



AUTOMATED INVESTMENT SERVICES

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Fully automated investment services provide automated investment management. Selected portfolios are low-cost and are rebalanced, tax managed and optimized, consistent with an investor's goals and risk tolerance. Everything, including deposits, withdrawals, transfers, and reporting, is handled electronically. The substantial advantages made available by technology are enumerated.



Investors need professional advice. When left on their own they tend to make several types of errors. They are overconfident and inadequately diversified.¹ They let their emotions dictate investment decisions, leading them to buy stocks during periods of exuberance when prices are high and to sell them when widespread pessimism depresses prices.² They save and invest too little to provide for a comfortable retirement.³ Professional investment advice that can tailor a diversified investment portfolio to an individual's age and capacity to accept risk will provide important benefits to that person's financial well-being.

1 Traditional investment advisers provide costly advice

Professional investment advice is usually costly when provided by traditional face to face methods. Two types of costs are involved. First, the adviser charges the client for the service of establishing an account with an appropriately diversified portfolio. Second, some advisers may be conflicted and will use investment instruments that may be "suitable" for the client but may not be optimal. As a result, investors are too often steered to expensive, actively-managed portfolios instead of low-cost index funds.⁴

Traditional investment advisers charge fees that are a percentage of the assets under management. Fees generally range from $\frac{3}{4}$ of one percent to $1\frac{1}{2}$ percent. PriceMetrix, Inc. calculated the industry average at just over one percent.⁵ But most advisers have a minimum annual fee of at least \$1,000 to \$1,500. That means that small investors are effectively shut out of the market for investment

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advice, or that they will have to pay a far greater percentage of their investment portfolio than the average one percentage point referenced above.⁶ Charges tend to be smaller for 401(k) plans. Ayres and Curtis estimate that average 401(k) plan costs are 42 basis points (42/100 of one percent) and that “all-in fees” are 113 basis points (including the basis points of direct fees).⁷

A portfolio management fee of 1 percent per year might seem like a small amount. But if a diversified portfolio earns 5 percent per year, such an investment expense amounts to 20 percent of the portfolio’s earnings. Moreover, these costs compound over time. Over a 30-year investment period, a 1 percent per year portfolio management fee wipes out almost one-third of the portfolio’s total earnings as is shown in Table 1. And if 1½ percentage points are deducted each year as a portfolio management fee, the final accumulation is reduced by 46 percent. Bogle (2013) calls this “the tyranny of cost compounding.”⁸

In addition to the fees charged by the investment adviser, investors also bear the costs of the investment funds in which they are invested. If such funds are high-cost actively-managed funds, the all-in fees charged by the funds are likely to be as large as the expenses for the overall management of the investment portfolios. Moreover, there is no evidence that higher fund fees are associated with higher returns. Higher fund fees simply lower the net return available to the investor.

There is considerable evidence to confirm that actively-managed investment funds are unable to produce returns after fees that are superior to low-cost, broad-based index funds that simply buy and hold all the stocks in the market. Jensen (1968) confirmed that actively-managed funds underperformed broad-based indexes over the period 1945–1964.⁹ Malkiel (1995) confirmed Jensen’s finding for the years 1971 through 1991 and (2016) presented similar data for the period through 2014.¹⁰ Standard and Poor’s, in their annual SPIVA reports, confirm that in a typical year two-thirds of actively-managed funds underperform their benchmark indexes.¹¹ Moreover, the one-third that beat their benchmarks in a given year are typically not the same as the overperformers in the next period. There is little persistence in performance. Hence, when performance is measured over longer periods of time, the number of funds that outperformed their benchmarks after expenses was very small. Table 2 shows the SPIVA results published in 2016. While not included in the table, the full SPIVA report reveals that active managers of international equity funds as well as bond funds are also outperformed by their passive benchmark indexes.

While there are some differences in the estimates depending on the time period used, the average difference between the net after-fee return of the average actively-managed funds and the

Table 1 Portfolio management costs expressed as a percentage of portfolio earnings.

Portfolio Return	Cost of 1% as a % of one-year earnings	Cost of 1% as a % of 30-year earnings	Cost of 1½ % as a % of one-year earnings	Cost of 1½ % as a % of 30-year earnings
3%	33%	43%	50%	61%
4	25	36	38	51
5	20	32	30	46
6	17	30	25	42
7	14	28	21	40

Table 2 Percentage of U.S. equity funds outperformed by benchmarks (Periods to December 31, 2015).

Fund category	Comparison index	One year (%)	Five years (%)	Ten years (%)
All Domestic Equity Funds	S&P Composite 1500	74.8	88.4	83.2
Large-Cap Funds	S&P 500	66.1	84.2	82.1
Mid-Cap Funds	S&P Mid-Cap 400	67.9	76.5	87.5
Small-Cap Funds	S&P Small-Cap 600	77.6	91.4	92.4

Source: Standard & Poor's Dow Jones Indexes, SPIVA[®] U.S. Score Card, March 2016.

Table 3 Estimates of excess direct expense ratios of actively-managed mutual funds over equivalent index funds (in basis points – i.e. hundredths of one percent).

	Excess direct expenses	
French	(2008)	67
Ayres & Curtis	(2013)	71
Malkiel	(2016)	86
Vanguard	(2016)	93
Bogle	(2013)	112

lowest-cost index funds is well approximated by the difference in their expense ratios. Table 3 presents a number of estimates. The average of the most recent estimates is 90 basis points. These additional costs should be added to the portfolio management costs described above in measuring the potential advantage of low-cost automated portfolio management services using index funds.

Traditional investment advisers as well as 401(k) and 529 college savings plan sponsors will often use actively-managed mutual funds as part of the diversified portfolios they recommend. Some advisers may believe that selecting active managers (rather than index funds) justifies the high fees they charge. Alternatively, they may be incentivized to use active funds because the active fund manager provides an extra commission to the adviser for placing a client in that fund. This potential “payment for distribution” adds a conflict of interest in the decision-making of many

traditional advisers. While some advisers will subscribe to a “fiduciary standard” of putting the client’s interest first, acceptance of such a standard is far from usual. In general, fully automated investment advisers do subscribe to a fiduciary standard.

It is clear that the current arrangement for providing portfolio management services to individuals and to 401(k) plan as well as 529 college savings plan sponsors is far from optimal. Fees are high and the provision of investment management services is often compromised by conflicts of interest. As a result individual investors and retirement and college savings participants will tend to hold portfolios with a large extra layer of costs charged by the investment fund managers. Particularly in what is likely to be a very low-return environment in the future, where nominal yields on the short-term bond instruments are near zero (and where real interest rates will be negative if the world’s monetary authorities achieve a 2 per cent inflation target) and where long-term rates are either below or barely above current inflation rates, current arrangements do not serve investors well. The situation is conducive for a disruptive technological advancement. The automated investment service arises to meet that need.

2 The automated investment service

This paper will focus on the provision of fully automated investment services provided by the fully automated investment adviser. The fully

automated investment service not only provides automated investment advice but also relies solely on the internet to acquire clients and to establish their accounts. There are no face-to-face meetings required, no forms to sign and mail in, and no checks to deposit. Everything, including deposits, withdrawals, transfers, reporting (and of course the investment management itself), is handled electronically via a web or mobile device. While the automated service may expend significant amounts to advertise its services, the benefit of such a software solution to set up accounts is to dramatically lower the costs to establish new accounts. Wealthfront, for example, is able to accept initial deposits as low as \$500 for new accounts. Such automated services are also of particular appeal to clientele who prefer not to have to talk with an individual to execute their financial tasks. Millennials are especially attracted to such services. They are used to subscribing to all of their services electronically. Many young people perceive having to talk to an adviser as a negative. They tend to define service in terms of convenience rather than interaction.

The fully automated investment service also provides online wealth management services. The automated service tailors diversified portfolios allocated among several asset classes appropriate to the needs of individual clients without the use of face-to-face interactions. By simplifying the channel through which investment management is offered, the automated investment services are able to drastically reduce fees. Often they are pejoratively called “robo advisers” by traditional wealth managers, implying that their services are mechanical and second rate. As we will see, however, in many dimensions they can provide superior outcomes to investors. Fully automated services are provided by firms such as Betterment and Wealthfront. Like traditional advisers, they employ algorithms such as modern portfolio theory to determine optimal portfolio allocations.

3 Competitors of fully automated investment services

Fully automated services compete not only with traditional face-to-face advisers but also with a new breed of lower-cost investment portfolio managers. Many of these competitors were organized under the aegis of traditional mutual fund complexes and discount brokers. While these competitors may use technology to assist some functions of their operations, they do not provide a fully automated service. These services tend to be more expensive but are less costly than the services offered by traditional advisers. Some examples are shown below.

“Vanguard Personal Advisory Services” provides portfolio management services using both low-cost indexed investments and funds managed by Vanguard. Vanguard gives clients the ability to speak directly with an adviser either by phone or by video chat. Neither client acquisition, the determination of goals and risk tolerance, nor portfolio management is automated. Vanguard’s annual fees are 30 basis points (a basis point is 1/100 of 1 percent) and the minimum investment requirement (\$50,000) tends to be higher than the fully automated services.

Charles Schwab, the leading discount broker, has introduced his own portfolio service called “Schwab Intelligent Portfolios.” Schwab requires a \$5,000 minimum investment and selects and rebalances portfolios consistent with the investor’s age and goals. While no explicit fee is charged for the service, the portfolios contain mainly Schwab-sponsored funds with expense ratios that are generally considerably higher than the ratios of simple capitalization-weighted index funds. Moreover, the investor is required to hold a substantial portion of the portfolio in cash. While Schwab describes its service as “automated,” the selected portfolios are unlikely to be consistent

with those resulting from an automated optimized program.

Rebalance IRA specializes in tax-advantaged retirement portfolios. They are the least automated of all the portfolio services (portfolios are selected by an investment committee), and they stress the advantage of having a dedicated adviser who is always available by telephone. The human touch comes with a price as this service charges investors an annual management fee of 50 basis points.

Many other examples of portfolio services could be listed. These might be called “technology assisted advisers”; they offer services that are less costly than those offered by traditional advisers. They are not, however, “fully automated investment services.”

4 The operations of the fully-automated adviser

We describe below the major functions and operations of the fully automated investment service provider.

4.1 The determination of goals and risk tolerance

The following is a description of what should be considered “best practices” offered by automated investment services.

The process starts with an online interview. The client is asked about his or her salary, tax situation, assets, and indebtedness, if any. The client is asked to provide information on investment objectives as well as to answer a number of questions to assess capacity for risk and temperamental willingness to assume market volatility. The adviser is told if the investment fund is devoted to retirement savings or if there is some specific purpose for the fund such as accumulating

the down payment on a home or providing a safety net in case of illness.

The client is encouraged to link any other savings, retirement, and investment accounts to the automated service. This allows the automated service to provide advice that is consistent with the individual’s total financial situation. Linking of all of a client’s financial accounts will also allow the automated adviser to provide financial planning as well as targeted investment management services. The automated service is able to advise the client on the amount of the savings over time that is likely to be necessary to meet the individual’s retirement goals. Collection of inputs into financial planning programs is all done electronically.

Data from one’s financial accounts is more likely to reflect a person’s actual spending practices and attitudes toward risk and is likely to be far more accurate than what one might tell a traditional financial adviser. Periodically the client is asked to reassess his/her financial situation and family responsibilities (e.g. has there been a birth of a new child) and whether the individual’s risk capacity or risk tolerance may have changed. Considerable effort is placed on continuing investor education such as reminding the investor that panic selling after a sharp market sell-off is seldom a good idea. From all this information, the automated service assigns a risk score that is used to select an optimal portfolio from the efficient opportunity set of possible portfolios.

Insights from behavioral economics are used to inform the risk identification process. Objective information about age, income, and assets helps determine the client’s capacity to accept risk. Subjective questions help determine the individual’s willingness to accept risk. The less consistent are the answers to the subjective questions, the less risk tolerant the individual is likely to be. The overall risk matrix combines both objective and

subjective scores and overweights the component that is more risk averse. This approach tends to offset the tendency for individuals (particularly males) to overstate their true risk tolerance.¹²

4.2 *The investment instruments used*

One difference between traditional and automated advisers is that most automated portfolios are made up exclusively of index funds. Only the lowest cost index funds are used, and they are accessed through ETFs (Exchange-Traded Funds). The criteria for selection are cost, marketability, and tracking error. No one ETF provider is given preference by the fully automated advisers, and usually two alternative ETFs are used to allow for tax loss harvesting described below. For those services offered by providers such as Vanguard and Charles Schwab, however, the funds sponsored by the provider are generally employed. Since the instruments used by the automated adviser are all low-cost, the excess direct expense described in Table 3 is avoided.

4.3 *Asset classes*

A broad set of asset classes are selected to serve as building blocks for the portfolios. U.S. equities, foreign developed markets, and emerging market equities are considered separate equity asset classes as are REITs, real estate investment trusts. U.S. government bonds, corporate bonds, treasury inflation-protected securities, foreign bonds, and tax-exempt securities are used as the bond equity classes. Some automated advisers also include dividend growth stock ETFs to use as a partial substitute for a portion of the relatively safe fixed-income part of the portfolio during times of unusually low interest rates. In addition ETFs are used to represent commodity/natural resource assets. The next step is to identify the optimal mix of asset classes for each level of risk assumed and type of account (taxable vs. tax advantaged retirement account).¹³

4.4 *Modern portfolio theory and mean-variance optimization*

The optimal mix of asset classes is chosen by solving for the Efficient Opportunity Set—portfolios that represent the highest expected return for every level of risk. Inputs to the process include each asset class's expected return, standard deviation, and correlation with other assets. Standard deviations are estimated from long-run historical data and the expected short-term volatility implied by the pricing of the asset class in the options market. Similarly the correlations among asset classes are estimated from long-run data adjusted by more recent evidence reflecting the evolution of financial markets.

Expected returns are influenced by a variety of factors. It is common to start with the Capital Asset Pricing Model – CAPM (Sharpe, 1964), which posits an upward sloping relationship between an asset's expected return and its systematic risk "Beta." With nominal risk-free rates close to zero and with real rates negative, the whole set of risk/return alternatives are considerably lower than the historical realizations. These CAPM estimates are then adjusted using a variety of factors such as credit spreads, cyclically adjusted price-earnings multiples, dividend yields, and macroeconomic variables. In addition, the Black Litterman (1992) and Gordon (1959) models are used to adjust CAPM returns to the asset class's expected returns used in the optimization model.

In addition to the careful estimation of the parameters used in the mean-variance optimization, it is common to enforce minimum and maximum allocation constraints. Such constraints ensure that portfolios are broadly diversified and that any parameter estimation errors are mitigated. These constraints are consistent with those advocated by professional portfolio managers such as Swensen (2000).

As in the classic contribution of Markowitz (1952), the client's utility is maximized subject to the individual's risk tolerance metric and subject to several constraints such as those listed above. The result is the determination of an efficient frontier: the set of portfolios that offer the highest after-tax return for any given level of risk.

If the investor has a high risk tolerance, he/she will focus on maximizing returns and will end up on the high return-high risk end of the efficient frontier. Those with low risk tolerance scores will land on the low end of the efficient frontier.

5 What can automation do more efficiently than traditional advisers?

There are several aspects of investment management that an automated adviser can do more efficiently than a traditional face-to-face adviser.

5.1 Cost minimization

We have already mentioned the substantial cost savings that automated advice can deliver. The overall cost of investment management can be lowered from 1 to 1½ percent per year to ¼ of 1 percent. Moreover, since the automated advisers tend to offer index funds and ETFs exclusively, the investor saves the difference between the very low cost of the indexed instruments used and the high cost of actively-managed funds. The sum of both of these cost savings can amount to 2 percentage points a year. If a diversified portfolio returns 5 percent per year in the future, this cost saving will amount to 40 percent of the investor's annual earnings. When compounded over a 30-year period, these costs can amount to well over half of the portfolio's earnings.

5.2 Rebalancing

Automated advisers can set up programs to ensure that the client's portfolio is automatically

rebalanced to keep the risk levels of the holdings consistent with the client's preference. Taxable portfolios will not necessarily be improved by rebalancing. (If rebalancing entails the sale of an asset class that has risen sharply in price, the sale would generate taxable gains.) However, an automated procedure can easily track the cost basis of all lots in the portfolio and determine whether the rebalancing trade should be made. Moreover, rebalancing can often be accomplished by investing dividends or by allocating new deposits of cash into the asset classes that have become underweighted. An automated procedure can easily determine when rebalancing is desirable and how it should be implemented.

5.3 Automated disposition of transferred assets

Automation can also be used to help clients who face the need to diversify concentrated positions in single companies that has resulted from the prevalence of stock-based compensation. This involves reducing the size of a concentrated position in an optimized fashion and managing such a transferred account in a way that minimizes the taxes incurred as the concentrated position is reduced through partial sale. While premium services such as these have been available to the very wealthy, they tend to be very time consuming. Only through automation can they be made available at low cost to a far larger clientele and can clients be assured that "blackout windows" are observed.

5.4 Tax loss harvesting (TLH)

The index funds used by automated advisers are already tax efficient since the funds are passive and do not realize capital gains as do active managers. Tax loss harvesting can add significantly to the after-tax return of the investor. While traditional advisers offer this service to wealthy

investors, automated advisers, by monitoring portfolios continuously, can harvest losses far more effectively and can make the technique available to all clients.

TLH involves selling a security (or ETF) that has experienced a loss and replacing it with an equivalent security to maintain the investor's exposure to the asset class. Capital losses can be used to offset capital gains, and net capital losses up to \$3,000 can be deducted from taxable income. While TLH only defers taxes if the portfolio will eventually be liquidated, the deferral itself can be quite valuable, especially if the gains eventually realized are taxed at lower long-term capital gains rates. Thus, the gain is not only deferred (and their funds remain invested in the portfolio) but the investor also gains from the arbitrage between short and long-term capital gains rates, assuming that such differentials are maintained in the future. Moreover, if the portfolio is held for a future bequest to one's heirs or is used for a charitable contribution, the tax can be avoided permanently.

Tax loss harvesting must be done carefully and must be coordinated across investment accounts to avoid the "wash sale" rule that would disallow the tax deduction. For a depreciated security to be eligible for loss realization, the investor is not allowed to purchase a "substantially identical" security 30 days before or after the sale. Were the investor to wait 30 days before restoring a position in the asset class that was sold, the portfolio would deviate from the optimal allocation consistent with modern portfolio theory.

Automated advisers seek to avoid the wash-sale problem by restoring the investor's position in the asset class through the purchase of an ETF that tracks a similar, but not identical, index. For example, suppose some portion of the portfolio is invested in an ETF tracking emerging market equities. If the ETF declines in price and the

investor wishes to realize a capital loss, a replacement emerging-market ETF could be purchased that tracks a different index. The iShares Emerging Market (EM) ETF (ticker EEM) tracks the MSCI EM index. The similar Vanguard ETF (ticker VWO) tracks the FTSE emerging markets index. The composition of the two indexes is different but their correlation is high so that the investor will retain exposure to this asset class after switching from one ETF to the other. This is why automated investment advisers will typically select two similar ETFs to be investable candidates for each asset class.

Software is uniquely suited to maximize the benefits of TLH. By monitoring portfolios 24/7, the automated adviser can take advantage of temporary dips in ETF prices. During a volatile year in the international equity and bond markets, such as 2015, it was possible to harvest tax losses amounting to almost 5 percent of a total ETF portfolio. Manual implementation of a loss harvesting strategy is highly unlikely to be as effective as a computerized one.

6 TLH with direct indexing

Tax loss harvesting using ETFs has proved to be an effective way to realize capital losses and thereby reduce the investor's tax bill. But loss realizations require that the ETF representing an entire asset class has declined below its purchase price. Within each ETF portfolio, however, there are likely to be some individual security losses that do not get realized. For example, even in a period where the total United States stock market portfolio has appreciated in price, at least some of the component stocks are likely to have declined. Holding all or a fraction of the stocks in an index (called "direct indexing") allows the investor to realize capital losses on individual stocks even during a period when the overall market has advanced.

What direct indexing does is to have the client buy all or a portion of the index stocks directly. If only a portion of the index is purchased (rather than a full replication), the individual stocks are chosen so that the tracking error with the index is minimized through an optimization program. For example, a total stock market index might be approximately replicated by buying 250 stocks out of the 500 stocks of the Standard and Poor's 500 Index and adding an ETF of smaller companies that is designed to be a "completion Index." As a result, the total portfolio would approximate roughly the characteristics of a total stock market portfolio ETF.¹⁴ Of course, there would be some tracking differences between the selected portfolios and the total stock market ETF. Nevertheless, direct indexing would have the advantage of substantially increasing the opportunities for tax loss harvesting. In such cases there is a trade-off between tracking error and realizing capital losses. Since tracking error can be both positive and negative, a reasonable utility function is likely to put a higher emphasis on recognizing capital losses and therefore tax savings.¹⁵

A stylized example will illustrate how direct indexing would increase the opportunities to harvest tax losses. Suppose the automated adviser established a direct indexing portfolio of 250 stocks, chosen to minimize the tracking error with the Standard and Poor's 500 stock index. Such a portfolio would resemble the S&P 500 in terms of size of company, industry composition, dividend yield, valuation metrics such as price-earnings and price-to-book ratio, etc. Assume that the entire index increases in value by 5 percent but that some industry groups decline in price. Accounts that simply held the S&P 500 ETF would have no opportunity to recognize a capital loss. But the direct indexer could take advantage of the fact that some industry groups (and some individual stocks) may have declined in price while the overall market average rose. If,

for example, the pharmaceutical industry group declined, the direct indexer would be holding only a sample of all the pharmaceutical stocks in the market. The portfolio could then sell Merck and buy Pfizer (or vice-versa) so as to retain the appropriate weight of pharmaceutical stocks in the index but still recognize a capital loss. If soft drink and automobile manufacturers declined, the portfolio could sell Coca Cola and General Motors and buy Pepsi Cola and Ford. Thus, direct indexing can significantly increase the opportunities to realize capital losses. And even if the industry group rose in price, there might be an opportunity to harvest a capital loss on one or more of its components.

Critics of tax-loss harvesting argue that during rising markets the cost basis of the stocks that continue to be held will tend to be increasingly low relative to market prices. Eventually the investor could run out of opportunities for harvesting losses. The experience of firms such as Parametric Portfolio Associates, a pioneer of TLH, shows that in a volatile, low-return environment, opportunities will not be exhausted, however. This is especially true if dividends are reinvested and if new money is invested in the account over time.

There are other advantages to direct indexing. Owning an index fund or ETF subjects the investor to a fee. While such a fee is likely to be small, it is still a cost that lowers the investor's net return. Direct indexing avoids that fee, although it does expose the client to additional trading costs. More important, direct indexing allows investors to realize losses that cannot be deducted by investors in ETFs. The Investment Company Act of 1940 specifically prohibits mutual funds from passing on tax losses to investors in the fund. While the ETF or fund can use losses to offset any realized gains that the fund distributes to stockholders, leftover losses cannot be used to further reduce taxes.

7 The direct indexing procedure for U.S. stocks¹⁶

The procedure used for direct indexing balances two competing objectives. Direct indexing attempts to maximize the tax benefit of harvesting losses. But it is also important to control the tracking error so that the portfolio that is held mimics the total U.S. Stock Market Index to the closest extent possible.

We define the tracking difference as the difference between the portfolio return in period i ($R_{p,i}$) and the benchmark return ($R_{\beta i}$) during the same period. The benchmark for the U.S. market is the “total stock market portfolio.”

The tracking difference is defined as $R_{p,i} - R_{\beta i}$. We can then define the tracking error (T) over N periods as the standard deviation of the tracking differences, all measured by returns before taxes

$$T = \sqrt{\frac{\sum_{i=1}^N (R_{p,i} - R_{\beta i})^2}{N}}$$

We can define the tax alpha in period i (α_i) as the tax benefits from realizing short-term capital losses ($CL_{s,i}$) multiplied by the combined federal and state tax rate on short-term gains (t_s) plus the long-term capital losses ($CL_{L,i}$) multiplied by the effective federal and state rate on long-term gains (t_L)

$$\alpha_i = \frac{[(CL_{s,i})t_s + (CL_{L,i})t_L]}{P_{i-1}}$$

where P_{i-1} is the portfolio balance at the beginning of the period. We can then set up a standard constrained maximization problem, which can be solved efficiently using quadratic programming:

Maximize Tax Alpha – (Tracking Error)² subject to several constraints

A number of constraints need to be considered in performing the constrained maximization. Wash sales need to be avoided. Moreover, an “exclusion

list” needs to be identified. For example, insiders may be prohibited from selling shares in the company for which they work. Also, large stock positions outside the direct indexing account, where dividend reinvestment programs have been established, need to be considered to avoid future wash sale difficulties. Finally, there are constraints on portfolio weights. Maximum portfolio weights are established to ensure proper diversification as well as maximum differences between portfolio and benchmark weights.

The effectiveness of direct indexing can then be assessed on the basis of how much tax benefit it produced and how closely the resulting portfolio tracks its benchmark index. Assuming that the tax savings are reinvested in the portfolio, benefits from direct indexing (DI) over time can be measured by the differential after-tax internal rate of return (IRR) relative to a portfolio without tax-loss harvesting:

$$\text{Differential } IRR = (IRR_{P,DI} - IRR_{P,NoDI})$$

Wealthfront has estimated differential IRRs for hypothetical clients with different sized portfolios as shown below. The clients are assumed to be California residents with higher annual incomes associated with larger portfolios and with risk scores of 7 on a scale of 0 to 10.

Note in the Table 4 that for smaller accounts, direct indexing is done only on the largest 100 stocks in the S&P 500 index. For the largest accounts, direct indexing is done on 1,000 stocks, with the remaining part of the total stock market index (VTI) simulated by adding the small capitalization ETF (VB). The tax rates are derived from the average incomes of Wealthfront clients by size of account.¹⁷

Results were backtested for three levels of direct indexing clients. Clients were assumed to make an initial deposit necessary to meet the minimum account size and then to add 10 percent of their

Table 4 Portfolio size, composition of U.S. portfolio, and combined tax rate.

Size of portfolio	U.S. portfolio	Tax rate
\$100,000–\$500,000	100 large stocks + S&P 500 small-cap ETF (VDO) + Extended Market ETF (VXF)	42.70%
\$500,000–\$1,000,000	500 stocks + ETF (VXF)	44.50%
\$1,000,000 +	1000 stocks + ETF (VB)	44.50%

Table 5 Estimated tax alphas on U.S. equity portfolios and tracking errors.

Number of stocks in direct indexing portfolios	Tax alpha	Tracking difference	Tracking error
100	2.15%	0.29%	1.82%
500	2.50%	–0.02%	1.73%
1000	2.66%	–0.15%	1.72%

initial deposits every quarter. The period of time covered was 2000–2014. Six overlapping 10-year periods were used in the simulation to estimate the tax alphas and tracking differences. As expected, the larger the size of the account (and therefore the larger the number of stocks in the direct indexing portfolio), the larger is the tax alpha and the smaller the tracking error (measured as the annualized average tracking difference). Table 5 shows the estimates.

Note that for an extra 1.72% of tracking error, after-tax returns may be enhanced by over 2½ percentage points. While these numbers come from a back test, they are similar to the extra after-tax returns achieved by managers such as Parametric Portfolio Associates and Natixis Managed Portfolio Advisors.

8 Concluding comments

Automated investment advisers aim to deliver an investment service that maximizes the net-of-fee,

after-tax investment return for each client’s capacity for and willingness to assume risk. Technology makes it possible to rebalance both taxable and tax-advantaged accounts efficiently. Automation also makes it possible for taxable investors to realize the greatest amount of available tax savings while ensuring that the portfolio does not violate any required constraints such as the avoidance of wash sales. The automated service makes it possible for small investors to get professional investment management for a rock bottom fee. And software makes for fewer errors on the repetitive tasks advisers need to perform on behalf of their clients. Direct indexing makes the service even more effective for larger investors by being able to deliver a larger tax alpha. The service avoids many of the conflicts of interest that accompany many financial advisory arrangements and avoids the risk of having the portfolio exposed to underperforming active portfolio managers.

It is true, as some critics argue, that the investor will not be exposed to the set of exotic investment instruments such as hedge funds and private equity portfolios.¹⁸ But the returns from these “alternative” investments have been extremely disappointing and the fees involved have been excessive. Moreover, even if some alternative managers do outperform the public markets after fees, the ordinary investor will not have access to them. The only thing that is certain in the investment business is that the higher the fee paid to

the investment manager, the lower will be the net return to the investor. Automated advisers provide state-of-the-art portfolio management at the lowest fees available.

Notes

¹ Kahneman, D. (2013). *Thinking Fast and Slow*, Farrar Straus and Giroux, New York.

² Dichev, I. D. (2007). "What are Stock Investors' Actual Historical Returns? Evidence from Dollar-Weighted Returns," *American Economic Review* **97**, 386–401. See also Dalbar Inc. (2015). "Quantitative Analysis of Investor Behavior."

³ Benartzi, S. and Thaler, R. H. (2007). "Heuristics and Biases in Retirement Savings Behavior," *Journal of Economic Perspectives* **2**, 81–104.

⁴ See *The Effects of Conflicted Investment Advice on Retirement Savings*, Executive Office of the President, February 2015.

⁵ A 2014 study by PriceMetrix put the industry average at 1.02 percent. A copy of the completed report is available at pricemetrix.com.

⁶ At both Fidelity and Vanguard average balances of retirement savings accounts were well under \$100,000. 110 million United States households have less than \$100,000 to invest.

⁷ Ayres, I. and Curtis, Q. (2013). "Beyond Diversification: The Pervasive Problem of Excessive Fees and Dominated Funds in 401(k) Plans," *Yale Law Journal*, 1476–1552.

⁸ Bogle, J. C. (2013). "The Train Wreck Awaiting American Retirement" in interview, *Frontline: The Retirement Gamble*, New York: PBS television. See also Ellis, C. D., Munnell, A. H., and Eschtruth, A. D. (2014). *Falling Short: The Coming Retirement Crisis*, Oxford University Press, New York.

⁹ Jensen, M. C. (1968). "The Performance of Mutual Funds in the Period 1945–1964," *Journal of Finance* **23**, 389–416.

¹⁰ Malkiel, B. G. (1995). "Returns from Investing in Equity Mutual Funds 1971–1991," *Journal of Finance* **50**, 549–572; and Malkiel, B. G. (2016). *A Random Walk Down Wall Street*, 11th ed., paper, W. W. Norton, New York.

¹¹ Standard & Poor's Dow Jones Indexes, SPIVA® U.S. Score Card, March 2016.

¹² See O'Dean, T. and Barber, B. (2001). "Boys Will Be Boys: Gender, Overconfidence, and Common Stock

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¹³ Tax-exempt securities are used exclusively in taxable accounts.

¹⁴ Alternately, for larger accounts some portion or all of the largest 1,000 individual stocks would be purchased and then augmented with a "small capitalization" equity ETF so as to replicate the total stock market index.

¹⁵ The tax savings will be realized to the extent that the investor has taxable capital gains in the rest of his portfolio or is able to use the \$3,000 net loss that is available under current tax laws.

¹⁶ The procedure described below is the one used by the automated adviser Wealthfront. A full description can be found in "Wealthfront's Tax-Optimized Direct Indexing" available at Wealthfront.com.

¹⁷ These computations assume that clients have sufficient capital gains (external to the Wealthfront portfolio) to take advantage of the capital losses harvested and that the tax savings are reinvested.

¹⁸ Automated advisers also do not provide trust services or specialized estate planning advice. Some traditional advisers do offer such services for an additional fee.

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