Capital tax competition and public education

Nagoya University, Weizhen Hu (胡唯真)

This paper investigates the effects of a coordinated capital tax reform across countries in an overlapping generations economy. We show that a coordinated tax increase alleviates the fiscal externality brought by tax competition, but affects human capital accumulation negatively. Therefore, each country should increase its wage tax rate to expand its domestic public education scale as a response. However, it still remains an ambiguous effect on social welfare, which challenges the general notion of "a coordinated increase in capital tax improve welfare".

Capital tax competition and public education

Nagoya University, Weizhen Hu (胡唯真)

1.Introduction

This paper investigates the effects of a coordinated capital tax reform across countries in an overlapping generations economy.

Following the discussion of Oates (1972), Zodrow and Mieszkowski (1986) and Wilson (1986) started a formal analysis to tax competition. According to their results, a tax on mobile capital decreases the level of public goods. In a symmetric framework, because each regional government takes the welfare of only its own citizens but those in other regions into consideration, it makes an inefficient policy decision that tax rate is excessively low. Consequently, this fiscal externality causes an efficiency of resource allocation. In general setting of static framework, it is believed that a coordinated increase in capital tax rate alleviates this kind of externality and improves social welfare.

In contrast to these static analyses, Batina (2009, 2012) provided a possibility from the dynamical perspective. Batina (2009) extended the static horizontal capital tax competition model to an overlapping generations economy and studied the effects of a coordinated reform that capital tax rates across all countries are increased which is aimed to alleviate the fiscal externality. It showed that this coordinated tax reform brings an ambiguous effect on welfare and turns not necessarily to be a Pareto improvement.

However, Batina (2009, 2012) only considered the accumulation of physical capital. It focused on only a redistribution of income but not an accumulation of human capital. In reality, the recent economic growth is driven by human capital or education and for this reason, governments control the scale of education to promote a higher economic growth or social welfare as well. As a policy tool, the design and effects of public education thus have been widely studied. Researches such as Glomm and Ravikumar (1992), Shirai (1990), Galor and Moav (2006) and Azarnert (2011) focused on the role of public education in social welfare or economic growth.

Naturally, here comes a question: when coordinated tax reform has affected the welfare, how the public education matters? While a tax competition brings a static fiscal externality, the existence of human capital determines the welfare of the next (following) generation and thus causes an intertemporal externality. To answer it, we study the role

of the public education policy under a coordinated tax reform. Based on Batina (2009, 2012) considering the mobile capital, we focus on an economy with public education program which is implemented independently in each country. We study, at a symmetric steady state Nash policy equilibrium, i) the response to the reform in each country, that is, how should each government adjust its domestic public education program funded by a wage tax rate and ii) how this affects social welfare.

We take both the physical capital accumulation and the human capital accumulation in to consideration. In this economy, both physical and human capital are the engine of raising social welfare. We show that a coordinated tax reform alleviates the fiscal externality brought by tax competition, but affects human capital accumulation negatively, which then has a negative effect on social welfare. Raising the wage tax rate to expand the public education program can be a policy measure to reduce this negative effect.

2. The Model

Time is discrete and the economy lasts forever, $t = 1,2,\ldots$. In this economy, there are $J > 1$ symmetric countries. Population in each country is normalized to be 1. Capital stocks moves among all countries while agents cannot. Individuals are homogeneous and live for three periods, firstly to be children, then to be the adults and finally to be the old. In their childhood, individuals accept a public education to accumulate their human capital level, h_t, but take no economic activities. We denote the adults in period t as generation t.

2.1 Firms

Firms are owned by the old and behave competitively in each country. We take them as identical and technology is of constant returns to scale. Firms use both physical and human capital to produce the private good. In each period, they maximize the profit per human capital $f(\kappa_t) - (r_t + \tau_t)\kappa_t - w_t$. Here, κ_t is the capital per human capital, r_t is the real interest rate determined in the real-world capital market, τ_t is the source-based capital tax rate, and w_t is the local wage per human capital. Location sub-script has been omitted for brevity. From the first order conditions of utility maximization by individuals, we obtain

$$\frac{df}{d\kappa_t} = f_\kappa(\kappa_t) = r_t + \tau_t = r_{nt}, \quad (1)$$

where $f_\kappa(\kappa_t)$ is the marginal product of capital per human capital in each country and r_{nt} is the net cost of capital. From (1), we can have the demand for capital per human capital, $\kappa_t = K(r_{nt})$, with $K_r = dK_t/dr_{nt} = d\kappa_t/d\tau_t = 1/df_{\kappa\kappa} < 0$ where $1/df_{\kappa\kappa} < 0$

is the second derivative. And the wage function is obtained by $w_t = f(K(r_{nt})) - r_{nt}K(r_{nt}) = W(K(r_{nt}))$, with $W_r = dw_t/dr_{nt} = dw_t/d\tau_t = -\kappa_t$.

2.2 Individuals

In period t, the adults devote themselves into the production process by providing their human capital. They thus earn a wage income and use it up either to consume a private good or to save. And when getting old, i.e., in period t+1, they pay for the private good by their savings and interest returns. Also, individuals consume a public good provided by the government in both their adulthood and old age. Therefore, they maximize their utility as

$$\max_{c_t, d_{t+1}} U^t(c_t, d_{t+1}, g_t, g_{t+1}) = u(c_t) + v(g_t) + b[u(d_{t+1}) + v(g_{t+1})]$$

$$s.t. \quad (1 - T_t)w_t h_t = c_t + s_t$$
$$(1 + r_{t+1})s_t = d_{t+1}$$

Here, c_t, s_t and d_{t+1} represent the private good consumption of their adulthood in period t, their savings in period t and the private good consumption of their old age in period t+1. g_t and g_{t+1} are the public goods in periods t and t+1. T_t is a wage tax rate.

2.3 Government

The government in each country takes two kinds of taxes on physical capital and wage income respectively: (a) it collects the taxes from physical capital to provide public good, known as a general tax authority (GTA); (b) it uses the tax revenue from wage income to fund a public education system, known as a public education authority (PEA). The budgets of each government in period t are given by

$$\tau_t K(r_t + \tau_t) = g_t, \quad (2)$$
$$T_t w_t h_t = e_t, \quad (3)$$

where e_t is the public education investments.

2.4 Formation of human capital

The human capital of the children born in period t (generation t+1) is formulated by the both the public education investment and the human capital level of their parents:

$$h_{t+1} = h(e_t, h_t). \quad (4)$$

We assume this formation is decreasing return to scale. And we have $h_e = dh_{t+1}/de_t > 0$, $h_h = dh_{t+1}/dh_t > 0$, h_{ee}, $h_{hh} < 0$ and $h_{eh} = h_{he} > 0$.

2.5 Capital market equilibrium

Equilibrium in the capital market in period t+1 satisfies

$$\sum_{j=1}^{J} K_{j,t+1} = \sum_{j=1}^{J} s_{j,t}. \quad (5)$$

where the sum is across countries indexed by j. In a symmetric and steady equilibrium, the market clearing condition can be written as

$$K_{t+1} \equiv h_{t+1}\kappa_{t+1} = s_t. \quad (6)$$

2.6 Nash policy equilibrium

A symmetric, steady-state, *Nash policy equilibrium* (NPE) is an interest rate, a policy for the representative GTA, (τ, g), and a policy for the representative PEA, (T, e), such that: i). consumers behave optimally as described above; ii) firms behave optimally as described above; iii) the agencies choose their policies optimally as described above; iv) equation (4) holds.

Totally differentiating (*4*) and (*6*) gives

$$\begin{bmatrix} k_{t+1} & \frac{h_{t+1}}{f_{\kappa\kappa}} - s_r \\ 1 & 0 \end{bmatrix} \begin{bmatrix} dh_{t+1} \\ dr_{t+1} \end{bmatrix} + \begin{bmatrix} \frac{h_{t+1}}{f_{\kappa\kappa}} \\ 0 \end{bmatrix} d\tau_{t+1} = \begin{bmatrix} s_w(1-T_t)w_t & -s_w(1-T_t)\kappa_t h_t \\ T_t w_t h_e + h_h & -T_t\kappa_t h_t h_e \end{bmatrix} \begin{bmatrix} dh_t \\ dr_t \end{bmatrix}$$

$$+ \begin{bmatrix} -s_w(1-T_t)\kappa_t h_t \\ -T_t\kappa_t h_t h_e \end{bmatrix} d\tau_t + \begin{bmatrix} -s_w w_t h_t \\ w_t h_t h_e \end{bmatrix} dT_t. \quad (7)$$

From (7), we can obtain the conditions of local stability at the steady-state NPE:

$$\left| Twh_e + h_h - \frac{(1-h_h)s_w(1-T)\kappa h - \kappa^2 T h h_e}{\frac{h}{f_{kk}} - s_r} \right| < 1 \text{ and } h_h s_w(1-T) + \frac{h}{f_{kk}} - s_r < 0. \quad (8)$$

3. Optimal policy rules

In period t, the indirect utility function of individuals is given by

$$V^t = u((1-T_t)w_t h_t - s(\cdot)) + bu((1+r_{t+1})s(\cdot)) + v(g_t) + bv(g_{t+1}).$$

And in each country, the social welfare function is defined as a sum of all generations' utility from period 1 to infinity weighted by a discount rate of individuals:

$$SW = u((1+r_1)s_0) + v(g_1)$$
$$+ \sum_{t=1}^{\infty} b^{t-1} [u((1-T_t)w_t h_t - s(\cdot)) + bu((1+r_{t+1})s(\cdot)) + v(g_t) + bv(g_{t+1})]. \quad (9)$$

Following Batina (2012), the GTA chooses the infinite policy sequence $\{\tau_t, g_t\}$ to maximize (9) subject to (2), taking the policy chosen by PEA and the policies in all other countries as given. And the PEA chooses the infinite policy sequence $\{T_t, e_t\}$ to maximize

(9) subject to (3), taking the policy chosen by GTA and the policies in all other countries as given.

Therefore, the GTA and PEA policy rules chosen by each government can be obtained respectively as:

$$(\kappa_t + \tau_t K_r)(1+b)v'(g_t) = bu_c(1-T_t)\kappa_t h_t, \quad (10)$$

$$bw_{t+1}h_e u'(c_{t+1}) = u'(c_t). \quad (11)$$

Proposition 1.

In a locally stable, symmetric steady-state NPE, the optimal policy rules are determined by:

$$(\kappa + \tau K_r)(1+b)v_g = bu_c(1-T)\kappa \quad (i)$$

and

$$bwh_e = 1. \quad (ii)$$

4. Response to a coordinated tax reform

In this section, we study the response to a coordinated tax reform to reduce the externality from the horizontal capital tax competition across countries in the steady state NPE: following Batina (2012), all countries make an agreement to increase in the capital tax rate permanently, and this is publicly announced and implemented simultaneously. All individuals believe the announcement and change their expectations accordingly.

At the steady state, we can obtain

$$\frac{dh}{d\tau} = -\frac{T\kappa h h_e s_r}{M} < 0, \quad (13)$$

$$\frac{dr}{d\tau} = -1 + \frac{(1 - Twh_e - h_h)s_r}{M} < 0, \quad (14)$$

Where $M = \kappa^2 Thh_e - (h/f_{\kappa\kappa} - s_r)(1 - Twh_e - h_h) - (1-h_h)s_w(1-T)\kappa h > 0$.

Here, (13) represents the effects of the tax reform on the human capital level. The increase in capital tax rate leads to a decrease in the wage income. This shrinks the tax base of public education program and thus reduces the level of human capital in each country. As a response, the government should increase the wage tax rate to maintain the scale of public education, which can be concluded as the following proposition:

Proposition 2.

Considering a coordinated capital tax reform such that $d\tau_j = d\tau > 0$ at the steady state. The response to the increase in the capital tax rate in every country follows that the wage tax rate rises in the steady state.

5. Welfare effects of the coordinated capital tax reform

In this section, we evaluate the effects on social welfare of the coordinated capital tax reform with considering a following wage tax reform at the steady state. We analyze these effects from two aspects: the effects through physical capital channel and those through human capital channel.

Following Batina (2012), consider a representative individual in the steady state. His or her utility function can be written as $U(c,d,g,g) = u(c) + v(g) + b[u(d) + v(g)]$. Differentiating U in τ gives

$$\frac{dU}{d\tau} = u_c[-(1-T)\kappa h + (1-T)w\frac{dh}{d\tau} - wh\frac{dh}{d\tau}] + bv_d\kappa\frac{dr}{d\tau} + (1+b)v_g[\kappa + \frac{\tau}{f_{\kappa\kappa}}(\frac{dr}{d\tau}+1)].$$

From the FOC of individual's utility maximization, $u_c = b(1+r)u_d$ and (i), we have

$$\frac{dU}{d\tau} = u_c\left\{(1-T)w\frac{dh}{d\tau} - wh\frac{dT}{d\tau} + \left[\frac{1}{1+r} + \frac{b(1-T)h\varepsilon\theta}{\varepsilon-\theta}\right]\kappa\frac{dr}{d\tau}\right\}, \quad (15)$$

where $\varepsilon \equiv -r_n K_r/\kappa > 0$ is the elasticity of capital per human capital to interest rate and $\theta \equiv \tau/r_n < 1$ (Batina, 2012).

Proposition 3.

Considering a coordinated capital tax reform in all countries such that $d\tau_j = d\tau > 0$ at the steady state. If its effects through physical capital (are positive and) dominate those through human capital, then agents are better off as a result of coordinated reform, where the welfare effects are evaluated in the symmetric steady state NPE.

6. Conclusion

In this paper, we evaluated the effects of a coordinated capital tax reform among symmetric countries in an overlapping generations model where public education breaks the static reallocation of resources and brings an intertemporal effect on social welfare. We found that since a coordinated increase in the capital tax rate brings a negative effect on wage income, the tax base of the domestic public education, each country, as a response, should increase its wage tax rate to "maintain" the public education level. We also showed that the increased taxes affect social welfare through two channels: physical capital and human capital. So, if the effects through physical capital dominates those through human capital, then individuals become better off as a result of coordinated reform.