Should the government be paying investment fees on $3 trillion of tax-deferred retirement assets?*

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Under standard assumptions, individuals and the government are indifferent between traditional tax-deferred retirement accounts and "front-loaded" (Roth) accounts. Adding investment fees to this benchmark, individuals are still indifferent but the government is not. We show that under weak conditions firms charge equal percent fees under both systems, yielding higher dollar fees under Traditional. We estimate that tax deferral increases demand for asset management services by $3.8 trillion, costing the government $23.4 billion in annual fees. In a general equilibrium differentiated-product model, tax deferral produces a larger asset management industry, higher taxes, and lower social welfare.
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1. Introduction

Retirement savings systems around the world incorporate tax incentives designed to increase saving and enhance retirement security. The traditional and most common incentive system is tax deferral: the U.S. alone has $30 trillion of tax-deferred retirement assets in both employer-based accounts (including defined-benefit plans, and defined-contribution plans such as "401(k)s") and individual retirement accounts ("IRAs"). A tax deferral system works by back-loading taxation, i.e., exempting contributions to retirement accounts from current income taxation and then taxing the principal and returns upon withdrawal.

Although the vast majority of retirement assets is held in Traditional (henceforth capitalized) accounts, an alternative system in which taxes are front-loaded has become increasingly available.[1] Under this system, referred to in the U.S. as "Roth," contributions are made with after-tax income, but then principal and returns are not taxed at any future time. A benchmark result under standard assumptions, including the equality of tax rates in working and retirement years, is that each system results in the same cash flows for the individual and the same present value of tax revenue for the government, with only the timing of taxes differing across systems.

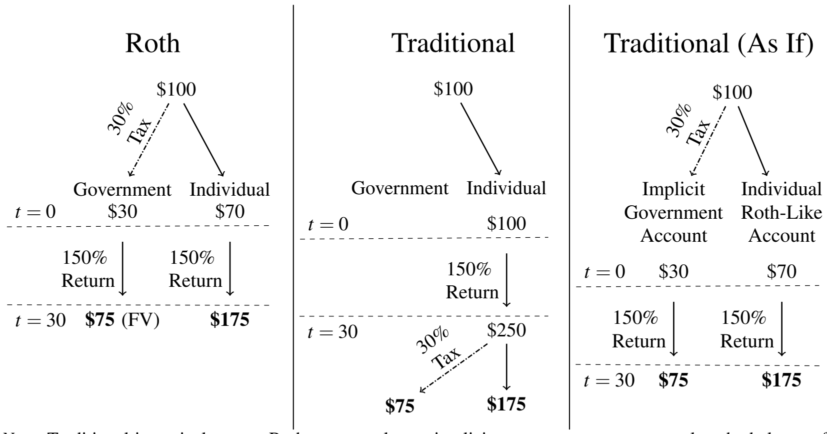
Additional "Rothification", i.e., increased reliance on front-loaded taxation, was introduced as part of the 2022 Secure 2.0 retirement system reform. Much of the recent U.S. debate on Rothification has been focused on the political economy of how front-loading tax revenue with a Roth system would affect current government spending. We abstract from this debate. Instead, our contribution is to highlight a hitherto ignored but important aspect of the real-world policy choice between Roth and Traditional: investment funds, recordkeepers, and financial advisors ("asset managers" for brevity) charge fees.

By deferring tax revenue with a Traditional system, the government generates an additional $3.8 trillion in assets under management (AUM) corresponding to the amount in retirement accounts that will be used to pay future taxes.[2] We estimate that these asset management services cost the government $23.4 billion annually in fees. We argue that the extra services paid for create little value for the government and therefore we refer to

[1] In the U.S., Roth accounts, named after the senator who originally proposed them, became available as Roth IRAs in 1997 and Roth 401(k)s in 2001. Roth assets have climbed to about 10% of total IRA assets as of 2022. Canada and the U.K. also started with tax-deferred accounts and later introduced front-loaded ones as an additional option.

[2] We focus on retirement accounts because they are the largest and cleanest instance of tax deferral, but similar issues arise with other forms of income subject to tax deferral, such as capital gains and deferred compensation.

Figure 1
Benchmark equivalence result.



Note: Traditional is equivalent to a Roth account plus an implicit government account equal to the balance of deferred taxes. Without asset management fees, the two accounts yield the same cash flows for individuals, and the same future value (FV) of cash flows for the government. A 150% return is approximately equal to a 3% rate compounded for 30 years.

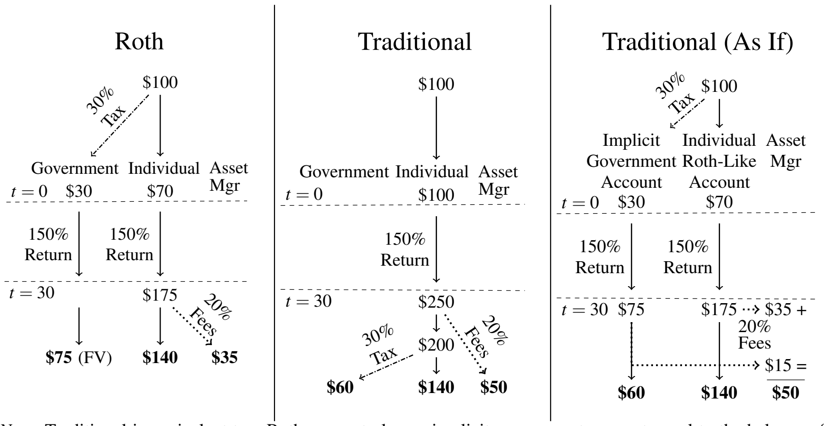
the corresponding expenditure on fees as an "implicit subsidy" to the asset management industry.[3]

Figures 1 and 2 summarize our basic argument. The first two panels of Figure 1, labeled Roth and Traditional, show a well-known equivalence result: under both Roth and Traditional, an individual who faces a 30% tax rate in both working years and retirement and puts aside $100 of pre-tax income to fund the account (consuming the same amount in each case) retires with the same resources ($175) and is thus indifferent between the two. Government revenue cash flows under Roth and Traditional have different timing but the same future value ($75). The third panel, labeled "Traditional (As If)," provides intuition for the equivalence result. An individual with $100 in a tax-deferred retirement account could be seen as owning $70 in a Roth-like account, with the government owning the remaining $30 in an implicit account equal to the balance of deferred taxes.

Note that we abstract from a variety of real-world considerations that could lead individuals or the government to prefer one type of account, such as detailed contribution and withdrawal rules and limits, progressive taxation, and behavioral biases, which we discuss in Section 7. The government's present-value indifference also crucially relies on the assumption that the government earns the same return on this implicit account under Traditional as it would earn explicitly on its upfront revenue under Roth. In making this assumption,

[3] One common form of subsidy is a payment to producers or consumers that drives a wedge between the respective effective prices. Here we reference another common form of subsidy in which government purchases create artificial demand that induces a positive shift in the demand curve.

Figure 2
Fee nonneutrality.



Note: Traditional is equivalent to a Roth account plus an implicit government account equal to the balance of deferred taxes. With asset management fees, the two accounts yield the same cash flows for individuals, but the Roth account yields a superior future value (FV) for the government thanks to lower total fees. A 150% return is approximately equal to a 3% rate compounded for 30 years; 20% fees are the future-value equivalent of 0.77%/year (the value we calibrate in this paper) over the same horizon.

we abstract from the fact that owning the implicit account under Traditional exposes the government to the risk and return of $2.6 trillion of equities—an exposure that would not automatically exist under Roth and is not the result of a deliberate policy choice. Natural policy questions, which to date have not been publicly debated, are whether this sizable exposure is desirable, and if so, whether it could be obtained in alternate ways under Roth. We discuss equity exposure in Sections 4.2 and 7.2.

Figure 2 shows the same setup, but with fees. We assume that asset managers charge a fixed percentage fee f on each dollar in the account. The individual attains the same future value ($140 = $175 − $35 in fees) under each type of account, and thus remains indifferent between the two. However, the future value of government revenues is lower ($60 instead of $75) because the government levies taxes later and the account size is larger, and therefore total fees are also larger ($50 instead of $35). The third panel again shows the decomposition into a Roth-like account and an implicit government account. Under Traditional the government effectively pays $15 in extra investment fees on its implicit account, which does not exist under Roth.

Regardless of fees, differences in tax rates during work and retirement break the equivalence by introducing an implicit "government match," which can be positive or negative, into Traditional. We show that if the government adds to the Roth account an explicit match (or, equivalently, partial deductibility of contributions) of corresponding size, our result remains: individuals' cash flows are the same under the two systems and the government incurs extra investment fees under Traditional relative to Roth. Our result is also robust to the inclusion of corporate taxes.

The fees on the government's implicit account are large. We produce an original, comprehensive, asset-weighted estimate of percentage investment fees on defined-contribution (DC) plan and IRA assets of 77 bps. We start from existing industry estimates of explicit fees on DC plans and explicit asset-level fees on IRAs and construct our own original estimate of explicit advisory fees on IRAs. We then combine academic volume-weighted estimates of trading costs with industry estimates of turnover and asset allocation to construct an asset-weighted estimate of trading costs for DC plans and IRAs. We estimate the size of the U.S. government's implicit account at the end of 2022 as \$3.8 trillion, equal to the total amount of tax-deferred assets in DC plans and IRAs (\$18.9 trillion) times 20%, our rough estimate of the average tax rate on retirement account withdrawals.[4] We assume that 21% of fees paid by the government are recovered via corporate taxation. Multiplying \$3.8 trillion by $.77\%\times(1-.21)$, we reach our estimate of \$23.4 billion per year in total fees on the government's implicit account. This added expenditure is the extra cost to the government of the current (mostly Traditional) system relative to an all-Roth system and translates into an equal subsidy for asset management services. Its magnitude depends only on the level of fees under the current system and not on the counterfactual level under Roth.[5]

Who benefits from this subsidy? Its incidence depends on how percent fees under an all-Roth system compare to those under the current system. In Figure 2, our individual indifference result relied on the assumption that percent fees remain the same. Is this assumption compatible with economic equilibrium? Intuitively, percent fees could drop because of the enhanced scale and resulting lower average cost, or rise because of the heightened demand, in which case individuals would no longer be indifferent and asset manager profits would be affected accordingly. As an analogy, consider a government purchasing and destroying a quart of milk for every four bought by individuals. What would the effect of such a policy be on milk prices? Would it be any different if the government purchased asset management services instead of milk? To help answer these questions, we prove a supply-side equivalence result: under weak conditions, it is indeed optimal for each asset management firm to charge the same percent fees under Roth and Traditional. This result holds, intuitively, because the same percent fees result in the same effective

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4 Our estimate of assets excludes the \$0.7 trillion (as of 2022) in the federal government's Thrift Savings Program (TSP), whose fees are negligible. It also excludes defined-benefit (DB) plans, although a parallel argument applies to these plans as well. Including corporate and state and local government DB plans would add \$8.3 trillion of tax-deferred assets as of 2022, increasing our estimate of the implicit government account by half.

5 This estimate represents the cost to the government and abstracts from any potential benefits of Traditional accounts that the government receives directly (such as customized asset allocations or better performance) and indirectly (such as price discovery externalities or exposure to equity the government could not obtain otherwise). In Sections 4.2 and 7, we discuss these potential benefits and explain why we are skeptical about their importance.

prices for individuals. Then, individuals with the same lifetime resources facing the same effective prices will make the same choices and have the same demand elasticities. For firms, the subsidy from the government’s implicit account under Traditional is proportional to the revenue obtained from the part of the account that truly belongs to the individual, and thus this subsidy is maximized when the revenue from the individual is maximized. Therefore, firms facing the same individual behavior find that the same percent fees are profit-maximizing. As long as this level of fees is above marginal costs, then, the profits of asset managers will be greater under Traditional than under Roth.

Our results on the size of the subsidy and its incidence leave many questions open, however. Continuing with the milk analogy, how would government purchases affect milk quality, milk variety, the number of milk producers, and aggregate welfare? How does the government pay for its purchases and does it matter what it does with the milk? To help address these questions in the context of asset management, we introduce a two-period, general equilibrium model with logarithmic utility in which firms have variable and fixed costs and asset management is a differentiated product as in Salop (1979). In this model, Traditional continues to have larger AUM. If all costs are variable, resources devoted to asset management are also larger, proportionally to AUM, as in our partial equilibrium model. Less obviously, Traditional uses higher resources even in the opposite extreme case in which all costs are fixed. In this case, firms *could* charge the same total dollar fees as under Roth, and obtain the same profits, but this would not be profit-maximizing. Instead, firms charge the same percent fees, resulting in higher profits. If firm entry is allowed, these higher aggregate profits attract additional competitors, which reduces profits to zero while raising the total aggregate resources devoted to asset management.

Finally, we show that a shift from Roth to Traditional in the model lowers social welfare, defined as the aggregate utility of all individuals. This is true even though the model incorporates benefits to individuals from a greater number of asset management firms. By comparing the market equilibrium quantities to those chosen by a planner, we show that the Roth equilibrium in the model has too many firms (i.e., too many resources devoted to asset management), and the Traditional equilibrium has even more firms. We quantify the loss with a simple calibration exercise. Relative to Roth, Traditional in the model results in a welfare loss equivalent to roughly one-third of the total tax expenditure on retirement accounts. Considering alternate policies, a switch from Traditional to Roth would allow the government to offer a match on all Roth contributions of roughly 6%, i.e., $6 for each $100 contributed while leaving tax rates and the budget deficit unchanged.

Our findings have important implications for the literature on the growth and the optimal size of finance. Existing evidence shows an upward secular trend in the size of the asset management industry as a fraction of gross domestic product (Philippon and Reshef 2012; Greenwood and Scharfstein 2013). We show that the growth of the government’s implicit account alone accounts for as much as one-fifth of the trend since 1980. In our model, this part of the growth is inefficient. Our model also provides a simple explanation for another related trend: in spite of a large increase in scale, asset management fees have been roughly constant as a fraction of AUM (Malkiel 2013; Philippon 2015). Existing explanations rely on time variation in regulation, moral hazard, or information frictions (Philippon and Reshef 2012; Bolton, Santos, and Scheinkman 2016). We construct a plausible, general equilibrium model in which firms charge constant percent fees under a variety of conditions. Not only do percent fees remain constant across Roth and Traditional (an effect of the government subsidy); they also remain constant, within a given retirement system, across different levels of wealth (AUM) and number of firms. As a result of imperfect competition, enhanced scale leads to higher dollar markups and ultimately firm and product proliferation, instead of lower percent fees.

Our results also have implications for public policy questions related to retirement saving. The primary question is whether it is appropriate for the government to mandate, subsidize, or otherwise encourage Rothification. Our model highlights one important factor that makes Roth more desirable. Although the model leaves out other factors (discussed in Section 7) such as macroeconomic effects, behavioral biases, and the political process, our qualitative discussion of these factors suggests that they are not likely to change our result. The model also leaves out progressive taxation, which complicates the analysis considerably because of its interaction with tax deferral. Among other things, by delaying the recognition of some income until the retirement years, Traditional can result in a lifetime tax burden that is better aligned with lifetime income.

The paper is structured as follows. Section 2 begins with the standard benchmark equivalence and examines how it changes when we add fees. Section 3 describes our supply-side equivalence. Section 4 presents our estimates of fees and the resulting implicit subsidy to the asset management industry due to Traditional accounts. Section 5 introduces our general equilibrium model. Section 6 shows that a shift from Roth to Traditional in the model lowers social welfare. Section 7 discusses certain elements of welfare that are outside of our model. Section 8 addresses potential public policy issues and concludes.

2. The benchmark model and the impact of fees

In this section we begin by describing the standard equivalence result that, under some simplifying assumptions, individuals are indifferent between Traditional and Roth, and the present value of government revenue is the same. Next, we show that with fees the equivalence result remains for individuals but the government implicitly pays additional fees under Traditional. These results still hold when taking into account the taxation of asset managers and the existence of risky assets. Our demand-side analysis in this section takes the supply side as given.

2.1 Assumptions

There are two periods. At $t = 0$, individuals earn exogenous pre-tax labor earnings Y, consume an amount C_0, and save an amount S in a retirement account. At $t = 1$, individuals retire and consume C_1, equal to the accumulated balance of their account (net of any taxes), leaving no bequest. An asset management firm charges fees equal to a fixed proportion f of the value of retirement account assets, which earn a fixed non-stochastic return of r.[6] While we assume here that percentage fees are independent of account size, in Section 3 we prove that this arises endogenously in a general model with fixed and variable costs.

2.1.1 Types of retirement accounts. Money earned and saved for retirement can be taxed at three points: when earned (labor income), as returns are generated (investment income), and when paid out of the account in retirement (account withdrawals). We assume three proportional tax rates, one for labor income (τ_L), one for intermediate investment returns (τ_I), and one for retirement income (τ_R). In addition, time-0 taxes are reduced by τ_S for every dollar contributed to a retirement account. Tax rates do not vary, either across time or with the level of income, and we abstract from details such as contribution limits, withdrawal penalties, and required minimum distributions.[7]

Table 1 compares three possible account types: a common taxable account (Taxable), back-loaded taxation (Traditional) and front-loaded taxation (Roth). Based on the timing of taxation, these accounts are also conventionally referred to as TTE, EET, and TEE, respectively (see, e.g., OECD 2018). A common taxable account is TTE because contributions are nondeductible ($\tau_S = 0$, so that $\tau_L - \tau_S = \tau_L > 0$), investment returns are taxable ($\tau_I > 0$), and account distributions in retirement are exempt ($\tau_R = 0$). A traditional retirement account is EET because it has fully deductible contributions ($\tau_L - \tau_S = 0$), exempt returns ($\tau_I = 0$), and taxable distributions ($\tau_R > 0$). A Roth

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6 Formally, we assume a linear storage technology, with storage allowed to be positive or negative. The individual invests her assets in this storage technology or in riskless government bonds (which, by no-arbitrage, yield r as well). To reflect the passage of T years between work life and retirement, when we calibrate the model, we set $r \equiv (1 + r_{annual})^T - 1$ and $f \equiv 1 - (1 - f_{annual})^T$. The two-period setup is chosen for simplicity only and none of the results in this section depend on it.

7 In practice, the tax system is instead progressive (i.e., marginal tax rates increase with income), so that even if the tax rate schedule is constant over time, a lower level of income in retirement would imply $\tau_L > \tau_R$. This is our main motivation for allowing distinct tax rates. Progressivity also introduces additional complications: when coupled with uncertain labor income or asset returns, marginal tax rates become stochastic. In addition, Roth accounts have less restrictive effective contribution limits (Burman, Gale, and Weiner 2001) and more flexible withdrawals. We also ignore for now any behavioral factors that could cause individuals to choose a consumption plan that differs from the optimum computed here under one or both accounts. We discuss these factors in Section 7.

Table 1
Different tax treatment of retirement savings.

Account type	Taxable	Traditional	Roth
Type of taxation	Front-loaded	Back-loaded	Front-loaded
Label	TTE	EET	TEE
Deduction for saving τ_S	0	τ_L	0
Net tax on saved income $\tau_L - \tau_S$	τ_L	0	τ_L
Tax rate on investment returns τ_I	τ_I	0	0
Tax on retirement payouts τ_R	0	τ_R	0

account is TEE because it has aftertax contributions ($\tau_L - \tau_S > 0$), exempt returns ($\tau_I = 0$), and exempt distributions ($\tau_R = 0$). Typically and in the current US system, $\tau_S^{Trad} \equiv \tau_L^{Trad}$ and $\tau_R^{Trad} > 0$, whereas $\tau_S^{Roth} \equiv 0$ and $\tau_R^{Roth} \equiv 0$. While the tax rate on labor income could differ between an all-Roth and an all-Traditional system (e.g., to balance the government budget), in this section we assume that it is the same ($\tau_L^{Roth} = \tau_L^{Trad} = \tau_L$); later, in our general equilibrium analysis of Section 5, we allow τ_L to be endogenous and potentially differ across systems ($\tau_L^{Trad} \neq \tau_L^{Roth}$). We use superscripts only when necessary to highlight that a given tax rate only applies to one of the two systems.

Money contributed to a Traditional account receives a subsidy at rate τ_S to be later taxed at a rate τ_R. Thus, in addition to the exemption of returns described above, the individual receives a tax benefit if $\tau_R < \tau_S$, and incurs a tax cost if $\tau_R > \tau_S$. This differential could be thought of as an implicit "government match", akin to an employer match, as if the government matched every dollar of forgone consumption with a (positive or negative) contribution of

$$\tau_M \equiv (\tau_S - \tau_R)/(1 - \tau_S) \tag{1}$$

dollars to the account. Note that Eq. (1) also applies to Roth but, since $\tau_S^{Roth} = \tau_R^{Roth} = 0$, it evaluates to zero, reflecting the absence of an implicit match.

Since under Traditional $\tau_S = \tau_L$, each dollar of the account balance can be decomposed into three virtual accounts:

$$\underset{\substack{\text{Roth-like} \\ \text{Individual Account}}}{(1-\tau_L)} + \underset{\substack{\text{Roth-like} \\ \text{Match Account}}}{(\tau_L - \tau_R)} + \underset{\substack{\text{Implicit} \\ \text{Govt. Account}}}{\tau_R} . \tag{2}$$

As in Figures 1 and 2, the first term is a "Roth-like" account of size $1 - \tau_L$, as if the individual had contributed to a Roth account, and the third term is the "implicit government account" of size τ_R, representing the government's claim on future taxes when the investor takes distributions from the account. The middle term is new: for each dollar in a Traditional account, the individual has forgone $1 - \tau_L$ dollars of consumption, and hence implicitly received a match of $(1 - \tau_L)\,\tau_M = \tau_L - \tau_R$ dollars.

We assume that earnings Y are the same regardless of account type. We also assume that the government issues debt to cover any difference between revenue and expenditures.

2.1.2 Individuals' budget constraints. Based on the taxation described above, individuals face the following budget constraints at times 0 and 1, respectively:

$$S = \frac{Y(1-\tau_L) - C_0}{1-\tau_S}, \tag{3}$$

$$C_1 = S(1+r)(1-f)(1-\tau_R). \tag{4}$$

Because $\tau_S^{Roth} = 0$ and $\tau_S^{Trad} = \tau_L$, for any choice of initial consumption ($C_0 = C_0^{Trad} = C_0^{Roth}$), Traditional results in a larger account size ($S^{Roth}/S^{Trad} = 1 - \tau_L$).

2.2 Benchmark equivalence

Using (1), we can rewrite (3) and (4) as one intertemporal budget constraint that relates C_0 and C_1:

$$C_1 = [Y(1-\tau_L) - C_0](1+r)(1-f)(1+\tau_M). \tag{5}$$

Under the simplifying assumptions that $f = 0$ and $\tau_R^{Trad} = \tau_L^{Trad}$, τ_M^{Trad} evaluates to zero. Since τ_M^{Roth} always evaluates to zero, (5) implies a benchmark equivalence (e.g. Brady 2012): for any C_0, retirement consumption is the same under Roth as under Traditional. We state a stronger equivalence: since the set of all feasible consumption plans is the same under Roth and Traditional, then regardless of utility function the individual's *optimal* consumption plan (i.e. both initial and retirement consumption) must be the same under the two systems. Further, since C_0 is the same across Roth and Traditional, (3) implies that Traditional has more retirement assets than Roth. Finally, the government's cash flow differs across plans—revenue is received up front with Roth accounts and deferred with Traditional. However, since by no-arbitrage the government's discount rate is equal to the interest rate on government bonds (r), the present value of government revenue is the same ($Y \cdot \tau_L$) under both systems. The extra bonds the government issues to cover the greater budget deficit under Traditional are held within individuals' retirement accounts and their amount equals the size of the implicit government account.[8]

Brady (2012) and others rely on the assumption that $\tau_R^{Trad} = \tau_L^{Trad} = \tau_L^{Roth} \equiv \tau_L$. When $\tau_R^{Trad} \neq \tau_L$, the benchmark equivalence no longer holds because $\tau_M^{Trad} \neq 0$ while $\tau_M^{Roth} = 0$, so that the budget constraint (5) is no longer the same between the two systems. We now relax this assumption.

[8] Thus, even if r were determined endogenously, i.e. if the storage technology did not exist, a shift from Roth to Traditional would leave all consumption allocations, desired national savings, and the equilibrium interest rate unchanged.

Allowing for the possibility that $\tau_R^{Trad} \neq \tau_L$, we note two policies that re-establish the equivalence: the government could (i) introduce under Roth an explicit match of $\tau_M^{Roth} = (\tau_L - \tau_R^{Trad})/(1 - \tau_L)$ per dollar of contribution, or equivalently (ii) make Roth contributions partially deductible at a rate $\tau_S^{Roth} = (\tau_L - \tau_R^{Trad})/(1 - \tau_R^{Trad})$, thus creating an implicit match of the same size as Traditional. Note that, in our model's notation, the two policies are indistinguishable, as Eq. (1) establishes a one-to-one correspondence between τ_M and τ_S.

2.3 Adding a risky asset

The standard indifference result is usually stated without reference to asset allocation. So far we have assumed that there is only one asset in the economy: government bonds. In reality, however, roughly two-thirds of the government's $3.8 trillion implicit account is invested in stocks, mostly through actively and passively managed stock funds. The government does not choose this allocation—it is the aggregate of individual retirement account allocation choices.

Consider the base case above with $\tau_M^{Trad} = 0$, but now suppose that there are two assets: the government bond yielding r and a risky asset (stocks) that has a stochastic return $\tilde{r}_s$ with expected return $r_s > r$. Individuals choose the share a of the portfolio that is held in stocks. Holding tax rates and rates of return constant, and for the moment ignoring fees, it is straightforward to show that, as in the single-asset model, an equivalence result holds: under Roth and Traditional, the individual would choose the same initial consumption and portfolio share a, and thus have identical (risky) future consumption.

As before, the timing of the government's cash flows differs between Roth and Traditional, but now the delayed tax revenue under Traditional is positively correlated with realized stock returns, and thus has both higher expected value and higher risk than in the benchmark case.[9] A switch from Roth to Traditional is equivalent to an increase in the supply of government bonds, an equal increase in the private demand for government bonds in the government's implicit account, *and* a portfolio swap in that account that results in greater demand for stocks and lower demand for bonds. Thus, because the government's implicit account is allocated identically to the individual's own portfolio, Traditional results in higher overall demand for stocks than Roth.

If the government faces no binding constraints on its holdings of stocks, then it is indifferent to the allocation of its implicit account because it can simply adjust its stockholdings elsewhere, and our benchmark equivalence result continues to hold. Then, the appropriate rate for discounting the expected cash flows from the government's implicit stockholdings will be r_s, and so

[9] For every dollar of pre-tax income saved for retirement at time 0, the time-0 tax revenue under Roth is τ_L. Under Traditional, the tax revenue at time 1 is a random variable equal to $[a(1+\tilde{r}_s)+(1-a)(1+r)]\tau_L$. The expected tax revenue is equal to $[a(1+r_s)+(1-a)(1+r)]\tau_L$ and the standard deviation is $a\sigma_{\tilde{r}_s}\tau_L$, both increasing in a.

the present value of tax revenues will continue to be the same under the two systems. If the government cannot or does not offset its increased holdings of stocks, a switch from Roth to Traditional could affect both the probability distribution of future government revenue and aggregate welfare. We discuss revenue in Section 4.2 and welfare in Section 7. The formal analysis of our paper, however, leaves out stocks for simplicity.

2.4 Adding fees

The top half of Table 2 summarizes our benchmark equivalence results from Section 2.2. Rows 1 and 2 show the initial and future cash flows for both the individual and the government for a given C_0 ($= C_0^{Trad} = C_0^{Roth}$). We normalize the initial account balance under Traditional to \$1 (row 1), which can be funded with \$1 of pre-tax income, yielding no revenue for the government. At time 1, the balance, $1+r$, is paid out and taxed. The government receives a fraction τ_R^{Trad} of the balance, and the individual receives the remaining fraction $1-\tau_R^{Trad}$. With a Roth account (row 2), \$1 of pre-tax income pays for an account contribution of $1-\tau_L$, yielding immediate tax revenue of τ_L. No subsequent taxation happens, and therefore at time 1 the individual keeps the entire balance, $(1-\tau_L)(1+r)$. Row 3 shows the difference between Traditional and Roth. If $\tau_R^{Trad} = \tau_L$, i.e., if Traditional does not have an implicit match, then our benchmark equivalence holds. If $\tau_R \neq \tau_L$, the equivalence does not hold. Row 4 examines the case in which the government restores the equivalence by introducing a match under Roth equal to the implicit match under Traditional: $\tau_M^{Roth} = (\tau_L - \tau_R^{Trad})/(1-\tau_L)$. The initial balance is increased by the amount of the match. In this case, individuals have the same cash flows under the two systems and the government has the same PV of cash flows so that the equivalence always holds (row 5).

We now introduce an asset manager charging proportional fees f on the account, assuming initially that the government does not tax its income (the corporate tax τ_C is zero) and that f is the same under Roth and Traditional. The structure of rows 6–10 of Table 2 parallels rows 1–5. Row 8 shows the difference between Traditional and Roth. If $\tau_L = \tau_R^{Trad}$, the equivalence result continues to hold for the individual, even with fees. For the government, however, the present-value revenue under Traditional is lower by an amount $\tau_R^{Trad} \cdot f$ so that the present value equivalence that held with $f = 0$ no longer holds. Intuitively, τ_R^{Trad} is the initial size of the government's implicit account under Traditional and f is the fraction of the account that gets eroded by fees.[10]

[10] The additional assets under management under Traditional generate higher dollar fees. While in Table 2 all added fees under Traditional are borne by the government, alternative assumptions about the deductibility of fees could shift some or all of the burden to individuals. In Section 1 of the Internet Appendix, we examine four types of accounts. In addition to standard Roth accounts (in which fees are non-deductible) and standard Traditional accounts (in which fees are effectively deductible), we consider two hypothetical accounts: a "fee-deductible Roth", in which individuals receive a deduction for fees, and a "fee-nondeductible Traditional", in which the government taxes the individual based on the gross-of-fees balance. We thank Mariacristina DeNardi for suggesting we examine the latter account type.

Table 2: **Present value of tax revenue under Traditional and Roth without fees and with fees.**

		Individual			Government		
Fees	Account	Initial balance	Future balance	Final payout	Initial revenue	Future revenue	PV @ r
No fees ($f = 0$)	1. Traditional	1	$1+r$	$(1+r)\cdot(1-\tau_R^{Trad})$	0	$(1+r)\cdot\tau_R^{Trad}$	τ_R^{Trad}
	2. Roth	$1-\tau_L$	$(1-\tau_L)\cdot(1+r)$	$(1-\tau_L)\cdot(1+r)$	τ_L	0	τ_L
	3. Diff. 1 − 2	τ_L	$\tau_L\cdot(1+r)$	$(1+r)\cdot(\tau_L-\tau_R^{Trad})$	$-\tau_L$	$(1+r)\cdot\tau_R^{Trad}$	$-(\tau_L-\tau_R^{Trad})$
	4. Roth with explicit match	$1-\tau_R^{Trad}$	$(1-\tau_R^{Trad})\cdot(1+r)$	$(1-\tau_R^{Trad})\cdot(1+r)$	τ_R^{Trad}	0	τ_R^{Trad}
	5. Diff. 1 − 4	τ_R^{Trad}	$\tau_R^{Trad}\cdot(1+r)$	0	$-\tau_R^{Trad}$	$(1+r)\cdot\tau_R^{Trad}$	0
With fees ($f > 0$)	6. Traditional	1	$(1+r)\cdot(1-f)$	$(1+r)\cdot(1-f)\cdot(1-\tau_R^{Trad})$	0	$(1+r)\cdot(1-f)\cdot\tau_R^{Trad}$	$(1-f)\cdot\tau_R^{Trad}$
	7. Roth	$1-\tau_L$	$(1-\tau_L)\cdot(1+r)\cdot(1-f)$	$(1-\tau_L)\cdot(1+r)\cdot(1-f)$	τ_L	0	τ_L
	8. Diff. 6 − 7	τ_L	$\tau_L\cdot(1+r)\cdot(1-f)$	$(1+r)\cdot(1-f)\cdot(\tau_L-\tau_R^{Trad})$	$-\tau_L$	$(1+r)\cdot(1-f)\cdot\tau_R^{Trad}$	$-(\tau_L-\tau_R^{Trad})-\tau_R^{Trad}\cdot f$
	9. Roth with explicit match	$1-\tau_R^{Trad}$	$(1-\tau_R^{Trad})\cdot(1+r)\cdot(1-f)$	$(1-\tau_R^{Trad})\cdot(1+r)\cdot(1-f)$	τ_R^{Trad}	0	τ_R^{Trad}
	10. Diff. 6 − 9	τ_R^{Trad}	$\tau_R^{Trad}\cdot(1+r)\cdot(1-f)$	0	$-\tau_R^{Trad}$	$(1+r)\cdot(1-f)\cdot\tau_R^{Trad}$	$-\tau_R^{Trad}\cdot f$

Note: An asset manager charges proportional fees f on the account. The individual has the same retirement wealth with a Traditional or a Roth account if either (i) under Traditional the tax rates on retirement income and on labor income are the same ($\tau_R^{Trad} = \tau_L$) or (ii) Roth includes a match equal to Traditional's implicit match $\tau_M^{Roth} = (\tau_L - \tau_R^{Trad})/(1-\tau_L)$ (see text). Under either assumption, and with no fees ($f = 0$), the government has the same present value of revenue. However, with fees ($f > 0$), the present value of government revenue is lower with Traditional. Throughout, we ignore corporate taxes and assume that the government's discount rate is the same (r) as the return on its debt.

If an implicit match exists under Traditional ($\tau_R^{Trad} \neq \tau_L$), this match again creates a difference for the individual and the government. Row 9 shows the effect of introducing a match under Roth equal to the implicit match under Traditional as in row 4. Adding such a match restores the equivalence for individuals and makes the difference in present-value government revenue equal to $\tau_R^{Trad} \cdot f$, the same result as in the absence of an implicit match (row 10).

Taxing the income of asset managers shrinks, but does not eliminate, the present value loss in tax revenue. For simplicity we assume that $\tau_R^{Trad} = \tau_L$ under Traditional and that all asset manager costs are fixed, so that every extra dollar of revenue turns into an extra dollar of pretax profits and an extra τ_C dollars of tax revenue.[11] Then, the difference in PV of government revenue becomes

$$\text{PV}(\text{Tax Revenue}^{Trad}) - \text{PV}(\text{Tax Revenue}^{Roth}) = -\tau_R^{Trad} \cdot f \cdot (1 - \tau_C)\,. \quad (6)$$

3. A supply-side fee equivalence result

In Section 2 we showed that if tax rates, individual income, and percentage fees are the same across Roth and Traditional, individual consumption choices and utility are the same under the two systems and the higher government expenditure subsidizes asset managers.

In this section, we prove a novel and less-obvious supply-side equivalence: again holding tax rates and individual income constant, and given some mild restrictions on cost and fee structure, it is indeed optimal for each asset management firm to charge the same percentage fees under Roth and Traditional. This result does not depend on the specific market structure or shape of the individuals' utility functions, and justifies our Section 2 assumption that percent fees remain the same under Traditional and Roth.

We prove this result for a general linear fee and cost structure. In the presence of a fixed cost component, the economies of scale under Traditional result in lower average costs. One might think that percent fees would drop to reflect this reduction in average costs. However, while feasible, lowering percent fees would not be profit-maximizing. In models with fixed costs, firms generally have market power (i.e. face downward-sloping, as opposed to vertical, demand curves), so that price competition alone does not cause firms to pass savings along to consumers. Profit-maximizing firms with market power, facing higher demand (i.e., AUM) but identical demand elasticities

[11] Here, τ_C represents all taxation of the asset manager income, including possibly any double taxation at the corporate and personal level. If the additional assets result in additional costs, the recovery by the government may be less than τ_C—for instance, if these costs do not correspond to incremental income for any taxable entity, or if they do correspond to incremental income, but for a more lightly taxed entity (such as wages for a worker in a low tax bracket). Even if these costs correspond to incremental income for a more heavily taxed entity, the total recovery will be of the order of a tax rate, i.e., much less than 100%. For further discussion of these issues in a general equilibrium model, see Section 5.

under Traditional, instead choose to charge the same percent fees and capture the additional government expenditures as profits.[12] In other words, investors understand that a portion of the fees they pay under Traditional will simply lower their tax liability upon withdrawal, and hence they do not respond to fees in a way that induces profit-maximizing asset management companies to lower their proportional fees under Traditional.

3.1 Assumptions: cost and fee structure

We model a two-period economy with a unit continuum of individuals $i \in [0,1)$. Individuals and tax rates are as described in Section 2. The unit of production is a generalist firm that produces asset management services, i.e., invests on behalf of individuals. We ignore the existence of multiple layers of financial intermediation (e.g., recordkeepers, asset managers, fund families, subadvisors, securities brokers, etc.).

Individual saving, S_i, must be allocated to one of N asset management firms, indexed by $j \in \{1,2,\ldots N\}$. Individual i's utility $u_i\left(C_{0,i},C_{1,i},j\right)$ depends on time-0 and time-1 consumption as well as on the chosen firm j. (Since individuals each choose their own firm, a more precise notation would be j_i. We omit this subscript for legibility.) u_i is assumed to be separable in its arguments. We assume that the market for consumption goods is perfectly competitive, but that asset management firms have market power.[13] Individual preferences over firms are driven by unspecified firm-specific attributes. Possible examples of differentiating attributes include salience, trust, the level of customer service, location, or portfolio characteristics. We assume that firms cannot engage in price discrimination based on individual attributes (i.e., based on i).

To allow for the possibility of economies of scale in asset management services, we use a simple but flexible firm-level cost function equal to the sum of a fixed component and a variable component that is proportional to assets under management. We assume that all costs (measured in goods) are incurred by firm j at time 0, and equal

$$Costs_j = \phi + c \cdot AUM_j, \tag{7}$$

where ϕ is the fixed component, and $c \cdot AUM_j$ is the variable component, equal to a fraction c of assets under management of firm j.[14]

[12] Scharfstein (2018) describes a scenario in which, with fixed costs and no variable costs, an increase in assets results in a matching drop in percent fees, so that total dollar fees remain constant. This scenario is a result of assuming fixed costs, no entry, *and* zero profits. We argue that these three conditions would not simultaneously hold in a reasonable microfounded equilibrium, regardless of back-loaded taxation.

[13] Assuming market power in the goods market as well would not affect our later results because a switch from Roth to Traditional does not create any artificial demand for consumption goods—only for asset management.

[14] Note that under this specification firms incur variable costs on their gross AUM, i.e., including the part that is used to cover fixed costs. Therefore, the fixed cost of operating a firm in the usual sense is $\phi/(1-c)$, not ϕ. This assumption is made for tractability and does not affect our results qualitatively.

Similarly, we allow for the possibility that larger accounts are offered lower average percent fees. To approximately capture this feature, we assume firms set a two-part fee structure with a fixed component (F_j) and a variable component proportional to assets ($f_j^v \cdot S_j$):

$$Revenue_j = \left(F_j + f_j^v \cdot S_j\right) q_j, \tag{8}$$

where q_j is firm j's market share, S_j is the saving choice of each of its investors, and $q_j \cdot S_j = AUM_j$.[15] Reflecting the notation of the previous sections, we define f_j as the average percent fees charged by firm j:

$$f_j \equiv F_j/S_j + f_j^v, \tag{9}$$

which of course is greater than the proportional variable component as long as $F > 0$.

3.2 The individual's problem

The individual faces the following intertemporal budget constraint:

$$C_{1,i} = \left\{[Y(1-\tau_L) - C_{0,i}]\left(1 - f_j^v\right) - F_j(1-\tau_S)\right\}(1+r)(1+\tau_M), \tag{10}$$

where τ_M continues to indicate a match (implicit or explicit) as defined in Section 2. This equation mirrors Eq. (5) in Section 2 with a few differences. First, this equation holds for a specific individual i who chooses a specific firm j. Second, fees are based on the more general linear fee schedule of (8), which nests the simple percentage fees of Section 2. (Note that individual i will pay at least F_j even when $S_i = 0$.) As in Section 2, we assume equal individual incomes ($Y^{Trad} = Y^{Roth} = Y$), income tax rates ($\tau_L^{Trad} = \tau_L^{Roth} = \tau_L$), and match rates ($\tau_M^{Trad} = \tau_M^{Roth}$) across Roth and Traditional. As in Section 2, saving is

$$S_i = \frac{Y(1-\tau_L) - C_{0,i}}{1-\tau_S}. \tag{11}$$

The individual chooses $C_{0,i}$, $C_{1,i}$ and j to maximize utility u_i:

$$\max_{C_{0,i}, C_{1,i}, j} u_i(C_{0,i}, C_{1,i}, j), \tag{12}$$

subject to the budget constraints (10), resulting in the following first-order condition with respect to consumption:

$$u'_{i,0}(C_{0,i}) = \delta(1+r)\left(1 - f_j^v\right)(1+\tau_M)u'_{i,1}(C_{1,i}), \tag{13}$$

[15] The quantity S_j is well-defined because, conditional on having chosen firm j, all of its investors (who are identical in all respects except for their preference for firm nonprice attributes) will make the same consumption and saving choices. If each individual were to make different saving choices, AUM would have to be defined as $AUM_j \equiv \int_{\{i\to j\}} S_i$, where $\{i \to j\}$ indicates the set of individuals who choose firm j.

where $u'_{i,t}(\cdot) \equiv \partial u_i/\partial C_{t,i}$. For the choice of a firm there is no first-order condition. Individuals simply pick the firm that gives them the highest utility:

$$j^* = \arg\max_{j\in\{1,2,\ldots N\}} u_i\left(C_{0,i}, C_{1,i}, j\right). \tag{14}$$

Note both $C_{0,i}$ and $C_{1,i}$ depend on j: in choosing a firm, individuals are willing to pay higher fees (and thus have lower consumption) in exchange for the attributes of j that they value.

3.3 Competition between firms and the firm's problem

Each of the N firms chooses f_j^v, its variable fee, and F_j, its fixed fee, to maximize profits π_j. The firm understands that its fee choices affect its profits via both its market share, q_j, and the saving choices of each of its investors, S_j, but it takes aggregate income and competitors' choices as given.Profit π_j is calculated as fee revenue, $(F_j + f_j^v S_j)q_j$, minus variable costs, cS_jq_j, minus the fixed cost ϕ:

$$\max_{f_j^v, F_j} \left[F_j + \left(f_j^v - c\right) S_j\right] q_j - \phi, \tag{15}$$

where $f_j^v - c$ is the markup of variable fees over marginal cost. The firm has first-order conditions

$$\frac{\partial \pi_j}{\partial f_j^v} = S_j \cdot q_j + \left[F_j + \left(f_j^v - c\right) S_j\right] \cdot \frac{\partial q_j}{\partial f_j^v} + \left(f_j^v - c\right) \cdot \frac{\partial S_j}{\partial f_j^v} \cdot q_j = 0, \tag{16}$$

$$\frac{\partial \pi_j}{\partial F_j} = q_j + \left[F_j + \left(f_j^v - c\right) S_j\right] \cdot \frac{\partial q_j}{\partial F_j} + \left(f_j^v - c\right) \cdot \frac{\partial S_j}{\partial F_j} \cdot q_j = 0. \tag{17}$$

Raising variable fees f_j^v by 1 basis point has three effects. First, the firm gains some revenue on its existing market share ($S_j \cdot q_j$); second, the firm loses some market share ($\partial q_j/\partial f_j^v < 0$) and the associated margin over variable costs $[F_j + (f_j^v - c)S_j]$; third, the investors that choose to remain with firm j may change saving ($\partial S_j/\partial f_j^v$), thus changing the asset base on which the firm earns a markup (defined as the gross profit over marginal cost per dollar of saving, $f_j^v - c$). Raising fixed fees F_j by 1 cent has the same three types of effects. Eqs. (16) and (17) say that the firm's optimal fee level is such that the three effects balance out.

3.4 Equilibrium and asset-management-side fee equivalence

We focus on a symmetric equilibrium of this market. In this equilibrium, we define a linear pricing schedule $\Phi^{Roth} = \left(f_j^v, F_j\right)$ that is profit-maximizing for firm j under Roth, and an *equivalent* schedule $\Phi^{Trad} \equiv \left(f_j^v, K \cdot F_j\right)$ under Traditional. Here, K is the increase in saving per unit of forgone consumption under Traditional over the same quantity under Roth. Assuming zero match for simplicity, $K \equiv 1/(1-\tau_L)$.

Proposition: *Under the assumptions of Sections* 3.1–3.3, *if a linear pricing schedule is profit-maximizing for a firm under Roth, an equivalent schedule that results in the same variable and fixed percent fees is profit-maximizing under Traditional.*

To understand the intuition underlying this result, note that our individual equivalence result of Section 2 implies that, at any given level of percent fees, consumption is the same under both systems and the level of saving under Traditional is K times the level under Roth. Then, the dollar response of consumption to percent fees is the same across systems, which implies that the elasticity of saving (and thus AUM) with respect to percent fees is the same under both systems. If every firm charges the same percent fees (both fixed and variable) under Roth as it does under Traditional, individuals choosing the same firm obtain the same consumption and utility under the two systems, and therefore individuals choose the same firm under either system. Then, for any given choice of percent fees, revenue under Traditional is simply K times revenue under Roth, so that the same percent fee structure maximizes revenue under both systems. If there are no variable costs, the revenue-maximizing fee structure also maximizes profit. The *profit*-maximizing percentage fee structure is thus also identical under the two systems, though profits are higher under Traditional than under Roth. The same holds if variable costs scale proportionally with assets. This result does not depend on the two-part fee structure we assumed. It continues to hold if firms are constrained to charge variable fees only, i.e., F_j is constrained to be zero, so that total percent fees equal the variable component, i.e., $f_j = f_j^v$. For a proof, see Section 4.1 of the Internet Appendix.[16]

A slightly more general version of this result is formally proved in Section 4.1 of the Internet Appendix and makes use of the firm's first-order conditions (16) and (17). We also show that this result continues to hold when, under Traditional, the tax rate on retirement income is different from that on labor income (i.e., there is an implicit match), as long as there is an equal explicit or implicit match under Roth as defined in Section 2.1.1.

4. Quantitative estimates of the subsidy

4.1 Definition

Within the two-period model of Section 2, the subsidy is simply defined as the dollar value of saving under Traditional (S^{Trad}) times the per-dollar difference in the present value of government revenue between Traditional and Roth (Eq.

[16] Note that this result depends on our assumed firm cost function (7), which does not entail a per-customer cost. With per-customer costs, variable costs would not scale proportionally with assets.

6):

$$\text{Subsidy} = S^{Trad} \cdot \tau_R^{Trad} \cdot f \cdot (1 - \tau_C). \tag{18}$$

Thus defined, the subsidy excludes the effect of any differences in tax rates between labor and retirement income under Traditional, which induce their own differences in government revenue and asset manager revenue.[17]

Our two-period setup in which the individual saves only once at time 0 does not allow us to distinguish between the flow of new saving and the stock of existing savings. In the real world, wealth is accumulated gradually over many time periods so that the stock and the flow are no longer the same. In this case, the subsidy can be measured in a variety of ways, corresponding to different interpretations of S and f in Eq. (18). For instance, if we let S denote the stock of accumulated assets and f the current-period flow of fees, the subsidy is defined as the current fees (net of any resulting corporate tax revenue) on the government's implicit account. Alternatively, if S denotes the flow of current-period contributions and f the present value of lifetime fees generated by these contributions, the subsidy is defined as the present value of all future fees on the government account attributable to current contributions. Finally, if S is the present value of a cohort's lifetime contributions and f the present value of fees generated by these contributions, the subsidy is defined as the present value of all future fees on the government account attributable to that cohort.

For our quantitative analysis we choose the first measurement at annual frequency, and therefore our subsidy estimate measures the annual loss of government revenue on all tax-deferred retirement assets (S^{Trad}) under the status quo, relative to a world in which these assets were switched to Roth today. (Choosing a different measurement would correspond to a different policy experiment.) Here, $f(1 - \tau_C)$ indicates annual net percentage fees on retirement accounts, τ_R is the effective tax rate on retirement payouts, and $S^{Trad} \cdot \tau_R$ is the size of the government's implicit account.

Next, we calibrate Eq. (18) on U.S. data. In Section 3 of the Internet Appendix we do the same for six additional countries with the largest dollar size of Traditional retirement assets.

4.1.1 Measuring investment fees (f) and other inputs (S^{Trad}, τ_R, and τ_C).

We produce an original, comprehensive, asset-weighted estimate of explicit fees (both asset-level and account-level) and trading costs for U.S. DC plans and IRAs, whose assets are overwhelmingly Traditional. Weighting by assets is necessary for our purposes because lower-cost funds tend to have more AUM (Hubbard et al. 2010). However, most published estimates of mutual

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[17] If Traditional has an implicit match and Roth has no corresponding match (as defined in Section 2.2), the resulting difference in present value of government revenue is $S^{Trad}\left(\tau_L - \tau_R^{Trad}\right)(1 - f\tau_C)$. The total difference between Roth and Traditional in asset manager revenue is $S^{Trad} \cdot \tau_L \cdot f$. Of this difference, a fraction τ_R^{Trad}/τ_L is due to the government's implicit account (a transfer from the government to asset managers), and the remaining fraction $\left(\tau_L - \tau_R^{Trad}\right)/\tau_L$ is due to the match (compensation for the additional asset management services received by the individuals). We do not count the latter part as a component of the subsidy.

Table 3
Overview of our estimates of investment fees and costs (bps).

Tax-Deferred Assets	1. Explicit Fees Account Fees, Exp. Ratios, Distr. Fees		2. Trading Costs Commissions, Bid/Ask, Mkt. Impact	Total [1+2]
A. DC Plans ($9.3 trillion)	All-in fees	50*	14†	64
B. IRAs ($12.0 trillion)	Asset-level fees Advisory fees	33* 41‡	13†	87
Weighted Average (A, B)		63	14	77

Source: (*) Based on Deloitte (Rosshirt, Parker, and Pitts 2014) and BrightScope/ICI (2015; 2022; 2023) studies; (†) estimate derived from volume-weighted academic estimates of trading costs using industry estimates of fund turnover; (‡) original estimate based on SEC 10K filings. DC plans' all-in fees are estimated independently of the 40 bps asset-level fees estimate of Table 4. Asset totals are estimated in Appendix A.3. Rows may not add up to totals because of rounding.

Table 4
Asset-Level Fees and Trading Costs Breakdown (bps).

		DC Plans			IRAs			
	Asset Class	Alloc.	Asset Fees	Trading Costs	Alloc.	Asset Fees	Trading Costs	Asset Cost
Funds	Equity	51%◊	39◊	14§	26%*	57*	14§	62
	Bonds	9%◊	32◊	27§	8%*	39*	27§	63
	Balanced**	24%◊	44◊	19§	9%*	55*	19§	69
	Cash	3%◊	26◊	0ˆ	3%*	26◊	0ˆ	26
Ind.Sec.	Equity	-	-	-	24%*	0ˆ	14¤	7
	Bonds	-	-	-	9%*	0ˆ	27¤	15
	Cash	-	-	-	5%*	0ˆ	0ˆ	0
	Other¶	9%*	59†	0ˆ	17%*	59†		59
	Empl. stock‡	4%*	0ˆ	0ˆ				
	Average		40	14		33	13	

Note: (*) Our estimation based on ICI, EBRI, and Deloitte data (Rosshirt, Parker, and Pitts 2014; Copeland 2020; ICI 2021); (†) Reported in (BrightScope and ICI 2021), IRA assumed same as DC; (ˆ) Assumed negligible; (§) Based on academic estimates of volume-weighted costs (Anand et al. 2012 and Busse et al. 2021 for equity; Bessembinder et al. 2018, Choi, Huh, and Shin 2024, and Goldstein and Hotchkiss 2020 for bonds) and industry turnover estimates (BrightScope and ICI 2021 for equity; Rowley and Dickson 2012 and Novick et al. 2016 for bonds); (◊) Based on ICI research (Holden, Duvall, and Chism 2021; ICI 2021), IRA cash fees assumed same as DC; (¤) assumed same as funds; (**) assumed to be 60% equity and 40% bonds; (¶) "Other" assets include real estate assets, fixed and variable annuities, and any remaining assets that do not fit into equities, bonds, money or balanced funds; (‡) Sponsor employer stock. Percentages may not add up to 100% because of rounding.

fund fees and overall net-of-fees performance are equal-weighted at the fund level in order to measure average fund quality or average manager skill. Similarly, most published estimates of trading costs are volume-weighted in order to measure trader execution skill or overall market liquidity.

Our fee estimate is summarized in Tables 3 and 4 and described in greater detail in the Appendix (A.1 and A.2). Our estimates are based on several sources, listed in the captions to Tables 3 and 4, covering approximately the years 2015–2020. We start from existing industry estimates of explicit "all-in" fees on DC plans and explicit asset-level fees on IRAs. We then construct our own original estimate of explicit advisory fees on IRAs. Finally, we combine academic volume-weighted estimates of trading costs with industry estimates of turnover and asset allocation to construct an asset-weighted estimate of trading costs for DC plans and IRAs. Our overall estimate of f is 77 basis points (bps), obtained as the asset-weighted average of 64 bps for DC plans and 87 for IRAs.

We estimate S^{Trad} as \$18.9 trillion, the total amount of tax-deferred assets in IRAs and DC plans based on the ICI's Retirement Market statistics and our own calculations, and τ_R as 20%, a lower-bound estimate based on existing literature and our own analysis of SCF data, thus resulting in a conservatively small value for the government's implicit account. Our methodology to estimate these values is described in the Appendix (A.3 and A.4). For τ_C, the corporate tax rate, we simply use the top statutory corporate tax rate of 21%.

4.1.2 Results. Equation (18) describes the annual government revenue loss in an all-Traditional world relative to an all-Roth world. The U.S. retirement system is a mix of both systems, though heavily weighted towards Traditional. Assuming, realistically, that in a mixed system fees on Roth assets are the same as the fees on Traditional assets, Eq. (18) still applies to our current system. Note that S^{Trad} here refers to the tax-deferred (Traditional) portion of retirement assets, rather than to total retirement assets in a hypothetical all-Traditional world. Substituting our estimates into Eq. (18) yields:

$$\begin{aligned} \text{Annual subsidy} &= S^{Trad} \cdot \tau_R^{Trad} \cdot f \cdot (1 - \tau_C) = \\ &= \$18.9 \text{ trillion} \cdot 20\% \cdot 0.77\% \cdot (1 - 21\%) = \$23.4 \text{ billion}. \end{aligned} \tag{19}$$

The size of the government's implicit account is $S^{Trad} \cdot \tau_R$ or \$3.8 trillion. Multiplying this by the after-tax fees $f(1 - \tau_C)$ reveals that the government is currently spending \$23.4 billion per year on asset management fees on this account, an amount that it would not be paying under an all-Roth system. This result does not depend on our Section 3 argument that percentage fees would remain the same under an all-Roth system or, in general, on any assumptions about cost structure. Because there is no implicit government account under Roth, the value of the current subsidy depends only on the fee level under the current system and is independent of what the fees would be under an all-Roth system.[18] This amount is equal to a fraction $\tau_R(1-\tau_C) \approx 16\%$ of the asset management industry's total fee revenue from tax-deferred DC plans and IRAs. In terms of the 2022 U.S. government budget,[19] this amount is also equal to 7.7% of the total interest paid on the federal debt ($305 billion) or 1.6% of the 2022–26 projected average federal budget deficit ($1,490 billion), and is about the size of the budget of NASA ($24.8 billion).

Our subsidy estimate would be higher if, as discussed in Appendix A.3, we were to include in our estimate of assets under management the $8.3 trillion of tax-deferred assets in state and local government and corporate defined-benefit pension plans. Although these assets do not belong to any individual in particular, they are subject to the same tax deferral benefit: the contribution is made with pretax money, and benefits are taxed only when paid out. Therefore, defined-benefit plan assets can also be decomposed into an employees' account and a government account earmarked to pay future taxes. While defined-benefit plans are likely to incur lower fees than defined contribution plans or IRAs, fees are still material. Accounting for the government's implicit share of DB assets would increase our estimate of the government's account by another 8.3 trillion $\times$ 20% = $1.7 trillion. Assuming lower fees for DB plans (45 bps instead of 77 bps),[20] the estimated subsidy rises to $29.3 billion.

The government's implicit account has grown substantially over time. By our rough estimate, this growth (including DB) may explain as much as one-fifth of the growth in conventional asset management relative to GDP since 1980. Greenwood and Scharfstein (2013, Figure 2) estimate that from 1980 to 2007 the securities industry's revenue grew by 3.75 percentage points of GDP. Of these, 0.95 percentage points were attributable to conventional (i.e., not alternative) asset management. In the same period, asset manager revenue attributable to the government's implicit account rose from 0.01% to 0.10% of GDP for DC plans and IRAs (assuming constant fees of 0.77%) and from 0.03% to 0.13% of GDP for DB plans (assuming constant fees of 0.45%). This growth of 0.19 percentage points of GDP is roughly one-fifth of 0.95. Even if we instead allow percent fees to start at a level twice as high and fall over

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[18] This statement is exact in a model without corporate taxation. With corporate taxation, the relative cost of the current system depends on the difference between current corporate taxes and those raised in an all-Roth system. This difference in turn depends on profits under an all-Roth system, a function of fee levels and saving behavior under Roth. With different fee levels ($f^{Trad} \neq f^{Roth}$), and assuming no difference in saving behavior ($S^{Trad}(1-\tau_L) = S^{Roth}$), (18) becomes $S^{Trad}\tau_R f^{Trad}(1-\tau_C) - S^{Trad}(1-\tau_L)(f^{Trad} - f^{Roth})\tau_C$. The additional term represents the difference in the present value of corporate taxes on the individual's portion of the account due to the fee difference. Allowing for a saving response, (18) becomes $S^{Trad}\tau_R f^{Trad}(1-\tau_C) - \tau_C[(1-\tau_L)S^{Trad} f^{Trad} - S^{Roth} f^{Roth}]$. If, realistically, the fee difference is small relative to the fee level (and thus the saving response, if any, is also small), the additional term is second-order relative to the first.

[19] Available at `https://web.archive.org/web/20210528181354/https://www.govinfo.gov/app/collection/budget/2022`.

[20] This rough estimate is implied by Table II of Dyck and Pomorski (2011). We define total plan fees as "Overall asset-class-level costs" plus "Plan-level administrative costs." We then calculate an approximate asset-weighted average of 31 bps based on the average plan size in each size quintile and add our estimate of trading costs of 14 bps.

time to their current values, the implicit account's contribution to the growth of asset management remains similar (0.15 instead of 0.19 percentage points).

4.2 Potential asset allocation benefits of Traditional

Our results so far have ignored any potential benefits received by the government due to its implicit account. Here we discuss the value of the services and other benefits it directly receives. In Section 7, we discuss the potential value of indirect economic benefits in the context of our general equilibrium model.

A substantial fraction of the fees on investment products held in retirement accounts covers recordkeeping, distribution, and marketing.[21] The implicit government account, however, does not benefit from these services. Another fraction of fees covers advice on asset allocation and the creation of products to implement such an allocation, such as funds focusing on style (conservative/aggressive) or age (target-date funds). These benefits largely cancel out in aggregate for the government, which holds a fraction of all individual accounts. Moreover, if the advice results in lower fees, this benefit is already reflected in the observed level of fees. We examine the possibility that the fees paid by the government on its implicit account result in better services for individuals in Sections 5 and 6.

What the government does get through its implicit account is exposure to stocks' risk and any corresponding risk premium. Because of the performance of stocks relative to government bonds over the past 40 years, this exposure has turned out, *ex post*, to be very beneficial to government finances relative to a Roth alternative in which the government received tax revenue upfront and used it to pay down its debt. Given that future returns are unknown, however, one should ask whether this exposure is desirable *ex ante*. Note that mere exposure to stocks is an inexpensive commodity: for instance, the U.S. federal government's Thrift Savings Plan (TSP) pays BlackRock no explicit portfolio management fees for its stock funds, all of which are index funds, instead only giving up roughly 1 bp worth of securities lending revenue (Thrift Savings Plan 2018). However, these inexpensive alternatives could be unavailable to the government, for example due to political constraints as democracies are usually averse to direct government holdings of productive assets (see, e.g., Che and Qian 1998).[22]

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[21] While we do not have data on cost breakdowns within retirement accounts, data on the general asset management sector support this view. Roussanov, Ruan, and Wei (2021) find that distribution fees are close to one-third of revenue. As an example, we examined the 2017 annual report of Invesco, one of the largest listed U.S. investment management companies. Invesco had operating revenues of 57 bps, with third-party distribution, service and advisory expenses (including passing through of 12b-1 and similar fees) of 17 bps, and direct marketing expenses of 1.4 bps, totaling 32% of revenue.

[22] These constraints are not universal, however, as holdings of the 100 largest global sovereign funds amount to roughly $12 trillion (`https://www.swfinstitute.org/sovereign-wealth-fund-rankings/`). Holdings of productive assets vary, but as of end 2021 Norway's Government Pension Fund Global, the world's largest, held 71 percent of its assets in equities (`https://www.nbim.no/en/the-fund/market-value/`). Data retrieved on 11/28/2023.

Moreover, it is possible that the average fund held in retirement accounts earns abnormal return, or "alpha," in excess of fees, to a point that it outperforms the investment opportunities available to the government outside retirement accounts. This alpha would need to come from either systematically winning a zero-sum game against other market participants, or making prices more efficient and capturing the resulting value (e.g., as activist hedge funds aim to do). The existing empirical evidence paints a pessimistic picture: while we have no specific evidence for funds held in retirement accounts, active mutual funds as a group lose the zero sum game against other market participants (Shive and Yun 2013; Ince, Kadlec, and McKeon 2018, etc.) and their aggregate alpha is negative (Fama and French 2010; Berk and van Binsbergen 2015).[23]

It is not clear that under Roth any constraints on additional government stock holdings would necessarily be binding. A full analysis would require a complete equilibrium specification of the nature of the constraints. First, the government could face a binding constraint under Roth that precluded it from *reducing* its equity exposure. The government already has substantial implicit exposure to equities through the tax system due to the positive correlation between tax revenue cash flows and stock market performance (Auerbach 2004), and it may not be advantageous for it to increase this exposure beyond the level that would be present under an all-Roth system. Second, if the government faced a binding constraint from increasing its stock holdings under Roth, the analysis would still need to weigh the loss from the higher fees paid on the added assets held in retirement accounts against any net benefits from the added stock holdings under Traditional. (Note that even if under Roth an incremental increase in equity exposure were efficient, the discrete increase from a full switch to Traditional could overshoot and be inefficient.)[24] The issues that arise here are similar to those in the literatures on whether the Social Security trust fund should invest in equities.[25]

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23 Berk and van Binsbergen (2015) compare active funds against "investable" benchmarks (i.e., retail shares of Vanguard funds), estimating a value-weighted net alpha of -12 bps. This cost of active management is in addition to the cost of investing in the specific passive benchmark (18 bps plus any implicit trading costs). According to Petajisto (2009), the S&P 500 index itself has implicit trading costs of 20-28 bps. Aggregate alpha can also be negative due to marketing and search costs (Roussanov, Ruan, and Wei 2021). Adding account-level fees would imply total investment fees of the same order of magnitude as ours, though somewhat lower. Furthermore, even if aggregate alpha were positive, an increase in assets due to a switch from Roth to Traditional would likely result in lower abnormal returns because of industry-level diminishing returns to scale in asset management (Pástor and Stambaugh 2012; Pástor, Stambaugh, and Taylor 2015).

24 Note that the entire balance in the government account (bonds and stocks) pays fees at a rate f, but only a fraction a is invested in stocks, for a cost f/a. For instance, with fees equal to 0.77% (our asset-weighted estimate) and $a = 2/3$ (a value close to the actual asset allocation of U.S. retirement accounts), the effective fees on additional equity investment are 1.5 times as large, i.e., 1.16% $(= 0.77/(2/3))$. For Traditional to be preferred to Roth, the average dollar of resulting additional equity exposure needs to clear this higher hurdle.

25 See, for example, Bohn (1990), Geanakoplos, Mitchell, and Zeldes (1999), Abel (2001), Diamond and Geanakoplos (2003), and Lucas and Zeldes (2009). See also the related discussion in Romaniuk (2013).

5. A general equilibrium model of retirement savings and asset management

Our analyisis so far has ignored certain features of general equilibrium. First, firm profits accrue to individuals. Second, with a change in government expenditure, taxes need to change to balance the budget. Finally, firms may enter and exit the market. Taking these factors into account is necessary in order to address important questions about social resources and individuals' welfare. Does the greater government spending on asset management services create additional costs, thereby diverting actual economic resources away from other productive uses? How do any changes in fees and costs affect the revenue and profits of asset management firms, the quality of services provided to individuals, and aggregate welfare? How do tax rates need to adjust to balance the government's intertemporal budget constraint?

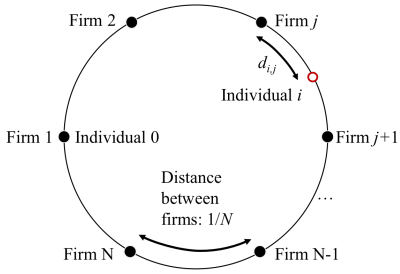
In this section and the next, we address these questions by embedding the setup of the previous sections in a two-sector, general equilibrium model. This requires making a variety of modeling decisions related to cost structure (which we began to explore in Section 3), product market competition, entry, and the value of asset management services to individuals.

Our main finding of this section is that Traditional entails higher additional societal resources devoted to asset management than Roth. This result is robust to a variety of assumptions on cost and competition. At one extreme, assume that all asset management costs are variable and proportional to assets under management. Under these assumptions, each dollar of additional assets would directly lead to additional societal resources devoted to asset management. At the other extreme, assume that all costs are fixed and the marginal cost of managing additional assets is zero, so that an increase in assets results in no additional aggregate costs and a decline in average per-dollar costs. Holding constant the number of firms, equilibrium percent fees remain the same under Traditional as under Roth (a new fee equivalence result), implying that profits are higher under Traditional. If new firms are allowed to enter, positive equilibrium profits induce entry. Entry implies additional firm-level fixed costs, which raises aggregate costs. Thus, even under these diametrically opposite assumptions, the higher assets under Traditional result in additional societal resources devoted to asset management. Further, regardless of entry and cost structure, Traditional requires a higher income tax rate to cover the higher fees on the government's implicit account.

5.1 Additional modeling assumptions

5.1.1 Cost structure. The existence of economies of scale with assets under management seems uncontroversial: academic studies agree that larger funds and larger plans have lower administrative costs per dollar of AUM (Latzko 1999; Gao and Livingston 2008; Hubbard et al. 2010; Dyck and Pomorski 2011). Statements by industry insiders also support this idea: Kahn (2002) quotes the director for portfolio review at a major fund family as saying that

Figure 3
Spatial competition.



Note: N firms are uniformly spaced along a circle of circumference 1, as in Salop (1979). Individuals are distributed uniformly along the circle, and prefer firms located at a closer distance.

the "marginal cost of managing increasing dollars is minimal."[26] To reflect this cost structure, we use the cost structure of Eq. (7) with positive fixed cost (ϕ) and non-negative marginal cost (c).

5.1.2 Market structure and competition. A classic benchmark model used to study aggregate welfare implications of competition and related policies in the presence of market power and free entry (the forces we discussed above) is Salop's (1979) circular city, a model of oligopolistic competition with differentiated products (see, e.g., Tirole 1988, ch. 7). In this model, asset management firms face a downward-sloping demand curve, i.e. if they raise their fees, their demand falls, but not to zero. While other models with market power and entry exist, we believe that the assumptions underlying Salop are most consistent with the realities of the asset management industry.[27]

We embed the circular city in our two-period economy. Following Salop (1979), we assume that individuals are uniformly distributed over a circle of

[26] A substantial literature has examined economies of scale in *performance* (as opposed to cost). On one hand, Dyck and Pomorski (2011) show that larger DB plans outperform smaller ones at least in part because of access to a better investment opportunity set. On the other hand, for active mutual funds the existence of diseconomies of scale has been theorized and empirically observed both at the fund level (Perold and Salomon 1991; Berk and Green 2004; Gabaix et al. 2006) and the industry level (Pástor and Stambaugh 2012). The available evidence shows that size is negatively associated with performance both at the fund level (Chen et al. 2004; Yan 2008; Berk and van Binsbergen 2015) and at the industry level (Pástor, Stambaugh, and Taylor 2015). We do not directly model investment performance and therefore net economies of scale are positive in our model. Explicitly modeling diseconomies of scale in performance would strengthen our result and widen the difference between Roth and Traditional.

[27] For instance, under Dixit and Stiglitz (1977), every firm has relationships with every customer, and firms create surplus by providing variety. In practice, asset management customers do not tend to engage in relationships with multiple financial advisors and recordkeepers, nor do they select many investment funds when a large number are available (see, e.g., Huberman and Jiang 2006).

circumference 1 and the N firms are evenly distributed around the circle, as shown in Figure 3.[28]

5.1.3 The individual's problem. Following Salop, we incorporate a measure of "distance" into the utility function described in Section 3.1. The utility of individual i is assumed to be

$$u_i(C_{0,i}, C_{1,i}, j) = \ln C_{0,i} + \delta \ln C_{1,i} - \gamma \ln d_{i,j}, \tag{20}$$

increasing in current real consumption ($C_{0,i}$) and future real consumption ($C_{1,i}$), and decreasing in distance $d_{i,j}$ from the chosen firm, defined as the shortest arc distance between i and the location of their chosen firm j. We choose a logarithmic utility specification because it is both economically sensible and tractable.[29] A low distance can be thought of as literally low physical distance from the nearest branch, but may also capture any of the firm attributes described in Section 3.1. To rule out what Salop (1979) calls a "supercompetitive" equilibrium (the situation in which a firm charges sufficiently low fees to be competitive with firms other than its immediate neighbors), we assume that the individual only considers the two nearest firms (denoted j^- and j^+):

$$j^* = \arg \max_{j \in \{j^-, j^+\}} u_i(C_{0,i}, C_{1,i}, j). \tag{21}$$

For the time being, we do not yet require that profits received by individuals (Π) equal aggregate firm profits ($\sum_{j=1}^{N} \pi_j$). For simplicity, we assume that profits are rebated at time 0 to individuals (an equal amount per individual) and are taxed at the personal level only, at the same rate as labor income, so that the budget constraint for each individual is an updated version of (10), now including profits:

$$C_{1,i} = \left\{ \left[(Y + \Pi)(1 - \tau_L) - C_{0,i} \right] \left(1 - f_j^v \right) - F_j (1 - \tau_S) \right\} (1 + r)(1 + \tau_M), \tag{22}$$

where f_j^v and F_j are variable and fixed fees as defined in Section 3. We can now solve for the optimal saving S_i as a function of F_j and f_j^v, for any given j:

$$S_i = \frac{\delta}{1+\delta} \left[(Y + \Pi) \frac{1 - \tau_L}{1 - \tau_S} - \frac{F_j}{1 - f_j^v} \right] + \frac{F_j}{1 - f_j^v}. \tag{23}$$

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[28] It is easy to show that equidistant firms maximize social welfare and a planner would choose this location pattern. Economides (1989) derives location endogenously in a three-stage game, albeit at the cost of restrictions on the utility function and greater complexity.

[29] We are not aware of any works using the circular city model that feature either an intertemporal choice problem or logarithmic distance disutility. Salop (1979) and many subsequent works feature linear consumption utility and linear or quadratic distance disutility (see Gong, Liu, and Zhang 2016, for a review). We choose logarithmic consumption utility because linear consumption utility does not permit us to study the savings decision. We choose logarithmic distance disutility for tractability, and because it allows for an interpretation of "distance" as something whose importance increases with the individual's wealth.

The first term in this expression represents the part of saving that finances time-1 consumption. The term inside the square bracket represents lifetime resources net of fees and taxes. As in the usual logarithmic utility solution, the individual devotes a fraction $\delta/(1+\delta)$ of lifetime resources to time-1 consumption. The second term is simply money that is placed in the account to immediately pay for fees.[30]

Young individuals are endowed with one unit of labor, which they supply inelastically. Individuals can work either in the consumption goods sector or in the asset management sector and are indifferent (for a given wage) between the two. Denote with L the amount of labor employed in asset management and $1-L$ in the consumption goods sector. The production technology for the consumption good is linear and there are no fixed costs. We let ψ denote the marginal (and average) product of labor, so that the output of the consumption goods sector is $Y_C \equiv \psi(1-L)$. The consumption good industry and the labor market are perfectly competitive, so that the consumption good firms pay a wage ψ. These assumptions imply, among other things, that the asset management industry faces a perfectly elastic supply of labor at a wage ψ. (We make this simplifying assumption to abstract from the wage implications of a larger asset management sector.)

Since the marginal product of labor is ψ, and defining $AUM \equiv \sum_{j=1}^{N} AUM_j$, the amount of labor going to the asset management sector is

$$L = \frac{c \cdot AUM + \phi \cdot N}{\psi}. \tag{24}$$

Note thus that individuals' income is always $Y = \psi$ regardless of the amount of resources devoted to asset management, and government revenue from taxing labor income is then constant ($Y \cdot \tau_L$), regardless of the size of the asset management industry.

5.2 Equilibrium fees

In this subsection we derive an expression for the fees charged by firms under the assumption that individuals are maximizing utility and firms are maximizing profits. We do not yet impose the equilibrium conditions that (i) profits (Π) received by individuals are equal to aggregate firm profits and (ii) taxes (τ_L) are consistent with balancing the government's budget, so that the results in this subsection hold for any values of profits received by, and taxes paid by individuals.

30 The first term inside the square bracket is aftertax income, grossed up by a factor $1/(1-\tau_S)$ because dollars contributed to the account either are tax-deferred under Traditional ($\tau_S^{Trad} = \tau_L$) or possibly receive an explicit match under Roth ($\tau_S^{Roth} \geq 0$). Both the second term inside the square bracket and the equation's last term owe their form to our assumption that retirement account money is used to pay variable fees *and then* fixed fees, so that the individual has to put $F_j/(1-f_j^v)$ in the account to pay F_j in fixed fees. Taken together, these two terms show that every dollar spent on fixed fees (i) reduces retirement resources by $\delta/(1+\delta)$ and (ii) increases nominal saving by the full dollar, so that saving is an increasing function of F and f.

We examine a symmetric equilibrium in which each firm has market share $q_j = 1/N$ and therefore total assets under management of S/N. Individuals' behavior is captured by the Euler equation (13), where now u_i is the logarithmic utility (20), and by Eq. (21), and subject to the budget constraint (10). Firms choose fees to maximize profits taking into account the effect of a fee change on their market share as well as their customers' saving response (Eq. 23), as described by the first-order conditions (16) and (17) (for f_j^v and F_j, respectively) in Section 3.3. Solving for S, f_j^v, and F_j, we find that optimal variable fees are equal to marginal cost c, and firms capture surplus via the fixed component:

$$f_j^v = f^v = c, \tag{25}$$

$$F_j = F = \frac{2\gamma}{1+\delta+2\gamma}(1-c)(Y+\Pi)\frac{1-\tau_L}{1-\tau_S}. \tag{26}$$

In Section 4.2 of the Internet Appendix, we also consider what happens if firms are restricted to set either f_j^v or F_j to zero.

Eq. (25) is a special case of a classic result (see, e.g., Oi 1971) that does not depend on our choice of logarithmic utility: when firms are allowed to charge a two-part tariff with fixed and variable components, the variable component is optimally set to be equal to marginal cost. This pricing scheme maximizes the surplus that can then be captured via the fixed component.[31] Any increase in variable fees above this level at the expense of fixed fees (and similarly any decrease) distorts investors' intertemporal consumption choices and thus their willingness to pay for asset management services. On the other hand, fixed fees do not create distortions and firms set them based on the amount customers are willing to pay to reduce the distance from their firm ("willingness to pay"), which depends on lifetime resources and the extent to which fees are effectively deductible from taxes.

Substituting Eqs. (25) and (26) into (23), and aggregating over all individuals, we can also obtain a new expression for individuals' saving that does not depend on fees:

$$S = \frac{2\gamma+\delta}{1+\delta+2\gamma}(Y+\Pi)\frac{1-\tau_L}{1-\tau_S}. \tag{27}$$

Next, we use the newly obtained expressions to compute total percent fees f as

$$f \equiv f^v + F/S = \frac{2\gamma+c\delta}{2\gamma+\delta}. \tag{28}$$

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[31] Multi-part tariffs were first proposed by Coase (1946) as an alternative to government subsidies to attain marginal cost pricing with economies of scale. The ensuing debate (see., e.g., Vickrey 1948; Oi 1971; Tirole 1988, Ch. 3) discusses the consequences of a nonlinear cost structure, among other things. Our assumption that marginal costs are constant implies that the difference between the fixed components of fees and costs equals firm surplus. It also implies that f^v does not depend on the fund's AUM: thus, while we continue to assume, as in Section 3, that fees are a linear function of assets, this fee structure would arise endogenously when costs are linear.

Note that this expression for total percent fees depends only on fixed model parameters, and therefore implies a stronger fee equivalence result: even if Roth and Traditional have different profits or tax rates, percentage fees will be the same across the two systems. This stronger result follows from our assumption of log utility. With log utility, first-period consumption is independent of the (after-tax and after-match) rate of return (see Eq. 27 in the Internet Appendix), and saving and the willingness to pay to avoid extra distance (and thus fixed fees) are each simply proportional to after-tax first period income $(Y+\Pi)\cdot(1-\tau_L)$, which also corresponds to lifetime labor and profit income. (Here, we define willingness to pay as the amount of consumption an individual is willing to forgo to avoid traveling one more unit of distance, as in Section 5.8 of the Internet Appendix.) As a result, F/S in each system is unaffected by Y, Π, or τ_L. This would not be the case with an arbitrary utility function (see immediately below).[32] Finally, (28) does not depend on the number of firms (N), and thus it also holds allowing N to be endogenously determined, as we do in Section 5.4 below.

As we discuss in Sections 5.6–5.8 of the Internet Appendix, with arbitrary utility, willingness to pay does not scale proportionally to lifetime resources. In this case, the fee equivalence between Roth and Traditional holds only if $c=0$, i.e., if total lifetime resources are the same under Roth and Traditional. If there are any variable costs ($c>0$), a switch from Roth to Traditional causes an increase in resources devoted to asset management and a reduction in lifetime income. (The same obtains if there are fixed costs and firms are allowed to enter the market.) In turn, a lower lifetime income causes individuals to make different choices, resulting in different equilibrium fees.

5.3 Market equilibrium with fixed number of firms: assets, profits and taxes

We now close the model by assuming that taxes (τ_L) are consistent with balancing the government's budget, and that profits received by individuals are equal to aggregate firm profits ($\Pi = \sum_{j=1}^{N} \pi_j$). We solve for a market equilibrium, i.e., a set of values (f^v, F, S_0, j) such that firms are maximizing their profits, individuals are maximizing their utility, all budget constraints are satisfied, and markets clear.

The government sets tax rates to fulfill its single (intertemporal) budget constraint,

$$G = (Y+\Pi)\,\tau_L - (F/S+f^v)\cdot(\tau_R\cdot S) - S\,(\tau_S-\tau_R)\,, \tag{29}$$

[32] Note also that $S^{Trad}/S^{Roth} = (Y^{Trad}+\Pi^{Trad})/(Y^{Roth}+\Pi^{Roth})\cdot 1/(1-\tau_L^{Roth})$ (see Eq. 30 in the Internet Appendix), so that the ratio of saving across systems will depend on how profits differ across systems, but not on how tax rates differ. This is because S^{Trad} is independent of the tax rate under Traditional—an increase in the tax rates (τ_L^{Trad} and τ_R^{Trad}) decreases consumption but leaves saving unchanged—due to a decrease in the amount truly owned by the individual and an exactly offsetting increase in the size of the implicit government account.

where G is government expenditure and the right-hand side is the present value of tax revenue.

Under Traditional, $\tau_S = \tau_L$, so government revenue has three terms: the tax on labor income and profits, minus the fixed and variable fees it pays on its implicit account, minus the implicit government match on saving. The government has two policy variables (the labor income tax rate τ_L^{Trad} and the retirement income tax τ_R^{Trad}), and one intertemporal budget constraint (29), leaving it with one degree of freedom. To simplify comparison between the two account types, we assume here no implicit or explicit matches: $\tau_L^{Trad} = \tau_R^{Trad}$ so that $\tau_M^{Trad} = 0$, and $\tau_M^{Roth} = 0$.

Under Roth, with no match, both τ_S and τ_R equal zero. Because the government receives no revenue at time 1, it cannot borrow. Its only option is to balance the budget at time 0 by setting the tax rate on labor income equal to the ratio of government expenditure to the sum of wages and profits:

$$\tau_L^{Roth} = G/\left(Y + \Pi^{Roth}\right). \tag{30}$$

It is easy to show (see Section 4.4 of the Internet Appendix) that, for a given N, Traditional always results in a higher tax rate ($\tau_L^{Trad} > \tau_L^{Roth}$). This higher tax rate is due to the fees the government pays on its implicit account under Traditional. As discussed in Section 2.4, only a part of these fees returns to the government through the taxation of asset manager profits; the remainder must be covered by higher taxes. The extra asset manager revenue is offset by higher variable costs (an additional dollar of assets creates new revenue at a rate f but profits only at a rate $f - c$), so that only a fraction $(f - c)/f \cdot \tau_L < \tau_L < 1$ of the subsidy is recovered by the government. Note that our result that $\tau_L^{Trad} > \tau_L^{Roth}$ does not depend on our choice of logarithmic utility.

We also find that Traditional has higher assets under management than Roth (we show this in Section 4.3 of the Internet Appendix). Since, as shown above, percent fees are the same under both systems, it follows that aggregate profits of the asset management industry are greater under Traditional than they are under Roth. When variable costs exist ($c > 0$), the higher assets under Traditional also result in higher employment in the asset management industry (see Eq. (24)). Note that this result does not depend on the tax rate, as long as $\tau_L^{Roth} > 0$, and therefore it holds regardless of whether the government must balance the budget.

Does our individual consumption equivalence result continue to hold in general equilibrium? In general it does not, because the higher resources devoted to asset management under Traditional leave individuals with fewer resources, leading to lower consumption (the higher profits received by individuals are more than offset by the higher taxes they pay). However, in the absence of variable costs ($c = 0$), the higher profits exactly offset the higher taxes, and since individuals face the same intertemporal tradeoff, they choose the same consumption.[33]

5.4 Market equilibrium with endogenous number of firms

In this subsection we solve for the equilibrium allowing firms to enter or exit endogenously, driving equilibrium profits to zero. Traditional continues to have higher assets, higher taxes, and higher employment in asset management and lower consumption of non-asset-management goods.

5.4.1 Additional assumptions: entry. Empirical evidence and casual observation suggest low barriers to entry in the mutual fund industry (Hubbard et al. 2010). In 2020 alone, 268 new mutual funds, 313 new exchange-traded funds, and 28 new fund sponsors entered the industry (ICI 2021), with similar numbers exiting.[34] To reflect this evidence, we assume that there is no entry cost, other than the fixed operating cost. For any given N, the marginal firm exits if its profits are negative and enters if profits are positive conditional on entry. Because our model allows for product differentiation, the assumption of a fixed cost component does not result in a monopoly. Moreover, as discussed below in footnote 36, an increase in the number of competitors does not affect price directly via increased intensity of competition. We assume that N can be noninteger, and therefore firms enter the market until equilibrium profits π_j equal zero for all firms j. [35]

5.4.2 Equilibrium quantities and taxes with entry. In Sections 4.5–4.6 of the Internet Appendix, we show that, as N increases, the higher aggregate fixed costs cause aggregate profits (Π) to fall.[36] Allowing firms to optimally choose

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[33] This result does not depend on our assumption of logarithmic utility, but holds with arbitrary utility. We conjecture that our results on profits and taxes (regardless of c) also do not depend on the specific utility function chosen. Variable fees are equal to variable costs so that the variable component of revenue does not affect profits, and fixed costs are constant by assumption. Then, for profits to be higher under Traditional, it is sufficient that the fixed fee F be higher under Traditional (under which it is paid with pretax dollars) than under Roth (under which it is paid with aftertax dollars). This conjecture seems especially likely to hold because under Traditional, holding N fixed, the only way for individuals to have lower lifetime resources (and thus a lower willingness to pay) is if assets under management (and thus total variable costs) are higher ($S^{Trad} > S^{Roth} \iff (Y+\Pi^{Trad})(1-\tau_L^{Trad}) < (Y+\Pi^{Roth})(1-\tau_L^{Roth})$). Finally, since the higher profits are obtained at the expense of the government, the tax rate is also higher.

[34] A similar situation is reflected in the non-mutual fund segments of the asset management industry. For instance, the majority of the leading third-party retirement plan administrators were established in the past 25 years (see Plansponsor's 2016 TPA survey of 1,070 administrators available at `https://web.archive.org/web/20160719124946/http://www.plansponsor.com/2016-Third-Party-Administrator-Survey/`).

[35] Requiring N to be integer can lead to a situation in which N firms make positive profits, and $N+1$ firms make negative profits. This possibility, which could have important consequences if N were small, is analyzed by Mankiw and Whinston (1986).

[36] The higher aggregate fixed costs also cause lifetime resources to fall and thus S and F to fall proportionally, as we also show in Section 4.6 of the Internet Appendix. Note, however, that an increase in the number of competitors (N) does not affect price (F) directly via a change in the intensity of competition. This is apparent by examining the limit as fixed costs go to zero ($\phi \to 0$) in the closed-form solution for F (Internet Appendix Eq. 31), in which case an increase in N has no effect on F. (The special $\phi = 0$ case is discussed in greater detail

whether to enter and exit, the equilibrium number of firms N and aggregate employment in asset management L are

$$N = \frac{Y}{\phi} \cdot \frac{2\gamma(1-c)}{1+\delta+2\gamma} \cdot \frac{1-\tau_L}{1-\tau_S}, \text{ and} \tag{31}$$

$$L \equiv \frac{cS+\phi N}{Y} = \frac{c\delta+2\gamma}{1+\delta+2\gamma} \cdot \frac{1-\tau_L}{1-\tau_S}. \tag{32}$$

In an equilibrium with free entry and zero profits, the government budget constraint once again implies that in this case the tax rate under Traditional must be higher than under Roth, i.e., $\tau_L^{Roth} = G/Y$ and $\tau_L^{Trad} = G/(Y - F - f^v S) > G/Y$. As was the case with no entry, the government needs to set a higher tax rate under Traditional in order to finance the revenue loss arising from the fees it effectively pays on its implicit account. This inequality does not depend on the utility function because it is derived directly from the government's budget constraint under the assumption that $\Pi = 0$. With log utility, the tax rate is

$$\tau_L^{Trad} = G/Y(1+\delta+2\gamma)/(1+\delta(1-c)). \tag{33}$$

Further, because variable and fixed asset management costs ($cS + \phi N$) are higher under Traditional, consumption is proportionately lower than under Roth:

$$\frac{C_0^{Trad}}{C_0^{Roth}} = \frac{C_1^{Trad}}{C_1^{Roth}} = \frac{1-\tau_L^{Trad}}{1-\tau_L^{Roth}} = \frac{1 - G/Y \cdot \frac{1+\delta+2\gamma}{1+\delta(1-c)}}{1 - G/Y} < 1. \tag{34}$$

Note that the exact value of C_t^{Trad}/C_t^{Roth} depends on our log utility specification; however, the qualitative result that $C_t^{Trad}/C_t^{Roth} < 1$ holds under a wider range of assumptions, as we show in Section 5 of the Internet Appendix.

Moreover, under Traditional, the equilibrium saving, fixed fees, total fees, number of firms, and employment in the asset management industry are all equal to their corresponding values under Roth, scaled up by a factor $1/(1-\tau_L^{Roth}) > 0$:

$$\frac{S^{Trad}}{S^{Roth}} = \frac{F^{Trad}}{F^{Roth}} = \frac{F^{Trad} + fS^{Trad}}{F^{Roth} + fS^{Roth}} = \frac{N^{Trad}}{N^{Roth}} = \frac{L^{Trad}}{L^{Roth}} = \frac{1}{1-\tau_L^{Roth}} > 1. \tag{35}$$

Note that the ratio S^{Trad}/S^{Roth} is the same as in Section 2, even though now tax rates under Traditional are not the same as tax rates under Roth. Because there are no equilibrium profits under either Roth or Traditional, $Y + \Pi$ is the same under both, which is sufficient to obtain (35) under logarithmic utility.

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in Section 4.5.1 of the Internet Appendix.) This is because an increase in N has two effects on competition. On one hand, each fund loses market share as its competitors become closer; on the other, the remaining clients are on average closer and thus more price-insensitive. In our logarithmic specification, the two forces perfectly balance out, resulting in constant intensity of competition.

6. General equilibrium: welfare

In this section, we compare welfare under three alternatives: i) the Roth market equilibrium, ii) the Traditional market equilibrium, and iii) the optimum chosen by a hypothetical social planner. We showed above that a Traditional system yields a greater equilibrium number of firms than a Roth system. We now show that the number of firms under Roth is more than the planner optimum. Because Traditional in the model has even more firms than Roth, it generates lower welfare than Roth. We quantify the welfare difference with three calibration exercises.

6.1 The planner's problem

We characterize the social optimum in the model by assuming the planner directly chooses individual consumption $\{C_{0,i}\}$ and $\{C_{1,i}\}$ for all i and the number of firms N to maximize the sum of individual utilities:

$$\max_{\{C_{0,i}\},\{C_{1,i}\},N} U, \quad U \equiv \int_0^1 (\ln C_{0,i} + \delta \ln C_{1,i} - \gamma \ln d_{i,j})\, di, \tag{36}$$

subject to the resource constraint

$$C_1 = [(Y - C_0 - G)(1-c) - \phi N](1+r), \tag{37}$$

where $C_t \equiv \int_0^1 C_{t,i} di$ is aggregate consumption at time $t \in \{0,1\}$, G is an exogenously given amount of public expenditure, and r is the exogenously given return on the storage technology. Since we assume that no production occurs in period 1, the only way the planner can allocate consumption in period 1 is via the asset management industry. The planner incurs fixed asset management costs ϕ for each of the N firms and variable costs at a rate c on $Y - C_0 - G$.[37]

The planner optimally allocates equal consumption to all individuals ($C_{0,i} = C_0$ and $C_{1,i} = C_1$), because consumers have identical preferences and productivity and because the planner's objective function is concave, separable in its arguments (consumption and distance), and unaffected by inequality in utility caused by, e.g., differences in distance. Since all firms are identical except for location, it is also optimal for the planner to allocate each consumer to the nearest firm. Using these facts and the assumption that the N firms are located equidistantly along the circle, the planner's objective simplifies to (see Section 4.7 of the Internet Appendix for a derivation)

$$\max_{C_0,C_1,N} U, \quad U = \ln C_0 + \delta \ln C_1 + \gamma \ln N - \gamma(1 + \ln 2). \tag{38}$$

The last term $[\gamma(1+\ln 2)]$ is a constant which we henceforth omit for brevity.

[37] Consistent with the cost function in Eq. (7), the planner incurs variable costs on all of $Y - C_0 - G$, including the resources devoted to the fixed costs of asset management.

There are two first-order conditions. The first is

$$U'(C_0^*) = \delta\,(1+r)\,(1-c)\,U'(C_1^*), \tag{39}$$

where $U'(C_t) \equiv \partial U/\partial C_t = 1/C_t$. This equation says that, at the planner's optimum, the marginal cost in terms of lost utility of giving the consumer one less dollar of period-0 consumption must equal the marginal benefit of allocating that dollar plus returns and net of the marginal asset management costs to period 1 consumption.

This first-order condition of the planner potentially differs from that of the individuals in the market (13) in two ways. First, if present in the market economy, an implicit or explicit match would introduce a wedge in the market Euler equation $(1 + \tau_M)$ that is not present under the planner solution.[38] Second, for the planner the cost of future consumption relative to today's consumption depends only on the return on assets net of variable *costs* $[(1+r)\,(1-c)]$, whereas for the individual it depends on the return on assets net of variable *fees* $[(1+r)(1-f_j^v)]$. In the absence of a match and of restrictions on fees, however, the planner's and the market's first-order conditions are the same.

The planner's choice of N, however, relies on a very different mechanism than the market's. The planner's first-order condition for N is

$$\phi\,\frac{1}{1-c}U'(C_0^*) = U'(N^*), \tag{40}$$

and says that at the optimum the cost of adding another firm, $\phi/(1-c)$, expressed in units of utility, must equal the utility benefit, γ/N, that arises due to the drop in the average distance. Under the market equilibrium, on the other hand, N is determined by the zero-profit condition (see Eq. 31).

Combining and simplifying the first-order conditions yields the expressions for the optimal time-0 and time-1 consumption and number of firms (C_0^*, C_1^*, N^*). We show in Section 4.8 of the Internet Appendix that the resources devoted to each at time 0 are proportions $1/(1+\delta+\gamma)$, $\delta/(1+\delta+\gamma)$, and $\gamma/(1+\delta+\gamma)$ of net resources $(Y-G)$. Among other things, this implies that the total allocation to the fixed costs of asset management $(N^*\phi)$ does not depend on the size of the fixed cost ϕ.

6.2 Roth vs Traditional: Welfare analysis

We denote welfare, defined in (38), as

$$U^k = \ln C_0^k + \delta \ln C_1^k + \gamma \ln N^k, \tag{41}$$

where $k \in \{*, Roth, Trad\}$ indicates the respective quantities under the planner solution (U^*) and the market equilibria (with entry, unless otherwise indicated) under Roth (U^{Roth}) and Traditional (U^{Trad}).

[38] Note that, in our setup, labor income taxes do not distort labor supply (which is fixed by assumption), whereas capital income taxes introduce a wedge in the Euler equation and distort the intertemporal consumption decision.

We begin by comparing social welfare under Roth and Traditional:[39]

$$U^{Trad} - U^{Roth} = (1+\delta)\ln\left(\frac{1-\tau_L^{Trad}}{1-\tau_L^{Roth}}\right) + \gamma \ln\left(\frac{1}{1-\tau_L^{Roth}}\right) < 0. \tag{42}$$

The two terms of (42) have different signs. The first term is negative because higher total asset management costs under Traditional relative to Roth lead to higher taxes in the model, resulting in proportionally lower consumption and welfare under Traditional. However, the second term is positive because Traditional also generates a larger number of asset management firms in the model, decreasing average distance and contributing to higher welfare. In Sections 4.9 and 4.13 of the Internet Appendix, we prove that the sum of the two terms is always negative, so that social welfare under Traditional in the model is always lower than under Roth.[40] This result is obvious if all costs are variable, but it holds even if some or all costs are fixed.

To understand this result, note that

$$N^{Roth}/N^* = 1 + \frac{1+\delta}{1+\delta+2\gamma} > 1, \tag{43}$$

i.e., the number of firms under the Roth equilibrium is strictly greater than under the planner, and welfare in the model is correspondingly lower. The corresponding expression under Traditional is

$$N^{Trad}/N^* = \frac{1}{1-G/Y}\left(1 + \frac{1+\delta}{1+\delta+2\gamma}\right). \tag{44}$$

Since $G/Y \in (0,1)$, this expression is strictly greater than (43), indicating (consistent with (35)) that the Traditional equilibrium has even more firms than the Roth equilibrium. This fact, together with an unaltered Euler equation for consumption (and higher total variable costs if $c > 0$), generates lower welfare in the model under Traditional than under Roth.

To get a sense of the magnitude of the efficiency loss, let us express the Traditional–Roth gap (i.e., the additional firms under Traditional relative to Roth) as a fraction of the Roth–planner gap:

$$\frac{N^{Trad} - N^{Roth}}{N^{Roth} - N^*} = 2 \cdot \frac{G/Y}{1 - G/Y} \cdot \frac{1+\delta+\gamma}{1+\delta}. \tag{45}$$

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[39] Note that a Roth (“TEE”) account generates higher welfare in our model than a standard Taxable account (“TTE”) even if individuals are rational savers. This is shown in Section 4.13 of the Internet Appendix, in which Roth is modeled as a special case of Taxable account with the tax rate on investment returns (τ_I) equal to zero. With no marginal costs ($c = 0$) and no distance disutility ($\gamma = 0$), the optimal tax rate τ_I^* is zero, because $\tau_I \neq 0$ distorts the Euler equation. With either marginal costs ($c > 0$) or distance disutility ($\gamma > 0$), $\tau_I^* < 0$ and thus Roth is superior to a TTE account with a positive tax rate on investment returns. The intuition is that a negative tax rate on investments forces the government to raise the tax rate on labor τ_L to balance the budget. This reduces saving, and therefore the number of firms, increasing welfare in the model. For small negative values of τ_I, this effect more than compensates for the distortion induced in the Euler equation.

[40] We prove this result in Section 4.9 of the Internet Appendix, for given N or endogenous N with free entry, and in Section 4.13, for τ_L^{Trad} and τ_R^{Trad} chosen to maximize aggregate utility, resulting in a slightly increasing time path of tax rates ($\tau_R \geq \tau_L$, holding with equality if $c = 0$).

Assuming a range for G/Y (the ratio of government expenditure to output) between 0.2 and 0.25, and ignoring the last term, the Traditional–Roth gap is between half as large and two-thirds as large as the Roth–planner gap.

In Section 4.12 of the Internet Appendix we also examine the case in which firms are restricted to charge only fixed fees or only variable fees. The resulting potential mismatch between cost structure and fee structure creates an additional friction in the model, affecting our welfare analysis. However, we show that under reasonable parameterizations Traditional continues to have lower welfare in the model than Roth.

It is important to understand why our model generates too many firms under Roth. If N^{Roth} were exogenously set to N^*, firms would make positive profits, which would then induce additional firms to enter. Our model inherits from the Salop model a tendency to excessive entry in equilibrium. Other models (e.g., Dixit and Stiglitz 1977) have the opposite tendency. The main driver of this difference is that the Salop model allows entrants to target the least satisfied (i.e., highest-distance) customers and thus to capture a large fraction of the gross surplus created by their entry ("business-stealing"). In contrast, under Dixit and Stiglitz (1977) ("DS"), every firm sells to every variety-seeking customer, creating surplus not by targeting but by providing variety.[41] As discussed in Section 5.1.2, however, we believe that the Salop model's assumptions are more consistent with the reality of asset management.

6.3 Calibration and quantitative welfare findings

The previous subsection shows that in the model Traditional generates lower welfare than Roth. To quantify the economic importance of this difference, we now carry out three calibration exercises based on our model. The details of each calibration exercise are in Section 4.11 of the Internet Appendix, and the results are in Table 5.

In our first exercise, we express and quantify the welfare gain in the model of a switch from Traditional to Roth as a percent of retirement consumption. Specifically, we define α as the fraction of retirement consumption that could be taken away under Roth such that aggregate utility would be the same as under Traditional. We conduct this exercise for a variety of cost structures, summarized by the ratio c/f, ranging (left to right) from no variable costs (i.e., all fixed costs) to 100% variable costs (no fixed costs). The resulting α is a substantial number regardless of cost structure, varying between 3.70% and 5.69% of retirement consumption in the model. Note that α should be understood as the fraction of retirement consumption financed by retirement account payouts; while in the model retirement account payouts are the only way to finance retirement consumption, in the real world they are just one of many sources. Also note that α represents the benefit from a switch to

[41] The interplay of business-stealing and variety-seeking is discussed in, e.g., Mankiw and Whinston (1986) and Tirole (1988).

Table 5
Welfare calibration.

c/f	**0%**	**25%**	**50%**	**75%**	**100%**
c (annualized, bps)	0	18	36	56	77
γ	0.083	0.062	0.041	0.021	0.000
α (Equiv. retirement consumption)	3.70%	4.21%	4.71%	5.21%	5.69%
$\ldots =$ Gain from lower fixed costs	6.61%	4.70%	2.96%	1.40%	0.00%
$\ldots -$ Loss from fewer firms	2.91%	2.18%	1.46%	0.73%	0.00%
$\ldots +$ Gain from lower variable costs	0.00%	1.70%	3.20%	4.53%	5.69%
$\alpha/$(Tax Exp.%)	22.6%	25.7%	28.8%	31.8%	34.7%
τ_M (Equivalent saving match)	5.85%	5.82%	5.80%	5.78%	5.75%
$\ldots =$ Compensating match	2.91%	2.24%	1.53%	0.78%	0.00%
$\ldots +$ Welfare-enhancing match	2.93%	3.59%	4.28%	5.00%	5.75%

Note: α is the welfare gain in the model due to a switch from Traditional to Roth. $\alpha/$(Tax Exp.%) scales α by the tax expenditure on retirement accounts, also expressed as a percent of retirement consumption. τ_M is the match the government can afford upon a switch from Traditional to Roth leaving taxes unchanged. Each column assumes a different value of c/f, i.e., $c/f = 0\%$ means that all costs of asset management are fixed, and $c/f = 100\%$ implies that all costs are variable.

Roth from an all-Traditional system, rather than from the current U.S. system. However, the difference is not material because Roth assets are currently only 6.3% of total Roth and Traditional assets (see Appendix A.3).

To better understand the role of fixed and variable costs, the next three rows of Table 5 decompose the calibrated values of α into three components. Starting from a market equilibrium under Traditional, we first decrease the number of firms to the Roth level while remaining under a Traditional system. This step produces two welfare effects: a gain from lower fixed costs, and a loss from the reduction in the number of firms (i.e., from the increase in average distance between investors and their chosen firm). Next, we switch to Roth while leaving $N = N^{Roth}$. This second step reduces aggregate assets and produces a third welfare effect: a gain from lower variable costs. The quantitative details of this decomposition are detailed in Section 4.10 of the Internet Appendix. Regardless of the relative importance of fixed costs, the gain from the lower fixed costs under Roth is roughly double the loss from having fewer firms. To this net gain one must add the gain from variable costs due to the lower assets under Roth. The greater the importance of variable costs, the higher the welfare gain of Roth accounts in the model.

In our second exercise, we scale α by the overall tax expenditure on retirement savings accounts under Roth, defined as the additional revenue that the government would receive if it eliminated the tax break on retirement saving, or $218 billion in 2021.[42] The consumption-equivalent welfare gain of Roth relative to Traditional in the model is large—depending on cost structure assumptions it ranges between one-quarter and one-third of the total tax expenditure on Roth retirement accounts. Unlike the previous measure, scaling by the tax expenditure sidesteps the problem of how retirement consumption is financed in practice.

In our third and last exercise, we start from a zero-profit world with Traditional accounts and assume that, upon a switch to Roth, τ_L remains the same. We assume that the government uses the resulting budget surplus to provide an explicit match $\tau_M^{Roth} > 0$ to those who save in a Roth account (e.g., if $\tau_M^{Roth} = 5\%$, for every $100 contributed, the government adds an extra $5 into the account). We further decompose this match into two parts: a "compensating match" to compensate individuals for the lower number of firms upon the switch, and a welfare-enhancing match. As shown in Table 5, a switch from Traditional to Roth leaving tax rates unchanged would allow the government to provide a roughly 6% match on all retirement saving, regardless of whether asset management costs are primarily fixed or variable. If all costs are variable, the entirety of the match generates a net welfare improvement in the model. If all costs are fixed, this 6% match is still 3% in excess of what would be needed to compensate for the lower number of firms under Roth.

Note that this result is obtained in an equilibrium model in which Traditional is assumed to have no implicit match, i.e., tax rates during work and retirement are the same. If Traditional did have an implicit match ($\tau_L^{Trad} > \tau_R^{Trad}$), then upon a switch to Roth the government would be able to offer an even larger explicit match ($\tau_M^{Roth} \geq \left(\tau_L^{Trad} - \tau_R^{Trad}\right) / \left(1 - \tau_L^{Trad}\right)$).[43]

7. Outside the model: Indirect economic costs and benefits

We discuss here a few possible factors and mechanisms that could be relevant to the choice between Roth and Traditional but are beyond the scope of our model.

7.1 Real-world plan rules

Some real-world features of the actual way accounts are implemented have been omitted from the model for simplicity. For instance, U.S. Roth account

[42] Summing DC plans, DB plans, IRAs and self-employed plans, tax expenditure on retirement tax deferral totaled $218 billion in 2021. The only larger tax expenditure item is the exclusion of employer contributions for medical insurance premiums ($252 billion). Source: U.S. Treasury [`https://web.archive.org/web/20211201180446/https://home.treasury.gov/system/files/131/Tax-Expenditures-2021.pdf`] In Section 4.11 of the Internet Appendix, we roughly estimate as part of our calibration that 16.4% of retirement wealth of an individual who has saved in a retirement saving account is the result of not having paid taxes on returns.

[43] For a small tax wedge ($\tau_L^{Trad} - \tau_R^{Trad}$), the combined explicit match would be approximately equal to the sum of the match in Table 5 and the explicit match based on the tax wedge.

contribution limits are effectively less restrictive because the same nominal limit applies to both types of accounts even though Roth and Traditional contributions are tallied in after-tax and pre-tax dollars, respectively (Burman, Gale, and Weiner 2001). Roth accounts also have more flexible withdrawal rules, e.g., no withdrawals are required for almost all Roth account holders.[44] These features make Roth contributions more desirable for the individual, other things being equal. On the other hand, under some conditions, U.S. employer plan participants are able to borrow using their accounts as collateral. Because of the implicit government account and the resulting higher balance under Traditional, plan participants can borrow more than Roth participants. Although we have abstracted from all of these U.S.-specific details, an all-Roth system could be easily adjusted to provide (or not provide) the same features.

7.2 Macroeconomic effects

Part of our contribution is to highlight that the U.S. government indirectly owns about $2.6 trillion in equities via tax-deferred retirement accounts (roughly two-thirds of its implicit portfolio). Could this added exposure to the stock market be beneficial to society for reasons not addressed in our model?

For instance, as discussed in Section 4.2, the government could desire a portfolio with a higher risk and expected return but could be constrained from achieving this allocation in the absence of a Traditional system.

Alternatively, the additional assets could potentially contribute to social welfare by overcoming one or more externalities. For example, active asset managers could make prices more efficient without fully capturing through trading the value they generate (Grossman and Stiglitz 1980; van Binsbergen and Opp 2019), resulting in underprovision of asset management services in equilibrium. However, there remain serious theoretical doubts about the effectiveness of retail funds as agents of price discovery (see, e.g., Gârleanu and Pedersen 2018) and in Section 4.2 we saw empirical evidence that mutual funds lose the zero-sum game against other market participants, further casting doubt on their contribution to price discovery.

Similarly, Scharfstein (2018) argues that the greater household savings in countries with funded (as opposed to pay-as-you-go) retirement schemes result in greater availability of equity financing for entrepreneurial projects. A casual observer might think that the additional assets under Traditional, relative to a Roth benchmark, would have similar effects. These additional assets, however, do not directly result in greater availability of equity financing, because they are financed with additional government borrowing and therefore do not increase national saving. The additional assets could still result indirectly in greater availability of equity financing if the government does not offset the

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[44] Required minimum distributions (RMDs) have never been required for original-owner Roth IRAs. RMDs on other Roth accounts (e.g., Roth 401(k)s) were eliminated, effective in 2024, by the SECURE 2.0 Act of 2022. RMDs still apply to inherited Roth accounts, except in the case of surviving spouses.

stock exposure from its implicit account, thereby boosting demand for stocks (see also Romaniuk 2013). This increase in demand for risky assets, coupled with the corresponding increase in supply of safe and liquid assets (see, e.g., Holmström and Tirole 1998 and Krishnamurthy and Vissing-Jorgensen 2012), would have ambiguous welfare consequences.

Even if one were convinced of the merits of these arguments, in each case the same objection as in Section 4.2 holds: Traditional could be an improvement over Roth only if the government desired a greater level of exposure to the stock market and were unable to obtain it in a more cost-effective and direct way. While it is possible that this is the case, we have no evidence that the government's $2.6-trillion equity portfolio is the fruit of a conscious policy choice, let alone one that has been publicly debated.

Finally, issuing government debt and transferring the proceeds to private agents who would otherwise borrow (or want to borrow) through private markets has been shown in some contexts to lower the costs of intermediation and be efficient (Barro 1974; Aiyagari and McGrattan 1998; Heathcote 2005). In our context, however, rather than providing greater liquidity to households, the transfer and associated debt issuance instead temporarily increase private sector assets in illiquid retail retirement accounts. Thus, the transfer is inefficient because it generates substantial investment costs and thereby adds to intermediation costs.

7.3 Behavioral effects

Behavioral biases that cause individuals to save too little are an oft-cited motive for the provision of retirement saving incentives and could alter the relative effectiveness of the two systems at boosting retirement saving. If Traditional were substantially more effective than Roth, this could potentially more than compensate for the welfare loss from diverting extra real resources to asset management under a Traditional system. Behavioral arguments cut both ways. If workers ignore or underestimate the future "tax bite" under back-loaded taxation, they would perceive the Traditional system as having a large implicit match, without a corresponding explicit match under Roth. On one hand, this perceived match under back-loaded taxation could lower working-age consumption through substitution effects (future consumption feels cheaper) because of the "instant gratification" of an immediate tax benefit from saving (Feenberg and Skinner 1989). On the other hand, income effects (individuals feel wealthier due to their higher account balances) would lead to higher working-age consumption and lower retirement consumption relative to front-loaded taxation (Iwry and John 2009). Beshears et al. (2017) find empirically that Roth induces individuals to consume less during working years, and argue that this is because individuals underweight future taxes and focus on dollar contributions and saving rather than on consumption.[45] As part of the British debate, an *Economist* editorial claimed that tax deferral "is actually quite useful in that it stops people blowing their pension pot in a spending spree at 65" (Buttonwood 2015) because progressive taxes penalize large one-time withdrawals. Of course, there are legitimate reasons for lump-sum withdrawals such as hardship or investment. We are not aware of any systematic study of this tradeoff.

Behavioral and information frictions also affect the welfare outcomes of a switch from Roth to Traditional in our model. Intuition suggests that including them would magnify the welfare difference between Traditional and Roth because in models with such frictions an increase in the number of funds is typically pure deadweight loss.[46] Indeed, there is abundant evidence these frictions are central to the market for asset management services. Although funds with lower fees tend to have higher market shares (Hubbard et al. 2010), multiple studies point to the pervasiveness of dominated products,[47] and investors are not very sensitive to the price of asset management services. For instance, updating Hortacsu and Syverson (2004), we find that in 2016 there existed 79 S&P 500 index fund share classes (46 distinct funds) with large dispersion in fees (an interquartile range of 102 bps).[48]

[45] Our model results rely on the assumption that, for a given level of tax rates, individuals rationally adjust their contributions to smooth consumption. Generalizing Beshears et al.'s findings to the policy experiments we consider would complicate our welfare analysis, but the gist of our argument would still be valid. Roth is more cost effective than Traditional because, for a given tax rate, the government pays individuals the same subsidy per dollar of forgone consumption under either system, but under Traditional it also pays fees. If individuals save the same nominal amount of assets under Traditional and Roth (i.e., they consume fewer real resources under Roth in the first period), under Roth individuals forgo more consumption and thereby receive a larger dollar subsidy. If, at the other extreme, individuals consume the same amount of real resources in the first period (i.e., they save a greater nominal amount under Traditional), then they forgo the same amount of consumption and receive the same dollar subsidy under either system.

[46] For instance, we could have based our analysis on a search-based model like Anderson and Renault (1999) or Roussanov, Ruan, and Wei (2021), on a model with captive demand and shrouded fees, or on a model based on trust such as Gennaioli, Shleifer, and Vishny (2015). These models, compared to a model without these frictions, generally feature excess entry, greater expenditure of social resources on asset management, or inferior allocations. These welfare losses due to the frictions would then be magnified by the larger asset base under Traditional.

[47] "Dominated products" include, e.g., funds that are costlier *and* underperform (Bergstresser, Chalmers, and Tufano 2009; Gil-Bazo and Ruiz-Verdú 2009), structured equity products with negative expected returns (Henderson and Pearson 2011), and "closet indexers" that charge fees as if they are active (Cremers et al. 2016). All proposed explanations for these phenomena and price insensitivity in general point to information frictions or outright inertia: marketing (Roussanov, Ruan, and Wei 2021), search costs (Hortacsu and Syverson 2004), captive DC plan participants (Pool, Sialm, and Stefanescu 2016), shrouded prices (Gabaix and Laibson 2006; Carlin 2009), noisy quality of fund management (Gil-Bazo and Ruiz-Verdú 2008; Gârleanu and Pedersen 2018), relationships or trust (Bergstresser, Chalmers, and Tufano 2009; Hubbard et al. 2010; Gennaioli, Shleifer, and Vishny 2015), or even irrationality (Elton, Gruber, and Busse 2004).

[48] Hortacsu and Syverson (2004) found, in 2000, 82 share classes (50 distinct funds) with an interquartile range of 98 bps. Christoffersen and Musto (2002) show evidence of fee dispersion for money market mutual funds. Cooper, Halling, and Yang (2021) show that fee dispersion has increased over the last 20 years in a comprehensive study of equity mutual funds with homogeneous holdings.

7.4 Political economy considerations

There are political economy considerations that are important to the debate over a shift from Traditional to Roth. U.S. budget rules make it more cumbersome to pass bills that increase the total budget deficit over a five- or ten-year window. A transition from Traditional to Roth generates more cash flow upfront and less when the relevant workers retire, thus bringing more revenue into the budget window, resulting in a temporary deficit reduction which could ease the passage of other legislation that involved lower taxes or higher spending. This additional short-run fiscal flexibility may or may not be considered desirable, but it certainly makes Roth attractive to many real-world policymakers. Indeed, one of the purported motivations for originally proposing Roth accounts in the U.S. was to help "fund" cuts in the capital gains tax (Pine 1989).

7.5 Progressive taxes

Progressive taxes complicate the analysis. Most real-world tax systems have a progressive schedule with marginal tax rates that are increasing in income, which generates both cross-sectional heterogeneity and uncertainty in marginal and average tax rates (Brown, Cederburg, and O'Doherty 2017). Vickrey (1939) pointed out that a progressive tax system based on annual income can inefficiently cause individuals with the same lifetime income to face different lifetime taxation burdens. For example, consider two workers with the same lifetime income: one with higher annual earnings and a shorter work life (e.g. a firefighter), and another with lower annual earnings but a longer work life (e.g. a librarian). Under Roth, as in the absence of retirement accounts, the firefighter would pay more lifetime taxes than the librarian. Under Traditional, the gap between the lifetime taxes paid by the two workers will be smaller and potentially zero, suggesting a possible advantage of a Traditional system.

Tax progressivity also enhances the value of the implicit match under Traditional by enabling individuals to time their withdrawals to coincide with periods of relatively low income, i.e., lower marginal tax rates. (Tax timing is even easier under U.S. law because of the option to convert funds to Roth at any time.) Finally, in a progressive tax system the implicit match under Traditional also differs across individuals. While the size, direction, and desirability of these differences is not well understood, a switch to Roth—even with an explicit match—would inevitably create winners and losers relative to the status quo.

These are important considerations. However, it is plausible that ways exist to retain the desirable characteristics of Traditional in an all-Roth system, such as a one-time retirement bonus based on the relative magnitude of lifetime taxes and lifetime income.

8. Conclusion

Under some simplifying assumptions about tax rates, a standard benchmark model yields an equivalence result between front-loaded (Roth) and back-loaded (Traditional) taxation of retirement savings. Individuals' consumption in each period is the same under Roth as under Traditional, and the *present value* of government tax revenues is the same under the two systems. However, the timing of taxation is different, and as a result back-loaded taxation leads to higher outstanding government debt and a correspondingly greater amount of retirement assets. These additional assets represent an implicit government portfolio, i.e., resources earmarked to pay future taxes when the money is distributed from the account. In this paper, we add one crucial bit of realism to the benchmark model: asset management fees. We show that the equivalence result breaks down because the government is paying an estimated $23.4 billion a year in fees on its $3.8 trillion implicit portfolio. These assets represent added demand for asset management services and an implicit subsidy to the asset management industry. The growth of the government's implicit account helps explain up to one-fifth of the total growth of conventional asset management revenue as a fraction of output from 1980 to 2007 as measured by Greenwood and Scharfstein (2013).

We then ask whether the subsidy results in lower percent fees for individuals. We show that, under weak conditions, firms with market power under Traditional charge the same percent fees (and thus, higher dollar fees) as under Roth. This arises because individuals' effective wealth and willingness to pay for asset management services are the same under both systems. Our model featuring market power also helps explain an important puzzle in the finance literature, namely that higher assets under management do not result in lower percent fees despite economies of scale (see, e.g., Malkiel 2013).

Next, we develop a simple general equilibrium model to examine how the added demand for asset management services affects asset management profits, firm entry, and the allocation of real resources. We find that, keeping fixed the number of firms, Traditional in the model results in higher asset management profits than Roth. Allowing firms to enter freely drives profits to zero, but the equilibrium number of firms and thus resources spent on asset management are greater under Traditional. Finally, we show that this additional allocation of resources to asset management is inefficient and thus welfare in the model is lower under Traditional than under Roth. The size of the welfare loss depends on the degree to which asset management costs are fixed or variable. With only variable costs, all of the extra costs generate welfare losses. At the other extreme, when all costs are fixed, higher dollar fees result in higher profits for the asset management industry. With firm entry, the higher profits under Traditional lead to a greater number of firms, and thus inefficiently high aggregate resources devoted to asset management. This result would be reversed only by assuming an alternative model in which (i) variable costs are very low and (ii) absent tax and other distortions, the market equilibrium features a substantial undersupply of asset management services.

Regardless of the importance of fixed costs, the overall welfare cost in the model is substantial, equal to about 1/4 to 1/3 of the government's tax expenditure on subsidizing retirement saving, the second-largest tax expenditure. We also show that a switch from Traditional to Roth that leaves tax rates unchanged would enable the government to offer an explicit match (as is done for Lifetime ISAs in the United Kingdom) equal to about 6% of all Roth contributions. This is separate from the explicit match that could be implemented under Roth to replicate the implicit match under Traditional due to any tax rate differentials between working and retirement years.

Our results raise a number of policy issues. The most important one is whether governments should encourage or possibly mandate wider adoption of Roth. While our models focus on two extreme options (Traditional only vs. Roth only), in countries where front-loaded taxation is available, both systems typically coexist and there is a choice between the two. In such a scenario, Traditional creates a negative "externality" and therefore one possible policy would be to subsidize Roth (or tax Traditional). Our model highlights one advantage of such a policy. The main limitation of our analysis is that it abstracts from other potential drivers of the policy choice between front-loaded and back-loaded taxation of retirement savings, including macroeconomic effects, behavior, progressive taxes, and political economy of the budgetary process. Our qualitative discussion of these factors in Section 7 suggests that they are not likely to change our conclusions and could generally be overcome with appropriate modifications to a Roth system.

A. Appendix

A.1 Explicit fees

An individual saving for retirement faces at least two types of explicit fees: asset-level fees and account-level fees. Asset-level fees are charged based on what financial products the account money is invested in, and include both ongoing fees (mutual fund expense ratios) and one-time fees (front or back-end loads). Some of these fees are paid to asset managers (e.g., mutual fund sponsors, insurance companies, and issuers of structured notes) and some (typically revenue from sales loads and/or 12b-1 fees that are included in the expense ratio) are paid to distribution channels (e.g., mutual fund brokers, securities brokers, and 401(k) plan advisors and recordkeepers).

Account-level fees include account maintenance fees in IRAs and DC plans charged by the recordkeeper or account provider, typically as a fixed dollar amount per account. They also include advisory fees charged by financial advisers for providing expertise to individuals in asset allocation, estate and tax planning, and other services covering one or multiple accounts belonging to the same individual or household. These advisory fees, sometimes also referred to as "wrap" fees, are generally charged as a percent of the total value of advised assets.

Our estimates of these fees are shown in the first column of Table 3. For the various components, we use the most recent data available to us. For DC plans, we rely on asset-weighted estimates made by industry participants in partnership with the industry trade association, the Investment Company Institute. We begin from two estimates based on data from the same year

(2013) and focused on 401(k) accounts (thus excluding 403(b) and other plan types). Deloitte (Rosshirt, Parker, and Pitts 2014) estimates the "all-in fee" on 401(k) plans at 58 bps, while BrightScope and ICI (2015) estimate "total plan costs" at 42 bps. The discrepancy (16 bps or 38%) is likely due to the fact that BrightScope excludes about $1.5 trillion or 22% of total assets held in the smallest, and likely most expensive, plans.[49] BrightScope also appears to exclude employer-paid fees. The benefit of BrightScope, however, is that it provides annual updates for both 401(k) plans and 403(b) plans. The most recent BrightScope estimates (using 2019 data) are somewhat lower: respectively, 35 bps (2022) and 43 bps (2023), resulting in an asset-weighted average of 36 bps. We adopt this figure but we adjust it upwards by 38% (the above-mentioned discrepancy) to 50 bps to reflect the absence of the smallest plans in the Brightscope estimates.

Next, we consider explicit fees on IRAs. IRA asset-level fees are estimated as an asset-weighted average by type of product (mutual funds, individual securities, and other) and asset class (stocks, bonds, money markets, and other) based on industry estimates. As shown in Panel B of the table, about 38% of IRA assets is invested in individual securities or cash without explicit fees other than trade commissions, about 45% is held in mutual funds with asset-weighted average fees of 52 bps, and the remaining 17% is invested in other products like real estate funds, commodity funds, etc. whose fees are estimated at 59 bps.[50,51] This yields an asset-weighted estimate of IRA asset-level fees of 33 bps.

IRA account-level fees, particularly advisory fees, are challenging to estimate. There is no systematic source of information on what fraction of investors participate in programs of paid advisory services or on the size of the fees paid by those who participate, and to the best of our knowledge no comprehensive estimate of these fees is available. We construct original "supply-side" estimates of account-level AUM-based advisory fees by relying on SEC filings and other publicly available information. Most of the largest IRA providers are exchange-listed discount brokers, mutual fund families, and the retail arms of large banks and insurance companies, who disclose the relevant information in their annual reports (SEC 10K forms). Using industry sources, we identify the top 20 IRA account providers by 2019 assets under administration. For 18 of the top 20 (corresponding to 74.9% of total IRA assets and 97.9% of top-20 assets), we are able to estimate percent advisory fees as total revenue from AUM-based advisory programs divided by total client assets, regardless of assets actually enrolled in fee-based advisory programs.[52]

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[49] The BrightScope estimate is based on filings by audited plans, which generally means plans with 100 or more participants. The Deloitte estimate is survey-based excluding plans with less than $1 million in assets and oversampling large plans, yielding representation of roughly 97% of the assets (36% of the plans) within the universe of plans filing Form 5500 with the Department of Labor. Note also that Holden, Duvall, and Chism (2021) provide asset-weighted estimates of explicit mutual fund fees. Weighting these estimates by current DC plan asset allocation implies asset-level fees alone of 40 bps, as shown in Table 4.

[50] Average mutual fund fees in IRAs (52 bps) are estimated using IRA-specific asset allocations and expense ratios from the ICI (Duvall 2021). This figure is higher than mutual funds held in DC plans (39 bps, analogously estimated) due mainly to distribution fees. The asset allocation for individual securities is inferred by crossing the same ICI data with EBRI data on overall IRA asset allocation (Copeland 2020). Having no IRA-specific data on money-market funds and "other" investments, we use the corresponding DC plan figures (26 bps and 59 bps respectively) reported by BrightScope and ICI (2021). The assumption of no fees for individual securities is conservative, because some of these securities may be structured notes, known for their high implicit fees (Carlin 2009; Henderson and Pearson 2011). More information on sources is in the table caption.

[51] Based on our information, it is not clear whether ETFs are included within mutual funds or within individual securities. ETFs hold approximately 1/3 of the assets under management of mutual funds, i.e., 1/4 of the combined assets (see, e.g., `https://web.archive.org/web/20240604155233/https://www.ici.org/faqs/faqs_etfs_other_invest`, retrieved on 4 December 2023). If ETFs are included within mutual funds, assuming conservatively that ETFs have zero fees, our estimated fees for mutual funds decrease to 39 bps and overall fees decrease to 74 bps.

[52] For instance, if half of the clients pay 100 bps in advisory fees and the other half does not use a fee-based advisor, our methodology produces an estimate of 50 bps. Note that we exclude from revenue any distribution-related fees, which are already counted as part of asset-level fees. Two providers are large, privately held mutual fund families. For one, we are able to obtain the relevant information from press reports, and for the other we simply

Table A1
Estimates of advisory fees in IRAs.

IRA provider type	Market share		Advisory Fee	No. of
	Overall	Within top 20	Revenue (bps)	Firms
Full-service broker or MF family	36.9%	48.2%	57	10
Discount broker or MF family	35.6%	46.5%	16	6
Insurance company	2.4%	3.1%	166	2
Total	74.9%	97.9%	41	18

Note: Advisory fee revenue is measured as total advisory and brokerage account revenue as a fraction of total client assets, advised and non-advised (see footnote 52). Full-service brokers are large banks with a wealth management arm. Full-service mutual fund (MF) families are firms that hold a substantial fraction of assets under management in actively managed mutual funds. Discount brokers are companies that offer a brokerage account and a simple set of tools to manage one's portfolio, and discount mutual fund families are firms that offer predominantly low-cost index funds.

We estimate average IRA advisory fees to be 41 bps (see Table A1 for this estimate and more information on its derivation).

A.2 Trading costs

Both collective investment funds and individual investors who directly trade individual securities pay trading commissions and bid-ask spreads. Trading commissions are not included in the expense ratio of mutual funds (Livingston and Zhou 2015). Funds also incur costs due to market impact, defined as adverse price moves caused by one's trades. Because of their size, unique disclosure requirements, and liquidity needs, mutual funds trade more predictably than other investors; as a result, they can be front-run and face adverse price pressure (Ben-Rephael, Kandel, and Wohl 2011; Shive and Yun 2013). Predictability is especially a problem for index funds who trade mechanically to rebalance and incorporate changes in the index (Pedersen 2018), even though overall their trading costs are lower than active funds because they trade less and their uninformed trading generates less market impact. Market impact and bid-ask spreads are not straightforward to assess even for the fund itself, and they are rarely if ever disclosed, but they are reflected in returns.[53]

Our estimates of trading costs are shown in the second column of Table 3 and, more in detail, in Table 4. We first estimate asset-weighted trading costs at the asset class level, and then we construct separate estimates for IRAs and DC plans using their respective asset allocations. We estimate annual trading costs based on a standard approximation formula (trading costs per unit of volume $\times$ 2 $\times$ annual turnover). Trading costs per unit of volume are measured as explicit commissions plus execution shortfall, a standard volume-weighted measure of execution quality, defined as the difference between the actual execution price and a reference price observed at the

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use the average of publicly held mutual fund families and discount brokers. Finally, two nonprofit providers are excluded because we are not able to obtain the relevant information.

[53] To further complicate the picture, some broker-dealers offer "soft-dollar" arrangements under which they provide clients (i.e., funds) with services such as research reports in exchange for their business (Conrad, Johnson, and Wahal 2001; Livingston and Zhou 2015). These arrangements do not change the total of explicit expenses plus implicit trading costs, and thus do not affect our final fee estimate. However, they reduce the funds' explicit expenses to the detriment of execution quality (i.e. higher trading costs), and thus muddy the distinction between explicit fees and trading costs.

time the order is placed. Turnover is defined as the lesser of a fund's gross purchases and sales of securities divided by the fund's average net assets, so that $2\times$ annual turnover is a lower bound to total volume of trading as a fraction of total fund assets.

For stock funds, recent estimates place trading cost at roughly 26 basis points per unit of volume (Anand et al. 2012; Busse et al. 2021). The average turnover of U.S. equity funds (active and passive combined) is 32%, but only 26% for mutual funds held in 401(k) accounts (BrightScope and ICI 2021) because of a greater prevalence of low-turnover index funds. Assuming the latter figure applies to both DC plans and IRAs, we obtain annual trading costs for equity mutual funds of $26\times2\times26\%=14$ bps, lower than typical pronouncements by industry insiders.[54]

For bond funds, we conservatively use cost estimates for the largest corporate bond trades. Unlike in the case of stocks, large bond transactions have a *lower* cost per unit of volume, suggesting that execution shortfall is driven less by market impact and more by search frictions. A recent, comprehensive estimate (Bessembinder et al. 2018, Table III) places transaction costs on corporate bond trades of $5 million and up in the 2012–2014 period at roughly 17 bps of trade size for a round-trip, or 8.5 bps per unit of volume, consistent with other recent works (Choi, Huh, and Shin 2024; Goldstein and Hotchkiss 2020).

Assessing turnover for bond funds is less straightforward than for stock funds. Vanguard (Rowley and Dickson 2012) estimates that the asset-weighted average portfolio turnover of open-end bond funds ranges from 90% for index funds to 193% for active funds. Using AUM figures from Blackrock (Novick et al. 2016) we calculate asset-weighted average turnover of 178%, reflecting the predominance of active funds. We multiply this turnover by 1.8, rather than by 2, to reflect the fact that some reported turnover may be driven by reinvestment of coupon and principal payments, rather than sales and purchases.[55] Thus, our estimate of trading costs for bond funds is $8.5\times1.8\times178\%=27$ bps.

Summarizing, our estimate of trading costs is 14 bps for equity funds, 27 bps for bond funds, and 0 bps for money market funds, own-company stock and other investments. For individual securities, in the absence of data, we assume the same trading costs in the corresponding asset classes. Based on the overall asset allocation in DC plans and IRAs shown in Table 3, we estimate total asset-weighted implicit trading costs of 14 bps and 13 bps respectively.

Additional detail on fees, transaction costs, and net-of-fees performance is provided in Section 2 of the Internet Appendix.

A.3 Tax-deferred retirement assets in the U.S. (S^{Trad})

Table A2 summarizes the composition of tax-advantaged retirement assets in the U.S. Total retirement assets amount to $31.8 trillion. We estimate S^{Trad} as the total amount of tax-deferred assets in IRAs and DC plans. To be conservative, we exclude DB plans ($8.3 trillion), which are

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[54] A managing director for Morningstar (Phillips 2013) states that in the five years prior to March 31, 2013 "the average U.S. large-cap equity fund, on an asset-weighted basis, trails the market index by its expense ratio plus ... 25 basis points." Bogle (2014) guesstimates trading costs of 50 bps for active equity funds, and negligible for passive equity funds. Taken at face value, and assuming that active funds' market share is equal to their overall U.S. market share (roughly 50%), Bogle's figures imply asset-weighted trading costs of roughly 25 bps.

[55] When selling a security and purchasing another, a fund trades twice; when reinvesting a coupon or principal payment, a fund trades only once. If reported turnover is defined as the lesser of purchases on one hand, and sales plus issuer payments on the other, the "2" coefficient would overstate trading costs. In practice, however, many bond funds and indices have rules that cause them to sell bonds before maturity. For instance, "most flagship Bloomberg Barclays Aggregate, High Yield, Inflation-Linked and Emerging Markets Indices have a minimum time to maturity" (Barclays 2017). In particular, the most widely followed bond index (the Barclays Capital U.S. Aggregate Index) has annual turnover of 42.0%, of which only about one-fifth is due to coupon and principal paydowns (Tucker 2011). Accordingly, our adjusted coefficient counts one-fifth of the volume once instead of twice ($2\times4/5+1\times1/5=1.8$). To the extent that any funds already report turnover net of issuer payments, our adjustment is conservative. In principle, a similar adjustment should apply to stocks as well, but it would be minimal because of the lack of principal paydowns and an average dividend yield of less than 2%.

Table A2
U.S. Retirement assets by type of account.

$ billion	Total	Roth (TEE)	Traditional (EET)
Total retirement assets	31,786	1,670	27,958
Individual retirement accounts (IRAs)	11,950	1,210	10,740
Defined contribution (DC) plans	9,345	460	8,885
401(k) and 403(b)	7,700	412	7,288
Other private-sector DC	535	0	535
Thrift Savings Plan (TSP)	725	27	698
457	385	21	364
Annuities	2,158	N/A	N/A
Defined benefit (DB) plans	8,333	0	8,333

Source: ICI Retirement Market statistics 2022:Q4 (totals and Roth IRAs) and own estimates (Roth DC plans). *Note*: 401(k), 403(b), and TSP are standard DC plans sponsored respectively by private-sector employers, non-profit employers, and the federal government. Other private-sector DC plans include Keogh, profit-sharing, thrift-savings, stock bonus, and money purchase plans. 457 plans are tax-advantaged deferred compensation arrangements available for certain employers in the United States. DB Plans exclude $2,414 billion of U.S. government employee DB plans which are required by law to be invested in U.S. government obligations.

also tax-deferred and to which a similar argument applies. We also exclude annuities ($2.2 trillion) because their special tax treatment entails only a small amount of tax deferral. The remainder of retirement assets ($21.3 trillion) includes two main components: employer-sponsored defined contribution retirement accounts such as 401(k) and 403(b) plans (DC plans), and individual retirement accounts (IRAs), with $9.3 and $12.0 trillion of assets respectively. From these assets we further remove $0.7 trillion of assets in the federal government's Thrift Savings Plan (TSP), whose fees are negligible, and $1.7 trillion of Roth assets.[56] This results in an estimated amount S^{Trad} of $18.9 trillion.

A.4 Effective tax rate on retirement payouts (τ_R)

Because of progressive taxation, the effective tax rate on retirement payouts, τ_R, is challenging to estimate: it is neither the marginal tax rate on retirement income nor the average, because individuals may have retirement income from sources other than tax-deferred accounts. Rather, the appropriate definition of τ_R is the present value of future taxes paid on distributions financed by Traditional balances accumulated as of today (S^{Trad}) as a fraction of the present value of these distributions.

We estimate τ_R using data on retirement wealth reported in the 2013 Survey of Consumer Finances (SCF) and the U.S. marginal tax schedule in place at the time of the survey, assuming they remain constant moving forward from 2013. Our resulting estimate of the effective tax rate on

[56] The ICI's 2022:Q4 Retirement Market statistics report that $1,210 billion or 10.1% of IRA assets is in Roth IRAs. We roughly estimate that, as of 2022:Q4, $460 billion or 4.9% of total DC assets are in Roth DC plans based on information on Roth adoption rates in T. Rowe Price's 2017 *Reference Point* and Vanguard's *How America Saves 2017* reports, together with ICI information on contribution flows, and the fact that Roth options were introduced in 2001 for 401(k) and 403(b) plans and in 2012 for TSP. We are not aware of data on Roth options for other private-sector DC plans.

retirement wealth is 25.8%.[57] This estimate could be overstated because it is obtained assuming individuals do not adjust the timing of their withdrawals to take advantage of fluctuating marginal tax rates, but it could also be understated because it does not take into account the taxable part of Social Security benefits and any labor income. As a check, we also reverse-engineer present-value tax expenditure estimates published by the federal government (Office of Management and Budget 2014) or its staff (Lurie and Ramnath 2011). Depending on the study, we obtain a range for the effective marginal tax rate of 20%–30%. As a conservative estimate (i.e., a lower bound resulting in the smallest value of the government's implicit account and thus the subsidy) we use 20%, the lowest of all our estimates. Note that this estimate also excludes any state income taxes on Traditional retirement payouts.

Code Availability: No new code was generated in support of this research.

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[57] For each SCF observation in which the head of household is aged 65 to 74 we calculate taxable wealth (W^T), and tax-deferred retirement wealth (W^{Trad}). We assume baseline retirement taxable income to be equal to taxable wealth times a constant nominal rate of return $r = 3\%$ ($Y_{Baseline} = W^T \cdot r$). In addition to this baseline income, we assume that the individual uses W^{Trad} to withdraw an equal nominal amount each year for 20 years (computed as a term annuity stream using the same rate $r = 3\%$. This implies that $Y_{Combined} = W^T r + W^{Trad}/\{[1-(1+r)^{-T}]/r\}$. Using the 2013 tax schedule, we then calculate total dollar tax on the baseline income ($T_{Baseline}$) and on the combined total income ($T_{Combined}$), and calculate τ_R as $[\sum_i (T_{Combined,i} - T_{Baseline,i})w_i] / [\sum_i (Y_{Combined,i} - Y_{Baseline,i})w_i]$, where w_i are the SCF sampling weights for household i.

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