Working Paper 99-2/ Document de travail 99-2

Capital Gains and Inflation Taxes in a Life-cycle Model

by
Charles Leung
Chinese University of Hong Kong
and **Guang-Jia Zhang**
Bank of Canada

Bank of Canada Banque du Canada

ISSN 1192-5434
ISBN 0-662-27458-X

Printed in Canada on recycled paper

Bank of Canada Working Paper 99-2

November 1998

Capital Gains and Inflation Taxes in a Life-cycle Model

by

Charles Leung
Chinese University of Hong Kong

and

Guang-Jia Zhang
Bank of Canada

Contents

Acknowledgments

Most of this work was done when the authors were at the University of Rochester. The authors are grateful to Robert Amano, J-P Aubry, Thomas Cooley, Walter Engert, Jeremy Greenwood, Hugo Hopenhayn, Sergio Rebelo, Jack Selody, Mingwei Yuan, and the seminar participants at the Bank of Canada, Chinese University of Hong Kong, Hong Kong University of Science and Technology, the Rochester Macro Lunch Workshop, University of Guelph, the 1996 CEA meeting (St. Catharines), and the 1996 SEDC meeting (Mexico City) for comments.

Abstract

Inflation distorts an economy through many channels. This paper highlights the interaction between inflation and capital gains tax and how they distort an economy through the financial market. Several observations motivate this research. First, capital formation or investment is an important channel for economic agents to smooth their consumption over their life cycles. Second, capital gains are taxed only when the gains are realized. Third, inflation introduces an upward bias in the calculation of the tax base. Thus, a capital gains tax in the presence of inflation can have a large welfare effect even though its contribution to the government revenue is relatively small.

This paper supplements the literature on the overlapping generations model with money. In a world with imperfect capital markets where all agents consume cash goods, inflation transfers purchasing power from cash-rich generations to cash-poor generations who suffer more from liquidity constraints. This observation makes the welfare analysis here more interesting.

Résumé

L'inflation exerce des distorsions de toutes sortes dans l'économie. Dans cette étude, les auteurs mettent en lumière l'interaction qui existe entre l'inflation et l'imposition des gains en capital ainsi que les distorsions que ces deux facteurs créent dans l'économie par le truchement des marchés financiers. Leur analyse s'appuie sur plusieurs observations. Premièrement, la formation du capital, c'est-à-dire l'investissement, est un important outil qui permet aux agents économiques de répartir plus également leur consommation sur l'ensemble de leur vie. Deuxièmement, les gains en capital ne sont imposés qu'une fois réalisés. Troisièmement, l'inflation entraîne un gonflement de l'assiette fiscale. L'imposition des gains en capital en période inflationniste peut donc avoir une incidence considérable sur le bien-être même si sa contribution aux recettes de l'État demeure relativement mineure.

Les auteurs de l'étude font intervenir la monnaie dans un modèle à générations imbriquées. Dans un monde où les marchés des capitaux sont imparfaits et où les agents doivent payer comptant les biens qu'ils consomment, l'inflation engendre un transfert de pouvoir d'achat des générations disposant de sommes d'argent importantes vers celles qui subissent des contraintes de liquidité. La prise en compte de ce phénomène aboutit à une analyse plus riche des effets de l'inflation sur le bien-être.

1. Introduction

Recently, there has been some debate about whether the capital gains tax should be indexed (i.e, adjusted for inflation) or eliminated. Since both capital gains tax revenue and seigniorage constitute a small amount of federal government revenue, the major concern is whether such a policy change will have a significant impact on social welfare.[1] Since capital gains are measured in nominal terms, inflation will introduce an upward bias in the calculation of capital gains.[2] The consequences of such a distortion on individual behaviour is complicated. On the one hand, inflation will discourage investors to re-allocate their portfolio towards capital.[3] On the other hand, capital gains tax will decrease the total amount of investment. This paper attempts to quantify the joint welfare loss due to inflation and capital gains taxes. The model developed here differs from the previous literature by incorporating life-cycle effects.

Life-cycle considerations are important along several dimensions. First, life-cycle models accept the challenge to reproduce the age-dependent portfolio choice observed in the data. As shown in Table 1, which is reproduced from Kennickell and Starr-McCluer (1996), a household's portfolio composition changes over its life-cycle.

Second, life-cycle models provide a natural environment for the study of the effects of tax policies on portfolio choice as well as the extent of consumption smoothing over the life cycle. In this type of models, an agent's labor productivity

1. Champ and Freeman (1994, p.66-67) observed that for most developed countries during normal times, seigniorage contributes very little to government revenue. In the United States, during the period 1948-89, seigniorage accounted on average for less than 2% of total federal government revenues and for around 0.3% of GNP. According to Auerbach (1988), the total capital gains tax revenue seldom constitutes more than 3% of the total Federal government revenue in the post war years.
2. For instance, Feldstein and Slemrod (1978) argue that in the U.S. "...in 1973 individuals paid nearly $500 million of extra tax on corporate stock capital gains because of the distorting effect of inflation."
3. See Champ and Freeman (1994) for a discussion.

(and thus the stream of his wage income) is a hump-shaped function of his age.

Table 1: The distribution of financial assets of all families (1989)

Age	Liquid assets	Retirement accounts	Securities	Other assets
<35	24.3	38.9	13.1	23.7
35-44	19.8	36.0	19.5	24.7
45-54	14.9	30.5	37.3	17.3
55-64	17.0	17.8	50.4	14.8
65-74	19.1	7.9	55.1	17.9
>75	25.2	0.1	50.3	24.4

To have a smooth consumption profile, agents make their investment at an earlier age and cash in gradually in later years. Agents might trade less frequently in the presence of capital gains tax because it is a tax on capital trading rather than capital ownership. In fact, a decrease in the trading volumes due to a change in taxes probably reflects a decrease in the consumption smoothing incentives over the life cycle.

Third, life-cycle models also assign to the inflation tax the role of wealth redistribution. Recently, macroeconomists have emphasized that money improves social welfare due to its role as a medium of exchange. As demonstrated by Marshall et al. (1987), money can also improve social welfare by allowing a government to redistribute wealth among households. More precisely, in a world with imperfect capital markets where all agents consume cash-goods, inflation becomes a vehicle to transfer purchasing power from cash-rich agents to cash-poor agents, who suffer more from liquidity constraints. This observation makes the welfare analysis here more interesting.

Forth, the unique feature of capital gains tax provides an additional justification for using a multi-period overlapping generations model rather an infinite horizon model. Under persistent inflation, capital purchased earlier will carry a heavier tax obligation. Therefore, investors tend to sell newly bought capital first ("last-in-first-out"). In this case, the stationary distribution of capital, if it exists, may have an infinite support in an infinite horizon economy. Fortunately, multi-period overlapping generations models put an upper bound on the tax-induced vintage of capital and ease the computation significantly. [4].

Although the burden of the computation of general equilibrium is eased by selecting the overlapping generation framework, the choice of the algorithm is limited by the very nature of capital gains tax. As emphasized by Stiglitz (1983), capital gains are taxed only upon the realization of sale, it introduces an "option feature" or "lock-in" effect in the consumers' decisions. The fact that inaction can be an optimal strategy over some range of state variables invalidates all Euler-equation type approaches in general equilibrium computation.[5] Following Imrohoroglu, Imrohoroglu and Joines (1993, 1994), our model discretizes the state space and obtains the decision rules by searching over the space.

Furthermore, the unique characteristic of capital gains tax demands that the model keeps track of both the distribution of capital purchased in the past as well as the distribution of the corresponding prices. As mentioned before, in a world with persistent inflation and capital gains taxation, capital with different buying prices will generate different after-tax revenues even though they face the same selling price at sale and pay the same amount of dividend when they are held.[6] In order to take up this challenge, this paper makes simplifying assumptions along other dimensions.

---

4. This framework has been used to study different issues recently. For instance, see Huggett (1994) and Imrohoroglu, Imrohoroglu and Joines (1993, 1994)
5. See the monograph by Dixit and Pindyck (1994)
6. Thus, this model is a consumption-side analog of the (production-side) vintage capital model, as will be discussed later.

The focus of this paper is different from the previous literature with respect to both the capital gains tax and the inflation tax. Previous theoretical work focuses on the impact of the capital gains tax on portfolio composition.[7] That work assumes that both the interest rate and labor income are exogenous. Since this paper attempts to calculate the welfare cost to the economy, both the interest rate and wage rate are endogenous here.[8] The empirical literature on capital gains tax tends to focus on whether capital gains tax significantly alters the capital gains realizations.[9] This paper simply focuses on individual behaviour under the interaction of inflation tax and capital gains tax.

The inflation tax literature, aside from Diaz-Gimenez et al.(1992), focuses on the distortions related to the "real side" of the economy.[10] Diaz-Gimenez et. al. (1992) examine the distortion of inflation through the mortgage market. This paper explores another inflation-tax distortion affecting the "financial side" of the economy, in particular, the capital market for inter-generational trade. This paper is, therefore, close to Altig and Carlstrom (1991) in spirit. They examine the distortion of the income tax base introduced by inflation. The only role of money is to serve as a unit of account in their model, while money is introduced into the portfolio via cash-in-advance constraint here. Money growth (inflation) generates welfare effect through its impact on consumption as well as stock holdings. Another important difference in this paper is the discrete choice of buying and selling (the "option ef-

---

7. For instance, see Auerbach (1992), Haliassos and Lyon (1993) and Hendershott, Toder and Won (1990).
8. Also, the time horizon of this model is longer than the typical assumption, where the economies generally considered do not last for more than 3 periods. In contrast, our model considers an infinite-horizon economy in which agents live for a finite number of periods.
9. Auerbach (1988) provides a review of earlier findings. The results seem to be inconclusive. Using aggregate data, Poterba (1987) argues that sophisticated portfolio strategies are able to permit investors to avoid capital-gains taxes. However, in a later study which utilizes panel data between 1981 to 1988, Seyhun and Skinner (1994) find that relatively few investors trade securities to reduce their taxes.
10. For instance, see Cooley and Hansen (1989, 1991).

fect"). Postponement of the sale of capital is coupled with the deferral of capital gains tax. To quantify such a discontinuity in the income stream as well as the tax payment, this paper adopts a different algorithm, which generalizes the one used by Imrohoroglu, Imrohoroglu and Joines (1993) to a multi-asset environment.

2. The Model

2.1 The economic environment

This section describes the baseline model. There is no uncertainty in this model. It is assumed that there is only one kind of capital in the economy. Continuous monetary growth drives the nominal price of the capital stock to increase over time. Taking capital gains tax and inflation into consideration, utility-maximizing agents treat stocks purchased at different dates as different assets. An economic agent lives for J periods. In each time period t, there exits J different age cohorts in the economy, each of equal size. Therefore, the size of the total population is constant over time and is normalized to unity. It follows that the population size of each age group is $1/J$.

Within a period, the timing of events is similar to that utilized in Greenwood and Huffman (1987). At the beginning of each period, individuals collect transfers, if any, from the government. Consumption in that period can be financed only by cash carried over from the previous period and transfer. Then individuals supply their capital and labor to firms. Labor supplied is exogenous and is normalized to unity. Individuals receive labor income (which depends on both their age-dependent productivity h_j, and wage per efficiency unit w^e), and dividends (which is the marginal product of capital) from firms. Capital depreciates before trading occurs in the capital market. Agents can receive revenue by selling capital. After paying taxes, agents divide income into the part for investment and the part for consumption, cash holdings, for the following period.

2.2 Individual optimal portfolio choices under tax distortion

The maximization problem faced by the age j representative agent, $2 \le j \le J$, at time t, with portfolio $k_t^j = (k_{t,1}^j, \ldots, k_{t,j-1}^j)$, individual j's n-period stock holding at time t, $k_{t,n}^j \ge 0, n=1,\ldots,j-1$, real money balance $m_{t-1}^j / p_t \ge 0$, and age-dependent labor productivity index h_t^j, is described as follows:[11]

$$V^j(X_t) = max_{c_t^j, s_t^j, k_{t,0}^j, m_t^j} \{u(c_t^j) + \beta E V^{j+1}(X_{t+1})\} \tag{1}$$

s.t.

$$c_t^j \le m_{t-1}^j / p_t + TR_t \tag{2}$$

$$q_t k_{t,0}^j + c_t^j + m_t^{j+1} / p_t \le m_{t-1}^j / p_t + TR_t + w_t^e h^j + r_t \Sigma_{n=1}^{j-1} k_{t,n}^j + S_t \tag{3}$$

$$k_{t+1,n+1}^{j+1} = (1-\delta) k_{t,n}^j - s_{t,n}^j, \; for \;\; n=1,\ldots,j-1, \tag{4}$$

$$0 \le s_{t,n}^j \le (1-\delta) k_{t,n}^j, for \;\; n=1,\ldots,j-1, \tag{5}$$

$$V^{J+1} = 0 \tag{6}$$

where

$$X_t = (k_t^j, h_t^j, m_{t-1}^j / p_{t-1}; q_t, Q_t, \Pi_t) \tag{7}$$

$$S_t = \sum_{n=1}^{j-1} \left\{ q_t - \tau_g \left[q_t - q_{t-n} \Pi_{d=1}^{n-1} \left(\frac{1}{1+\pi_{t-d}} \right) \right] \right\} s_{t,n}^j \tag{8}$$

$$s_t^j = (s_{t,1}^j, \ldots, s_{t,j-1}^j) \tag{9}$$

---

11. The non-negativity constraints in capital and money holdings reflect a form of imperfection in capital market and it motivates agents to hold assets to smooth out consumption.

$$Q_t^j = (q_{t-1}, q_{t-2}, \ldots, q_{t-J+1}) \tag{10}$$

The first inequality is a form of cash-in-advance constraint. Transfers, TR_t, (in real terms) are distributed to all agents except the newly born, who are assumed to have zero consumption. The second inequality is simply the budget constraint. Total income, which is the sum of money carried over from last period, (m_{t-1}^j/p_{t-1}), revenue from selling capital stock, $s_{t,n}^j$, n=1,...j-1, at the price, q_t, the transfer collected from the government if any, plus current period labor income $w_t^e h_j$ and dividend $r_t\Sigma_{n=1}^{j-1}k_{t,n}^j$, should be able to cover total expenditure, which is the sum of investment, $q_t k_{t,0}^j$, consumption, c_t^j, and money holding for the next period, (m_t^{j+1}/p_t).[12] Notice that the purchasing power of a real money balance carried from a previous period, (m_{t-1}^j/p_{t-1}), is discounted by inflation between period (t-1) and t, $(p_{t-1}/p_t) = \frac{1}{1+\pi_t}$, where π_t is the period t inflation rate and $\Pi_t=(\pi_t,\pi_{t-1},\ldots,\pi_{t-j+1})$ is the history of inflation rates experienced by age-j agent. Equation (4) says that the amount of (n+1) period old capital in period (t+1), $k_{t+1,n+1}^{j+1}$ is the amount of n period old capital in period t, $k_{t,n}^j$, after depreciation (with rate of δ) and net of sales, $s_{t,n}^j$.[13] The next equation places restrictions on the

12. Let the nominal price of capital be cp_t, so $cp_t=p_t*q_t$.

Hence $$\frac{cp_{t-n+1}}{p_t} = \left(\frac{cp_{t-n+1}}{p_{t-n+1}}\right)\cdot\left(\frac{p_{t-n+1}}{p_{t-n+2}}\right)\cdots\left(\frac{p_{t-1}}{p_t}\right) = q_{t-n+1}\prod_{g=1}^{n-1}(1+\pi_{t-g})^{-1}$$

where $\frac{p_t}{p_{t-1}} = 1+\pi_{t-1}$. It is then easy to see that the term

$$\left\{q_t - \tau_g\left[q_t - q_{t-n+1}\prod_{g=1}^{n-1}(1+\pi_{t-g})^{-1}\right]\right\}$$ is the after-tax revenue of selling one unit of capital purchased at price cp_{t-n+1} at price cp_t (in nominal terms). This simplification is due to Jeremy Greenwood.

amount of sales. Sales can neither exceed the amount of capital after depreciation nor short-sale. Equation (6) is a mathematical expression of the no- bequest assumption.[14]

[Discussion of the tax distortion]: In an investor's budget constraint, we can rewrite the after-tax revenue of selling a unit of stock that has been held for *n* periods as an average of selling price and buying price, weighted by the capital gains tax rate. That is,

$$\left\{q_t - \tau_g\left[q_t - q_{t-n}\prod_{d=1}^{n-1}\left(\frac{1}{1+\pi_{t-d}}\right)\right]\right\} = \tag{11}$$

$$\left\{(1-\tau_g)q_t + \tau_g q_{t-n}\prod_{d=1}^{n-1}\left(\frac{1}{1+\pi_{t-d}}\right)\right\}$$

Recall the assumption that capital produced at different dates is homogeneous in terms of production. If $q_{t-n} \leq q_t$ and since by assumption $\pi_{t-d} > 0$, then the after-tax revenue is strictly smaller than the selling price.[15] *The wedge between the selling price and after-tax revenue is merely caused by the capital gains tax.* Notice that if the capital gains tax rate, τ_g, is zero, inflation by itself cannot drive this wedge. Thus, this expression demonstrates the distortion caused by the interaction of the inflation tax and capital gains tax.

[The *last-in-first-out* conjecture]: When an investor considers to sell as-

---

13. Notice that in this model, capital depreciates after production but before sale. Therefore, "old capital" that is re-sold in the market or kept by the original owner will face the same depreciation rate whereas newly produced capital will not depreciate.
14. In the case of bequests, agents do not have to sell all the stocks before they die but simply transfer some of their stocks purchased to their children. This case is not considered here.
15. Indeed, they will be equal in the steady state, $q_t = q_{t-n}$, $\forall\, t, \forall\, n$.

sets, he/she will first sell those bought last. That is, if $k^{j+1}_{t+1,n+1} = (1\text{-}\delta)k^{j}_{t,n} > 0$, then

$k^{j+1}_{t+1,n'+1} = (1\text{-}\delta)k^{j}_{t,n'}, \forall\ n' \geq n.$

The intuition of this conjecture is clear. Selling a unit of capital that has been held for n periods can generate $\left\{(1-\tau_g)q_t + \tau_g q_{t-n}\prod_{d=1}^{n-1}\left(\frac{1}{1+\pi_{t-d}}\right)\right\}$ units of consumption goods, and selling a unit of capital that has been held for n' $(n < n')$ periods, can generate $\left\{(1-\tau_g)q_t + \tau_g q_{t-n}\prod_{d=1}^{n-1}\left(\frac{1}{1+\pi_{t-d}}\right)\prod_{d=n}^{n'-1}\left(\frac{1}{1+\pi_{t-d}}\right)\right\}$ units of consumption goods, where $\pi_{t-d}>0$. It is easy to see that the after-tax revenue of selling the former will be higher. Now consider their opportunity cost. Recall that capital purchased at different dates receives the same amount of dividend per unit. And notice that nominal capital gains will be inflated by the same factor $\left(\frac{1}{1+\pi_{t+1}}\right)$ if their sales are both postponed one period. The difference in after-tax revenue persists as long as both inflation and capital gains tax rates are positive. Hence, it is optimal to sell the capital purchased later. While this conjecture is not verified formally, it is confirmed in the numerical experiments considered.

This feature can be compared with situations in labor economics and investment theory. Consider the layoff decisions in an environment with specific human capital investment. While workers might have the same "shadow wages", the workers who joined the firm later will always be laid off first because they have accumulated less specific human capital. Here, capital purchased later are taxed less but can be sold at the same market price as those purchased earlier, and therefore they will be sold first. Now consider the vintage capital model such as Cooley, Greenwood and Yorukoglu (1994). Newly purchased capital is more productive and hence capital bought earlier is discarded first. Here, the marginal returns of an asset sale decline as the capital ages. Therefore, newly purchased capital is always sold first. In this model, the potential size (in terms of number of different assets) of the portfolio is bounded by the maximum periods of lives.

2.3 The equilibrium

The rest of the model is similar to the standard neoclassical growth model. The utility function is CRRA,

$$u(c_t^j) = \frac{(c_t^j)^{1-\sigma}}{1-\sigma} \tag{12}$$

The production function exhibits constant returns to scale in aggregate capital and labor. Hence factor returns are equal to the corresponding marginal products.

$$F(K_t, L_t) = A \cdot K_t^{\alpha} L_t^{1-\alpha} \tag{13}$$

$$w_t^e = F_2(K_t, L_t) \tag{14}$$

$$r_t = F_1(K_t, L_t) \tag{15}$$

where

$$K_t = \left(\frac{1}{J}\right) \sum_{i=1}^{J} \sum_{n=1}^{J-1} k_{t,n}^j \tag{16}$$

and L_t is simply the sum of exogenous labor supply [16]

$$L_t = \left(\frac{1}{J}\right) \sum_{i=1}^{J} h_t^j \tag{17}$$

---

16. This model abstracts from labor supply decisions because the focus of the paper is the inflation tax effect under an anticipated monetary expansion. According to Lucas (1996), anticipated monetary expansions are not associated with stimulus to employment and production. As well, the abstraction simplifies the problem considered here.

The equilibrium conditions for the capital market and money market are described by the following equations respectively:

(1) capital market:

$$F(K_t, L_t) - C_t = q_t(I_t - S_t) \tag{18}$$

(2) money market:

$$\left(\frac{1}{J}\right)\sum_{i=1}^{J}\left(\frac{m_t^{j+1}}{p_t}\right) = \frac{M_t}{p_t} \tag{19}$$

where

$$C_t = \left(\frac{1}{J}\right)\sum_{i=1}^{J} c_t^j \tag{20}$$

$$I_t = \left(\frac{1}{J}\right)\sum_{i=1}^{J} k_{t,0}^j \tag{21}$$

and

$$S_t = \left(\frac{1}{J}\right)\sum_{i=1}^{J}\sum_{n=1}^{J-1} s_{t,n}^j \tag{22}$$

The value of the net investment, $q_t(I_t\text{-}S_t)$, is equal to the total output net of aggregate consumption, $F(K_t, L_t)\text{-}C_t$.[17] The total amount of capital in the next period is simply the sum of existing capital after depreciation and new investment,

$$K_{t+1} = (1-\delta)\cdot K_t - S_t + I_t \tag{23}$$

---

17. Notice that without depreciation, $It=St$ holds for any t in the steady state. The intuition is that now economic agents have only finite periods of life, and therefore all capital purchased will be sold eventually. In addition, the cash-in-advance constraint implies that consumption out of capital directly is impossible without a market transaction. In other words, a "sale" is necessary. Numerical experiments confirm this intuition.

The government collects taxes and makes transfer payments to the non-working generations. The amount of transfer payments must be financed by money creation and capital gains tax revenue.[18]

$$\left[\frac{J-R+1}{J}\right] \cdot TR_t = \frac{M_t - M_{t-1}}{p_t} + \frac{\tau_g}{J} \sum_{j=1}^{J} \sum_{n=1}^{J-1} \left[q_t - q_{t-n} \prod_{d=1}^{n-1} \frac{1}{1+\pi_{t-d}} \right] \cdot s_{t,n}^{j} \quad (24)$$

where $M_t = zM_{t-1}$.[19] Notice that the total population is unity. However, not all agents receive transfers. This is reflected by the fact that TR_t is attached to a scaling factor $(J\text{-}R+1)/J$.

[Discussion]: Money creation, $(M_t\text{-}M_{t-1})$, is an exogenous process in the model. $(M_t\text{-}M_{t-1})/p_t$ is real seigniorage to the government. An alternative way to model real seigniorage is to write it as $r_t M_t / p_t$ in the government budget constraint. In fact, seigniorage consists of a very small fraction of total government revenue. In addition, major investors, those who are working, do not receive the transfer payment, TR_t, from the government. As a consequence, any moderate change in seigniorage has a small impact on an investor's consumption and investment decisions. Therefore, how to model seigniorage should not affect the principal conclusions of the model.

This section will be closed by a formal description of the stationary competitive equilibrium.

---

18. The assumption about the inter-generational transfer here can be justified by the empirical findings in Gokhale, Kotlikoff, and Sabelhaus (1996) that for the U.S. the elderly now hold a much bigger share of total wealth than they did a generation ago. The biggest contributors to this increase are government entitlement programs which take more in taxes from the young, and pay more in benefits to the old.

19. The real inflation tax revenue is $\frac{M_t - M_{t-1}}{p_t} = (z-1) \cdot \frac{M_{t-1}}{p_t}$. It is assumed that monetary expansions are anticipated in the model.

A competitive equilibrium is a collection of a sequence of prices $\{w_t^e, r_t, q_t\}_{t=0}^{\infty}$ and real allocations $\left\{k_{t,n}^j, \frac{m_t^j}{p_t}, s_{t,n}^j\right\}_{n=1,\ldots,J-1;t=0,\ldots,\infty}^{j=1,\ldots,J}$, such that:

- Real allocations, $\left\{k_{t,n}^j, \frac{m_t^j}{p_t}, s_{t,n}^j\right\}_{n=1,\ldots,J-1;t=0,\ldots,\infty}^{j=1,\ldots,J}$, solve investors' optimal portfolio choice problems subject to the constraints (2)-(3), taking the sequence of prices $\{w_t^e, r_t, q_t\}_{t=0}^{\infty}$ as given;
- The sequence of prices, $\{w_t^e, r_t, q_t\}_{t=0}^{\infty}$, is consistent with all market clearing conditions (18)-(19); and
- The government balances its budget (24).

From this point on, this paper will focus on the steady state of the life-cycle economy. A steady state is a competitive equilibrium with the following conditions satisfied:

- A typical agent's lifetime asset holding profile coincides with the whole population asset holding profile at a given time period, e.g. $k_{t,n}^j = k_{t+s,n+s}^j$. In general, all time subscripts will be suppressed;
- The interest rate is constant over time, $r_t = r$, (hence, the wage rate must also be constant);
- Real money holdings for each generation, $\hat{m}^j = \frac{\hat{m}_t^j}{p_t}$, is constant over time;
- The relative price of capital is constant over time, $q_t = \hat{q}$; and
- The inflation rate π_t is constant and equal to the money growth rate, z-1.

Therefore, the real value of money creation in steady state, $(M_t - M_{t-1})/p_t$, is equal to $(1-z^{-1}) \cdot \sum_{i=1}^{J} \frac{\hat{m}^j}{J}$. It should be noticed that although the technology allows perfect reversibility between consumption and capital goods, the introduction of a capital gains tax leads to an apparent depreciation when capital goods are converted back to consumption goods. Therefore, even in a deterministic steady state, $\hat{q}$ is not necessarily equal to unity.

The details of the algorithm used to solve for the stationary equilibrium are given in the appendix. The next section presents the parameter values used in the computation and the results obtained.

3. Calibration

The calibration procedures are standard and the parameter values, drawn from U.S.-based research, are summarized in the following table.

Table 2: Calibrated Parameter Values

Parameter	Numerical Value
z	1.00, 1.10, 1.15, 1.20
τ_g	10%
δ	30%
A	2
α	0.36
β	0.86
σ	1.5

This paper focuses on the steady state in which the inflation rate will coincide with and around the actual inflation rate. This implies a steady state annual inflation of 2%. There is no consensus about the precise values of marginal capital gains tax rates over the years. Nevertheless, the empirical work of Auerbach (1988), Gouveia and Strauss (1994) and Protopapadakis (1983) gives similar estimates and

10% is within their range. Stokey and Rebelo (1995) find that the usually assumed 10% depreciation rate per year is overstated and provide evidence that it should be 6% per annual instead. The latter implies approximately 30% depreciation every five years, which is the length of time period in the model. Values assigned to the parameters of the production function and preferences are adopted from the real business cycle literature, except for the adjustment that the duration of one period in this model is 5 years while in the real business cycle literature it is typically a quarter. This setup is consistent with the buy-and-hold long term investment strategy. The labor productivity index is constructed by Rios-Rull (1994), based on CPS. [See Table 3.]

Table 3: Labour Productivity Index

Parameter	Numerical Value
h_1	0.2822
h_2	0.8332
h_3	1.2736
h_4	1.4540
h_5	1.6200
h_6	1.7100
h_7	1.6208
h_8	1.4090
h_9	0
h_{10}	0
h_{11}	0

Furthermore, given the computing constraints, capital is exogenously limited not to held for more than 4 periods. This assumption is equivalent to assume that an investor adapts a complete new portfolio in every five years. This is merely a technical condition and can be readily relaxed.

4. The Findings

A certain number of policy experiments are designed and conducted. The policy parameters, money growth rate (or the inflation tax rate), z, and capital gains tax rate τ, are calibrated so that the model can predict how the capital gains tax interacts with the inflationary monetary policy to determine total investment, aggregate real cash balances, total consumption, and government transfers. The model also quantifies the impact of these taxes on social welfare. Here the variation in social welfare is measured in terms of the percentage change in average consumption. The quantitative results are given below.[20]

Table 4: How capital gains tax affects aggregate stock holdings (K/Y)

	τ =5%	τ =10%	τ =15%	τ =20%
p =2% (annual)	0.2803	0.2712	0.2678	0.2432

Table 5: How inflation affects aggregate stock holdings (K/Y)

	p =1% (annual)	p =2%	p =3%	p =4%
τ=10%	0.3018	0.2712	0.2644	0.25751

It is clear from Tables 4 and 5 that for a given inflation rate, on one hand, an increase in capital gains tax rate leads to a decrease in the ratio of capital stock to output. On the other hand, for any given capital gains tax rate, the ratio of capital stock to output decreases as the inflation rate increases. This finding is consistent with that in Stockman (1981) in which agents also face cash-in-advance constraints. Both taxes discourage capital accumulation.

---

20. This model predicts that the output level decreases either with an increase in the rate of capital gains tax or inflation tax.

Notice that the capital-output ratio (5 year frequency) is 0.48 in the data, which is larger than the numbers in Tables 4 and 5. This implies that capital is under-accumulated in our model. This is because agents can live only finite periods and there is no inter-generational bequests in our model. As shown in Jones and Manuelli (1992), capital under-accumulation is a standard feature existing in any life-cycle model. It is clear that the analytical results reported here will be strengthened when capital is not under-accumulated in the model because a larger investment is more sensitive to the changes in two tax rates.

Table 6: How capital gains tax affects real cash holdings (RM/Y)

	τ=5%	τ=10%	τ=15%	τ=20%
p=2% (annual)	0.3284	0.3328	0.3371	0.3549

Table 7: How inflation affects aggregate real cash holdings (RM/Y)

	p=1%	p=2%	p=3%	p=4%
τ=10%	0.3509	0.3328	0.3168	0.2811

The results in the above tables show clearly that there are two offsetting effects of the taxes on real cash holdings, a portfolio effect (i.e., capital gains tax lowers the real return to stock holdings) and a wealth effect (i.e., inflation tax makes money less valuable). At low inflation rates, the portfolio effect dominates so that an increase in the capital gains tax rate encourages people to hold more cash and less capital. In contrast, at high inflation rates, the wealth effect dominates so that a further increase in capital gains tax rate discourages people to save in the form of money (and capital).

In this model, real cash holding represents an investor's real purchasing power. Therefore, RM/Y is not necessarily close to the ratio of monetary aggregate to GDP.

In addition, the current setup assumes that a transfer payment is financed partially by increased money growth, $(M_t - M_{t-1})/p_t$. This can be replaced by a more realistic modelling of Seigniorage term in the government budget constraint, $r_t M_t$. Will this modification change the dynamics of the real effects caused by inflation and capital gains tax? No, the modification will reduce the magnitude of transfers financed by increased money growth, and so would reduce the possible social welfare benefit of increased inflation. As a result, the change will strengthen our model's principal conclusions.

Table 8: How capital gains tax affects government transfer (TR/Y)

	τ=5%	τ=10%	τ=15%	τ=20%
p=2% (annual)	0.0309	0.0312	0.0320	0.0333

Table 9: How inflation affects government transfer (TR/Y)

	p=1%	p=2%	p=3%	p=4%
τ=10%	0.0146	0.0312	0.0439	0.0608

Given that a capital gains tax and inflation tax are the only two taxes in this model, the government transfer that is financed by taxes increases in both taxes. The numerical results show that the transfer is more responsive to inflation tax than capital gains tax. In the benchmark case, inter-generational redistribution is implicitly built into the transfer. Hence, in a world with a cash-in-advance constraint and imperfect capital markets, an increase in transfers, due to an increase in some tax rate, could increase social welfare. Government transfers essentially redistribute wealth from old generations to young generations through a tax system which distorts the incentives. Numerical results in Tables 8 and 9 confirm this proposition.

Table 10: How capital gains tax affects consumption (C/Y)

	τ=5%	τ=10%	τ=15%	τ=20%
p=2% (annual)	0.3421	0.3452	0.3497	0.3554

Table 11: How inflation affects consumption (C/Y)

	p=1%	p=2%	p=3%	p=4%
τ=10%	0.3761	0.3452	0.3238	0.2992

For a given inflation rate, a higher capital gains tax rate induces people to invest less but to consume more. The cash-in-advance constraint tells us why aggregate consumption increases in capital gains tax. That is because consumption is financed partially by government transfers, which increase in the capital gains tax revenue. In contrast, the inflation tax has an opposite effect on aggregate consumption. That is because a consumer's real purchasing power decreases in inflation. Specifically, if an agent saved m/p amount of cash last period, due to inflation, this agent encounters the loss, $(m/p)(1\text{-}1/z)$ in real purchasing power. Therefore, higher inflation means more purchasing power for government which comes from consumers who hold money. Inflation makes both liquid and illiquid assets (money and other assets) less valuable. Hence a higher inflation rate implies less investment and a lower level of consumption.

Table 12: How capital gains tax affects social welfare $((\frac{\Delta c}{c})\,/Y)$

	τ=5%	τ=10%	τ=15%	τ=20%
p=2% (annual)	0%	0.1%	-0.3%	-0.8%

Table 13: How inflation affects social welfare ($(\frac{\Delta c}{c})/Y$)

	$\dot{p}$=1%	$\dot{p}$=2%	$\dot{p}$=3%	$\dot{p}$=4%
τ=10%	0%	-1.6%	-2.4%	-3.9%

Note that in Tables 12 and 13 the numbers represent the welfare changes (from the lowest tax rate case) in terms of the percentage changes in the average consumption of all generations. The experimental results show that higher inflation implies lower social welfare given a fixed capital gains tax rate. In this case, the welfare loss due to the inflation distortion is larger than the welfare gain from the inter-generational transfer. However, the quantitative results also show that social welfare is not strictly decreasing while capital gains tax rate increases. When the initial inflation and capital gains tax rates are low, the welfare gains due to government transfer payment dominate the welfare loss due to the distortion tax. Therefore, this exercise suggests that the distributive effect of taxes can not be ignored in the welfare analysis. This result is consistent with the empirical evidence found by Groshen and Schweitzer (1997).

Relative to the 0.5% consumption equivalent welfare cost found by Imrohoroglu and Prescott (1992), the result here is more significant. With a 10% capital gains tax rate, even when the annual inflation rate increases slightly, say from 1% to 4%, the welfare loss experienced by the consumers is large. Average consumption of each consumer needs to be increased by 3.9% to restore the social welfare level to that at the lower 1% inflation rate. Also, it is worth noting that the welfare cost due to capital gains tax is much smaller than that due to inflation. In summary, the analysis conducted in this paper identifies a channel from which inflation generates a large welfare cost, namely the interaction with capital gains taxation. This paper also supplements the literature on the overlapping generation model with money. It demonstrates that money transfer as wealth transfer can still play some role in social welfare.

5. Concluding Remarks

For decades, economists have tried to identify channels through which inflation distorts the economy. *Inter alia*, Lucas (1972) focuses on the confusion between aggregate and relative price movement, Cooley and Hansen (1989) on the transaction role of money, Cooley and Hansen (1991) on the substitution between cash goods and credit goods, Imrohoroglu and Prescott (1991) on the self-insurance purpose of money, Diaz-Gimenez et al. (1992) on the distortion through mortgage market, and Cho, Cooley and Phaneuf (1994) on the distortion through nominal wage contracting.

This paper highlights the interaction between inflation and a distorting tax in the financial market. It demonstrates that asset holdings over the life cycle as well as aggregate capital accumulation are significantly affected by a change in inflation and capital gains tax rate. Given a 10% capital gains tax, an annual increase in the inflation rate from 1% to 2% can result in a 1.6% consumption- equivalent social welfare cost in five years. In summary, this paper finds a channel through which inflation generates a relatively large welfare cost. In addition, this paper supplements the literature of overlapping generations model with money. It shows that the money transfer as wealth transfer can still play some role in the determination of social welfare. An ongoing extension of this research includes idiosyncratic shocks in the model and an examination of the welfare cost of the joint distortions.[21]

This research also provides an algorithm to solve a life-cycle portfolio problem when there are some thresholds in asset trading.[22] The thresholds studied in this paper are totally artificial and created by a distorting government policy, namely, a capital gains tax.[23] The algorithm developed here can be modified to study other thresholds in financial markets such as the artificially large denomination of assets such as government bonds and indivisible household capital investment.

---

21. There is one hypothesis we need to test in this model: a higher variance of inflation might lead to even higher welfare cost. Intuitively, in a stochastic inflation model, people might want to wait for lower inflation to sell their stock to realize the gains. We plan to use a simulation technique to test if our model can generate such results.
22. For instance, Aiyagari and Gertler (1991) study the thresholds in asset trading created by transaction costs.
23. An example of this as such includes asset-based social insurance studied by Hubbard, Skinner and Zeldes (1995).

Appendix: The algorithm

For the representative agent of generation j, his state variables are:

$k_j = (k_{1j}, \ldots, k_{j-1j})$: a historical summary of his asset holdings;

$\hat{m}^j$: money holdings at the beginning of period; and

h^j : labor productivity index.

The economy-wide state variables are:

$\hat{q}$: relative price of capital goods; and

z : inflation rate.

The basic algorithm for computing the stationary equilibrium consists of the following steps:

(1). Given a triple of the policy parameters, $\{z, \tau_m, \tau_g\}$, and an initial aggregate capital stock, k_0; select the grids for each variable in the state space, $k_l^j \in \tilde{K} = [\tilde{k}_1, \ldots, \tilde{k}_{n_1}]$, l=1,2,...,j-1, and $\hat{m}^j \in \tilde{M} = [\tilde{m}_1, \ldots, \tilde{m}_{n_2}]$.

(2). Given a guess on the lump-sum transfer, $\widehat{TR}$, and asset price, $\hat{q}$, solve a typical agent's finite-period dynamic programming problem by backward recursion approach to get the policy function on $(c^j; k^j, s_n^j; \hat{m}^j)_{j=1,\ldots,J}^{n=1,\ldots(j-1)}$, starting from the generation J, for each point in the discrete state space, $\tilde{K} \times \tilde{M}$.

•For the generation J, given each point, $\hat{m}^J \in \tilde{M}$,[24] the representative agent in this generation has a trivial decision rule: he will consume the sum of his money holdings and transfer,

$$V^J(\hat{m}^J) = max\{u(c^J)\} \tag{25}$$

$s.t.$

24. We do not need to consider the grids for asset holdings here since the last generation will sell all their assets before last period. Since J-1<R (the retired age), there is no wage income for the retired agents.

$$c^J = \frac{\hat{m}^J}{z} + \hat{TR} \tag{26}$$

•For the generation J-1, given each point, $(k_1^{J-1}, \ldots, k_{J-2}^{J-1}, \hat{m}^{J-1})_{(J-1)\times 1}$, the representative agent will sell all his stocks, k_n^{J-1} for n=1,...,J-1, and solve the problem:

$$V^{J-1}(k_1^{J-1}, \ldots, k_{J-2}^{J-1}, \hat{m}^{J-1}) = max_{\{c^{J-1}, \hat{m}^J\}}\{u(c^{J-1}) + \beta \cdot V^J(\hat{m}^J)\} \tag{27}$$

s.t.

$$c^{J-1} = \frac{\hat{m}^{J-1}}{z} + \hat{TR} \tag{28}$$

$$\hat{m}^J = r \cdot \sum_{n=1}^{J-2} k_n^{J-1} + \hat{q} \cdot \sum_{n=1}^{J-2} [1 - \tau_g(1 - z^{-n})] \cdot (1 - \delta) \cdot k_n^{J-1} \tag{29}$$

Since the cash-in-advance constraint (CIA) and the budget constraint hold in equality at optimum, c^{J-1} is determined by the CIA constraint and it's a $n_2 \times 1$ vector. For each point in state space, we use the agent's budget constraint to compute the solution matrix for money holdings, which is a $(n_1^{J-1} \cdot n_2) \times 1$ vector. $\hat{m}^J$ is determined by the budget constraint so it may not be one of the grids for $\hat{m}$. Since the value function is monotonic on $\hat{m}$'s, we can use the linear interpolation to get the value of the value function if this case happens.[25]

•For the generation J-2, given each point, $(k_1^{J-2}, \ldots, k_{J-3}^{J-2}, \hat{m}^{J-2})$, the representative agent solves the following problem; this problem is valid for all agents with ages falling between R and J-2.

$$V^{J-1}(k_1^{J-2}, \ldots, k_{J-3}^{J-2}, \hat{m}^{J-2}) = max_{\{k_0^{J-2}, s^{J-2}, c^{J-2}, \hat{m}^{J-1}\}}\{u(c^{J-2}) + \beta \cdot V^{J-1}(k_1^{J-1}, \ldots, k_{J-2}^{J-1}, \hat{m}^{J-1})\} \tag{30}$$

s.t.

$$c^{J-2} = \frac{\hat{m}^{J-2}}{z} + \hat{TR} \tag{31}$$

25. This method is widely used in the literature. For instance, see Gomme and Greenwood (1995) and Imrohoroglu, Imrohoroglu and Joines (1993). For more details, see Press et. al. (1992).

$$\hat{q}\cdot k_0^{J-2} + \hat{m}^{J-1} = r\cdot\sum_{n=1}^{J-3} k_n^{J-2} + \hat{q}\cdot\sum_{n=1}^{J-3}[1-\tau_g(1-z^{-n})]\cdot s_n^{J-2} \tag{32}$$

$$0 \le s_n^{J-2} \le (1-\delta)\cdot k_n^{J-2} \tag{33}$$

with the laws of motion for asset holdings,

$$k_1^{J-1} = k_0^{J-2} \tag{34}$$

and

$$k_{n+1}^{J-1} = (1-\delta)\cdot k_n^{J-2} - s_n^{J-2} \tag{35}$$

for n=1,...,J-3. According to the feature that agents sell their newly purchased assets first, when we search across the grids for optimal s_n^{J-2}, we start from $s_n^{J-2} = 0$. If the total sales are larger than k_n^{J-2}, then select s_{J-3}^{J-2} to be the smallest grid of $\tilde{K}$. The same logic is applied for the choices of other sales variables.

•For the agents of generation $j\in\{2,\ldots,R\text{-}1\}$, they solve the following problem,

$$V^{j-1}(k_1^{j-1},\ldots,k_{j-2}^{j-1},\hat{m}^{j-1}) = max_{\{k_0^{j-1},s^{j-1},c^j,\hat{m}^j\}}\{u(c^j) + \beta\cdot V^j k_1^j,\ldots,k_{j-1}^j,\hat{m}^j\} \tag{36}$$

s.t.

$$c^j = \frac{\hat{m}^{j-1}}{z} + \hat{TR} \tag{37}$$

$$\hat{q}\cdot k_0^{j-1} + \hat{m}^j = r\cdot\sum_{n=1}^{j-2} k_n^{j-1} + \hat{q}\cdot\sum_{n=1}^{j-2}[1-\tau_g(1-z^{-n})]\cdot s_n^j + w^e\cdot h^j \tag{38}$$

$$0 \le s_n^j \le (1-\delta)\cdot k_n^{j-1} \tag{39}$$

where

$$k_1^j = k_0^{j-1} \tag{40}$$

$$k_{n+1}^{j-1} = (1-\delta) \cdot k_n^{j-1} - s_n^j \tag{41}$$

•For the first generation,

$$V^1(°) = max_{\{k_0^1, c^1, \hat{m}^2\}} \{\beta \cdot V^2(k_1^2; \hat{m}^2)\} \tag{42}$$

s.t.

$$\hat{q} \cdot k_0^1 + \hat{m}^2 = w^e \cdot h^1 \tag{43}$$

and

$$k_1^2 = k_0^1 \tag{44}$$

(3). Once we determine the first generation optimal decision rules, $(k_0^1, c^1, \hat{m}^2)$, we can use them and combine them with the decision rules for other generations to get the optimal route, $(k_0^1, s^{j-1}, c^j, \hat{m}^j)_{j=1}^J$.

The aggregate capital stock is updated by the following formula

$$K^{*'} = (1-\delta) \cdot K^* - S^* + I^* ,$$

and it will determine the marginal product of capital in the next iteration which is equal to the interest rate.

In equilibrium, all markets will be clear and the government budget will be in balance. Notice that money is assumed to be in equilibrium in all iterations and the commodity price plays no role here. Therefore it suffices to check only if the distribution of real money balance converges, which is part of the task of the next step.

(4). Relative price of capital $\hat{q}'$ is adjusted to clear the capital market,

$$\hat{q}' = \frac{[F(K^*, L) - C^*]}{[I^* - S^*]} \tag{45}$$

(5). Update the lump-sum transfer, $\hat{TR}'$, by equating the government budget constraint, that is,

$$\left[\frac{(J-R+1)}{J}\right] \cdot \hat{TR}' = \left(\frac{1-\frac{1}{z}}{J}\right) \cdot \sum_{j=1}^{J} \hat{m}^{j*} + \frac{\tau_g \cdot \hat{q}}{J} \cdot \left\{ \sum_{j=1}^{J} \sum_{n=1}^{j-1} [1-z^{-n}] \cdot s_n^{j*} \right\} \quad (46)$$

where $\hat{m}^{j*}$ is the real cash balance for generation j from the last iteration.

(6). If $|\hat{q}' - \hat{q}| \leq \varepsilon_q$ and $|\hat{TR}' - \hat{TR}| \leq \varepsilon_{tr}$, go to next step. Otherwise, $\hat{q} = \hat{q}'$ and $\hat{TR} = \hat{TR}'$, and $K^* = \sum_{i=1}^{J} \sum_{n=1}^{j-1} k_n^{j*}$, and repeat the process from the beginning.

Steady state means that the following distributions are stabilized, the distribution of real money holdings and the distribution of asset holdings. (Recall that the last generation agent will not buy new capital stock). If the two distributions have converged, stop. Otherwise, update the aggregate capital stock, and go to step (2).

References

Aiyagari, Rao. 1994. "Uninsured idiosyncratic risk and aggregate saving," *Quarterly Journal of Economics* 109, 659- 684.

Altig, David and Charles Carlstrom. 1991. "Inflation, personal taxes, and real output: a dynamic analysis," *Journal of Money, Credit and Banking* 23, 547-571.

Auerbach, Alan. 1988. "Capital gains taxation in the United States: realizations, revenue, and rhetoric," *Brookings Papers on Economic Activity* 0(2), 595-631.

Balcer, Yves and Kenneth Judd. 1987. "Effects of capital gains taxation on life-cycle investment and portfolio management," *Journal of Finance* 42, 743-758.

Champ, Bruce and Scott Freeman. 1994. *Modeling Monetary Economies*, New York: John Wiley & Sons, inc.

Cooley, Thomas, Jeremy Greenwood and Mehmet Yorukoglu. 1994. "The replacement problem," *Journal of Monetary Economics*, forthcoming.

Cooley, Thomas and Gary Hansen. 1989. "The inflation tax in a real business cycle model," *American Economic* Review 79, 733- 48.

Cooley, Thomas and Gary Hansen. 1991. "The welfare costs of moderate inflations," *Journal of Money, Credit and Banking* 23, 483-503.

Feldstein, Martin and Joel Slemrod. 1978. "Inflation and the excess taxation of capital gains on corporate stock," *National Tax Journal* 31, 107- 118.

Fischer, Stanley. 1982. "Seigniorage and the case for a national money," *Journal of Political Economy* 90, 295- 313.

Gomme, Paul. 1993. "Money and Growth revisited: Measuring the costs of inflation in an endogenous growth model," *Journal of Monetary Economics* 32(1), 51–78.

Groshen, Erica and Mark Schweitzer. 1997. "Inflation goals: guidance from the labour market?" *Current Issues in Economics and Finance*, Volume 3(15), Federal Reserve Bank of New York.

Imrohoroglu, Ayse and Edward Prescott. 1991. "Seigniorage as a tax: a quantitative evaluation," *Journal of Money, Credit and Banking* 23, 462-75.

Imrohoroglu, Ayse, Selahattin Imrohoroglu and Douglas Joines. 1993. "A numerical algorithm for solving models with incomplete markets," *International Journal of Supercomputer Applications* 7, 212- 230.

Internal Revenue Service. 1987-1991. "Statistics of Income: Individual Income Tax Returns," Publication 1304, Statistics of Income Division, Washington D.C.

Lucas, Robert. 1996. "Nobel Lecture: monetary neutrality," *Journal of Political Economy* 104, 661-682.

Marshall, John, Jon Sonstelie and Christian Gilles. 1987. "Money and redistribution", *Journal of Monetary Economics* 20, 3-23.

Poterba, James. 1987. "How burdensome are capital gains taxes? evidence from the United States," *Journal of Public Economics* 33, 157-72.

Prescott, Edward. 1986. "Theory ahead of business cycle measurement," *Carnegie-Rochester Conference on Public Policy* 24, 11-44.

Seyhun, Nejat and Douglas Skinner. 1994. "How do taxes affect investors' stock market realizations? evidence from tax- return panel data," *Journal of Business* 67, 231- 62.

Stiglitz, Joseph. 1983. "Some aspects of the taxation of capital gains," *Journal of Public Economics* 21, 257- 294.

Bank of Canada Working Papers
Documents de travail de la Banque du Canada

Working papers are generally published in the language of the author, with an abstract in both official languages. ***Les documents de travail sont publiés généralement dans la langue utilisée par les auteurs; ils sont cependant précédés d'un résumé bilingue.***

1999

99-2	Capital Gains and Inflation Taxes in a Life-cycle Model	Charles Leung and Guang-Jia Zhang
99-1	Dynamic Employment and Hours Effects of Government Spending Shocks	Mingwei Yuan and Wenli Li

1998

98-22	A Non-Paradoxical Interpretation of the Gibson Paradox	S. Coulombe
98-21	Une nouvelle méthode d'estimation de l'écart de production et son application aux États-unis, au Canada et à l'Allemagne	R. Lalonde, J. Page et P. St-Amant
98-20	Evaluating Alternative Measures of the Real Effective Exchange Rate	R. Lafrance, P. Osakwe, and P. St-Amant
98-19	Can a Matching Model Explain the Long-Run Increase in Canada's Unemployment Rate?	A. Hornstein and M. Yuan
98-18	The Sale of Durable Goods by a Monopolist in a Stochastic Environment	G. Srour
98-17	La politique monétaire a-t-elle des effets asymétriques sur l'emploi	L. Pichette
98-16	Consumer Attitudes, Uncertainty, and Consumer Spending	D. Côté and M. Johnson
98-15	On the Believable Benefits of Low Inflation	C. Ragan
98-14	Non-Linearities in the Output-Inflation Relationship: Some Empirical Results for Canada	C. Dupasquier and N. Ricketts
98-13	Le PIB potentiel des États-Unis et ses déterminants : la productivité de la main-d'oeuvre et le taux d'activité	R. Lalonde
98-12	Un examen de la crédibilité de la politique monétaire au Canada	P. Perrier
98-11	Liquidity Effects and Market Frictions	S. Hendry and G. Zhang
98-10	Fundamentals, Contagion and Currency Crises: An Empirical Analysis	M. Kruger, P. Osakwe, and J. Page
98-9	Buying Back Government Bonds: Mechanics and Other Considerations	T. Gravelle
98-8	Easing Restrictions on the Stripping and Reconstitution of Government of Canada Bonds	D. Bolder and S. Boisvert

Copies and a complete list of working papers not listed here are available from:
Pour obtenir des exemplaires et une liste complète des documents de travail, prière de s'adresser à:

Publications Distribution, Bank of Canada
234 Wellington Street Ottawa, Ontario K1A 0G9

Diffusion des publications, Banque du Canada
234, rue Wellington, Ottawa (Ontario) K1A 0G9

E-mail / Adresse électronique: publications@bank-banque-canada.ca
WWW: http://www.bank-banque-canada.ca/
FTP: ftp.bank-banque-canada.ca (login: anonymous, to subdirectory/pub/publications/working.papers/)