Tax Avoidance, Welfare Transfers, and Asset Prices*

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February 15, 2013

[PRELIMINARY AND INCOMPLETE]

Abstract

Does tax avoidance have any implications for financial markets? This paper quantifies the general equilibrium implications of tax avoidance by setting up an incomplete markets production economy model in which households pay capital gains taxes and have access to tax avoidance technologies provided by financial institutions. I find that changes in the level of tax avoidance have disproportionate effects on different groups of agents and generally benefit the old, wealthy and high income households and detrimental for young, poor and low income households. Furthermore, these changes have asset pricing implications primarily due to the distortion in the optimal portfolio allocation generated by capital gains taxation.

JEL classification: D53, G12, H24
Keywords: Capital Gains Tax, General Equilibrium, Tax Avoidance

*I am very grateful to my advisor Nicola Fuchs-Schündeln for her continuous support and invaluable advice. For useful comments and suggestions I thank Alex Bick, Kenneth Judd, Felix Kübler, Ctirad Slavík, Grigory Vilkov and the participants at the Brown Bag seminar of the Goethe University Frankfurt. All remaining errors are my own.

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1 Introduction

Offshore Financial Centers (OFC) have considerably increased their holdings of foreign assets over the last 20 years. In 1989, OFC owned about 1% of the value of the U.S. equity market. By June 2007, this share has risen to nearly 9% (see Figure 1 for more details). Similar trends can be documented for the rest of the G-7 countries. While these international capital flows may benefit host countries by augmenting the supply of domestic savings, little is known about the potential adverse consequences of tax avoidance associated with assets domiciliated in OFC.

Does growing tax avoidance have any implications for financial markets? Who benefits the most from avoiding capital gains taxes in a model with realistic heterogeneity? This paper aims to quantify the general equilibrium implications of tax avoidance by setting up an incomplete markets production economy model in which households pay capital gains taxes and have access to tax avoidance technologies provided by financial institutions. I find that changes in tax avoidance have disproportionate effects on different groups of agents and are generally benefic for old, wealthy and high income households and detrimental for young, poor and low income households. The average household in this economy does not experience any significant changes in lifetime consumption after an increase or decrease in the level of tax avoidance.

To understand the complexity of an environment in which only a share of the population faces taxes on capital gains, one needs to look into the potential effects of taxation on asset pricing. First, in the presence of capital gains taxes the investor holds a larger proportion of stocks. This is partly due to the fact that taxes effectively reduce the after-tax volatility of the stock and partly due to the value of the tax-timing option. Second, investors demand a lower price for assets upon which they have to pay capital gains taxes in the future (the capitalization effect). Third, investors require higher prices for selling assets on which they have to pay taxes (the lock-in effect). Thus, a market populated by agents who are subject to capital gains taxes will generate intermittent trade, since investors will agree on prices only occasionally and their trading behavior will exhibit a *no trade* region. In contrast, trading will occur without barriers in markets where investors can avoid taxes via OFC. This paper incorporates all these features in the decision problem of a household that wants to smooth consumption across the life cycle.

Next, to study the welfare implications, the model in this paper accounts for heterogeneity of households in terms of income and age. Since capital gains taxes will likely affect the supply of assets in the economy, agents who are dissaving due to ageing or lower earnings will bear most of the pain unless they manage to avoid capital gains taxes. Furthermore, given that

these agents own most of the wealth, they will be dictating prices on the equity and bond markets. Hence, any change in the taxation of capital gains trickles down to asset prices in this model.

An important novelty in this paper is the introduction of a OFC as the financial intermediaries providing tax avoidance services. Since equities held by these jurisdictions are to a large extent exempt from any capital gains taxes, the owner of these holdings can realize gains without any distortions caused by taxation. This comes at a cost for the households engaging in tax avoidance. First, there is a minimum account balance requirement that the client must fulfill. Second, the client has to pay an annual fee which does not depend on the volume of transactions. In order to capture these features, I set up a simple decision problem for the OFC and assume that there is perfect competition among OFCs such that they cannot extract any rents from the portfolio management operations that they perform in the name of the households. These entities act like financial intermediaries that solve a *mean-variance portfolio choice* problem "as if" they had preferences over the wealth given to them by households directly. Households will weigh in the benefits of avoiding taxes via the costs of tax avoidance when deciding about their portfolio allocations.

This paper relates to three strands of literature. First, it builds on the literature regarding the link between capital gains taxation and asset pricing. This literature was pioneered by Constantinides (1983) and studies the optimal dynamic portfolio policy in the presence of capital gains taxes, albeit in a partial equilibrium framework where investor's behavior cannot influence asset prices. This paper intends to fill this gap by studying the general equilibrium implications of the capitalization and lock-in effects characteristic for problems where households are liable for capital gains taxes. It uses a similar setup and underlying assumptions regarding the realized gains and cost basis as in Dybvig and Ross (1986), Dammon et al. (2001), DeMiguel and Uppal (2005) and Gallmeyer et al. (2006). Dai et al. (2008) and Sialm (2009) provide empirical evidence on the distortion to individual portfolio holdings caused by capital gains taxes.

Second, this papers borrows heavily from the literature on heterogeneity, incomplete markets and equity prices. It follows the same setup as in Krusell and Smith (1997), Storesletten et al. (2007), Gomes and Michaelides (2008), and Favilukis (2013). Heathcote et al. (2009) provide a detailed overview of this literature. The overarching theme of these papers is that exogenous differences lead to heterogeneity in endogenous choices (e.g. labor supply, portfolio choice), which either amplify or reduce inequality in economic outcomes. This paper uses a somewhat similar model to study the quantitative implications of growing tax avoidance. In essence, it adds to the existing framework by incorporating the cost basis of previously purchased equites as a state variable in the optimization problem of the house-

hold. Furthermore, it also includes the decision to avoid taxes in the optimization problem of a household. These allow me to model the nonlinearities characteristic for an economy in which households face capital gains taxes on their assets and can avoid such taxes.

Third, this paper relates to the growing literature on models linking financial intermediaries and asset prices, such as Brunnermeier and Sannikov (2012), He and Krishnamurthy (2012b), and He and Krishnamurthy (2012a). In these models, delegated portfolio management and intermediation frictions are at the core of a framework that endogenously generates financial crises. This study follows the trend in this literature by integrating a financial intermediary in a macroeconomic model. In this paper, the intermediary will provide access to tax avoidance technologies for households. To qualify for such services, a household should possess wealth above an exogenously specified threshold. This condition mimics the minimum account balance requirement of offshore banks. The household also incurs a cost when delegating investment. In essence, the intermediaries behave as if they have preferences over the portfolio transferred to them by households and optimize the return of this portfolio in a mean-variance fashion, albeit without having any explicit friction modeled in their optimization problem.[1] This simplification is meant to keep the model tractable and to assure a clear identification of the tax avoidance channel. To the best of my knowledge, there does not exist a paper bridging these three areas of research. The hope is that this paper can forge such a connection.

The remainder of the paper is organized as follows. In section 2, I present the model, describe the solution method and provide details regarding the calibration of the model. Section 3 outlines my results on the welfare and asset pricing implications of tax avoidance. Section 4 concludes.

2 The Model

This section introduces the model and describes the solution method. The setup is similar to the ones in Krusell and Smith (1997), Storesletten et al. (2007), Gomes and Michaelides (2008), and Favilukis (2013). Households supply labor inelastically and receive wages that are subject to uninsurable idiosyncratic shocks. In order to smooth consumption, households invest in two assets: a one-period riskless asset (bond) traded among the mass of households and a risky capital stock (equity) which they buy from the firms. They have to pay taxes on any realized gains stemming from the sales of their stock holdings, similar to the decision problems in Dammon et al. (2001), DeMiguel and Uppal (2005) and Gallmeyer et al. (2006). Households can avoid this tax by transferring their wealth to the OFC and paying a certain

[1] See Muir (2013) for a similar setup.

cost. OFC act as intermediaries in this economy and earn zero profits after optimizing their portfolio. Firms are competitive and produce a non-durable consumption good by employing labor and capital from households. Figure 2 summarizes all the connections between the participants in this model.

2.1 Setup

Households. A continuum of households are born in every period. Each household lives for a maximum number of years, A=80 (100 years). There are A overlapping generations of households in this economy, indexed by $a = 1, ..., A$. The lifespan of the household is divided in two periods: the households works from age 21 to 65 (a=1,...,45) and enjoys retirement between ages 66 and 100 (a=46,...,80). Retirees die with an age-dependent probability, $1-p_a$, where p_a is the probability of being alive at age a. When the agent reaches age A, he dies with certainty. Upon death, all remaining wealth is transferred to the new generation of the same dynasty.

Agents derive utility from consumption and from bequeathed wealth. The per period utility derived from consumption at each age a and time t takes the CRRA form, $U(C_{a,t}) = \frac{(C_{a,t})^{1-\gamma}}{1-\gamma}$. Bequeathed wealth enters the utility function as $\widetilde{V}(W_t) = b\frac{W_t^{1-\gamma}}{1-\gamma}$, where b is the bequest motive parameter which does not change for a particular dynasty.[2] This implies that each new generation of households in a dynasty inherits this preference parameter from its precursor. The overall per period utility is the sum of the two.

During the working stage of life, every household supplies one unit of labor inelastically. Workers are heterogenous in terms of their labor productivity. Their labor income process follows a stochastic process $Y_{a,t}^i = w_t L_{a,t}^i$. $Y_{a,t}^i$ stands for labor income of agent i of age a in time t. w_t is the wage per unit of productivity quoted on the labor market by the firms employing households. $L_{a,t}^i$ represents the labor endowment of each household. This endowment is a product between an age- and skill-specific profile, H_a^i, a transitory shock, η_t^i, and a persistent individual shock to income, Z_t^i:

$$L_{a,t}^i = H_a^i e^{\eta_t^i} Z_t^i, \qquad \eta_t^i \sim \text{i.i.d. } (0, \sigma_\eta^2) \tag{1}$$

$$\ln(Z_{a,t}^i) = \ln(Z_{a-1,t-1}^i) + \varepsilon_{a,t}^i, \qquad \varepsilon_{a,t}^i \sim \text{i.i.d. } (0, \sigma_{\varepsilon,t}^2) \tag{2}$$

[2] In what follows, I will discuss separately the case when households leave no bequests ($b = 0$), the case when all households leave some bequest ($b \neq 0$), and the case when only some households leave wealth for their future dynasties ($b = 0$ for some agents and $b \neq 0$). These cases prove to be important when discussing the reset provision at death characteristic for the US tax code. Whenever a person dies with a positive wealth and there are capital gains accumulated on that wealth, whoever inherits this wealth will not be liable to pay any capital gains taxes.

The presence of an age- and skill-specific profile, H_a^i, in the labor endowment function is motivated by two factors. First, households are born with certain skills i that they carry on during their working life. This allows the model to account for the skill premium. Second, keeping track of the age a in H_a^i allows to mimic the typical hump-shaped profile in life-cycle earnings. I use the following specification for the variance of the persistent individual shock:

$$\sigma_t^2 = \begin{cases} \sigma_E^2 & \text{if } Z_t \geq E[Z_t] \\ \sigma_C^2 & \text{if } Z_t < E[Z_t] \end{cases} \qquad \sigma_E^2 < \sigma_C^2 \tag{3}$$

This two-state function allows to capture the counter-cyclical variation in idiosyncratic risk similar to the one documented by Storesletten et al. (2004). It implies that agents will be subject to shocks that have higher variances during contractions ($Z_t \geq E[Z_t]$), as opposed to the ones during expansions ($Z_t < E[Z_t]$). Z_t is the aggregate productivity shock which I describe when presenting the firm's problem.

Wealth, Taxation, and Capital Gains. The household can invest its wealth in two assets: a one-period riskless bond and a risky asset. The bond is traded at price q_t and delivers on unit of consumption next period. $B_{a,t}^i$ is the amount invested in bonds by household i of age a. The risky asset trades at price P_t and the amount held by agent i of age a is denoted by $n_{a,t}^i$. Finally, the wealth that a particular agent i carries into period t (before trading) is

$$W_{a,t}^i = n_{a,t}^i P_t + B_{a,t}^i \tag{4}$$

Agents are liable for income taxes (τ_w) and capital gains taxes (τ_g).[3] The income tax is proportional to wage income, whereas the capital gains tax is applied only if any gains are realized in a particular period t. Realized losses are rebated at the same rate in the same period.[4] Gains and losses are calculated based on the difference between the current price of the stock, P_t, and the cost basis, P_{t-1}^i. The cost basis is specific to each agent and has the following law of motion:

$$P_t^i = \begin{cases} \frac{n_{a-1,t-1}^i P_{t-1}^i + \max\left(n_{a,t}^i - n_{a-1,t-1}^i, 0\right) P_t}{n_{a-1,t-1}^i + \max\left(n_{a,t}^i - n_{a-1,t-1}^i, 0\right)}, & \text{if } P_{t-1}^i < P_t \\ P_t, & \text{otherwise} \end{cases} \tag{5}$$

[3] For simplicity, I assume that returns on bonds are exempt from taxation and that there are no dividends associated with the stock.

[4] According to the US tax code, capital losses can be carried indefinitely from one year to another if these losses are below a certain threshold ($3000 per year).

This law of motion is conditional on whether there is an embedded capital gain or loss on the shares held by an agent at time t and includes some optimality decisions. In case of a capital gain, $P^i_{t-1} < P_t$, the cost basis remains the same if the agent sells some shares ($n^i_{a,t} < n^i_{a-1,t-1}$). However, if the agent acquires new shares ($n^i_{a,t} > n^i_{a-1,t-1}$), the cost basis is equal to weighted average between the previous cost basis and the current quoted price in the market where the weights are determined by the holdings of old vs. new shares $\left(\frac{n^i_{a-1,t-1}P^i_{t-1}}{n^i_{a,t}} + \frac{\left(n^i_{a,t}-n^i_{a-1,t-1}\right)P_t}{n^i_{a,t}}\right)$. This assumption approximates the exact basis by an average basis, and is in line with existing rules of the US tax code which allow households to report as their exact basis for each share a weighted average cost basis calculated based on their transactions in a given year. DeMiguel and Uppal (2005) show that the certainty equivalent loss from using the average cost basis instead of the exact basis is quantitatively insignificant. Agents are indifferent between the two options, because at almost all points in time they do not find optimal to hold shares with two different cost bases. As it turns out, a risk-averse agent would rarely buy any additional shares of stock whenever the price of the stock is increasing.

In case of a capital loss, $P^i_{t-1} > P_t$, the cost basis is set to the current price, since the agent finds it optimal to sell all his shares in order to obtain the tax rebate and rebalance his portfolio. This implicitly assumes that there is no wash-sale constraint that would prevent the agent from selling and buying the stock in the same period in order to reset the cost basis. If wash-sales were not allowed, agents would hold more of the equity with an embedded loss and would generally trade more equities whenever trades occur to insure against this additional source of non-convexity in their feasibility set (see e.g. Garlappi et al., 2001; and DeMiguel and Uppal, 2005). Figure 3 exemplifies the timeline of the updating rule for the cost basis.

The budget constraint for a household i of age a before retirement is:

$$
\begin{aligned}
C^i_{a,t} &= W^i_{a,t} + (1-\tau_w) w_t L^i_{a,t} - n^i_{a+1,t+1} P_t - B^i_{a+1,t+1} q_t - \tau_g G^i_{a,t} && (6)\\
W^i_{a+1,,t+1} &\geq -\omega && (7)\\
n^i_{a,t} &\geq 0 \qquad \forall a,t && (8)
\end{aligned}
$$

Households cannot have exiting per period wealth below a certain threshold ω. Also, short sales are disallowed in this model. $G^i_{a,t}$ is the realized capital gain/loss and is given by:

$$
G^i_{a,t} = \left\{ n^i_{a,t} \cdot \mathbf{1}_{P^i_{t-1} > P_t} + \left[1 - \mathbf{1}_{P^i_{t-1} > P_t}\right] \max\left(n^i_{a,t} - n^i_{a+1,t+1}, 0\right) \right\} \cdot \left(P_t - P^i_{t-1}\right) \qquad (9)
$$

where $\mathbf{1}_{P^i_{t-1}>P_t}$ is an indicator function that takes the value of one when there is an embedded capital loss and zero otherwise. This specification of the realized capital gain/loss $G^i_{a,t}$ rationalizes three cases that an agent might face. In case of a gain ($\mathbf{1}_{P^i_{t-1}>P_t}=0$) and a consequent purchase of stock ($n^i_{a,t}<n^i_{a+1,t+1}$), the realized gain function will be equal to zero ($G^i_{a,t}=0$). In case of a gain ($\mathbf{1}_{P^i_{t-1}>P_t}=0$) and a sell-off ($n^i_{a,t}>n^i_{a+1,t+1}$), the realized gain will be measured according to the amount of shares sold and the difference between the sale price and the cost basis ($G^i_{a,t}=(n^i_{a,t}-n^i_{a+1,t+1})\cdot\left(P_t-P^i_{t-1}\right)$). Lastly, in the presence of a capital loss ($\mathbf{1}_{P^i_{t-1}>P_t}=1$), the agent realizes a loss ($G^i_{a,t}=n^i_{a,t}\left(P_t-P^i_{t-1}\right)$). Note that this case and the absence of short wash-sale constraint implies that the agent can buy stocks in period t, namely that $n^i_{a+1,t+1}$ is not restricted to $n^i_{a,t}$.

The budget constraint for a household after retirement differs from (6) only in terms of the net labor income received. Instead of wages, the household receives a pension that is calculated based on the capital gains and income taxes (net of the rebates for capital losses). Hence, the tax revenue is distributed directly into the model without any dynamic decision of the side of government. I denote the pension level as $\Phi^i_{a,t}$ and set it equal to:

$$\Phi^i_{a,t}=Z^i_{a=r}\cdot w_t\tau_w\frac{N^W}{N^R}+\sum_i\sum_a\frac{\tau_g G^i_{a,t}}{N^R} \tag{10}$$

where $Z^i_{a=r}$ is the last persistent shock to labor productivity before retirement ($a=r$). Hence, households get different pensions according to their productivity. N^R is the number of retirees and N^W is the number of workers.

To sump up, households maximize their expected discounted value of future utilities:

$$V^i_a(W^i_a)=\max_{C^i_a,n^i_{a+1}}E_t\left\{\sum_{j=a,80}\beta^j\left[(1-p_j)U(C^i_j)+p_j\widetilde{V^i}(W^i_j)\right]\right\} \tag{11}$$

subject to the constraints (6), (7) and (8). Note that the bond optimal decision regarding bond holdings can be obtained from the budget constraint (6), once the optimal consumption and stockholding are known. The budget constraint changes to adjust for pensions when the agent retires.

Offshore Financial Centers. Little is known about the way Offshore Financial Centers operate since secrecy is part of the services that they offer to their clients. Nonetheless, we do know that financial institutions that can help their clients avoid capital gains taxes impose two conditions for the clients. First, there is a minimum account balance requirement that the client must fulfill. Second, the client has to pay an annual fee which does not depend on the volume of transactions.

In order to capture these features, I set up a simple decision problem for the OFC and assume that there is perfect competition among OFCs such that they cannot extract any rents from the portfolio management operations that they perform in the name of the households. These entities act like financial intermediaries that solve a *mean-variance portfolio choice* problem "as if" they had preferences over the wealth given to them by households directly:

$$\max_{\theta_t} \theta_t \left\{ E_t(R^K_{t+1}) - R^B_t \right\} - \frac{1}{2} \left\{ \theta_t Std(R^K_{t+1}) \right\}^2 \tag{12}$$

As a consequence of this one period problem, the optimal share invested in risky equities will be equal to $\theta_t = \frac{E_t(R^K_{t+1}) - R^B_t}{Std(R^K_{t+1})}$, where $R^B_t = \frac{1}{q}$ is the return on the riskless bond. The wealth of the households that engage in tax avoidance is given by

$$W^i_{a,t} = W^i_{a,t-1} \left[1 + \underbrace{\theta_t}_{n^i_{a,t}} (R^K_t - R^B_{t-1}) \right] - F^i_{a,t-1} \tag{13}$$

where $F^i_{a,t-1}$ is the cost associated with tax avoidance and which follows

$$F^i_{a,t-1} = \begin{cases} \phi W^i_{a,t-1} & \text{if } W^i_{a,t-1} \geq \overline{W} \\ \infty & \text{if } W^i_{a,t-1} < \overline{W} \end{cases} \tag{14}$$

This specification of cost allows me to capture the two conditions set by the OFC that I have described earlier. First, it sets a lower bound on the wealth that the household must have in order to have access to the OFC, $\overline{W}$. I set up the problem of the household in such a way that once wealth is above that level, the household will decide to avoid taxes whenever the cost of avoidance $\phi W^i_{a,t-1}$ is lower than the cost of expected future realized gains. Hence, the household with wealth $W^i_{a,t-1} \geq \overline{W}$, will have a budget constraint that incorporates (13) and does not have to pay any taxes on capital gains, $\tau_g = 0$, in the periods when it avoids taxes, and budget constraint (6) otherwise. Note that households are allowed to avoid taxes both during working age and during retirement. In the case when the wealth of the agent is below the threshold level ($W^i_{a,t-1} < \overline{W}$), the household will never find it optimal to avoid taxes, as it will lead to large negative levels of wealth that it cannot sustain due to the borrowing constraint.

Firms. I model the productive sector in terms of an environment with perfect competition in which firms produce a nondurable consumption good by combining capital and labor. For this purpose, firms use a Cobb-Douglas production function with total output Y_t given by:

$$Y_t = Z_t K_t^{\alpha} L_t^{1-\alpha} \tag{15}$$

where K_t is the stock of capital at time t and L_t is the total labor supply. Z_t is the aggregate stochastic productivity shock which follows the law of motion that contains a constant secular growth component g and a stochastic component U_t that follows a two-state Markov process capturing the average length of business cycles:

$$\begin{aligned} Z_t &= \varrho_t U_t & (16)\\ \varrho_t &= (1+g)^t & (17) \end{aligned}$$

I assume that firms decide regarding their capital to labor ratios after observing the aggregate shocks. Hence, the problem of a firm becomes static and deterministic, and the factor prices that it posts are given by its first-order conditions.

$$\begin{aligned} w_t &= (1-\alpha) Z_t (K_t/L_t)^{\alpha} & (18)\\ R_t^K &= \alpha Z_t (K_t/L_t)^{\alpha-1} - \delta_t & (19) \end{aligned}$$

where R_t^K is the return on capital and α is the share of capital in total output. The price of shares that households pay for capital is defined as $P_t = R_t^K P_{t-1}$. The depreciation rate δ is time-dependent in my model and follows the process:

$$\delta_t = \delta + s \cdot \rho_t, \quad \rho_t \sim \text{i.i.d. } N(0,1) \tag{20}$$

where δ is a constant and s is a scalar. This can be viewed as a replacement for modeling explicit adjustment costs. The end result of both specifications is an increase the volatility of returns in the economy. However, using a stochastic discount rate instead of adjustment costs absolves me from computing a stochastic discount factor (SDF) in an economy where different stock holders will have different SDFs. Similar specifications for the depreciation rate in incomplete markets production economy models have been recently used by Krueger and Kübler (2006), Storesletten et al. (2007), Gomes and Michaelides (2008). In general, this depreciation rate can be viewed as a combination of physical depreciation, adjustment costs and investment-specific shocks.

Equilibrium. The state space of this economy can be summarized by $[\mu_t, Z_t, \rho_t]$. μ

is a measure defined over $S = \mathcal{A} \times \mathcal{Y} \times \mathcal{W} \times \mathcal{P} \times \mathcal{O}$, where $\mathcal{A}$ is the set of ages, $\mathcal{Y}$ is the set of individual productivity levels, $\mathcal{W}$ is the set of individual wealth, $\mathcal{P}$ is the set of individual cost bases and $\mathcal{O}$ clarifies whether the household is avoiding taxes or not. Z_t is the aggregate productivity shock, while ρ_t is the depreciation rate shock. The presence of these two aggregate shock implies that μ_t will evolve stochastically, according to the law of motion $\mu_{t+1} = \Gamma(\mu_t, Z_t, Z_{t+1}, \rho_t, \rho_{t+1})$

Am equilibrium in this economy is defined as a set of endogenously determined prices given by the time-invariant functions $R_{K,t} = R_K(\mu_t, Z_t, \rho_t)$, $q_t = q(\mu_t, Z_t, \rho_t)$ and $w_t = w(\mu_t, Z_t, \rho_t)$; a law of motion for μ, $\mu_{t+1} = \Gamma(\mu_t, Z_t, Z_{t+1}, \rho_t, \rho_{t+1})$ (where μ is the distribution of agents across ages, idiosyncratic shocks, wealth, tax bases and avoidance statuses); and a set of cohort-specific value and policy functions for each household i, $\left\{V_a^i, C_{a,t}^i, n_{a+1,t+1}^i\right\}_{a=1,\ldots,A}$ such that:

1. Households optimize

$$\begin{aligned} V_a(\mu_t, Z_t, \rho_t, Z_{a,t}^i, W_{a,t}^i) &= \max_{C_{a,t}^i, n_{a+1,t+1}^i} U(C_{a,t}^i) + p_a \beta \widetilde{V^i}(W_{a+1,t+1}^i) \\ &+(1-p_a)\beta \quad E_t \quad \left[V_{a+1}(\mu_{t+1}, Z_{t+1}, \rho_{t+1}, Z_{a+1,t+1}^i, W_{a+1,t+1}^i)\right] \end{aligned}$$

   subject to all the constraints and laws of motion described above.

2. Firms maximize profits by equating the marginal products of labor and capital to their respective marginal costs:

$$\begin{aligned} w_t &= (1-\alpha) Z_t (K_t/L_t)^{\alpha} \\ R_t^K &= \alpha Z_t (K_t/L_t)^{\alpha-1} - \delta_t \end{aligned}$$

3. OFC solve a portfolio problem by choosing the optimal weight $\theta_t = \frac{E_t(R_{t+1}^K) - R_t^B}{Std(R_{t+1}^K)}$

4. The risky asset market clears: $\int n_{a,t}^i d\mu = 1$

5. The bond market clears: $\int B_{a,t}^i d\mu = 0$

6. The labor market clears: $L_t = 1$

7. The aggregate resource constraint is satisfied for any time t: $\int C_{a,t}^i d\mu + \int F_{a,t}^i d\mu + (1 - \delta_t) K_t = Y_t$

8. The presumed law of motion for the state space $\mu_{t+1} = \Gamma(\mu_t, Z_t, Z_{t+1}, \rho_t, \rho_{t+1})$ is consistent with individual behavior.

2.2 Solution Method and Calibration

Due to the presence of deterministic growth g, I need to normalize the non-stationary variables in this economy by $(1+g)^{\frac{t}{1-\alpha}}$ as in Gomes and Michaelides (2008). Furthermore, in order to simplify the problem I can divide all the variables by the beginning-of-period wealth W_t, essentially using it as the numeraire.[5] These allow me to reduce the state space by expressing the problem of the household in terms of three relevant state variables $n^i_{a,t}, B^i_{a,t}, P^i_{t-1}$ after the normalization.

I solve the model using and algorithm similar to Krusell and Smith (1997) but which accounts for the existence of a tax basis and stochastic depreciation. Households have to optimize given their expectations about future returns and wages and subject to the cost basis that they have been carrying into each period. Essentially, agents have to forecast prices which under the framework in Krusell and Smith (1997) is equivalent to guessing the future mean of capital stock. Adapting the algorithm of Krusell and Smith (1997) to this model implies that it is possible to forecast the future price of stocks using the current price P_t and state-contingent realizations of the two aggregate shocks U_t and ρ_t (aggregate productivity and depreciation):

$$P_{t+1} = \Gamma_K(P_t, U_t, \rho_t) \tag{21}$$

Similarly, the household has to forecast bond prices as their price might change after one period:

$$q_{t+1} = \Gamma_B(q_t, P_t, U_t, \rho_t) \tag{22}$$

This routine introduces four additional state variables in the optimization problem of the household (q_t, P_t, U_t, ρ_t). The calibration of this model is described in Table 2. The decision problem is solved at annual frequency. The borrowing constraint parameter is set to be equal to 25% of the median wealth. The annual OFC portfolio management fee ϕ and the minimum account balance $\overline{W}$ are set to be equal to 1% and 300% of the median wealth.[6]

3 Results

This section describes the main implications of the model in terms of welfare gains/losses associated with a decrease of the minimum wealth needed to get access to OFC, and in terms

[5] This is a widely used shortcut in the literature about capital gains taxes and portfolio optimization (see e.g. Dammon et al. (2001)).

[6] Median wealth in this model is around $90000.

of the asset pricing moments. Before presenting these results, I study the implications of capital gains taxation for the optimal allocation problem of the households. The immediate effects of taxation are plotted in Figure 4. This figure describes optimal trading for different embedded capital gains at $t = 0$ for a household, given a certain path for aggregate and idiosyncratic shocks. Trades are reported as a percentage of wealth for different cost-basis-to-price ratios. The presence of capital gains taxes is generating a no trade region (the flat parts of the lines) in which the cost of a transaction is higher than the embedded gain. Note that the trade region depends on the size of the gain (difference between price and basis). High gains will be costlier in terms of the capital gains tax and the household will decide to postpone the realization to periods when the benefit from the transaction outweighs the cost. Also note that, when there is no embedded gain, $Basis = 1$, the household can adjust its portfolios without any cost.

3.1 Welfare Implications of Tax Avoidance

To quantify the welfare implications of growing tax avoidance, I compute the equivalent variation measure EV_a^i.

$$EV_a^i = \left(\frac{\overline{V_a^i}(\cdot, \overline{W} + \Delta)}{\overline{V_a^i}(\cdot, \overline{W})} \right)^{\frac{\gamma}{\gamma - 1}} - 1 \tag{23}$$

where $\overline{V_a}$ is the household's value function when all risks are integrated out. This measure compares consumption in two states: a state in which the threshold of wealth for avoiding taxes is set at $\overline{W}$ (300% of median wealth), and another state in which this threshold is increased/decreased by Δ (100% of median wealth).[7] It quantifies by how much the household's lifetime consumption must be increased in order for the lifetime utility to remain the same across the two states ($\overline{W} + \Delta$ vs. initial $\overline{W}$). I then aggregate this measure across different age, wealth and income groups.

Figure 5 displays welfare implication of a decrease/increase by 100% of median wealth in the minimum wealth required by OFC. All values are expressed in percent. Welfare gains correspond to positive values of the EV_a^i, and vice versa for negative values. Figure 5 shows that the welfare implications are distinct for different age-groups. Young people seem to lose more than what the old people gain in terms of lifetime consumption in the case of a decrease in $\overline{W}$. This is due to the influence of tax avoidance on the returns in the markets. Given that more people can avoid taxes now, they decrease their holdings of the risky asset as these

[7] This should mimic the fact that banks located in OFC have consistently reduced their minimum account balance requirement over the past two decades.

assets earn higher net returns when exempt from taxes. This leads to a decrease in the price of the risky asset and an increase in the price of the riskless asset which hurts the young who borrow heavily in the early stage of their life. An increase in $\overline{W}$ has opposite effects, albeit to a lesser magnitude. The difference in magnitude is caused by a the decrease in the mass of the population which keep access to the OFC. The demand distortion coming from this mass of households (the ones avoiding taxes) is now less important for the aggregate allocations and prices.

Figure 6 repeats the same exercise, but this time only for a decrease in the wealth threshold necessary for avoiding capital gains taxes. It shows that this decrease will lead to higher dispersion in gains and losses across wealth and income groups within each age basket. Wealthy households and the ones which receive high income do not suffer from the transition, as they do not rely heavily on borrowing. Furthermore, gains are disproportionately allocated to wealthy old households who happen to be in their dissaving stage of their life and hold most of the capital in this economy. They can sell their stocks without any losses associated with taxation.

3.2 Tax Avoidance and Asset Prices

To be added.

4 Conclusion

To be added.

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A Data

The data on annual foreign portfolio holdings of U.S. securities come from the Treasury International Capital System (TIC). U.S. portfolio holdings of foreign securities are also sourced from TIC. The measure for total U.S. equity outstanding, U.S. GDP and the market value of U.S. corporations are based on data retrieved from the Flow of Funds Accounts of the United States. Total equity outstanding is the sum of corporate equities (Table L213, row 1), mutual funds shares (Table L214, row 1) and money market mutual funds (Table L206, row 1) minus foreign equity owned by U.S. residents (Table L213, row 3). GDP values come from Table F6, row 1, while the market value of U.S. corporations is taken from Table L213, row 23.

B Numerical Solution Procedure

To be added.

C Figures and Tables

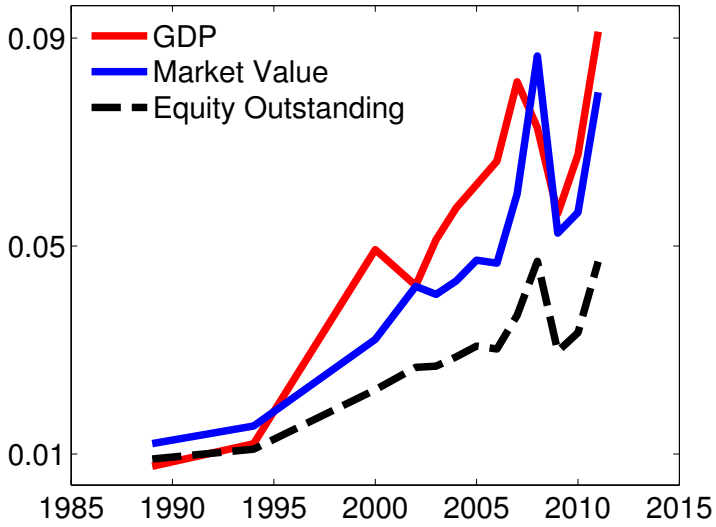

Figure 1: Evidence from the US.

This figure plots the ratio between equity holdings of OFC and: (i) GDP, (ii) market value of US equities (traded), (iii) total US equity outstanding (both traded and closely held). 46 countries/teritories are categorized as OFC by the IMF (2000). These do not include onshore tax havens such as Delaware, Florida, Nevada, Wyoming and the City of London. Due to data unavailability, I use the equity holdings of 42 OFC from the IMF list to calculate the aggregate equity holdings of OFC (excl. Bahrain, Nauru, St. Lucia, and St. Vincent and the Grenadines). The list of the jurisdictions that are used for this plot is described in Table 1. Data on the equity holdings of OFC come from the Treasury International Capital System survey. Data on GDP, market value and total value of US equity outstanding come from the Flow of Funds Accounts.

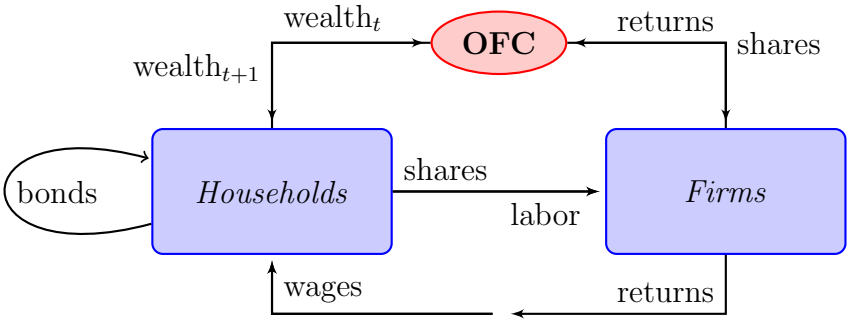

Figure 2: Model diagram.

This figure describes the links between participants in the model. Arrows correspond to flows from/to each participant. A brief description of the flow is listed above/below each arrow.

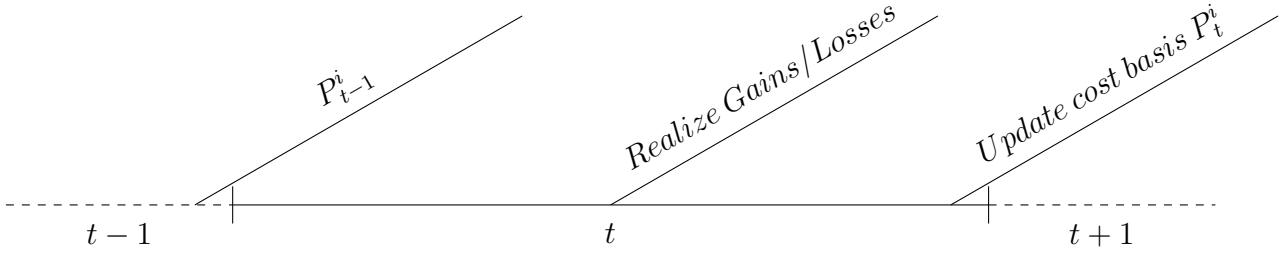

Figure 3: Timing of the cost basis.

This figure describes the timing for updating the cost basis. The household enters period t with a certain cost basis P^i_{t-1}. It takes all the optimal decisions at time t given realized prices P_t. At the end of period t (but before the start of period $t+1$), the cost basis is adjusted given the transactions that have occurred during period t.

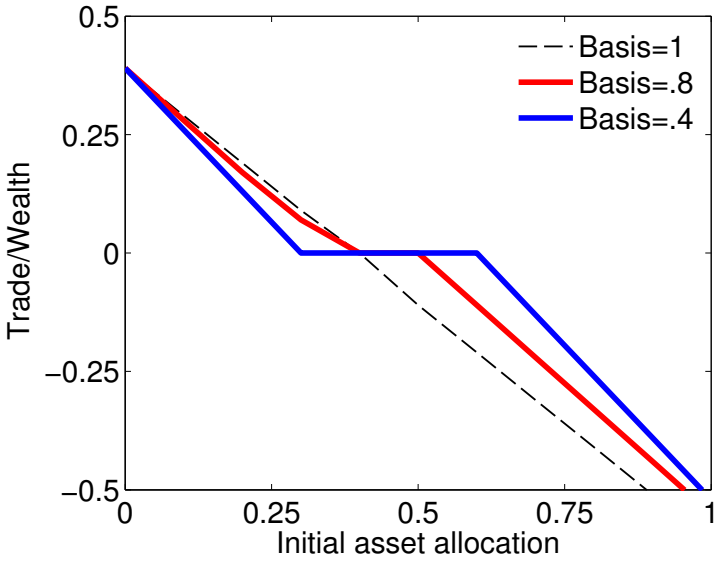

Figure 4: No trade region

This plot describes optimal trading for different embedded capital gains at $t = 0$ for a household, given a certain path for aggregate and idiosyncratic shocks. Trades are reported as a percentage of wealth for different cost-basis-to-price ratios.

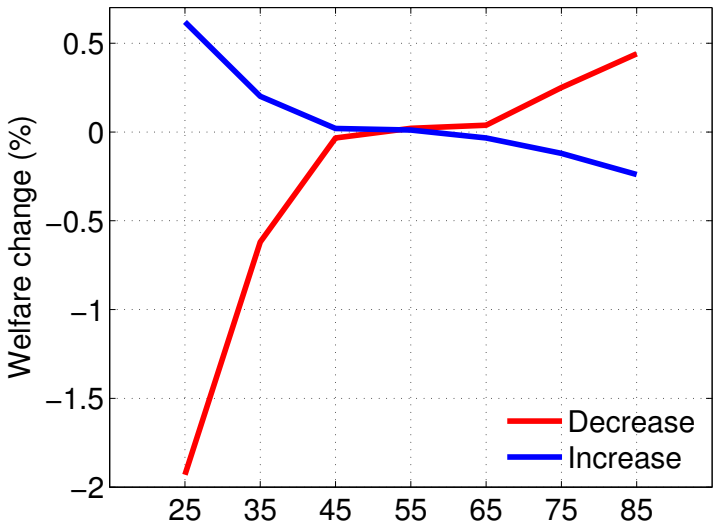

Figure 5: Entry wealth - average changes

Equivalent variation of an increase (decrease) in the minimum wealth necessary to avoid taxes, $\overline{W}$, by 100 percentage points. Age buckets: 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, 81-100.

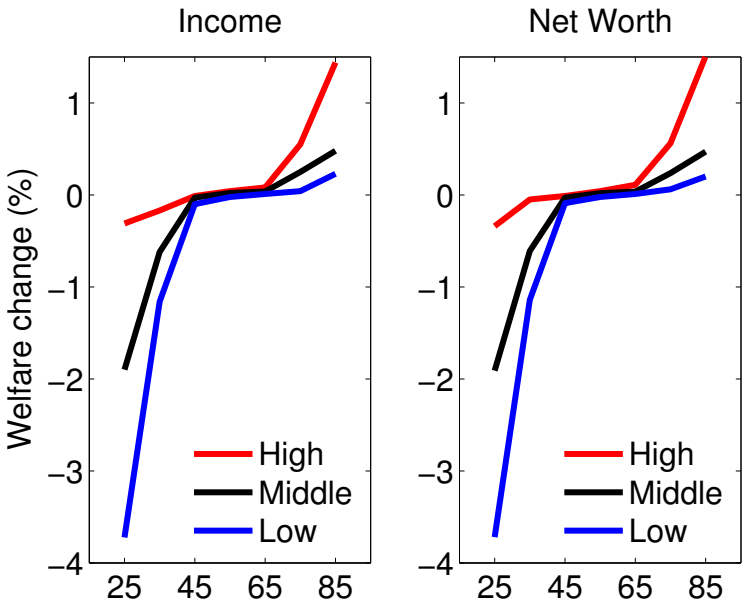

Figure 6: Entry wealth - distributional changes

Equivalent variation of a decrease in the minimum wealth necessary to avoid taxes, $\overline{W}$, by 100 percentage points. Age buckets: 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, 81-100.

Country	$\frac{\text{Equity Assets}}{\text{GDP}}$		
	1989	2002	2011
Andorra	-	0.31	0.21
Anguilla	-	3.43	56.61
Antigua and Barbuda	-	0.11	0.08
Aruba	-	0.14	0.18
Bahamas, The	0.64	1.41	2.40
Barbados	-	0.47	0.25
Belize	-	0.09	0.19
Bermuda	2.90	9.78	9.86
British Virgin Islands	-	24.49	66.44
Cayman Islands	-	20.96	120.34
Cook Islands	-	0.05	0.28
Costa Rica	-	0.01	0.01
Cyprus	-	0.00	0.00
Dominica	-	0.04	0.07
Grenada	-	0.00	0.28
Hong Kong SAR	0.04	0.09	0.18
Ireland	0.03	0.27	0.48
Lebanon	0.04	0.02	0.02
Liechtenstein	-	0.72	0.45
Luxembourg	-	4.15	4.89
Macao SAR	-	0.01	0.00
Malaysia (Labuan)	0.00	0.00	0.01
Malta	-	0.00	0.05
Marshall Islands	-	0.95	1.59
Mauritius	-	0.01	0.05
Monaco	-	0.27	0.20
Montserrat	-	0.52	0.14
Netherlands Antilles	1.65	4.98	1.37
Palau	-	0.06	0.32
Panama	0.18	0.46	0.25
Samoa	-	0.02	0.19
Seychelles	-	0.00	0.06
Singapore	0.07	0.49	0.41
St. Kitts and Nevis	-	0.60	0.91
Switzerland	0.12	0.36	0.34
Turks and Caicos Islands	-	0.29	0.43
Vanuatu	-	0.03	0.01
Average	0.57	2.04	7.29

Table 1: List of Offshore Financial Centers.

This table reports the ratio between the US equity assets held by the OFC and the current price GDP level of the OFC (expressed in USD). Data on GDP comes from the UN National Accounts. Data on equity holdings comes from the Treasury International Capital System survey. The table contains results for 37 out of the 42 OFC used in Figure 1. The OFC missing in this table have no data on GDP available (Gibraltar, Guernsey, Isle of Man, Jersey, and Niue). Equity data for all 42 OFC are used to compute aggregate OFC holdings in Figure 1.

Parameter	Description	Value
	Production	
g	avg. growth rate	0.01
δ	avg. annual depreciation rate	0.10
α	share of capital	0.36
s	parameter that determines return vol.	0.16
π_g	probability of remaining in the current state	2/3
σ_z	st. dev. of the technology shock	.01
	Preferences	
β	discount factor	.99
γ	risk aversion	5
b	bequest strength (no reset option)	0
	Income and Demographics	
H_a	age-dependent earnings profile	SCF (2001)
σ_E	st. dev. of earnings during expansion	0.0768
σ_R	st. dev. of earnings during recession	0.1298
p_a	survival probability	U.S. Census
	Taxation	
τ_g	tax rate on realized gains/losses	0.15
τ_w	tax rate on wages	0.25
ω	borrowing constraint	25%
ϕ	portfolio management fee	1%
$\overline{W}$	minimum wealth to avoid taxes	300%

Table 2: Calibration.