in the presence of asymmetric information.

Based on the framework of Bose and Cothren (1996, 1997), the existence of asymmetric information in financial markets gives rise to conflicts between lenders and capital borrowers. Specifically, a lender is endowed with a storage technology and cares only about old-age consumption. There are two types of capital borrowers: high-risk (with a lower probability of success) and low-risk (with a higher probability of success). Borrowers' types are private information. Under a competitive credit market where the loan rate is negatively related to the project's probability of success, a high-risk capital borrower may have an incentive to pretend to be a low-risk one to enjoy a lower loan rate. As in Bose and Cothren (1996), to ease this problem, the lender may establish a screening device to monitor borrowers who claim to be low-risk borrowers. Screening, of course, is costly.[6] We then add a government budget constraint that is combined from Uhlig and Yanagawa (1996) and Barro (1990) into this framework, and investigate how government fiscal policies affect asymmetric information and thereby capital accumulation.

Under the above framework, an increase in capital income taxation for a given government spending share will generate two opposite forces on economic growth. First, an increase in the capital income tax rate is associated with a decrease in the labor income tax rate under the assumption that the government maintains a balanced budget in each period. With a decrease in the labor income tax rate, lenders' after-tax wage income will increase, leading to an increase in the size of the funds available for loans, which in turn facilitates capital accumulation as well as economic growth. This effect resembles what Uhlig and Yanagawa (1996) have pointed out. Remember that lenders care only about old-age consumption; hence, all of the younger generation wage incomes are saved, implying that the interest elasticity of savings is zero. According to Uhlig and Yanagawa, an increase in the capital income tax rate will therefore lead to a higher growth rate under a zero-interest elasticity of savings. As a second effect, an increase in the tax rate for capital income reduces the rate of return on savings, which depresses capital investment and hence economic growth. Uhlig and Yanagawa show that the first effect dominates the second one under a zero-interest elasticity of savings, implying that the optimal tax rate for capital income is equal to 1. In our model, there is an additional effect that may change the conclusion of Uhlig and Yanagawa. Specifically, an increase in the capital income tax rate in the presence of asymmetric information will affect the rates of return to capital borrowers in an asymmetric way. That is, the expected payoff from high-risk borrowers decreases more than that from the lower-risk ones. This gives high-risk borrowers a greater incentive to pretend to be low-risk borrowers and hence exacerbates the problem of asymmetric information. In response to this, lenders must screen borrowers more often, which, in turn, impedes capital investment and economic growth.[7] As a result, the negative effect of capital income taxation on growth is relatively large in this article, as compared with that of Uhlig and Yanagawa. This implies that the optimal tax rate for capital income should be less than 1.

With respect to the government share of public spending, Barro (1990) proposes a model in which output tax-financed government spending has two opposite effects on economic growth. First, it enhances the productivity of private capital, which facilitates capital investment and economic growth. Second, output taxation causes distortions as it absorbs private resources. By balancing these two effects, Barro finds an optimal government share of public spending that is equal to the output elasticity of public spending. By adding a factor taxation policy into the government budget constraint of Barro, this replicates two opposite effects of government spending proposed by Barro for a given policy of factor taxation. However, the key finding of this article is that a well-defined tax rate for capital income (i.e., the tax rate is less than 1) intensifies the negative effects of government public spending on economic growth. As a result, the optimal share of public spending should be less than the output elasticity of public spending in this article. Moreover, financial development that leads to an increase in the tax rate for capital income will also lead to an increase in the optimal share of public spending.

Model

The model's environment is modified slightly from that of Bose and Cothren (1996) and Ho and Wang (2005). The economy consists of an infinite sequence of two-period-lived overlapping generations. Agents in each generation are identical in size and composition and are classified as lenders and borrowers. For simplicity, each population of lenders and borrowers is normalized to 1. Agents in each generation haveperfect foresight. Time is discrete and indexed by t $= 0, 1, 2, \ldots$

Each time t young borrower is endowed with a risky capital project, which can be used to convert time t output into time t + 1 capital. To implement the project, each borrower must seek external funds. Borrowers' investment projects are classified into two types: Type L and Type H. A fraction of borrowers' projects are of Type H and the remaining projects are of Type L. With probability p_i, i = H, L, an investment project of Type i can convert z units of time t output (consumption goods) into $Q \cdot z$ units of time t + 1 capital goods. With a probability of $(1 - p_i)$, the project fails and produces nothing. In this event, borrowers claim bankruptcy at the time of repayment. Assuming that $1 \geq p_L > p_H \geq 0$, Type L projects are low risk whereas Type H projects are high risk. For simplicity, we call the borrowers whose investment projects are of Type H (Type L) the high- (low-) risk borrowers. Borrowers' types are private information although all agents know the distribution.

Each young lender is endowed with a unit of labor, which is supplied to earn the real wage rate w_t. For simplicity, it is assumed that both borrowers and lenders are risk neutral and care only for their old-age consumption.[8] Each young lender can lend his or her after-tax real wage income to a borrower in exchange for consumption goods in the next period. Alternatively, a young lender has access to a home production technology that can convert one unit of time t output into $Q \cdot \varepsilon$, $\varepsilon > 0$, units of time t + 1 capital. Thus, to consume in one's old age, a young lender can simply save his or her young-age income by means of this home technology.

For simplicity, we assume that each borrower can operate a firm in his or her final period of life, implying that the number of firms is normalized to 1 in each period.[9] Each firm at time t produces the final output according to the Cobb–Douglas production function given as

$$y_t = G_t^{\eta} k_t^{\gamma} l_t^{1-\gamma}, \quad \gamma \in (0, 1) \tag{1}$$

where k_t and l_t are, respectively, the amount of private capital and labor employed by each firm, and G_t is the aggregate government provision of public capital. Both private capital and public capital depreciate fully after production. Following Barro (1990), it is assumed that $\eta = 1 - \gamma$. Note that $l_t = 1$ in each period as the number of firms and the amount of labor supplied (young lenders) are both equal to 1. Under competitive factor markets, the rental rates of labor and capital are given as

$$w_t = (1 - \gamma) G_t^{1-\gamma} k_t^{\gamma} l_t^{-\gamma} \tag{2}$$

and

$$\rho_t = \gamma G_t^{1-\gamma} k_t^{\gamma-1} l_t^{1-\gamma} \tag{3}$$

Because the borrowers' types are ex ante private information and high-risk borrowers have the incentive to disguise themselves as low-risk borrower types, the problem of adverse selection arises in financial markets. To ease this problem, we follow Bose and Cothren (1996, 1997) by assuming that the lenders can establish credit rating organizations to screen the borrowers' investment projects (see the following section for details). Screening, of course, entails costs. As is in Bose and Cothren (1996) and Ho and Wang (2005), each unit of loan quantity screened absorbs δ units of output, where δ, $1 > \delta > 0$, is exogenously given. The advantage of this setting is that the screening cost can be viewed as an indicator of financial development. Indeed, as is asserted by Pagano (1993), the financial system absorbs the resources during the process of transferring savings from lenders to borrowers. As financial development enhances the efficiency of the financial sector and thereby reduces this leakage of resources, a decrease in δ can be interpreted as financial development.

The amount of aggregate public capital provided by the ?government at t + 1 is proportional to time t output; that is, $G_{t+1} = \theta y_t$, where $\theta \in (0, 1)$ is the policy parameter that governs the evolution of public capital. The government finances its provision of public capital by levying a tax rate on output; thus, the government budget constraint can be expressed as

$$G_{t+1} \equiv \theta y_t = \tau_L w_t l_t + \tau_k \rho_t k_t \tag{4}$$

where τ_L and τ_k, respectively, represent the tax rate on labor income and capital income.

Substituting Equations 1 to 3 into Equation 4, the balanced government budget constraint becomes

$$\tau_L = \frac{\theta - \tau_k \gamma}{(1 - \gamma)} \tag{5}$$

Equation 5 indicates that an increase in the capital income tax rate is associated with a decrease in the labor income tax rate. We then have the following proposition.

Proposition 1: An increase in the tax rate on capital income for a given θ implies a decrease in the tax rate on labor income, provided that the government maintains a balanced budget for each period.

Equilibrium Separating Contracts

The operation of the loans market is similar to that of Bose and Cothren (1996). Specifically, at the beginning of each period, each lender announces a set of contracts to borrowers. If a lender's offer is not dominated by those of other lenders, then he or she is approached by a potential borrower. Following Bose and Cothren, each lender can be approached by one borrower only and the competition among lenders drives the lenders' profit to zero. The equilibrium contracts at t are defined such that there is no incentive for any lender to offer an alternative contract, taking the tax rates, the rate of return on capital, and other lenders' offers as given. In accord with Bose and Cothren, we focus on the separating equilibrium, namely, that the lender offers a set of contracts intended to separate borrowers according to their risk type.[10]

We can express the general form of the loan contracts offered by the lenders at time t as $C_t^i = \{[\phi_{it}, q_{it}^s, R_{it}^s]; [(1-\phi_{it}), q_{it}^n, R_{it}^n]\}$, i = H, L (the subscript H represents the contract intended for high-risk borrowers whereas subscript L represents the counterpart for low-risk borrowers), where $\phi_{it} \in [0,1]$ is the probability that a Type i borrower is screened, q_{it}^s is the loan size offered and R_{it}^s is the gross loan rate when the borrower is screened. With probability $1 - \phi_{it}$, borrowers are not screened, and in this case q_{it}^n is the loan size and R_{it}^n is the gross loan rate. As in Bose and Cothren (1996), a borrower's loan application under screening will be denied by the lender if he or she is caught lying about his or her type.

Because borrowers care only about their old-period consumption, the expected old-age consumption of a Type i borrower who reveals his or her true type to the lender and applies for C_t^i, i = H, L, is given by

$$\phi_{it} p_i [(1-\tau_k) Q \rho_{t+1} - R_{it}^s] q_{it}^s + (1-\phi_{it}) p_i [(1-\tau_k) Q \rho_{t+1} - R_{it}^n] q_{it}^n \quad (6)$$

The first part of Equation 6 is the amount of consumption when the Type i borrower is screened. Under this case, the borrower will obtain the amount q_{it}^s and can convert this amount of output into Qq_{it}^s units of capital (with probability p_i) in the next period. The after-tax rate of return on capital is $(1-\tau_k)\rho_{t+1}$. After deducting the repayment $R_{it}^s q_{it}^s$, the rest of the output is consumed by the entrepreneur in his or her old age. Similarly, the second part of Equation 6 represents the expected payoff when the borrower is not screened. Competition among lenders implies that the lender will offer contracts to maximize Equation 6 for i = H, L.

Before determining the equilibrium contracts, we should point out that both $(1-\tau_k) Q \rho_{t+1} - R_{it}^s$ and $(1-\tau_k) Q \rho_{t+1} - R_{it}^n$ must be positive in equilibrium; otherwise, there is no demand for loans.[11] Given that $(1-\tau_k) Q \rho_{t+1} - R_{it}^s$ and $(1-\tau_k) Q \rho_{t+1} - R_{it}^n$ are positive, each Type i borrower will intend to borrow as much as possible, regardless of whether he or she is screened or not. Because a borrower can only approach a lender, it is clear that

$$q_{it}^s = (1-\delta)(1-\tau_L) w_t,^{12}\ i = \mathrm{H}, \mathrm{L} \quad (7)$$

and

$$q_{it}^n = (1-\tau_L) w_t,\ i = \mathrm{H}, \mathrm{L} \quad (8)$$

Competition among lenders implies that each contract, C_t^{L} and C_t^{H}, must separately yield a zero-expected economic profit to a lender under the separating equilibrium. This condition can be expressed as[13]

$$\phi_{it} p_i R_{it}^s q_{it}^s + (1-\phi_{it}) p_i R_{it}^n q_{it}^n = \left[\phi_{it} \frac{q_{it}^s}{1-\delta} + (1-\phi_{it}) q_{it}^n\right] Q \varepsilon \rho_{t+1}, i = \mathrm{H}, \mathrm{L} \quad (9)$$

which can be further simplified as

$$(1-\delta)\phi_{it} p_i R_{it}^s + (1-\phi_{it}) p_i R_{it}^n = Q \varepsilon \rho_{t+1}, \text{for } i = \mathrm{L}, \mathrm{H} \quad (10)$$

after using Equations 7 and 8. Because $p_L > p_H$, Equation 10 indicates that

$$(1-\delta)\phi_{\mathrm{L}t} R_{\mathrm{L}t}^s + (1-\phi_{\mathrm{L}t}) R_{\mathrm{L}t}^n < (1-\delta)\phi_{\mathrm{H}t} R_{\mathrm{H}t}^s + (1-\phi_{\mathrm{H}t}) R_{\mathrm{H}t}^n \quad (11)$$

for any values of δ, ϕ_{Lt}, $R_{\mathrm{L}t}^s$, $R_{\mathrm{L}t}^n$, $\phi_{\mathrm{H}t}$, $R_{\mathrm{H}t}^s$, $R_{\mathrm{H}t}^n$. Equation 11 implies that the expected interest payment for any type of borrower is lower in applying for the C_t^{L} contract than for the C_t^{H} contract. This further implies that all borrowers, irrespective of their risk type, prefer applying for the C_t^{L} contract to the C_t^{H} contract. As a result, the C_t^{L} and C_t^{H} contracts under a separating equilibrium must satisfy an incentive-compatibility constraint that prevents Type H borrowers from applying for the C_t^{L} contract. To achieve this, the lender will offer a contract C_t^{H}, which is the first best contract attainable by a Type H borrower and a contract C_t^{L}, which is distorted in such a way that Type H borrowers will have no incentive to apply for the contract C_t^{L}.[14]

The best contract for Type H borrowers can be easily derived by recognizing the following result[15]:

Lemma 1: The expected payoff for a Type H borrower is strictly decreasing in the screening probability.

Because screening is costly, the best contract for Type H borrowers requires that $\phi_{\mathrm{H}t} = 0$. In other words, in the equilibrium a lender will not screen a borrower who applies for C_t^{H}. Given this, Equation 10 implies that

$$R_{\mathrm{H}t}^{n} = \frac{Q\varepsilon\rho_{t+1}}{p_{\mathrm{H}}} \tag{12}$$

Given that $\phi_{\mathrm{H}t} = 0$ in C_t^{H}, the contract C_t^{L} can be obtained by maximizing Equation 6 for i = L subject to

$$p_{\mathrm{H}}[(1-\tau_k)Q\rho_{t+1}-R_{\mathrm{H}t}^{n}]q_{\mathrm{H}t}^{n} \geq (1-\phi_{\mathrm{L}t})p_{\mathrm{H}}[(1-\tau_k)Q\rho_{t+1}-R_{\mathrm{L}t}^{n}]q_{\mathrm{L}t}^{n} \tag{13}$$

and Equations 7, 8, and 10 for i = L. The left-hand side (LHS) of Equation 13 is the expected payoff of a Type H borrower who reveals his or her true type and applies for the C_t^{H} contract, whereas the right-hand side (RHS) of Equation 13 is the expected payoff to a Type H borrower who pretends to be a Type L borrower and applies for the C_t^{L} contract. As a result, Equation 13 is the incentive constraint that prevents Type H borrowers from applying for C_t^{L}. By substituting Equations 7, 8, and 10 into the lenders' objective function (Equation 6), we have

$$[\phi_{\mathrm{L}t}(1-\delta)+(1-\phi_{\mathrm{L}t})]p_{\mathrm{L}}(1-\tau_k)Q\rho_{t+1}(1-\tau_{\mathrm{L}})w_t - Q\varepsilon\rho_{t+1}(1-\tau_{\mathrm{L}})w_t \tag{14}$$

Thus the contract C_t^{L} can be simply determined by maximizing Equation 14 subject to Equation 13. From Equation 14, the objective function is linear in $\phi_{\mathrm{L}t}$, implying a corner solution for $\phi_{\mathrm{L}t}$. Because $1 > \delta > 0$, the objective function implies that the optimal value of $\phi_{\mathrm{L}t}$ should be as small as possible (i.e., $1 - \phi_{\mathrm{L}t}$ should be as large as possible), making the incentive constraint in Equation 13 binding. With the binding of the incentive constraint in Equation 13, the optimal value of $\phi_{\mathrm{L}t}$ is given by

$$\phi_{\mathrm{L}t} = \frac{R_{\mathrm{H}t}^{n}-R_{\mathrm{L}t}^{n}}{(1-\tau_k)Q\rho_{t+1}-R_{\mathrm{L}t}^{n}} \tag{15}$$

Using Equations 7, 8, and 10 for i = L as well as Equation 15, we obtain the following result (Appendix A):

Lemma 2: The expected payoff for a Type L borrower in applying for C_t^{L} (i.e., Equation 6) is increasing in $R_{\mathrm{L}t}^{n}$.

Lemma 2 implies that $R_{\mathrm{L}t}^{n}$ in the optimal C_t^{L} contract should be set as high as possible. The intuition for this result is straightforward. A Type H borrower has an incentive to misrepresent himself by applying for C_t^{L} because screening may not take place in the contract C_t^{L}. Under such a no-screening event, the misrepresented Type H borrower is able to obtain the loan. Setting the interest rate in the event of no screening, $R_{\mathrm{L}t}^{n}$, as high as possible can make such an event most unattractive and thereby deter cheating behavior. From the lender's zero economic profit constraint, setting $R_{\mathrm{L}t}^{n}$ as high as possible is equivalent to setting $R_{\mathrm{L}t}^{s}$ as low as possible. Hence, $R_{\mathrm{L}t}^{s} = 0$ and from Equation 10,

$$R_{\mathrm{L}t}^{n} = \frac{Q\varepsilon\rho_{t+1}}{p_{\mathrm{L}}(1-\phi_{\mathrm{L}t})}. \tag{16}$$

Finally, by substituting $R_{\mathrm{L}t}^{s} = 0$ and Equation 16 into Equation 15, we obtain

$$\phi_{\mathrm{L}t} \equiv \phi = \frac{\varepsilon}{1-\tau_k}\left(\frac{1}{p_{\mathrm{H}}}-\frac{1}{p_{\mathrm{L}}}\right) = \frac{1}{1-\tau_k}x \tag{17}$$

where x is implicitly defined and its value is between 0 and 1. Note that the equilibrium probability of screening cannot be greater than 1. Equation 17 then implies that there is an upper bound on the tax rate for capital income (denoted as $\bar{\tau}_k$), which is equivalent to 1 − x.

The following proposition summarizes the equilibrium contracts (Appendixes B and C):

Proposition 2: Suppose that $0 < \tau_k \leq \bar{\tau}_k$ holds. The equilibrium contract of high-risk borrowers is characterized by $C_t^{\mathrm{H}} = \{q_{\mathrm{H}t}^{n} = (1-\tau_{\mathrm{L}})w_t, R_{\mathrm{H}t}^{n} = Q\varepsilon\rho_{t+1}/p_{\mathrm{H}}\}$. The equilibrium contract of low-risk borrowers for $0 < \tau_k \leq \bar{\tau}_k$ is characterized by $C_t^{\mathrm{L}} = \{[\phi, R_{\mathrm{L}t}^{s}, q_{\mathrm{L}t}^{s}], [(1-\phi), R_{\mathrm{L}t}^{n}, q_{\mathrm{L}t}^{n}]\}$ with $\phi = \varepsilon(1/p_{\mathrm{H}} - 1/p_{\mathrm{L}})/(1-\tau_k)$, $R_{\mathrm{L}t}^{s} = 0$, $q_{\mathrm{L}t}^{s} = (1-\delta)(1-\tau_{\mathrm{L}})w_t$, $R_{\mathrm{L}t}^{n} = Q\varepsilon\rho_{t+1}/p_{\mathrm{L}}(1-\phi)$, and $q_{\mathrm{L}t}^{n} = (1-\tau_{\mathrm{L}})w_t$.

Proposition 2 leads to the following result.

Corollary 1: The probability of screening the contract C_t^{L} for $0 < \tau_k \leq \bar{\tau}_{\mathrm{k}}$ is increasing in the tax rate for capital income but is independent of the tax rate for labor income.

From Equation 17, it is easy to verify that $\partial\phi/\partial\tau_k > 0$ and $\partial\phi/\partial\tau_{\mathrm{L}} = 0$, which forms Corollary 1. The intuition underlying Corollary 1 is quite simple. Using Proposition 2, it is easy to see that an increase in the capital income tax rate results in a Type H borrower's payoff in applying for the contract C_t^{H} decreasing more than that arising from applying for the C_t^{L}. This gives a Type H borrower more of an incentive to misrepresent himself by applying for C_t^{L}. To deter such behavior, the lender must screen more often, leading to an increase in the probability of screening. Because screening is costly, an increase in the screening probability absorbs more resources and thereby creates additional distortions to private capital investment. Similarly, an increase in the tax rate on labor income τ_L that decreases q^n_{Ht} and q^n_{Lt} also reduces the expected payoffs of a Type H borrower in applying for C^H_t and C^L_t. Nevertheless, because $q^n_{Ht} = q^n_{Lt}$ in equilibrium, an increase in the labor income tax rate does not give rise to an asymmetric effect for a Type H borrower in applying for the C^H_t and C^L_t contracts. Hence, such an increase plays no role in affecting the incentive of Type H borrowers. As will be seen below, this gives the government a reason to collect more labor income tax and less capital income tax.

Optimal Tax Rate for Capital Income and Optimal Government Share Under the Balanced Growth Path

As the terms of the equilibrium loan contracts are obtained, we can investigate the optimal structure of factor taxation and the government provision of public capital in terms of maximizing economic growth under the balanced growth path. Recall that the number of firms and the per-firm labor employment l_t in each period are equal to 1, respectively. By denoting k_{t+1} as the per-firm capital stock at t + 1 (which is also equal to the economy-wide capital stock), we then have

$$\begin{aligned} k_{t+1} &= Q(1-\tau_L)w_t\{\lambda p_H + (1-\lambda)[(1-\phi)p_L + (1-\delta)\phi p_L]\} \\ &= Q(1-\tau_L)w_t[\lambda p_H + (1-\lambda)(1-\delta\phi)p_L] \\ &= Q(1-\tau_L)[\lambda p_H + (1-\lambda)(1-\delta\phi)p_L](1-\gamma)y_t \end{aligned} \quad (18)$$

where the last equality is obtained from the fact that $l_t w_t = w_t = (1-\gamma)y_t$. By comparing Equation 18 with $G_{t+1} = \theta y_t$, it can be seen that both the per-firm private capital k_{t+1} and aggregate public capital G_{t+1} must grow at the same rate along a balanced growth path. In equilibrium, the relative ratio of public to private capital used in production is given by

$$\frac{G_{t+1}}{k_{t+1}} = \frac{\theta}{Q(1-\tau_L)[\lambda p_H + (1-\lambda)(1-\delta\phi)p_L](1-\gamma)}$$

which is constant over time.

By combining Equations 1 and 18 with $G_{t+1} = \theta y_t$, we can see that the output per firm at t + 1 is given by

$$\begin{aligned} y_{t+1} &= (\theta y_t)^{1-\gamma}\{Q(1-\tau_L)[\lambda p_H + (1-\lambda)(1-\delta\phi)p_L] \\ &\quad (1-\gamma)y_t\}^{\gamma} = \theta^{1-\gamma}\{Q[\lambda p_H + (1-\lambda)(1-\delta\phi)p_L] \\ &\quad (1-\gamma)\}^{\gamma}(1-\tau_L)^{\gamma}y_t \end{aligned} \quad (19)$$

As with Barro's (1990) findings, the economy reaches its balanced-growth path right away, provided that θ, τ_k, and τ_L are time invariant. From Equation 19, the economy's balanced growth rate (denoted as g) is equal to

$$\begin{aligned} g &= \frac{y_{t+1}}{y_t} = \theta^{1-\gamma}(1-\tau_L)^{\gamma}\{Q[\lambda p_H + (1-\lambda)(1-\delta\phi)p_L] \\ &\quad (1-\gamma)\}^{\gamma} = \theta^{1-\gamma}[1-\theta-\gamma(1-\tau_k)]^{\gamma} \\ &\quad [\lambda p_H + (1-\lambda)(1-\delta\phi)p_L]^{\gamma}Q^{\gamma} \end{aligned} \quad (20)$$

where the last equality is obtained by using the government balanced budget constraint in Equation 5. The government chooses an optimal θ and τ_k to maximize economic growth. To see the existence of an optimal θ, note that an increase in θ for a given τ_k has two opposite effects on economic growth. First, it increases the government provision of public capital, which raises the productivity of private capital (i.e., θ^{γ} in Equation 20) and hence leads to a positive effect on economic growth. Second, such an increase implies that the government must absorb more private resources, which depresses private capital investment and hence economic growth. This corresponds to $[1-\theta-\gamma(1-\tau_k)]^{\gamma}$ in Equation 20. The optimal θ is obtained by balancing these two opposite effects, a result that has been highlighted by Barro. By considering factor taxation, the difference between this article and that of Barro is that the tax rate for capital income τ_k appears in the negative effect of an increase in θ on economic growth. Note that if τ_k is equal to 1, then the negative effect of an increase in θ on economic growth is represented by $(1-\theta)^{\gamma}$, which is identical to Barro (1990). For a value of τ_k that is less than 1, an increase in τ_k intensifies the negative effect of an increase in θ on economic growth.[16]

Similarly, an increase in τ_k for a given θ leads to two opposite effects on economic growth. On the one hand, an increase in τ_k for a given θ leads to a decrease in τ_L. As the interest elasticity of savings is equal to zero in this model, a decrease in τ_L leads to an increase in the savings, which is beneficial to capital investment and economic growth. This positive effect is proposed by Uhlig and Yanagawa (1996). Nevertheless, an increase in τ_k also leads to a negative effect on capital investment as well as economic growth. This is so because an increase in τ_k exacerbates the problem of asymmetric information and hence leads to an increase in the equilibrium screening probability. As screening is costly, an increase in τ_k leads to an increase in the total resources absorbed by the screening activity, which impedes capital investment and economic growth. It is clear that the optimal tax rate for capital income would be equal to 1 (as concluded by Uhlig & Yanagawa, 1996) if this latter effect were not to show up. This highlights the major difference between this article and that of Uhlig and Yanagawa.

To derive the optimal levels of θ and τ_k, we first take logs on both sides of Equation 20. Then, the first-order conditions for selecting the optimal values of θ (denoted as θ^*)

and τ_k (denoted as τ_k^*) are given as

$$\frac{1-\gamma}{\theta^*} = \frac{\gamma}{1-\theta^*-\gamma(1-\tau_k^*)} \quad (21)$$

and

$$\frac{\gamma}{1-\theta^*-\gamma(1-\tau_k^*)} = \frac{\gamma\delta\frac{\partial\phi}{\partial\tau_k}}{\lambda p_H+(1-\lambda)(1-\delta\phi)p_L} \quad (22)$$

Equation 21 implies that θ^* is given as

$$\theta^* = (1-\gamma)-\gamma(1-\gamma)(1-\tau_k^*) \quad (23)$$

Note that from Equation 17

$$\frac{\partial\phi}{\partial\tau_k} = \varepsilon\left(\frac{1}{p_H}-\frac{1}{p_L}\right)\frac{1}{(1-\tau_k)^2} = x\frac{1}{(1-\tau_k)^2} > 0$$

Making use of this and Equation 23, Equation 22 can be rewritten as

$$\frac{\lambda p_H+(1-\lambda)(1-\delta\phi)p_L}{\delta} = \varepsilon x\frac{\gamma-\gamma^2(1-\tau_k^*)}{(1-\tau_k^*)^2} \quad (24)$$

We state the existence of a positive τ_k^* in the following proposition:

Proposition 3: Define

$$\delta_1 \equiv \frac{\lambda p_H+(1-\lambda)p_L}{\varepsilon x[\gamma(1-\gamma)+(1-\lambda)p_L]}$$

and

$$\delta_2 \equiv \frac{\lambda p_H+(1-\lambda)p_L}{\gamma[(1/\varepsilon x)-\gamma]+(1-\lambda)p_L}$$

Then, (*i*) if $\delta_2 \le \delta \le \delta_1$, then there exists a unique τ_k^*, $\tau_k^* \in [0, \bar{\tau}_k]$, that maximizes the growth rate.

The result of this proposition is easy to grasp by examining the LHS and RHS of Equation 24. Because $\partial\phi/\partial\tau_k > 0$, it is clear that the LHS of Equation 24 is decreasing in τ_k. On the other hand, the RHS of Equation 24 is increasing in τ_k. We depict the loci of the RHS and LHS of Equation 24 in Figure 1. Note also that an increase in δ shifts down the locus of the LHS of Equation 24; however, the locus of the RHS is independent of δ. Define a δ_1 such that if $\delta = \delta_1$, then the locus of the LHS (labeled as LHS_1 in Figure 1) intersects the locus of the RHS at $\tau_k = 0$. Similarly, define a δ_2 such that if $\delta = \delta_2$, then the locus of the LHS (labeled as LHS_2 in Figure 1) intersects the locus of the RHS at $\tau_k = \bar{\tau}_k$. It is clear that $\delta_1 > \delta_2$, as an increase in δ shifts down the locus of the LHS. Obviously, both the loci of the LHS and RHS of Equation 24 will not intersect each other at $\tau_k \in [0, \bar{\tau}_k]$ if $\delta > \delta_1$ and $\delta < \delta_2$. For $\delta_2 < \delta < \delta_1$, both loci must intersect each other at a unique tax rate for capital income that is between 0 and $\bar{\tau}_k$. Thus, there must be a unique τ_k^*, $\tau_k^* \in [0, \bar{\tau}_k]$ that maximizes the growth rate when $\delta_2 \le \delta \le \delta_1$.

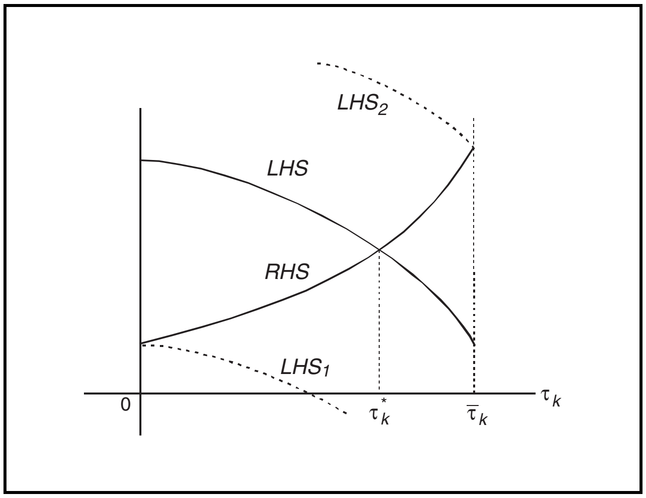

Figure 1. The Loci of the Left-Hand Side (LHS) and Right-Hand Side (RHS) of Equation 24

It is worth noting that the optimal tax rate for capital income in our model is less than 1, because the upper bound of the tax rate $\bar{\tau}_k$ in such a case is less than 1. This differs significantly from Uhlig and Yanagawa (1996), who find that, under a small interest elasticity of savings, the optimal tax rate for capital income is equal to 1, which is far from the tax rate for capital income in the real world. By considering the possibility of asymmetric information, we find that the optimal tax rate for capital income is less than 1, which is a reasonable result compared with the real world.

Proposition 3 leads to the following result for the optimal share of government spending on public capital:

Corollary 2: The optimal government share of public capital provision θ^* is less than the output elasticity of public capital for $\delta_2 < \delta < \delta_1$.

Proposition 3 indicates that if $\delta_2 < \delta < \delta_1$, then the optimal tax rate for capital income is positive and less than 1. Substituting this into Equation 23 leads to the above result. This differs significantly from Barro (1990), who finds that the optimal share of government spending is equal to the output elasticity of public spending that is equal to the complementary share of income for private capital under a constant-returns technology in Equation 1. As the income share of private capital is found to be between 0.3 and 0.5 in recent empirical studies, Barro's model implies that the optimal government share is between 0.5 and 0.7, which is obviously too high to be the government's share in practice. By considering factor taxation in a model with asymmetric information, we find that the optimal government share is less than the output elasticity of public spending, a result that is much more reasonable.

Financial Development and Optimal Fiscal Policy

We have derived an optimal government share of spending and an optimal tax rate for capital (and labor) income for a certain range of the screening cost. In this section, we explore the correlation between optimal fiscal policies and financial development.

The Relationship Between Financial Development and Fiscal Policy

It is worth noting that numerous studies have examined the effects of government expenditure financing policy and some guidelines on government taxation policy have been drawn up. Wang and Yip (1995), for example, point out that in a country with abundant human resources and labor-intensive industries, the government should levy a higher capital income tax and hence a lower labor income tax. The intuition behind this result is as follows. In a country with abundant human resources and labor-intensive industries, labor income taxation is likely to distort the human capital accumulation and thereby impede economic growth. Zeng and Zhang (2002) incorporate the individual's saving and leisure decisions into an R&D-type endogenous growth model and show that the innovation is able to compensate for the distortion created by the labor income taxation. Consequently, it is suggested that the government of the technology-leading country should levy a higher labor income tax rate and thereby a lower capital income tax rate. Song (2002), on the other hand, studies the issue of human capital accumulation and finds that the government should levy a greater capital income tax and a lower labor income tax if the factor elasticity of substitution is sufficiently large.

A work related to our study is that of Wang and Yip (1992), who find empirically that the liquidity constraint in Taiwan was very severe during the period 1954-1986, a period when the government imposed a strict regulation on its financial sectors. During that period, they found further evidence that the magnitude of the distortion created by capital income taxation (represented by corporate or business income taxation) was relatively larger than that of labor income taxation (measured by personal income taxation). As a result, the government should impose a bigger levy on labor income and a smaller one on capital income.[17] As to the government spending share, Ho and Wang (2005) calculate simple coefficient correlations between financial development and the government share from across countries and find a significantly positive correlation between financial development and the government spending share.

It is well recognized that financial markets are characterized by a wide variety of imperfections and many of these imperfections are informational in nature. Informational imperfections cause frictions in transferring resources from lenders to borrowers (McKinnon, 1973; Shaw, 1973) and financial development is claimed to reduce the cost of information to the economy (Fry, 1995; King & Levine, 1993; Rioja & Valev, 2004). Thus, in this article we may interpret a decrease in the information cost (the screening cost) as financial development. Given this, the setting of our model enables us to further shed light on the relationship between financial development (measured by a decrease in the screening cost) and government fiscal policies of factor taxation and spending on public capital. For this purpose, we first observe the following results:

> **Proposition 4:** A decrease in the screening cost δ, $\delta_2 \leq \delta \leq \delta_1$, leads to (i) an increase in τ_k^* and (ii) an increase in θ^*.

The intuition underlying Proposition 4 is as follows. Recall that an increase in τ_k leads to two opposite effects on economic growth. A decrease in the screening cost δ implies that the screening activity is less costly. This weakens the negative effect of an increase in τ_k on economic growth. The magnitude of the positive effect of an increase in τ_k on economic growth (the one proposed by Uhlig & Yanagawa, 1996), however, is not affected by δ. Because the optimal tax rate for capital income is derived by balancing these two effects, it is clear that the optimal response for a decrease in δ is to raise τ_k^*, leading to the first result. Recall that an increase in the tax rate for capital income weakens the negative effect of an increase in θ on economic growth. Because the positive effect of an increase in θ on economic growth is independent of the tax rate for capital income, a rise in τ_k^* also leads to an increase in θ^*.[18]

Preliminary Evidence

Proposition 4 indicates that financial development leads to an increase in the optimal tax rate for capital income and an increase in the optimal government share. We empirically evaluate these two implications from 18 countries of the Organization for Economic Co-operation and Development (OECD) for the period 1965 to 1990.[19] To increase the number of observations, we apply panel data analysis by pooling these 18 countries, in which each variable is averaged over 5 years.[20]

It is worth noting that some recent studies have found evidence that is consistent with our theoretical model. For example, Wang and Yip (1992) found that the magnitude of the distortion created by capital income taxation in Taiwan is relatively larger than that of labor income taxation

Table 1. Regressions for GROWTHSH and TAXCAP, 1966-1990

Explanatory Variables	1	2	3	4	5	6
Constant	25.41** (35.44)	24.55** (44.93)	24.54** (27.71)	23.56** (31.47)	24.51** (26.81)	24.20** (29.54)
RGDPSH	–2.65** (–32.99)	–2.49** (–42.85)	–2.64** (–33.43)	–2.48** (–41.48)	–2.65** (–30.17)	–2.58** (–33.41)
POP	18.42** (4.67)	8.20** (3.18)	18.47** (4.76)	5.63 (1.43)	8.53** (2.24)	8.25** (1.96)
SCHOOL60	0.04** (3.71)	0.04** (3.73)	–0.01 (–0.16)	–0.01 (–0.63)	0.02 (0.87)	0.01 (0.59)
TAXCAP	0.23* (1.93)	0.54** (5.72)	6.85** (3.51)	7.82** (3.92)	6.47** (3.41)	6.02** (3.23)
TAXCAP*2			–8.43** (–3.73)	–9.31** (–3.94)	–8.20** (–3.94)	–8.26** (–4.07)
TRADE		–0.20** (–5.69)		–0.32** (–8.94)	–0.21 (–0.58)	–0.21** (–7.97)
GOV		–2.22** (–8.71)		–2.12** (–9.53)	–0.24 (–0.57)	–0.63 (–1.32)
PRIVO					0.31** (7.84)	
TAXCAP*PRIVO						0.01** (6.21)
$\bar{R}^2$	.88	.89	.91	.92	.93	.93

Note: Figures in parentheses denote *t values*.
*$p < .1$. **$p < .05$.

in a time period when financial sectors were regulated. The government policy of financial regulation impedes financial development.[21] Based on this finding, for a time period when a government has imposed a strict regulation on its financial sectors (so that the value of δ is relatively large), the government, according to our theoretical model, should rely more on labor income taxation to finance its spending. Therefore, our model may be consistent with the evidence reported by Wang and Yip for Taiwan.

With regard to the optimal share of government, Proposition 4 has an implication that financial development leads to an increase in the optimal tax rate for capital income, which further leads to an increase in the optimal government share of public spending. This result is consistent with Ho and Wang (2005), who have found a significant positive correlation between various indicators of financial development and the government share. This result has an implication for economic development. Note that it is well-recognized that financial development is positively correlated with economic development; that is, countries with higher income levels possess more developed financial sectors than those with lower income levels.[22]

We now present our testing results. Table 1 presents the estimated results for the relationship between economic growth, financial development, and the tax rate for capital income.[23] In Table 1, the dependent variable is the growth rate and we include five independent variables (RGDPSH, POP, SCHOOL60, TRADE, GOV) found by recent studies to capture their effects on economic growth. Note that, as is argued by De Gregorio and Guidotti (1995), Levine and Zervos (1998), and Shen and Lee (2006), we use the ratio of bank credit in the private sector (termed PRIVO) as the indicator of financial development. As can be seen from Table 1, the coefficients of the tax rate for capital income (termed TAXCAP) are all significantly positive, which may support Uhlig and Yanagawa's (1996) argument that increasing capital income tax may lead to an increase in the growth rate. Nevertheless, the marginal effect of increasing in the capital income tax rate on economic growth is decreasing, as the coefficient of the square of TAXCAP is significantly negative. These two results imply that there is an optimal rate of taxation on capital income, which is consistent with our model. The key regression that provides preliminary evidence for our theoretical model is Regression 6 in Table 1, which adds an interaction term between financial development and TAXCAP. The coefficient of this term is significantly positive, indicating that countries with more developed financial markets should have a higher tax rate for capital income.

Panel data estimated results for the growth rate, government spending share, and financial development are provided in Table 2. The coefficients for the government spending share (termed GOV) may be positive or negative, depending on whether the square terms of GOV, TRADE, TAXCAP, and PRIVO are included. When TRADE, TAXACP, and PRIVO are included (Regression 5), the coefficient of GOV is significantly positive and the square of GOV is significantly negative, indicating that there is an optimal level of government spending share. Regression 6 in Table 2 also adds an interaction term between financial development and the government spending share. The coefficient of this interaction term is significantly positive, which also implies that countries with more developed financial markets should have a larger share of government spending. This result is consistent with our theoretical model.

Summary and Conclusion

Uhlig and Yanagawa (1996) have shown that when the savings interest elasticity is sufficiently small, there is a positive correlation between the capital income tax and

Table 2. Regressions for GROWTHSH and GOV, 1966-1990

Explanatory Variables	1	2	3	4	5	6
Constant	10.14** (15.67)	24.55** (44.93)	10.59** (10.73)	24.58** (41.82)	25.69** (40.67)	26.06** (50.05)
LRGDPSH	−0.82** (−7.95)	−2.49** (−42.84)	−1.01** (−4.15)	−2.46** (−42.15)	−2.82** (−53.21)	−2.76** (−54.44)
POP	−53.25** (−3.71)	8.21** (3.18)	−51.97** (−3.23)	8.95** (3.07)	10.48** (2.60)	7.13* (1.79)
SCHOOL60	0.12** (11.01)	0.04** (3.73)	0.15** (8.82)	0.04** (2.78)	0.09** (4.89)	0.08** (5.22)
GOV	−4.25** (−2.87)	−2.22** (−8.71)	17.01 (1.23)	−5.89** (−2.36)	7.96** (2.26)	2.06 (0.69)
GOV*2			−59.59* (−1.67)	10.18 (1.62)	−20.70** (−2.36)	−12.01 (−1.44)
TRADE		−0.20** (−5.69)		−0.18** (−5.47)	−0.08 (−1.20)	−0.14** (−2.35)
TAXCAP		0.54** (5.72)		0.48** (6.11)	−0.06 (−0.41)	0.08 (0.55)
PRIVO					0.45** (4.40)	
GOV*PRIVO						2.24** (4.19)
$\bar{R}^2$	.16	.89	.19	.89	.91	.90

Note: Figures in parentheses denote *t values*.
*$p < .1$. **$p < .05$.

economic growth, implying that the optimal tax rate for capital income is equal to 1. Moreover, Barro (1990) demonstrates that the optimal government share of public spending is equal to the output elasticity of public spending. This article revisits optimal government policies in relation to capital income taxation and public spending in a model of asymmetric information. We find that the presence of asymmetric information yields results that are more reasonable in comparison with the real world than those of Uhlig and Yanagawa and Barro.

With the presence of asymmetric information, we find that an increase in the capital income tax rate generates two opposite effects on the economic growth rate: First, it allows the government to reduce the tax rate on labor income which raises the share of each loan and thereby enhances the efficiency of capital investment and economic growth, and second, it exacerbates the problem of asymmetric information and hence increases the activity of screening which reduces the efficiency of capital investment and economic growth. We find an optimal tax rate on capital income, which is well-defined under the presence of asymmetric information. In particular, we find that the optimal tax rate for capital income is negatively related to financial development (measured by a decrease in the screening cost). Similarly, we find that an optimal share of government spending is less than the output elasticity of public spending, a result that is consistent with the findings of recent empirical studies. We also find some evidence in support of our theoretical implications.

A caveat regarding our study should be mentioned. It is well-recognized that financial markets are more developed in developed countries than in developing ones. Thus, Proposition 4 implies that government productive spending should be relatively higher in developed countries than in developing ones and, to finance their spending, governments of developed countries should rely more on capital income taxation than developing ones. These implications, however, cannot be supported from Tables 1 and 2, as OECD countries are all developed countries. To the best of our knowledge, there is no study that provides a consistent way of estimating the tax rates of capital and labor incomes from a large set of developing countries. We believe that it is important for future empirical studies to shed light on these implications.

Appendix A

By substituting the maximum loan quantity and Equation 10 into Equation 12, we obtain the expected payoff of a low-risk borrower as

$$\begin{aligned}&\phi_{Lt}p_L[(1-\tau_k)Q\rho - R^s_{Lt}](1-\delta)(1-\tau_L)w_t\\&\quad + (1-\phi_{Lt})p_L[(1-\tau_k)Q\rho - R^n_{Lt}](1-\tau_L)w_t\\&\quad = Q\rho(1-\tau_L)w_t\\&\quad [p_L(1-\tau_L)(1-\delta\phi_{Lt})-\varepsilon]\end{aligned}$$

From Equation 13 and $[(1-\tau_k)Q\rho - R^n_{Ht}] > 0$, we obtain

$$\frac{\partial\phi_{Lt}}{\partial R^n_{Lt}} = -\frac{(1-\tau_k)Q\rho - R^n_{Ht}}{[(1-\tau_k)Q\rho - R^n_{Lt}]^2} < 0$$

It then follows that the expected payoff of a low-risk borrower is strictly increasing in R^n_{Lt}.

Appendix B

The equilibrium contract of high-risk borrowers is $C^H_t = \{q^n_{Ht} = (1-\tau_L)w_t, R^n_{Ht} = Q\varepsilon\rho/p_H\}$. The equilibrium contract of low-risk borrowers is $C^L_t = \{[\phi, R^s_{Lt}, q^s_{Lt}], \ [(1-\phi), R^n_{Lt}, q^n_{Lt}]\}$ with $\phi = \varepsilon(1/p_H - 1/p_L)/(1-\tau_k)$, $R^s_{Lt} = 0$, $q^s_{Lt} = (1-\delta)(1-\tau_L)w_t$, $R^n_{Lt} = Q\varepsilon\rho/p_L(1-\phi)$, and $q^n_{Lt} = (1-\tau_L)w_t$. Here, $\varepsilon < (1-\tau_k)p_H$ implies that $R^n_{Ht} > R^n_{Lt}$. Hence, we can obtain $[(1-\tau_k)Q\rho - R^n_{it}] > 0$ and $[(1-\tau_k)Q\rho - R^s_{it}] > 0$.

Appendix C

Substituting the two equilibrium contracts C_t^{H} and C_t^{L} into the incentive mechanism in Equation 9, we obtain

$$\begin{aligned}
&\phi_{\mathrm{L}t}p_{\mathrm{L}}[(1-\tau_k)Q\rho-R_{\mathrm{L}t}^s]q_{\mathrm{L}t}^s+(1-\phi_{\mathrm{L}t})p_{\mathrm{L}}[(1-\tau_k)Q\rho-R_{\mathrm{L}t}^n]q_{\mathrm{L}t}^n\\
&=p_{\mathrm{L}}(1-\tau_k)w_t\left[\phi(1-\tau_k)Q\rho(1-\delta)+(1-\phi)(1-\tau_k)Q\rho-\frac{Q\varepsilon\rho}{p_{\mathrm{L}}}\right]\\
&=p_{\mathrm{L}}(1-\tau_k)w_t\left[\phi(1-\tau_k)Q\rho(1-\delta)+(1-\tau_k)Q\rho-\frac{Q\varepsilon\rho}{p_{\mathrm{H}}}\right]\\
&>p_{\mathrm{L}}(1-\tau_k)w_t\left[(1-\tau_k)Q\rho-\frac{Q\varepsilon\rho}{p_{\mathrm{H}}}\right]\\
&=(1-\phi_{\mathrm{H}t})p_{\mathrm{L}}[(1-\tau_k)Q\rho-R_{\mathrm{H}t}^n]q_{\mathrm{H}t}^n
\end{aligned}$$

As a consequence, the incentive compatibility constraint Equation 9 holds with strict inequality in equilibrium whereas Equation 8 holds with equality.

Appendix D
Data Description

Table D1. Summary of Variables, Descriptions, and Data Sources

Classification	Variable Name	Description
Dependent variable	GROWTHSH	Average annual growth rate of real per capita gross domestic product (GDP)
Financial development variable	PRIVO	Private credit
Macro control variable	GOV	Share of government expenditure in GDP
	TRADE	Trade share in GDP
	POP	Average annual population growth rate
	SCHOOL60	Average years of schooling in total population in 1960
	RGDPSH	Log (real initial per capita GDP)
	TAXCAP	Capital income tax rates

Source: Beck, Demirgüç-Kunt, and Levine (2000) and Mendoza, Milesi-Ferretti, and Asea (1997).

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Notes

1. Lucas (1990) states that "eliminating capital income taxation would increase the capital stock by about 35 percent." A low capital income tax increases the private return to capital, thus encouraging savings, investment, and growth.
2. Engen and Skinner (1996) indicate that a tax will engender an adverse influence on economic growth in the following ways: (a) reducing investment and labor inclination and influencing the formation of capital and the supply of labor; (b) reducing R&D, and slowing down the development of technology; and (c) distorting the arrangement of capital and labor among different industries, and decreasing the marginal productivity of capital and labor.
3. For example, the capital income tax rate calculated by Lucas (1990) for the U.S. economy is 0.36, which is far from the one proposed by Uhlig and Yanagawa (1996). For the tax rate for capital income in other OECD countries, please see Mendoza et al. (1997).
4. It is worth noting that the two opposite effects proposed by Uhlig and Yanagawa (1996) cannot be obtained by models with a finitely lived representative agent, as the infinitely lived agent is in fact always young.
5. For related issues, please see Hung (2005).
6. In Bose and Cothren's (1996) setting, the lenders may ration a fraction of capital borrowers to ease the problem of asymmetric information (a rationing regime). For simplicity, we consider only the screening regime under which the lenders use a screening technology to screen borrowers' projects.
7. In the neoclassical growth model where the saving rate is exogenously given, capital may be overaccumulated so that per capita consumption is not maximized in the steady state. In this case, however, capital income taxation may restore the economy to satisfy the golden rule of capital stock, which is obtained by maximizing steady-state per capita consumption. As a result, although capital income taxation is detrimental to capital accumulation, it may be optimal in terms of social welfare. In the endogenous growth models where the marginal product of capital as well as the steady-state growth rate are constant, such as the AK model considered in this article, capital income taxation impedes economic growth, which is also detrimental to social welfare.
8. To distinguish our study from Uhlig and Yanagawa (1996) and to focus our attention on the problem of asymmetric information, we ignore the savings decision.
9. Under the assumption of competitive factor markets, the number of firms is inessential; hence, we normalize the number of firms to 1.
10. As is indicated by Bose and Cothren (1996), the separating equilibrium is optimal if λ is sufficiently large. We maintain this assumption.
11. This is so because borrowers' capital technology is linear in the event of success. Note that, as indicated by Ho and Wang (2005), the condition for both to hold in the equilibrium is $\varepsilon<(1-\tau_k)p_{\mathrm{H}}$, which is also assumed to hold under our analysis.

12. Bose and Cothren (1996) originally set the screening cost as an expenditure of lenders; hence, adding together the screening cost δq_{it}^s and loan quantities q_{it}^s will be equal to the lenders' after-tax real wage income $(1-\tau_L)w_t$. As a result, $q_{it}^s \leq [(1-\tau_L)w_t]/(1+\delta)$. Although our setting simplifies the following analysis, it should be noted that both settings are qualitatively and quantitatively similar.
13. As pointed out by Ho and Wang (2005), for every unit of output loaned by a lender, only $1-\delta$ units will be received after screening by the borrower; hence, for every one unit of output received by a borrower, the amount spent by the lender, inclusive of the screening cost, will be equal to $1/(1-\delta)$. As a result, if a borrower intends to borrow q_{it}^s under screening, the amount needed by the lender will be equal to $q_{it}^s/(1-\delta)$.
14. This is optimal because the lender must offer contracts to maximize the borrowers' expected payoffs, taking asymmetric information into account.
15. The proofs of Lemma 1 and Lemma 2 (above) are shown by Ho and Wang (2005); hence, we ignore them.
16. The marginal impact of the negative effect of θ on growth is given by $\gamma/[1-\theta-\gamma(1-\tau_k)]^{1-\gamma}$, which is intensified by τ_k for $\tau_k \in (0,1)$.
17. According to Wang and Yip (1992, table 3), levying capital income taxation considerably reduces economic growth by a rate of 0.56%, whereas levying labor income taxation reduces economic growth by a rate of 0.05%.
18. Substituting Equation 23 into Equation 5, it is easy to verify that an increase in τ_k^* leads to a decrease in τ_L^*.
19. The following countries are included in the OECD: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Jamaica, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.
20. Because the economic structures of OECD countries are similar, pooling these countries seems reasonable. See Jones (2002, p. 66) for the analysis on this point. We calculate 5-year average data to abstract from business cycle relationships.
21. See Fry (1995).
22. For example, Goldsmith (1969) compared 36 countries over a period of a century and found that time periods with higher growth coincide with faster financial development.
23. Data sources, variables, and descriptions are provided in Table D1 of Appendix D.

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Bios

Fu-Sheng Hung is a Professor at the Department of Economics, National Taipei University. He is an executive editor of Taipei Economic Inquiry and has recent publications in Journal of Development Economics, Oxford Economic Papers, and Journal of Macroeconomics.

Chien-Chiang Lee is an associate professor at the Department of Finance, National Sun Yat-Sen University. He is an associate editor of Energy Economics and has recent publications in the Journal of Money, Credit and Banking, Energy Economics, and Resource and Energy Economics.