



# Cash-in-advance constraint, optimal monetary policy, and human capital accumulation<sup>☆</sup>



Mitsuyoshi Yanagihara<sup>a,\*</sup>, Chen Lu<sup>b</sup>

<sup>a</sup> Graduate School of Economics, Nagoya University, Furo-Cho, Chikusa-Ku, Nagoya, Aichi 464-8601, Japan

<sup>b</sup> Tan Kah Kee College, Xiamen University, Zhangzhou 363105, China

## ARTICLE INFO

### Article history:

Received 4 July 2012

Accepted 5 June 2013

Available online 1 July 2013

### Keywords:

Cash-in-advance constraint

Optimal monetary policy

Public education

Human capital accumulation

## ABSTRACT

This paper investigates optimal monetary policy in an overlapping-generations model with endogenous growth fueled by the accumulation of human capital and under a cash-in-advance constraint. We consider the case where the government finances public education fully by seigniorage. Three main results are obtained. First, there exists an optimal money growth rate that maximizes the economic growth rate along the steady growth path. Second, on this path, the Laffer curve of seigniorage takes the maximum. Finally, the money growth rate for maximizing seigniorage along the steady growth path, which also leads to maximization of the economic growth rate, is lower than that for maximizing seigniorage in the present period.

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## 1. Introduction

There is no doubt that education, or human capital accumulation, is important for economic development. It results in benefits not only to those individuals who receive the education, but also to society in general. This positive externality of education is the main justification for government provision of public education. Many studies have investigated the contribution of public education to economic growth within the literature regarding theories of economic growth.<sup>1</sup> When public education is financed by seigniorage, the effect of monetary policy on human capital accumulation should be investigated, not just the effect of education-related fiscal policies. This paper, therefore, considers the optimal monetary policy from the viewpoint of the accumulation of human capital where a cash-in-advance (CIA) constraint exists.

Crettez et al. (2002a, b) is the pioneering work analyzing fiscal and monetary policies in the presence of a CIA constraint using an overlapping-generations framework. By comparing the findings obtained in this paper with those of Crettez et al. (2002b), the key features of our model and its results can be highlighted. First, similar to the result of Crettez et al. (2002b), this paper shows that there is an optimal money growth rate that maximizes economic growth along the steady growth path due to the existence of a trade-off in resource allocation between private education financed by individuals' income and public education financed by seigniorage.<sup>2</sup> Second, in contrast to the result obtained in Crettez et al. (2002b), our endogenous growth model fueled by human capital accumulation demonstrates that the maximum point on the Laffer

<sup>☆</sup> We would like to thank an anonymous referee for valuable comments and helpful suggestions that have improved the quality of our manuscript.

\* Corresponding author. Tel.: +81 52 789 5952.

E-mail addresses: yanagi@soec.nagoya-u.ac.jp (M. Yanagihara), luchen@xujc.com (C. Lu).

<sup>1</sup> Glomm and Ravikumar (1992) is the pioneering study in examining how public education contributes to economic growth. Many other studies, for example, Saint-Paul and Verdier (1993), Glomm and Ravikumar (2001), Beauchemin (2001), Iturbe-Ormaetxe and Valera (2012) and Azarnert (2011) have followed their work.

<sup>2</sup> The reason for the existence of a Laffer curve for seigniorage obtained by Crettez et al. (2002b) is that a trade-off between seigniorage and public goods supply exists.

curve of seigniorage is reached when the economic growth rate is maximized. Finally, the money growth rate for maximizing seigniorage along the steady growth path, which also leads to maximization of the economic growth rate, is lower than that for maximizing seigniorage in the present period.

When considering measures to improve welfare and accelerate economic growth, scholars usually focus on fiscal policies, such as investment subsidies for private firms, provision of infrastructure, and various tax instruments. It is acknowledged in theory that monetary policies can affect welfare and growth. Therefore, numerous attempts have been made to investigate the optimal monetary policies in dynamic frameworks by introducing the motive for individuals to hold money. One plausible way of doing this is to assume that individuals face a CIA constraint. In fact, in the discussion of optimal monetary policies, the CIA constraint has been introduced widely into both infinitely lived representative agent and overlapping-generations models, as [Bhattacharya et al. \(2005\)](#) and [Gahvari \(2007\)](#) point out.<sup>3</sup>

Originally, analyses were conducted using the representative agent framework. [Stockman \(1981\)](#) shows that in a representative-individual model with a CIA constraint for both gross investment and consumption, higher inflation might lower the level of capital stock in the steady state. Using the same framework, [Stockman \(1981\)](#) and [Abel \(1985\)](#) further investigate the determination of the speed of convergence to the steady state if the CIA constraints for investment and consumption, or just for consumption, are binding. [Mansoorian and Michelis \(2010\)](#) consider the situation where the CIA constraint for durable goods consumption is binding in a small-country setting. [Ellison and Rankin \(2007\)](#) examine optimal monetary policy when lump-sum taxes are not available under discretion.

Similarly, using an infinitely lived representative agent model, [Hromcová \(2008\)](#) focuses on the relationship between the growth fueled by human capital accumulation and the growth rate of money velocity where a CIA constraint exists.<sup>4</sup> Recently, the relationship between growth and monetary policy has been examined when individuals care about their social status; see, for instance, [Chen \(2011, 2012\)](#) and [Chen and Guo \(2009, 2011\)](#). Specifically, [Chen \(2012\)](#) shows that if the desire for social status depends on the human capital of the individual relative to the aggregate human capital, an increase in the money growth rate will accelerate economic growth in the long-run.

In addition, the optimal monetary policy has been investigated using overlapping-generations frameworks with CIA constraints. [Crettez et al. \(1999\)](#) introduce several types of CIA constraints into an overlapping-generations model and compare the equilibrium dynamics. [Michel and Wigniolle \(2005\)](#) show that there exists a temporary bubble when a CIA constraint is binding and the bubble can be eliminated by money creation. [Erdogan and Saglam \(2006\)](#) show that when a CIA constraint exists and there are two kinds of individuals, workers and producers, monetary policy determines the shape of the long-run Phillips curve.

Among the studies using an overlapping-generations framework, the fiscal and monetary policies are discussed in [Crettez et al. \(2002a, b\)](#). [Crettez et al. \(2002a\)](#) analyze the fiscal and monetary policies necessary for the economy to achieve the optimal growth path in an overlapping-generations model with a CIA constraint. In [Crettez et al. \(2002a\)](#), labor income tax, capital tax, public debt, and money supply are considered as policy instruments. Using a similar framework to [Crettez et al. \(2002a\)](#), [Crettez et al. \(2002b\)](#) also consider the second-best monetary policy and money growth rate, together with fiscal policy and the quantity of public goods. In contrast to [Crettez et al. \(2002a\)](#), [Crettez et al. \(2002b\)](#) consider the case where elderly individuals obtain utility not only from their own consumption, but also from public goods that are financed entirely by seigniorage, and where the individuals confront a CIA constraint for their consumption in the old period. Under such circumstances, there exists a trade-off between monetary expansion (to permit individuals to save, which leads to the accumulation of physical capital) and an increase in the quantity of public goods. Therefore, [Crettez et al. \(2002b\)](#) conclude that there should be a Laffer curve for seigniorage and that the second-best optimal monetary policy is on the decreasing part of the Laffer curve.

Even though [Crettez et al. \(2002a, b\)](#) shed light on the importance of the optimal mix of fiscal and monetary policies, neither study pays attention to the optimal monetary policy for human capital accumulation. As seigniorage is one of the important sources of government revenue, it is worthwhile analyzing how monetary policy affects the education decisions for individuals' children, as well as their saving behavior. Therefore, in this paper, we address this gap in the literature by investigating the optimal monetary policy in an overlapping-generations model with endogenous growth fueled by the accumulation of human capital where the CIA constraint for goods consumption by the old is binding. In addition, following [Crettez et al. \(2002b\)](#), we consider the case where the government supplies public education financed entirely by seigniorage. The reasons why we use an overlapping-generations model are twofold. First, as [Crettez et al. \(2002a\)](#) point out, the arguments can be simpler and richer than those provided by using a representative agent framework, which requires sophisticated mathematics. Second, it becomes possible to compare our results with those of [Crettez et al. \(2002b\)](#).

This paper is organized as follows. [Section 2](#) introduces the model. [Section 3](#) describes the equilibrium in each period and the dynamics of the economy. [Section 4](#) presents the steady growth path. [Section 5](#) concludes the paper.

<sup>3</sup> [Gahvari \(2007\)](#) introduces the CIA constraint for consumption in the old period in an overlapping-generations model and shows that the optimal monetary policy is not unique and can be represented by a continuum of combinations of money growth rates and consumption taxes.

<sup>4</sup> Although a CIA constraint is not assumed, [De Gregorio \(1996\)](#) investigates how borrowing constraints decelerate growth. Both [Hromcová \(2008\)](#) and [De Gregorio \(1996\)](#) apply the technology of human capital accumulation given by [Lucas \(1988\)](#), which depends on the time input (of schooling). In contrast to the findings of [De Gregorio \(1996\)](#), [Jappelli and Pagano \(1994\)](#) show that a borrowing constraint accelerates growth. [Jappelli and Pagano \(1994\)](#) do not consider human capital accumulation, but rather an AK-type production function as an engine of growth.

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