Retrospective Capital Gains Taxation in the Real World

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Abstract

In this article, we analyze Auerbach's (1991) proposal of a retrospective capital gains tax, which is equivalent to an accrual tax on an ex-ante basis. Using a continuous-time model with stochastic interest rates, we prove that equivalence holds even if the risk-free asset return is correlated with other risky assets' returns. However, equivalence fails to hold on an ex-post basis. In other words, if an investor faces a huge gain (loss), the effective tax rate under this system is less (higher) than that what would be due under an accrual tax system. This leads to a fairness problem. For this reason, we also find the conditions that ensure equivalence on an ex-post basis. As will be shown, however, ex-post equivalence can be achieved only if a huge amount of information is available, making its implementation a hard task.

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Keywords: capital gains, risk, taxation.

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1 Introduction

Capital gains can be taxed either at accrual or at realization. The former method is preferable from a fairness point of view, as it taxes capital gains when they accrue, thereby providing a more precise measure of a taxpayer's ability to pay. Under this system, the taxpayer should fill an income tax return accounting for all changes in the assets' values. This would be easy if, during this period, shares were sold to other shareholders. Otherwise, the taxpayer would have to calculate changes in his/her portfolio on the basis of data that is often imprecise. In particular, it would not be easy to evaluate an asset that is not publicly traded (see Green and Sheshinski, 1979).[1] Given this limitation, most countries have therefore opted for a realization-based capital gains tax.[2] However, under this method, an investor is "locked-in", i.e., is encouraged to delay selling assets to save taxes (see, e.g., Constantinides, 1983).

In order to neutralize the lock-in effect and at the same time, implement a realization-based system, Auerbach (1991) proposes a retrospective capital gains tax device, which raises the effective tax burden if realization is postponed. He shows that this system is equivalent to an accrual method on an ex-ante perspective. By denoting this equivalence as holding-period neutrality, he proves that an investor is no longer encouraged to delay realization. Moreover, the Auerbach tax overcomes the informational problems arising from Vickrey's (1939) original proposal, which required the availability of information on past assets' price. Indeed, the retrospective tax formula simply requires asset's current price and the spot interest rate during the holding period.[3]

Auerbach's (1991) proposal suffers from at least two limitations. Firstly,

[1] The accrual method has another limitation if an investor is subject to liquidity constraints. As the tax burden may occur in a period when the taxpayer matures but does not realize the capital gains, a liquidity problem could arise. For instance, the taxpayer might be forced to sell part of his/her assets, against his/her own wishes, in order to pay the taxes.

[2] Italy is one of the few exceptions that implemented the accrual method for the management of non-qualified shareholdings in listed companies (see Bonzani et al., 2002; Alworth et al., 2003).

[3] Auerbach and Bradford (2004) merge Auerbach's (1991) and Bradford's (1997) findings and obtain a generalized cash-flow tax system. They show that from both an investor's and the government's point of view, their joint proposal is equivalent to a pure accrual tax system on an ex-ante basis.

it is based on the assumption that the risk-free interest rate is deterministic, although he states that the quality of results does not change if the risk-free asset is a "zero-beta" one, i.e., "carries no risk premium" (footnote 2, p. 169). Auerbach (1991) also implicitly assumes that risky asset returns are serially uncorrelated, i.e., evolve according to a random walk. As pointed out by Fama and French (2004) however, the "zero-beta" assumption is not supported by empirical evidence. As shown, e.g., by Shiller and Beltratti (1992), there is a negative correlation between stock returns and changes in interest rates. Peersman and Smets (2005) also show that monetary policy may deeply affect stock market returns. In particular, interest rate pegging strategies by central bankers have a heterogeneous impact on industries' returns. Moreover, Campbell and Shiller (1988) and Campbell (2008) show that excess stock returns can be predicted by means of lagged financial variables.

The second limitation of the retrospective tax device is given by the absence of ex-post equivalence. In other words, if an investor faces a huge gain, the effective tax rate under this system is less than that what would be due under an accrual tax system. The converse is true if an investor faces a loss. Auerbach (1991) argues that the absence of ex-post equivalence may be a problem in terms of fairness. In order to tackle this issue, Kaplow (1994) applies a two-period model and shows that the retrospective tax is neutral from an ex-post perspective, if the government can implement an optimal portfolio strategy. The reasoning behind this result is as follows: if the government can make the same portfolio strategies as individual investors (in each state of the world), it is therefore able to make the investors' actual net positions the same as they would be under an accrual tax.[4] A similar result can be obtained by letting fiscal policy be state-contingent, in line with Zhu (1992).

In this article we deal with Auerbach's proposal, by assuming a more realistic framework where the spot interest rate is stochastic and may be correlated with risky asset returns. Moreover, we account for Kaplow's caveat that "[a]llowing many periods [...] makes the definition and practical implementation of ex ante and ex post concepts more complex" (footnote 14, p. 797). For this reason, we will apply a continuous-time framework.

We have two results. Firstly, we will show that ex-ante holding-period neutrality holds in a more realistic setting, where the risk-free asset is not

[4] For further details see Weisbach (2004).

necessarily a "zero-beta" security. Secondly, we will prove that ex-post equivalence can be achieved by applying a state-contingent tax rule. To do so, however, we need information not only on current but also on past prices: this leads to the same critique raised on Vickrey's (1939) proposal and therefore, suffers from severe implementation problems.

The structure of this article is as follows. Section 2 introduces and discusses the assumptions of the model used to address the capital gains tax problem. Section 3 contains the equivalence results on both an ex-ante and ex-post basis. Section 4 summarizes our findings and discusses their policy implications.

2 A continuous-time model

In line with Auerbach (1991), we introduce a partial-equilibrium model, with continuous time. For simplicity, we assume the existence of only two assets: a risk-free asset and a risky one.

We define $S(t)$ and $r(t)$ as the price of the risky asset and the spot interest rate of the risk-free asset at time t, respectively. In a complete market we therefore have

$$S(t) = \mathbb{E}_t^{\mathbb{Q}} \left[S(T) \, e^{-\int_t^T r(s)ds} \right], \quad \forall t \geq T, \tag{1}$$

where $\mathbb{Q}$ is the (unique) risk-neutral probability.

Although the debate on financial phenomena is still lively and controversial, we cannot disregard the fact that there may be non-zero correlation between interest rates and risky assets, and/or some serial correlation on asset returns.[5] For this reason we introduce the following:

Assumption 1 *The value of the risky asset evolves as follows:*

$$\frac{dS(t)}{S(t)} = r(t)\, dt + \underset{1\times k}{\sigma(t, S)'} \underset{k\times 1}{dW(t)^{\mathbb{Q}}}, \quad S(t_0) = S_0 > 0, \tag{2}$$

[5] Canova and De Nicolò (2003) focus on G-7 countries and find that "real equity returns and the real risk-free rate do not significantly move together" (p. 227). However, they show that over certain subsamples, there is a significantly negative correlation between these variables. Moreover, when they account for price dynamics, they find a negative correlation between the real risk-free rate and price dynamics. Ang and Bekaert (2007) show that interest rates (rather than other past financial variables) can predict stock returns.

where S_0 is known at time t_0, $\sigma(t,S)' \sigma(t,S) \in \mathbb{R}$ is the variance of an asset's instantaneous return, $W^{\mathbb{Q}}(t)$ is a k dimension Wiener process under the risk-neutral probability measure $\mathbb{Q}$, and the prime denotes transposition.

Assumption 2 *The spot interest rate $r(t)$ evolves as follows:*

$$dr(t) = \mu_r(t,r)\,dt + \underset{1\times k}{\sigma_r(t,r)'}\underset{k\times 1}{dW(t)^{\mathbb{Q}}}, \tag{3}$$

where $\mu_r(t,r)$ and $\sigma_r(t,r)$ are the drift and the instantaneous standard deviation, respectively.

According to Assumption 1, the dynamics of $S(t)$ may be characterized by serial correlation. Assumption 2 lets the spot rate be stochastic. According to Merton (1973), the risk-free asset should be denoted as "instantaneously risk-less asset" (p. 874). In other words, the risk-free interest rate is known ahead of time for one instant dt (from t to $t+dt$). However, it may change later (i.e., at time $t+2dt$), and is therefore unknown in the future.[6]

Let us next find the conditions that make a realization-based system equivalent to an accrual one from either an ex-ante and ex-post perspective. Denoting the tax factor as $\theta(t) \equiv 1-\tau_c(t) \leq 1$, where $\tau_c(t)$ is the effective capital gains tax rate at time t, and assuming that a risky asset is bought at time t_0 and sold at $t > t_0$, the after-tax value is equal to

$$S(t)\,\theta(t).$$

Given the statutory tax rate on interest income τ, we can write the following:

Definition 1 *On an ex-ante basis, a retrospective tax device and an accrual system are equivalent if*

$$\mathbb{E}_t^{\mathbb{Q}}\left[\frac{d(\theta(t)\,S(t))}{\theta(t)\,S(t)}\right] = (1-\tau)\,r(t)\,dt. \tag{4}$$

In line with Auerbach (1991), Definition 1 says that ex-ante equivalence holds if the after-tax return on asset $S(t)$ is, *on average*, equal to the after-tax return on the risk-free asset, i.e., $(1-\tau)\,r(t)$.

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[6] The dynamics of the risk-free rate can also be examined in a general equilibrium model. See, e.g., Vasicek (2005). For a discussion of the equilibrium interest rate under a comprehensive income tax regime see Menoncin and Panteghini (2008).

Given Assumptions 1 and 2, however, the likelihood that the after-tax return $\frac{d(\theta(t)S(t))}{\theta(t)S(t)}$ is just equal to $(1-\tau)\,r(t)$ is nil. This means that tax liabilities may differ on an ex-post basis. For this reason we also introduce the following:

Definition 2 *On an ex-post basis, the retrospective tax device is equivalent to an accrual system if*

$$\frac{d\left(\theta\left(t\right)S\left(t\right)\right)}{\theta\left(t\right)S\left(t\right)}=\left(1-\tau\right)r\left(t\right)dt. \tag{5}$$

According to Definition 2, ex-post equivalence holds if the after-tax return on asset $S\left(t\right)$, under $\mathbb{Q}$, is equal to the after-tax return on the risk-free asset, *in any state of the world.* In this case, tax liabilities are always the same.

3 Equivalence results

Let us next find the conditions under which equivalence is met. To do so, we let the tax factor evolve as follows:

$$\frac{d\theta\left(t\right)}{\theta\left(t\right)}=\mu_{\theta}\left(t\right)dt+\sigma_{\theta}\left(t\right)'\,dW^{\mathbb{Q}}, \tag{6}$$

where $\mu_{\theta}\left(t\right)$ and $\sigma_{\theta}\left(t\right)$ are two tax tools. In particular, $\mu_{\theta}\left(t\right)$ is a drift component that can be chosen by the government to let the tax factor follow a deterministic trend. By adjusting $\mu_{\theta}\left(t\right)$, a policymaker can therefore implement a deterministic rule and obtain the ex-ante-equivalence condition (4). The term $\sigma_{\theta}\left(t\right)$ is a state-contingent tool that can offset any shock $dW^{\mathbb{Q}}$. This means that, by choosing $\sigma_{\theta}\left(t\right)$, a government can achieve condition (6) and thus obtain ex-post equivalence.

Using rule (6) we can prove the following:

Proposition 1 *Denoting $\theta_{a}\left(t\right)$ as the relevant tax factor, ex-ante equivalence holds if:*

$$\begin{aligned}\frac{d\theta_{a}\left(t\right)}{\theta_{a}\left(t\right)} &= -\tau r\left(t\right)dt,\\ \theta_{a}\left(t_{0}\right) &= 1.\end{aligned} \tag{7}$$

Proof. Using (2) and (6), let us differentiate $S(t)\theta(t)$, so that:

$$\begin{aligned}\frac{d(S(t)\theta(t))}{S(t)\theta(t)} &= \frac{dS(t)}{S(t)}+\frac{d\theta(t)}{\theta(t)}+\frac{dS(t)}{S(t)}\frac{d\theta(t)}{\theta(t)} \\ &= \left(r(t)+\mu_\theta(t)+\sigma(t,S)'\sigma_\theta(t)\right)dt \\ &\quad +(\sigma(t,S)+\sigma_\theta(t))'\,dW^{\mathbb{Q}}.\end{aligned} \tag{8}$$

Substituting (8) into (4) gives:

$$\mathbb{E}_t^{\mathbb{Q}}\left[\frac{d(\theta(t)S(t))}{\theta(t)S(t)}\right]=(1-\tau)r(t)\,dt=\left(r(t)+\mu_\theta(t)+\sigma(t,S)'\sigma_\theta(t)\right)dt. \tag{9}$$

If we set $\sigma_\theta(t)=\mathbf{0}$ and rearrange (9) we obtain $\mu_\theta(t)=-\tau r(t)$. Substituting this result into (6) gives the deterministic rule (7). The proposition is therefore proven. ■

Proposition 1 derives a sufficient condition for ex-ante equivalence to hold. In particular, solving (9) gives the same deterministic rule as that obtained by Auerbach (1991), i.e.,

$$\theta_a(t)=e^{-\int_{t_0}^{t}\tau r(u)du}, \tag{10}$$

where $\theta_a(t)$ is monotonically decreasing in time.[7] This implies that Auerbach's (1991) result holds in a more general setting, where the risk-free asset must not be a zero-beta security and risky asset returns may be serially correlated. The reasoning behind this result is simple: as shown in the proof of Proposition 1, if we set $\sigma_\theta(t)=\mathbf{0}$, we obtain a deterministic rules that just requires knowledge of variables $r(t)$ and $S(t)$. Since both are known at time t, correlation does not matter.

It is worth noting that Auerbach and Bradford (2004) addressed the implementation problems arising from the stochastic dynamics of interest rates. They proposed two alternative systems, both aimed at calculating the tax liability on ex-post basis. In line with Bradford's (1997) proposal, one possibility would be to postpone resolving the tax liability until the arrival of a gain reference date. An alternative option would be to choose a gain reference date that would always be in the past for the affected investor. Of course, Proposition 1 shows that these devices are not necessary in order for ex-ante equivalence to hold.

[7] Auerbach's (1991) Eq. (6) (on p. 170) is equal to (10).

As pointed out rule (7) does not ensure ex-post equivalence. To see this we apply Itô's lemma to (10) and find

$$\frac{d\left(S\left(t\right)\theta_{a}\left(t\right)\right)}{S\left(t\right)\theta_{a}\left(t\right)}=\left(1-\tau\right)r\left(t\right)dt+\sigma\left(t,S\right)'dW^{\mathbb{Q}}\left(t\right).$$

This means that, under a retrospective system, if an investor faces a huge gain (i.e., $dW^{\mathbb{Q}}\left(t\right)>0$), the effective tax burden is less than what would be due under an accrual tax, and vice versa. In order to ensure the same after-tax return in any state of the world, a policymaker should implement a state-contingent tax. Using Definition 2 we can prove the following:

Proposition 2 *Denoting $\theta_{p}\left(t\right)$ as the relevant tax factor, ex-post equivalence holds if and only if*

$$\begin{aligned}\frac{d\theta_{p}\left(t\right)}{\theta_{p}\left(t\right)} &= \left(-\tau r\left(t\right)+\sigma\left(t,S\right)'\sigma\left(t,S\right)\right)dt-\sigma\left(t,S\right)'dW^{\mathbb{Q}}\left(t\right), \qquad (11)\\ \theta_{p}\left(t_{0}\right) &= 1.\end{aligned}$$

Proof. Condition (5) holds if, given (8), the following equality holds

$$\begin{aligned}\frac{d\left(\theta\left(t\right)S\left(t\right)\right)}{\theta\left(t\right)S\left(t\right)} &= \left(1-\tau\right)r\left(t\right)dt=\left(r\left(t\right)+\mu_{\theta}\left(t\right)+\sigma\left(t,S\right)'\sigma_{\theta}\left(t\right)\right)dt \qquad (12)\\ &\quad +\left(\sigma\left(t,S\right)+\sigma_{\theta}\left(t\right)\right)'dW^{\mathbb{Q}}.\end{aligned}$$

This means that (12) holds only if the drift and diffusion coefficients $\mu_{\theta}\left(t\right)$ and $\sigma_{\theta}\left(t\right)$ are such that

$$\begin{aligned}\sigma\left(t,S\right)+\sigma_{\theta}\left(t\right) &= \mathbf{0},\\ r\left(t\right)+\mu_{\theta}\left(t\right)+\sigma\left(t,S\right)'\sigma_{\theta}\left(t\right) &= \left(1-\tau\right)r\left(t\right).\end{aligned}$$

Rearranging this two-equation system gives

$$\begin{aligned}\sigma_{\theta}\left(t\right) &= -\sigma\left(t,S\right),\\ \mu_{\theta}\left(t\right) &= -\tau r\left(t\right)+\sigma\left(t,S\right)'\sigma\left(t,S\right).\end{aligned}$$

Substituting these results into (6) gives (11). The proposition is therefore proven. ■

Proposition 2 derives a necessary and sufficient condition for ex-post equivalence to hold. As can be seen, rule (11) is state-contingent, since the equality $\sigma_\theta(t) = -\sigma(t, S)$ must hold. In other words, the tax tool $\sigma_\theta(t)$ is such that any asset price shock is just offset, so that the actual return is always $(1-\tau)\,r(t)$ in any time interval $(1-\tau)\,r(t)$. Solving the stochastic differential equation (11) gives

$$\theta_p(t) = e^{\int_{t_0}^{t}\left(-\tau r(s)+\frac{1}{2}\sigma(s,S)'\sigma(s,S)\right)ds-\int_{t_0}^{t}\sigma(s,S)'dW^{\mathbb{Q}}(s)}. \tag{13}$$

As can be seen in (13), the calculation of $\theta_p(t)$ requires the knowledge of past asset prices. Moreover, we need to know the value of $\sigma(s, S)$ for any $s \in [t_0, t]$. This is extremely difficult. Of course the equivalence result is an even harder task if: i) risky asset returns are heteroschedastic (i.e., σ depends on S) and ii) some assets are not listed. In sum we can say that the state-contingent rule (12) is informationally very demanding and is therefore to the same critique as that based on Vickrey's (1939) original proposal.

4 Conclusion

In this article, we have analyzed Auerbach's (1991) proposal of a retrospective capital gains tax. Using a continuous-time model, with stochastic interest rates, we have both good and bad news. The good news is that ex-ante holding-period neutrality holds in a more realistic framework, where the risk-free interest rate is correlated with risky asset returns. Contrary to what Auerbach and Bradford (2004) maintain, no ad hoc adjustments are needed to account for the stochastic dynamics of interest rates. The bad news is that, due to severe information problems, designing a state-contingent rule that ensures ex-post equivalence is a hard task.

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