Inflation and capital gains taxes in a small open economy

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Abstract

Inflation distorts an economy through many channels. This paper highlights the interaction between inflation and capital gains tax and their distortions to a small open economy through the financial market. This research captures several observations. First, capital formation or investment is an important channel for consumption smoothing over the life cycles. Second, capital gains are taxed only when the gains are realized. Third, inflation introduces an upward bias in the calculation of tax base. Thus, a capital gains tax in the presence of inflation can have a significant welfare effect even though its contribution to the government revenue is relatively small. The quantitative analysis shows that high inflation alone can lower social welfare. This problem becomes more severe when capital gains tax is introduced in an inflationary economy. The implicit inflation tax can be more hazardous to the economy than the explicit counterpart. © 2000 Elsevier Science Inc. All rights reserved.

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1. Introduction

As the financial markets mature in a modern economy, capital gains tax concerns more to economists and policy makers. This tax has been adopted in a certain number of countries such as Canada and the United States. The pros and cons has been discussed extensively in the literature.\textsuperscript{1} However, the literature typically focuses on

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the effect of capital gains tax on portfolio choices and asset returns. It has ignored the joint distortion of capital gains tax and inflation tax. By constructing a life-cycle economy, we plan to investigate how capital gain tax distorts consumption and investment decisions in an inflationary economy. We are more interested in the policy implications to some small open economies such as Canada and Hong Kong.

The consequences of such a distortion on individuals’ behavior may be complicated. On the one hand, inflation imposes a tax through the cash-in-advance constraint and encourages investors to reallocate their portfolio towards capital. On the other hand, capital gains tax will decrease the total amount of investment. This in turn will affect the wage rates. In addition, purchasing power is also redistributed to the “poor” through the transfer financed by taxes. The total effect on consumption and other macro variables is very complicated, and therefore a dynamic general equilibrium model is developed to capture and quantify these interactions.

This paper attempts to quantify the joint welfare loss due to inflation and capital gains taxes in a small open economy. As it is standard in the literature, the interest rate in the small economy is assumed to be constant and determined in the world capital market. Then the paper provides some estimates of the welfare cost of inflation and capital gains tax.

The general equilibrium inflation tax literature typically focuses on the distortions related to the “real side” of the economy. This paper, however, concerns how inflation distorts the economy through the financial side. In spirit, this paper is close to Altig and Carlstrom (1991) which analyzes how inflation amplifies the distortion caused by the income tax. However, our model is different from theirs in two ways. First, in their model money acts as a unit of account only, while here money exists as a medium of exchange. In addition, inflation is also a vehicle of income redistribution in this paper. Second, they focus on capital income tax but this paper studies the capital gains tax, which applies only when investors decide to realize the nominal gain. It has the “option feature.” 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 an algorithm different from many of the existing studies, which is a generalization of Imrohoroglu, Imrohoroglu, and Joines (1993).

The next section provides a formal description of the baseline model. Section 3 describes the calibration and discusses the results. The final section concludes.

2. The model

Time is discrete and the horizon is infinite. This is a multiperiod overlapping generation model without any uncertainty. An agent lives for exactly $J$ periods but retires at age of $R, R < J$. When the oldest cohort dies, a new cohort of exactly the same size will be born. Thus, at any given time, there are $J$ different age cohorts in the economy, each of equal size $1/J$. The total population is constant over time and is normalized to unity.

There is only one kind of good produced, which can be either consumed or invested in the economy. Continuous monetary growth drives the nominal price of consumption
goods and capital goods to increase over time. Since capital gains are measured in nominal terms, capital purchased at earlier periods can potentially realize “more” capital gains and thus carries more tax obligations after sale. Therefore, taking the constant capital gains tax rate \( \tau_g \) and inflation rate \( \pi \) into consideration, utility-maximizing agents treat stocks purchased at different dates as different assets.

At the beginning of period \( t \), individuals collect transfers \( TR_t \), 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 supply is exogenous and normalized to unity. Individuals receive labor from the previous period and transfer. Then individuals supply their capital and labor to firms. 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 supply is exogenous and normalized to unity. Individuals receive labor income (which depends on their age-dependent productivity \( h^t \), and wage per efficiency unit \( w^t \)), and rental income (which is the marginal product of capital) from firms. Capital depreciates before trading occurs in the capital market. Agents receive revenue from selling capital. After paying taxes, agents allocate the left funds between investment and money holding for consumption in the following period.

The maximization problem faced by the age \( j \) representative agent, \( 2 \leq j \leq J \), at time \( t \), with portfolio \( k^t_j = (k^t_{j,1}, \ldots, k^t_{j,n}) \), where \( k^t_{j,n} \) is individual \( j \)'s \( n \)—period stock holding at time \( t \), real money balance \( m^t_{t-1}/p_t \geq 0 \), and age-dependent labor productivity index \( h^t_j \), is described in Eq. (1) as follows:

\[
V^t(k^t_j, h^t_j, m^t_{t-1}/p_{t-1}; q_t, Q_t, \Pi_t) = \max_{s_t^j, h^t_j, m^t_{t-1}/p_{t-1}} \left\{ u(c^t_j) + \beta E \left[ \frac{1}{1 + \pi_{t+1}} \left( k^{t+1}_{j,1}, h^{t+1}_{j,1}, m^{t+1}_{t+1}/p_{t+1}; q^t_{t+1}, Q^t_{t+1}, \Pi^t_{t+1} \right) \right] \right\},
\]

where \( s^t_j = (s^t_{j,1}, \ldots, s^t_{j,n}) \), \( Q_t = (q^t_{t-1}, q^t_{t-2}, \ldots, q^t_{t-j+1}) \) and

\[
c^t_j \leq (m^t_{t-1}/p_{t-1})(p_{t-1}/p_t) + D_t \ast TR_t, \quad (2)
\]

\[
q_t k^t_{j,n} + c^t_j + (m^t_{t-1}/p_{t-1})(p_{t-1}/p_t)
\]

\[
+ \sum_{n=1}^{n-1} \left[ q_t - \tau_g \left[ q_t - q^t_{t-n} \Pi^t_{t-n-1} \frac{1}{1 + \pi_{t-n}} \right] \right] s^t_{j,n}
\]

\[
+ D_t \ast TR_t + w_t h^t_j + r_t \sum_{n=1}^{n-1} k^t_{j,n},
\]

\[
k^{t+1}_{j,n+1} = (1 - \delta)k^t_{j,n} - s^t_{j,n}, \quad \text{for } n = 1, \ldots, j - 1,
\]

\[
0 \leq s^t_{j,n} \leq (1 - \delta)k^t_{j,n}, \quad n = 1, \ldots, j - 1,
\]

for \( j = 1, 2, \ldots, J \). It is assumed that \( V^{t+1}(.) = 0 \). The explanations of these equations are in order. Eq. (2) is a form of cash-in-advance constraint. Transfers, \( TR_t \), (in real terms) are distributed only to the retired and the newly born. Therefore, an indicator function \( D_t \) is used,

\[
D_t = \begin{cases} 
1 & j = 1, R + 1, \ldots, J \\
0 & \text{otherwise}
\end{cases}
\]

Notice that the purchasing power of real money balance carried from previous period \( (m^t_{t-1}/p_{t-1}) \) is discounted by inflation between periods \((t - 1)\) and \( t \), \( (p_{t-1}/p_t) = \frac{1}{1 + \pi_t} \).
where $\pi_t$ is the period $t$ inflation rate. And we define a shorthand $\Pi_j = (\pi_j, \pi_{j-1}, \ldots)$ to represent the history of inflation rates experienced by the age-$j$ agent. For those newly born, cash balance is zero and their consumption can only be financed by government transfers. Eq. (3) is simply the age-$j$ agent’s periodic budget constraint. The right-hand side of this equation represents total income, which is the sum of the money carried over from last period $(m_{t-1}/p_{t-1})$, the revenue from selling capital stock, $s_{jt}$, $n = 1, \ldots, j - 1$, at the consumption price of capital, $q_t$, the transfer from the government if any, plus the current period labor income $w_t h_t^j$ and the dividend income $r_t \sum_{n=1}^{t-1} k_{t,n}$. The left-hand side of the equation is the total expenditure in consumption and investment, which is the sum of investment, $q_t k_{t,j}$, consumption, $c_t$, and money holding for the next period $(m_{t-1}/p_t)$. Given that it is a small open economy, we assume that interest rate is exogenously set at a constant level. Notice also that the after-tax revenue of selling a unit of stock that has been held for $n$ periods can be rewritten as,

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

an average of selling price and buying price, weighted by the capital gains tax rate. 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. 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, $\tau_s$, is zero, inflation by itself cannot drive this wedge. In that case, there is only inflation-based distortion in the open economy. Thus, this expression demonstrates the distortion caused by the interaction of the inflation tax and capital gains tax.

Eq. (4) is the law of motion for capital stock. It states that the amount of $(n+1)$ period old capital in period $(t+1)$, $k_{t+1,n+1}$ is the amount of $n$ period old capital in period $t$, $k_{t,j}$, after depreciation (with rate of $\delta$) and net of sales, $s_{jt}$. Eq. (5) places restrictions on the amount of sales. Since the capital market opens after the production (and the depreciation of capital), the amount of sale of each cohort of capital cannot exceed the corresponding amount of capital after depreciation. Short-sale is not allowed neither. $V^{t+1}(.) = 0$ implies that there will be no bequest at the equilibrium.

**Conjecture 1.** When an agent considers to sell capital, he/she will first sell that purchased later. That bought last will be sold first.

The idea behind this conjecture is clear. Selling a unit of capital that has been held for $n$ periods, can generate $\{(1 - \tau_s)q_t + \tau_s q_{t-n} \prod_{d=1}^{n-1} \left(\frac{1}{1 + \pi_t - d} \right) \}$ units of consumption goods, and selling a unit of capital that has been held for $n'$ $(n < n')$ periods, can generate $\{(1 - \tau_s)q_t + \tau_s q_{t-n'} \prod_{d=1}^{n'-1} \left(\frac{1}{1 + \pi_t - d} \right) \prod_{d=n}^{n'-1} \left(\frac{1}{1 + \pi_t - d} \right) \}$ 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. Also notice that nominal
Capital gains will be inflated by the same factor \( (1 + \pi_p) \) if their sales are both postponed one period. The difference in after-tax revenue persists. Hence, it is optimal to sell the one purchased later. While this conjecture is not verified formally, it is confirmed in the numerical experiments considered.

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

\[
    u(c_t) = \frac{(c_t)^{1-\sigma}}{1-\sigma},
\]

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

\[
    F(K_t, L_t) = AK_t^\alpha(L_t)^{1-\alpha}, \quad r_t = F_t(\cdot, \cdot), \quad w_t = F_t(\cdot, \cdot) \quad (6)
\]

where \( K_t = \left( \sum_{j=1}^J \sum_{n=1}^{t-1} k_{j,n} \right) \) and \( L_t \) is simply the sum of exogenous labor supply. \( L_t = \left( \sum_{j=1}^J h_t \right) \). The equilibrium conditions for the capital market and money market are described by Eqs. (7) and (8) respectively:

\[
    F(K_t, L_t) - C_t = q_t(I_t - S_t) \quad (7)
\]

and

\[
    \frac{1}{J} \sum_{j=1}^J \frac{m_t^{i+1}}{p_t} = M_t \quad (8)
\]

where \( C_t = \left( \frac{1}{J} \right) \sum_{j=1}^J c_t, \quad I_t = \left( \frac{1}{J} \right) \sum_{j=1}^J k_{j,0}, \) and \( S_t = \left( \frac{1}{J} \right) \sum_{j=1}^J \sum_{n=1}^{t-1} s_{t,n} \).

The value of the net investment, \( q_t(I_t - S_t) \), is equal to the total output net of aggregate consumption, \( F(K_t, L_t) - C_t \). The total amount of capital in the next period is simply the sum of existing capital after depreciation and new investment, as shown in Eq. (9):

\[
    K_{t+1} = (1 - \delta)K_t - S_t + I_t \quad (9)
\]

The government in this model is required to balance its budget in each period, as shown in Eq. (10):

\[
    [(J - R + 1)/J] \times TR_t = (M_t - M_{t-1})/p_t + \frac{z}{J} \sum_{j=1}^J \sum_{n=1}^{t-1} \left[ q_{t-\pi} - q_{t-\pi} \prod_{i=1}^{\pi-1} \left( \frac{1}{1 + \pi_p} \right) \right] s_{t,n} \quad (10)
\]

where \( M_t = zM_{t-1} \). The amount of transfer payments must be financed by money creation \( (M_t - M_{t-1})/p_t \) and capital gains tax revenue. Notice that the total population is unity. However, only the newly born and the retired receive transfers. This is reflected by the fact that \( TR_t \) is attached to a scaling factor \( (J-R+1)/J \). This assumption is justifiable in a country like Canada, where the government has designed various
welfare-enhancing programs for youth, seniors, and those who are less fortunate. The assumption tends to capture this stylized fact.

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

**Definition 2.** A Competitive Equilibrium is a collection of sequence of prices \( \{r_t, w_t, q_t\}^{\infty}_{t=0} \) and real allocations \( \{k_j^{t}, m_j^{t}/p_j, s_j^{t}\}^{\infty}_{t=1} \) for all \( j = 1, \ldots, J \) and \( t = 0, \ldots, \infty \), such that:

1. Real allocations \( \{k_j^{t}, m_j^{t}/p_j, s_j^{t}\}^{\infty}_{t=1} \) solve individuals’ maximization problems subject to the constraints (2)–(3), taking the sequence of prices \( \{r_t, w_t, q_t\}^{\infty}_{t=0} \) as given;
2. The sequence of prices \( \{r_t, w_t, q_t\}^{\infty}_{t=0} \) is consistent with all market clearing conditions (6)–(8) and
3. The government balances its budget (10).

### 3. Results

#### 3.1. Calibration

This section presents the parameter values used in the computation and the results obtained. Following the literature, we assume the “economically active lifetime” to be 55 years. We take 5 years as one period and hence set \( J \) to be 11 and \( R \) to 9. The rest of the calibration procedure is standard and the parameter values are summarized in Table 1.

This paper focuses on the steady state in which the inflation rate will coincide with the money growth rate. Different values of inflation rates are used in the experiment. It should be noted that one period in the model corresponds to 5 years, and that a 10% inflation rate will be translated into a 50% growth rate per period, or a growth factor of 1.5 per period. Even in the United States, there is no consensus about how to compute the precise value of marginal capital gains tax rates over the years. Nevertheless, the empirical work of Auerbach (1988), Gouveia and Strauss (1994) and Protopapadakis (1983) give similar estimates and 10% is within their range. We assume 10% capital gains tax rate for the numerical experiments here. Stokey and Rebelo (1995) find that the usually assumed 10% depreciation rate per year is over-
stated 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. The labor productivity index is constructed by Rios-Rull (1994), based on CPS:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$h^1$</th>
<th>$h^2$</th>
<th>$h^3$</th>
<th>$h^4$</th>
<th>$h^5$</th>
<th>$h^6$</th>
<th>$h^7$</th>
<th>$h^8$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical Value</td>
<td>0.28</td>
<td>0.83</td>
<td>1.27</td>
<td>1.45</td>
<td>1.62</td>
<td>1.71</td>
<td>1.62</td>
<td>1.41</td>
</tr>
</tbody>
</table>

and $h^i = 0$, $i = 9, 10, 11$. Furthermore, given the computing constraints, capital is exogenously limited not to held for more than four periods. This is merely a technical condition and can be readily relaxed. The computation procedures here follow Leung and Zhang (1996) closely and are available upon request.

3.2. Numerical results

A number of policy experiments have been conducted to examine how social welfare changes when (1) only inflation is introduced, and (2) both inflation and capital gains taxes coexist in this small open economy. The policy parameters, the annual money growth rate (or the inflation tax rate) $p = (z - 1)/5$, and capital gains tax rate $\tau$, 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. Here the variation in social welfare is measured in terms of the percentage change in consumption. The quantitative results are given below. (All the results are expressed as the ratio of the value of the variable to the value of its counterpart in the no-tax benchmark. Notice that there is not any tax distortion when there is no inflation in the economy.)

It is clear from Table 2 that for a given (positive) inflation rate, an increase in capital gains tax rate leads to a decrease in the ratio of capital stock to output. When there is no capital gains tax in the open economy, a moderate inflation tax motivates the agents to hold more capital stock. However, when the capital gains tax is 10%, an increase in the inflation rate tax will discourage capital accumulation severely. These apparently contradicting results can be better understood when we compare the tax effects on aggregate (real) money holding.

The results in Table 3 show clearly that there are two offsetting effects of the taxes on real cash holdings. From cash-in-advance constraint, we learn that inflation tax

<table>
<thead>
<tr>
<th>$\tau = 0%$</th>
<th>$p = 0%$</th>
<th>$p = 4%$</th>
<th>$p = 10%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tau = 0%$</td>
<td>100%</td>
<td>122%</td>
<td>92%</td>
</tr>
<tr>
<td>$\tau = 10%$</td>
<td>100%</td>
<td>80%</td>
<td>84%</td>
</tr>
</tbody>
</table>
reduces the value of real cash balance so as to make money less attractive. From the budget constraint, we understand that either inflation or capital gains tax decreases the total wealth and hence the total amount of investment. Therefore, these two taxes generate the opposite impacts on real cash holdings. As we can see from Table 2, at low inflation rates, the capital gains tax effect dominates the inflation effect and encourages agents to hold more cash and less capital (in percentage terms). When inflation is severe, agents prefer to consume now and eschew any form of investment.

Given that capital gains tax and inflation tax are the only two taxes in Table 4, the government transfer can only be financed by these two taxes. The numerical results in Table 3 show that the transfer is more responsive to inflation tax than capital gains tax. In the benchmark case, intergenerational 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 could increase the social welfare through a redistribution of consumption. Government transfers essentially redistribute wealth from the middle-aged generations to young and retired generations through a tax system which distorts the incentives.

As Table 5 shows, at any given inflation rate, a higher capital gains tax rate induces people to invest less but to consume more. In other words, it discourages the agents from “smoothing out” their consumption over the lifetime. 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, \( (m/p)(1 - 1/z) \), 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 for working-age agents but a higher level of consumption for the young and the old.

Higher tax rates lead to lower levels of aggregate consumption. This translates into higher levels of social welfare, as seen in Table 6. In a life-cycle model when the
agents have an inverted-U-shaped labor productivity and diminishing marginal utility of consumption in each period, the timing of consumption is very important. Since the channels of intertemporal allocation are distorted, the agents are forced to consume more than they would when the incomes are higher and less than they would when the incomes are low. Table 5 provides the welfare losses in terms of the percentage changes in consumption of all generations. When there is no capital gains tax and the inflation rate is low, the economy can in fact enjoy a higher social welfare relative to the zero tax regime. It is consistent with the general findings in the overlapping generation models that the competitive equilibrium is not socially optimal. However, the introduction of capital gains tax could outweigh the welfare gains. It means that it can actually do harm to even a small open economy with low inflation rate (such as Canada), and more harms to economies with high inflation rate (such as Hong Kong and Taiwan).

Recall that in Imrohoroglu and Prescott (1992), agents are subject to idiosyncratic employment risk and money is the only available asset for self-insurance. The welfare cost of increasing inflation from 0% to 4% is only 0.5% of average consumption. Here, we abstract from the idiosyncratic labor income shocks but instead introduce the capital gains tax. We also include physical capital as assets. At a 10% capital gains tax rate, even when the annual inflation rate increases slightly, say from 0% to 4%, the welfare loss experienced by the consumers can be just as large as the finding of Imrohoroglu and Prescott (1992). Table 6 tells us that consumption of each consumer needs to be increased by 0.72% (0.09% = (−0.63%) to restore social welfare level at 0% inflation rate. Social welfare cost becomes even larger at a higher level of inflation. 10% annual inflation rate coupled with 10% capital gains tax can lead to welfare loss more than twice of what Imrohoroglu and Prescott has found!

In summary, the analysis conducted in this paper identifies a channel from which inflation generates large welfare cost, namely the interaction with capital gains taxation. This paper also supplements the literature of overlapping generation model with

Table 5
How the two taxes affect consumption

<table>
<thead>
<tr>
<th></th>
<th>p = 0%</th>
<th>p = 4%</th>
<th>p = 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>τ = 0%</td>
<td>100%</td>
<td>109%</td>
<td>137%</td>
</tr>
<tr>
<td>τ = 10%</td>
<td>100%</td>
<td>130%</td>
<td>141%</td>
</tr>
</tbody>
</table>

Table 6
How the two taxes affect social welfare (∆c/c)

<table>
<thead>
<tr>
<th></th>
<th>p = 0%</th>
<th>p = 4%</th>
<th>p = 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>τ = 0%</td>
<td>0%</td>
<td>0.09%</td>
<td>−0.84%</td>
</tr>
<tr>
<td>τ = 10%</td>
<td>0%</td>
<td>−0.63%</td>
<td>−1.24%</td>
</tr>
</tbody>
</table>
money. It demonstrates that money transfer as wealth redistribution can still play some role in social welfare.

4. Concluding remarks

For decades, economists have tried to identify channels through which inflation distorts the economy. This paper highlights the interaction between inflation and a distorting tax in the financial market in a small open economy. It is demonstrated that asset holding over the life cycle as well as aggregate capital accumulation are significantly affected by the change in inflation and capital gains tax rate. In an economy without capital gains tax, an increase in the inflation rate from 4% to 10% can result in a social welfare cost equivalent to a deduction in 0.93% consumption of each consumer. When there is a moderate capital gains tax, the same change in the inflation rate will imply an additional 0.4% deduction in each consumption.

While these numbers are larger than the figures typically found in the literature, it still seems to be relatively small for policy considerations. There are several possible reasons for that. The real interest rate is fixed here (the small open economy assumption). Economic growth is assumed away. The labor supply is also assumed to be fixed here. The cash-in-advance constraint applies only to consumption but not investment goods. We did not consider the welfare cost along the transition path. If these assumptions are relaxed, it would lead to a bigger effect. We left these extensions to future research. In sum, this paper identifies the 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 have significant consequences on the social welfare. An ongoing extension includes idiosyncratic shocks in the model and an examination of the welfare cost of the joint distortions.

A side product of this research is to provide an algorithm to solve a life-cycle portfolio problem in a general equilibrium context when there are some “thresholds” in asset trading. The thresholds studied in this paper are totally artificial and created by a distorting government policy, namely, capital gains tax. The algorithm developed here can be modified to study other thresholds in financial markets like the artificially large denomination of assets such as government bonds and individual household capital investment.

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ees for comments and suggestions. We are also grateful to Wai Ling Law for capable technical assistance and Chinese University of Hong Kong Direct Grant for financial support. The opinions expressed herein are our own and do not necessarily represent those of the Bank of Canada.

Notes

1. For instance, see Balcer and Judd (1987), Auerbach (1988), and Seyhum and Skinner (1994).
2. Since capital gains are measured in nominal terms, inflation will introduce an upward bias in the calculation of capital gains. 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. There is a large literature on this effect and it is infeasible to discuss this literature here. For a textbook treatment, see Champ and Freeman (1994), among others.
4. We consider only the flat rate tax. See Stokey and Rebelo (1995) for justifications.
5. Inflation rates differ significantly across economies. For instance, while 10% inflation per annum is very high by Western standards, it is not so in Asia. According to International Financial Statistics, the consumer price index in Taiwan has increased at least 23 times between 1950 and 1995.
6. Again, the literature is too large for us to even mention half of the contribution. See, for instance, Cooley and Hansen (1995) for a survey.
7. For instance, see Kwong, Leung, and Lui (1999) for more on this point.
8. It should be emphasized that the capital gains tax considered in this paper is a flat-rate tax. See Stokey and Rebelo (1995) for a discussion.
9. The non-negativity constraints in capital and money holdings reflect a form of imperfection in capital market and motivate agents to hold assets to smooth out consumption.
10. It is well known that government transfers are not distributed in a lump sum manner. See Smeeding et al. (1993), and Hanushek, Cheah, and Leung (1998). In the model, as it will become clear, the youth and retired would be more “constrained” than the “middle-aged,” and hence transfer distributed to them would likely provide a higher level of social welfare than the scheme in which transfers are distributed equally. Thus, alternative assumption on the distribution of transfer would probably strengthen our results. Also, we might abuse the notion of cash-in-advance constraint, because the right-hand side of this constraint includes more than cash for some agents.
11. Let the nominal price of capital be \( cp_t \). So \( cp_t = p_t \times q_t \). Hence \( cp_{t-\tau} \times p_t = cp_{t-\tau} \times p_{t-\tau} \times (p_{t-\tau} / p_{t-\tau+1}) \cdots (p_{t-\tau} / p_t) = q_{t-\tau+1} \prod_{s=1}^{\tau-1} (1 + \pi_{t-s})^{-1} \) where \( p_t / p_{t-1} = 1 + \pi_{t-1} \). It is then easy to see that the term \( \{q_t - \tau \times \prod_{s=1}^{\tau} (1 + \pi_s)\} \) is the after-tax revenue of selling one unit of capital purchased at price \( cp_{t-\tau+1} \) at price \( cp_t \) (in nominal terms).
12. Indeed, they will be equal in the steady state, \( q_t = q_{t-n}, \forall t, \forall n \).
13. Notice that in this model, capital depreciates after production but before sale. Therefore, “old capital” that is resold 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. 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.
16. Notice that without depreciation, \( I_t = S_t, \forall t \) 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 without a market transaction is impossible. In other words, a “sale” is necessary. Numerical experiments confirm this intuition.
17. The real inflation tax revenue \( \frac{M_t - M_{t-1}}{p_t} = (z - 1) \cdot \frac{M_{t-1}}{p_t} \). It is assumed that monetary expansions are anticipated in the model.
19. It is already a very moderate tax rate for capital gains. For most taxpayers in economies such as Canada’s, 10% is definitely an understatement. In the case of Hong Kong, if a capital gains tax is adopted, it is likely that capital gains will be treated as any other source of income, which is taxed at an essentially flat rate of around 15%.
20. It should be noted that our calibration is focused on the steady state; readers should read the results with cautions.
21. This result should be taken with caution. A referee points out that if there is no intergenerational transfer, any inflation would decrease the social welfare. On the other hand, the current setting attempts to give the “best chance” to the capital gains tax, so to speak. We want to show that even in an environment in which a low inflation can improve welfare, adding capital gains tax will definitely be welfare-damaging.
23. For instance, see Wang and Yip (1992) for a survey.
24. There is one hypothesis we need to test in the ongoing work: 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 simulation technique to test if our model can generate such results.
25. For instance, Aiyagari and Gertler (1991) study the thresholds in asset trading created by transaction costs.

26. 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.

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

References


*International Financial Statistics*, CD-ROM, IMF.


