The Sustainability of (Global) Withdrawal Strategies

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Abstract
The most important financial issue retirees have to deal with is whether their strategy will be able to sustain all the withdrawals they expect to make in retirement, as well as a bequest they aim to leave. For this reason, it is critical to periodically monitor the evolution of a financial plan in order to detect early signs of trouble, which may lead a retiree to introduce dynamic adjustments to a strategy. To that purpose, this article features two tools, a sustainability test and the sustainable withdrawal, and shows how to apply them. It also discusses the empirical evidence on both tools based on a comprehensive sample of 22 countries over a 120-year period.

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1. Introduction

The sustainability of a withdrawal strategy is arguably the most important financial issue that retirees have to deal with. If the withdrawals needed to sustain a desired lifestyle and bequest are not consistent with a retiree's portfolio and its expected return, given the retiree's life expectancy, then something must adjust. In fact, the ultimate goal of a financial plan should be to ensure that the withdrawals planned for the retirement years, including a target bequest, are consistent with a portfolio's capacity to satisfy them.

Bengen's (1994) seminal article on safe withdrawal rates inspired a massive literature that debates his 4% rule as well as many other withdrawal strategies subsequently proposed.[1] Ultimately, Bengen aimed to highlight the importance of implementing a withdrawal strategy that does not deplete a portfolio earlier than a retiree planned for. A strategy that is expected to sustain all the withdrawals a retiree expects to make during retirement, as well as the bequest he aims to leave, is referred to here as a sustainable strategy.

Typically, the way to evaluate the feasibility of a withdrawal strategy is to select a metric and evaluate its performance over a large number of historical or simulated retirement periods. For example, a strategy of withdrawing 4% from a 60-40 stock-bond portfolio at the beginning of retirement, followed by 29 annual inflation-adjusted withdrawals, has a historical failure rate of less than 5% in the U.S. and over 65% in Italy. That evidence may lead an American investor to embrace the strategy with confidence and an Italian investor to reject it outright.

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[1] The 4% rule refers to a strategy that withdraws 4% of the portfolio at the beginning of retirement, and then adjusts all subsequent withdrawals by inflation, thus keeping purchasing power constant over time.

The two approaches proposed here are different from that in the previous example in a critical way: They both aim to be dynamic and forward looking in the sense that a retiree can use them *during* retirement to *periodically* evaluate whether the withdrawal strategy implemented is sustainable (the sustainability test); or to *periodically* determine a sustainable level of inflation-adjusted withdrawals (the sustainable withdrawal). Importantly, both the sustainability of the strategy and the sustainable withdrawal can, and most likely will, change from period to period depending on the performance of the retirement portfolio.

To be sure, this article does not aim to develop an optimal withdrawal strategy. Rather, it aims to provide retirees and their advisors with two tools they can use periodically during retirement: One to calculate the sustainability of whatever withdrawal strategy they have chosen to implement; and another to calculate a sustainable level of inflation-adjusted withdrawals, which could be compared to whatever withdrawals they have chosen to make. Both tools, the sustainability test and the sustainable withdrawal, can be used as a signal to consider the introduction of dynamic adjustments aimed at reducing the probability of failure.

This article also explores the evidence, using a sample of 22 markets over 120 years, on the sustainability of different strategies and on sustainable withdrawals. The tables in the text and the appendix provide a comprehensive historical perspective on several variables related to both issues. In a nutshell, the following are some relevant results that stem from the evidence. First, and perhaps unsurprisingly, both failure rates and unsustainability rates differ widely across countries; both rates also differ widely, for any given country, across initial withdrawal rates and asset allocations. Second, sustainable withdrawals vary widely over time, across asset allocations, and across countries; the variability over time, in particular, renders the periodic level of sustainable withdrawals an implausible withdrawal strategy.

The rest of the article is organized as follows. Section 2 motivates the two tools featured here, the sustainability test and the sustainable withdrawal, with an example based on a global portfolio of stocks and bonds; introduces the analytical framework; and discusses some related literature. Section 3 discusses the evidence for the 22 markets in the sample, with special emphasis on the World market and the U.S. market. Finally, section 4 concludes with an assessment. An appendix with tables concludes the article.

2. The Issue

This section first discusses the intuition behind the two tools featured in this article, the sustainability test and the sustainable withdrawal, with an example based on a portfolio of global stocks and bonds. Then it discusses both tools formally, introducing the expressions needed to implement them. And finally, it discusses some relevant insights from the literature on the evaluation of withdrawal strategies.

2.1. Motivation

Just as important as having a good retirement plan is monitoring periodically whether the plan remains on track. Because the actual returns experienced by a retiree hardly ever will be those expected in the plan, it is critical to evaluate over time whether the plan remains feasible. This is precisely what the first tool featured in this article aims to do.

Exhibit 1 shows the evolution of four portfolios (P), all starting with $1,000; with a 60-40 allocation to globally-diversified stocks and bonds (essentially, the World market in both asset classes), with an expected annualized real return of 4.2%; and subject to 30 annual withdrawals. All figures in the exhibit are in real (inflation-adjusted) dollars. Panels A through C are based on a 4% initial withdrawal rate (IWR), followed by 29 annual inflation-adjusted withdrawals.

Exhibit 1: Motivation

This exhibit shows, for the World market and a 60-40 stock-bond allocation, the evolution of four portfolios (P). It also shows the value of the sustainability test (B) given by expression (1), and the sustainable withdrawal (W^S) given by expression (2). The withdrawal strategy in panels A, B, and C is based on an initial withdrawal rate of 4% and subsequent withdrawals adjusted by inflation; in panel D it is based on taking the calculated W^S each year. All figures in real (inflation-adjusted) dollars.

Period	***A*: 1990-2019**		***B*: 1929-1958**		***C*: 1914-1943**		***D*: 1990-2019**	
	P	B	P	B	P	B	P	W^S
0	1,000	1,018	1,000	1,018	1,000	1,018	1,000	57
1	852	529	899	683	900	686	837	48
2	932	802	815	429	863	584	905	53
3	849	558	588	–235	790	378	811	49
4	951	873	664	35	615	–108	896	55
5	917	782	991	990	490	–414	846	53
6	1,045	1,134	987	978	341	–757	945	61
7	1,064	1,177	1,051	1,144	233	–964	936	62
8	1,126	1,323	1,135	1,345	250	–844	962	65
9	1,266	1,642	926	834	258	–751	1,046	73
10	1,377	1,868	938	869	211	–787	1,093	79
11	1,239	1,532	834	645	203	–733	940	70
12	1,073	1,161	846	684	177	–718	778	60
13	996	1,000	777	558	157	–690	693	55
14	1,193	1,379	715	456	142	–650	795	66
15	1,286	1,537	731	507	125	–616	813	71
16	1,298	1,536	736	537	79	–632	773	71
17	1,411	1,707	713	516	37	–638	787	77
18	1,444	1,732	511	204	Failure	N/A	748	77
19	1,134	1,216	411	77			542	60
20	1,282	1,430	375	61			565	67
21	1,370	1,539	365	85			548	71
22	1,321	1,449	362	117			474	68
23	1,415	1,556	349	134			448	72
24	1,536	1,688	333	149			420	77
25	1,588	1,724	303	146			363	79
26	1,517	1,611	351	236			279	74
27	1,540	1,612	352	267			214	74
28	1,724	1,787	313	255			160	82
29	1,557	1,581	254	223			73	73
30	1,789	N/A	261	N/A			0	N/A

The first column of panel A, which focuses on the 1990-2019 retirement period, shows the evolution of the portfolio subject to the withdrawal strategy just mentioned; as the last row shows, the returns during this period were such that, besides satisfying all withdrawals, the strategy made it possible to leave a bequest of $1,789.

The second column of panel A shows the first tool featured here, the sustainability test. In words, this test asks, at the beginning of each year in retirement, what is the expected bequest (B), given a sequence of annual inflation-adjusted withdrawals from that point on, and given the size (and expected return) of the portfolio at that point. As long as the expected bequest is not negative ($B \geq 0$), then the strategy is sustainable; that is, it is expected to sustain all the withdrawals planned. The expression used to calculate B is discussed in the next section.

Panel B, based on the 1929-1958 retirement period, illustrates that it is possible for a strategy to become unsustainable, as it happens in period 3 (B = –$235 < 0), but eventually become sustainable again, as it happens in period 4. To elaborate, the situation at some point during retirement may be such that the strategy is expected to fail, but subsequent strong returns make the strategy feasible again. In this particular case, the strategy becomes sustainable again just one year after it first became unsustainable, even though the retiree did not adjust his withdrawals in response to the signal from the sustainability test (that is, he still withdrew $40).

Panel C, on the other hand, based on the 1914-1943 retirement period, illustrates that it is also possible for a strategy to become unsustainable (as it happens in period 4), to never become sustainable again, and to eventually fail (as it happens in period 18). Unlike the previous case, in which ignoring the signal from the sustainability test still enabled the retiree to make it through the end of his retirement and leave a bequest, in this case ignoring the signal and not adjusting the withdrawals eventually leads to portfolio failure.

Panels B and C highlight that a strategy deemed to be unsustainable may or may not lead to portfolio failure. Put differently, failing the sustainability test provides a *warning signal* that a retiree may or may not decide to act upon. Cautious retirees may adjust their strategy right away, or at least keep a close eye on sustainability in the near future; more adventurous retirees, on the other hand, may refrain from adjusting their strategy and hope for a good run of returns that may restore the sustainability of their portfolio.

Finally, panel D, based on the 1990-2019 retirement period, illustrates the second tool featured in this article, the sustainable withdrawal (W^S). The first column of the panel shows the evolution of the portfolio, which by design should end with an amount equal to the target bequest, which in this case is $0. The second column shows the sustainable withdrawal; that is, the level of inflation-adjusted annual withdrawals that, given the size (and expected return) of the portfolio at the beginning of each period, leaves the target bequest at the end of retirement.

To illustrate, in period 15 the retiree has an \$813 portfolio. Thus, if over the 15 years left in his retirement he withdraws an inflation-adjusted \$71 every year, and his portfolio obtains its (4.2%) expected return every year, he will exhaust his portfolio by the end of 30 years, thus leaving his target bequest (\$0 in this case). Importantly, note that this could hardly be an acceptable withdrawal strategy; the very large variability in the withdrawals calculated amounts to the same very large variability in purchasing power during retirement. The expression used to calculate W^S is discussed in the next section.

That said, the sustainable withdrawal can help a retiree to evaluate how much he may need to adjust his withdrawals if his strategy is deemed to be unsustainable. To illustrate, if the sustainability test determines that a strategy of withdrawing (say) \$50 every year is unsustainable, and the sustainable withdrawal calculated is (say) \$51, then the retiree may hope that future returns are somewhat higher than he expects and refrain from adjusting his strategy. If, on the other hand, the sustainable withdrawal is calculated at (say) \$25, then hoping for somewhat better returns in the future may not save this retiree from portfolio failure; he may need to adjust his strategy or will eventually deplete his portfolio earlier than planned.

2.2. Formal Background

This section borrows from the analytical framework developed by Estrada (2020*c*).[2] The analysis is based on a retirement portfolio P with an expected annualized real return R, a T-year retirement period, and T annual inflation-adjusted withdrawals (W) made at the beginning of each of the T years in retirement. After the last withdrawal, the portfolio compounds for one more year and its terminal value becomes the bequest (B). Formally, at each time t the relationship between the portfolio, its expected return, the withdrawals, and the bequest is given by

$$B_t = P_t \cdot (1+R)^{T-t} + W \cdot (1+R) \cdot \left(\frac{1-(1+R)^{T-t}}{R}\right) \tag{1}$$

This expression yields the expected bequest and is the basis for the sustainability test; as long as the calculated value is not negative ($B_t \geq 0$), the strategy evaluated is deemed to be sustainable at the time (t) the evaluation is made.

To illustrate, in panel A of Exhibit 1, at the end of the tenth year in retirement, with a \$1,377 portfolio, an expected real return of 4.2%, and 20 inflation-adjusted withdrawals of \$40 to be made, the expected bequest is equal to

$$B_{10} = \$1{,}377 \cdot (1+0.042)^{(30-10)} + \$40 \cdot (1+0.042) \cdot \left(\frac{1-(1+0.042)^{(30-10)}}{0.042}\right) = \$1{,}868$$

[2] That framework, in turn, borrows from the analytical frameworks developed in Estrada (2019, 2020*a*, 2020*b*) for the accumulation period, the withdrawal period, and the lifecycle.

which is the figure for period 10 in the second column of the panel. In words, at the end of his tenth year in retirement, the retiree's withdrawal strategy is sustainable in the sense that the portfolio is not expected to be depleted before the end of the retirement period; in fact, the strategy is expected to leave a bequest of $1,868.

The calculation of the sustainable level of inflation-adjusted withdrawals (W^S) follows from expression (1) after solving for W, which for any time t yields

$$W_t^S = \frac{B - P_t \cdot (1+R)^{T-t}}{(1+R) \cdot \left(\frac{1-(1+R)^{T-t}}{R}\right)} \tag{2}$$

To illustrate, in panel D of Exhibit 1, at the end of the tenth year in retirement, with a $1,093 portfolio, an expected real return of 4.2%, 20 inflation-adjusted withdrawals to be made, and a target bequest of $0, the sustainable inflation-adjusted withdrawal is equal to

$$W_{10}^S = \frac{-\$1{,}093 \cdot (1+0.042)^{(30-10)}}{(1+0.042) \cdot \left(\frac{1-(1+0.042)^{(30-10)}}{0.042}\right)} = \$79$$

which is the figure for period 10 in the second column of the panel. In words, at the end of his tenth year in retirement, the retiree can expect to make 20 inflation-adjusted withdrawals of $79 every year, exhaust his portfolio, and leave no bequest (which is what he intended).

Expressions (1)-(2) are the backbone of the two tools featured here. The former aims to periodically evaluate the sustainability of a withdrawal strategy, and the latter aims to periodically calculate the sustainable level of inflation-adjusted withdrawals. Importantly, both are expected to change over time depending on the value of the portfolio and the number of years left in retirement. Evidence on the sustainability of different withdrawal strategies, as well as on sustainable withdrawals, is discussed in section 3 for the 22 markets in the sample.

2.3. Related Literature

The issues addressed in this article are broadly related to the literature on the evaluation of retirement strategies. Although the sustainability test and the sustainable withdrawal featured here are not really evaluation metrics, a historical (or simulation-based) perspective of their values, as that provided in section 3, can help to evaluate the feasibility of a withdrawal strategy.

The literature on the evaluation of retirement strategies begins with Bengen's (1994) seminal article, in which he aims to determine a safe withdrawal rate. He finds that an IWR of 4%, with subsequent annual withdrawals adjusted by inflation, is safe in the sense that (historically) it never depleted a balanced portfolio before 30 years, which he considered a minimum requirement for portfolio longevity. Bengen's groundbreaking article marked the beginning of both the 4% rule as a withdrawal strategy and the failure rate as an evaluation tool; subsequent research expanded Bengen's scope to different assets, time periods, countries, types of withdrawal strategies, and evaluation metrics.

Regarding evaluation metrics, it is important to note that however intuitive and widely used it may be, the failure rate is flawed in more than one way (Milevsky, 2016), which has led to the development of several alternatives. Blanchett (2007) proposed the success-to-variability ratio; Blanchett et al (2012) proposed the sustainable spending rate; Suarez et al (2015) and Clare et al (2017) proposed the perfect withdrawal amount; Estrada (2017, 2018*a*, 2018*b*, 2018*c*) proposed shortfall years, risk-adjusted success, the maximum withdrawal rate, and downside risk-adjusted success; and Estrada and Kritzman (2019) proposed the coverage ratio.

Frank and Blanchett (2010) are perhaps the closest reference to the issues discussed in this article. Although they propose a different metric (the probability of failure), their ultimate goal is, as it is here, to evaluate *periodically during retirement* whether a given strategy will be able to meet all the withdrawals and bequest contemplated in a financial plan.

3. Evidence

This section first discusses the data and methodology used in the empirical inquiry. Then it discusses the historical sustainability of withdrawal strategies (based on different IWRs and asset allocations) and historical levels of sustainable withdrawals, for all the markets in the sample. Finally, it concludes with some rounding comments on the analysis.

3.1. Data and Methodology

The sample is the Dimson-Marsh-Staunton (DMS) database, described in detail in Dimson, Marsh, and Staunton (2002) and in the annual updates of the database documentation. It contains annual returns for stocks and government bonds over the 1900-2019 period for 21 countries and the World market. Returns are real (adjusted by each country's inflation rate), in local currency, and account for both capital gains/losses and cash flows (dividends or coupons). Real returns for the World market are in dollars and adjusted by the U.S. inflation rate. Exhibit A1 in the appendix reports some summary statistics for all the series of stock and bond returns in the sample.

The analysis is based on a portfolio of 1,000 units of local currency at the beginning of retirement, a 30-year retirement period, and 30 annual withdrawals made at the beginning of each year in retirement. After the last withdrawal the portfolio compounds for one more year and its terminal value becomes the bequest. All returns and portfolio values are expressed in real (inflation-adjusted) terms. The first retirement period considered is 1900-1929 and the last one is 1990-2019, for a total of 91 rolling (overlapping) retirement periods.

The discussion of the sustainability test is based on a given IWR from the portfolio of 1,000 units of local currency, and 29 subsequent inflation-adjusted withdrawals. The discussion of the sustainable withdrawal is based on 30 withdrawals, each calculated at the beginning of each year in retirement, and a target bequest of $0. In both discussions, several asset allocations are considered, consisting of fixed proportions of stocks and bonds, with annual rebalancing. The expected return for each asset allocation considered is set equal to the allocation's long-term annualized return over the whole sample period.

3.2. The Sustainability Test – Base Case

Exhibit 2 provides a historical perspective, over a 120-year period and for the 22 markets in the sample, of failure rates (*F*) and unsustainability rates (*U*), for a base-case scenario consisting of a 60-40 stock-bond portfolio and a 4% IWR. The unsustainability rate is simply defined as the number of retirement periods in which a strategy became unsustainable, relative to the total number of retirement periods evaluated. The exhibit also reports the average year in which a strategy first became unsustainable (*Y*), and the proportion of times in which the new sustainable withdrawal was at least 10% (*D*10) or 20% (*D*20) lower than the initial withdrawal.[3]

Exhibit 2: Sustainability Test – Base Case – All Countries

This exhibit shows, for a 60-40 stock-bond allocation, and for an initial withdrawal rate of 4% with subsequent withdrawals adjusted by inflation, the failure rate (*F*), the unsustainability rate (*U*), the average year during the retirement period in which the strategy first became unsustainable (*Y*), and the proportion of times the sustainability test led to a decrease in the sustainable withdrawal of at least 10% (*D*10) and at least 20% (*D*20). All figures in percentage except for *Y* (in years).

Country	*F*	*U*	*Y*	*D*10	*D*20	Country	*F*	*U*	*Y*	*D*10	*D*20
Australia	18.7	34.1	9.2	54.8	12.9	N. Zealand	3.3	15.4	9.6	35.7	0.0
Austria	42.9	79.1	3.9	56.9	44.4	Norway	47.3	67.0	10.6	41.0	23.0
Belgium	50.5	75.8	4.8	37.7	11.6	Portugal	52.7	70.3	6.4	50.0	23.4
Canada	1.1	29.7	9.1	33.3	0.0	S. Africa	5.5	28.6	9.8	34.6	15.4
Denmark	14.3	41.8	10.8	28.9	2.6	Spain	40.7	64.8	7.4	42.4	20.3
Finland	36.3	47.3	7.4	67.4	32.6	Sweden	15.4	29.7	10.8	51.9	33.3
France	54.9	76.9	6.4	37.1	7.1	Switzerland	24.2	37.4	7.8	73.5	20.6
Germany	50.5	72.5	5.3	47.0	21.2	UK	22.0	46.2	7.8	71.4	33.3
Ireland	34.1	59.3	7.2	51.9	27.8	USA	4.4	28.6	8.9	34.6	0.0
Italy	67.0	80.2	5.4	50.7	26.0	World	22.0	44.0	8.1	47.5	5.0
Japan	36.3	51.6	8.3	63.8	42.6						
Netherlands	22.0	46.2	10.2	35.7	4.8	Average	30.7	51.5	8.0	47.6	19.2

It should not be surprising that the failure rate varies dramatically across countries, from a low of 1.1% in Canada to a high of 67% in Italy. Among other reasons, this is because, as Exhibit A1 shows, the equity risk premium also varies dramatically across countries, with a low of 1.6% for Spain and a high of 5.2% for Finland and South Africa, with an average of 3.7% across

[3] For any given country, a value of *Y* is calculated for each of the 91 retirement periods considered; the figure reported in the table is the average across those 91 retirement periods. *D*10 and *D*20 are calculated relative to the number of periods in which a strategy became unsustainable.

countries and 3.2% for the World. The average failure rate across countries is 30.7% and that for the World is 22%.

The unsustainability rate also varies widely across countries, between a low of 15.4% for New Zealand to a high of 80.2% for Italy, with an average of 51.5% across countries and 44% for the World. Importantly, note that the unsustainability rate is based on when the strategy *first* became unsustainable. As panel B of Exhibit 1 shows, that event does not necessarily imply that the strategy remained unsustainable from that point on, even if a retiree did not adjust his withdrawals. The goal of this part of the analysis is just to assess how often a given strategy became unsustainable, and how long it took for that to happen.

Regarding this second point, note that the strategy considered in Exhibit 2 became unsustainable, on average across countries, eight years into the retirement period, although that happened far sooner in Austria (after less than four years) and much later in Denmark and Sweden (where the strategy remained sustainable for almost 11 years). Finally, note that on average across countries, 47.6% (19.2%) of the times that the strategy became unsustainable, a return to sustainability required lowering the initial withdrawal by at least 10% (20%).

3.3. The Sustainability Test – Sensitivity Analysis

Exhibit 3 expands the previous analysis, based on a 60-40 stock-bond portfolio and a 4% IWR, to several asset allocations and IWRs, for both the World and the U.S. Unsurprisingly, for both markets it is the case that, all else equal, higher IWRs and more conservative asset allocations lead to higher failure rates and unsustainability rates.

IWRs 5% or higher have what most retirees would consider unacceptable failure rates and unsustainability rates, even for aggressive portfolios. For the 80-20 allocation, a 5% IWR has a failure rate higher than 36% in the World and just under 30% in the U.S. For the same allocation and IWR, the unsustainability rate is over 58% in the World and over 46% in the U.S. In both markets, the strategy first became unsustainable 6 to 7 years into retirement, requiring a decrease in withdrawals of at least 10% about half the time (over 50% in the World and over 45% in the U.S.) in order to restore sustainability.

Exhibit A2 in the appendix shows a similar sensitivity analysis for the rest of the countries in the sample. The results are obviously many and varied, but an interesting fact that the figures in the table highlight is that the experience of retirees has been substantially different across countries, being far better in countries like Canada, Denmark, and New Zealand than in countries like Austria, Germany, or Italy.

Exhibit 3: Sustainability Test – Sensitivity Analysis – World and USA

This exhibit shows, for stock-bond allocations between 80-20 and 20-80, and for individual withdrawal rates (IWR) between 2% and 6% with subsequent withdrawals adjusted by inflation, the failure rate (F), the unsustainability rate (U), the average year during the retirement period in which a strategy became unsustainable (Y), and the proportion of times the sustainability test led to a decrease in the sustainable withdrawal of at least 10% ($D10$) and at least 20% ($D20$). All figures in percentage except for Y (in years).

***A*: World**	*F*	*U*	*Y*	*D*10	*D*20	***B*: USA**	*F*	*U*	*Y*	*D*10	*D*20
IWR: 2%						IWR: 2%					
80-20	0.0	0.0	N/A	N/A	N/A	80-20	0.0	0.0	N/A	N/A	N/A
60-40	0.0	3.3	8.0	0.0	0.0	60-40	0.0	0.0	N/A	N/A	N/A
50-50	0.0	4.4	8.5	0.0	0.0	50-50	0.0	0.0	N/A	N/A	N/A
40-60	0.0	7.7	8.0	57.1	0.0	40-60	0.0	0.0	N/A	N/A	N/A
20-80	0.0	13.2	9.2	33.3	0.0	20-80	0.0	0.0	N/A	N/A	N/A
IWR: 3%						IWR: 3%					
80-20	0.0	15.4	9.1	57.1	21.4	80-20	0.0	0.0	N/A	N/A	N/A
60-40	3.3	19.8	10.4	61.1	22.2	60-40	0.0	0.0	N/A	N/A	N/A
50-50	5.5	20.9	10.7	68.4	15.8	50-50	0.0	1.1	5.0	0.0	0.0
40-60	8.8	24.2	10.6	54.5	27.3	40-60	0.0	4.4	10.0	0.0	0.0
20-80	26.4	34.1	9.5	41.9	12.9	20-80	0.0	23.1	11.6	33.3	0.0
IWR: 4%						IWR: 4%					
80-20	15.4	38.5	8.2	34.3	8.6	80-20	3.3	22.0	7.1	45.0	25.0
60-40	22.0	44.0	8.1	47.5	5.0	60-40	4.4	28.6	8.9	34.6	0.0
50-50	26.4	44.0	8.3	57.5	7.5	50-50	8.8	34.1	9.9	32.3	3.2
40-60	30.8	47.3	8.0	37.2	4.7	40-60	14.3	38.5	9.6	28.6	2.9
20-80	35.2	57.1	6.8	21.2	1.9	20-80	39.6	58.2	8.6	30.2	3.8
IWR: 5%						IWR: 5%					
80-20	36.3	58.2	6.3	50.9	13.2	80-20	29.7	46.2	6.7	45.2	21.4
60-40	45.1	67.0	5.2	32.8	11.5	60-40	35.2	56.0	6.8	35.3	13.7
50-50	47.3	68.1	4.4	33.9	9.7	50-50	42.9	60.4	6.6	32.7	16.4
40-60	51.6	75.8	3.6	29.0	7.2	40-60	47.3	68.1	5.2	27.4	4.8
20-80	61.5	100.0	0.0	0.0	0.0	20-80	65.9	83.5	2.8	18.4	1.3
IWR: 6%						IWR: 6%					
80-20	58.2	82.4	2.6	41.3	16.0	80-20	44.0	64.8	3.8	35.6	13.6
60-40	60.4	100.0	0.0	0.0	0.0	60-40	51.6	76.9	3.4	34.3	11.4
50-50	63.7	100.0	0.0	0.0	0.0	50-50	57.1	82.4	2.5	30.7	9.3
40-60	64.8	100.0	0.0	100.0	0.0	40-60	68.1	100.0	0.0	0.0	0.0
20-80	74.7	100.0	0.0	100.0	0.0	20-80	76.9	100.0	0.0	100.0	0.0

3.4. The Sustainable Withdrawal

When the sustainability test deems a strategy unsustainable, a retiree can easily calculate the new sustainable withdrawal (W^S) with expression (2). In fact, he could even calculate it periodically in order to benchmark the withdrawals in his selected strategy to the sustainable level at each point in time. Exhibit 4 reports, for the World and the U.S., three figures that summarize historical levels of sustainable withdrawals for several asset allocations.

The numbers reported need some explanation. For any given market, 30 sustainable withdrawals are calculated, one per year, for each of the 91 retirement periods considered. Then, for each of those retirement periods, the 30 W^S calculated are collapsed into three figures, the minimum, the maximum, and the average. The same is done for all the retirement periods considered, which leads to three series of 91 minimum, maximum, and average figures. The average of the minimum values (Min), the average of the maximum values (Max), and the average of the average values (Avg) are the figures reported in the exhibit.

Exhibit 4: Sustainable Withdrawals – World and USA

This exhibit shows, for stock-bond (S-B) allocations between 80-20 and 20-80, the average (Avg), minimum (Min), and maximum (Max) sustainable withdrawal given by expression (2), all as defined in the text. All figures in real (inflation-adjusted) dollars.

A: World				***B***: USA			
S-B	Avg	Min	Max	S-B	Avg	Min	Max
80-20	67.0	38.1	99.9	80-20	73.1	43.1	114.3
60-40	62.0	35.9	89.1	60-40	66.4	39.7	94.8
50-50	59.7	34.6	86.0	50-50	63.2	37.8	88.4
40-60	57.5	33.2	83.8	40-60	60.1	35.6	83.8
20-80	53.2	30.0	80.6	20-80	53.9	30.4	76.9

Unsurprisingly, the sustainable withdrawal increases with the proportion of stocks in the portfolio; more aggressive allocations deliver higher (long-term) returns, which translate into higher withdrawals. For example, just moving from a 40-60 to a 60-40 stock-bond portfolio would enable a retiree to increase his average sustainable withdrawal by almost 8% in the World and by over 10% in the U.S. Because the whole analysis is based on real returns, these figures imply an increase by the same amounts in purchasing power throughout retirement.

Exhibit A3 in the appendix reports a similar analysis for the rest of the countries in the sample. As in Exhibit A2, the results are many and varied. Perhaps an interesting result to highlight is that countries highlighted before as having provided a better experience for retirees (Canada, Denmark, and New Zealand) have a relatively small gap between the Min and Max sustainable withdrawals, implying less difference between good and bad retirement periods. On the other hand, countries highlighted before as having provided a worse experience for retirees (Austria, Germany, and Italy), have a much larger Min-Max gap, indicating the opposite.

3.5. Some Further Comments

The framework proposed in this article could be used by retirees and financial planners to periodically evaluate the sustainability of a financial plan during retirement. Because plans hardly ever develop as expected, this dynamic evaluation is critical to determine whether it is necessary to introduce adjustments aimed at restoring the viability of a plan. Estrada (2020*a*) shows that when adjustments need to be made, it is better to adjust withdrawals than to adjust the portfolio's asset allocation; that result applies to the issues discussed in this article.

The analytical framework summarized by expressions (1)-(2) is based on an expected annualized return for the portfolio, which in the empirical implementation was set equal to the annualized historical return of the asset allocation considered. Needless to say, this figure could be replaced by whatever expected return a retiree considers more plausible. It could also be replaced by sequences of (Monte Carlo) simulated returns, although that would imply changes in expressions (1)-(2) that would make them more cumbersome.

Finally, although part of the analysis is based on inflation-adjusted withdrawals that aim to keep purchasing power constant over time, this could be replaced by other policies, including dynamic strategies that periodically adjust withdrawals. The price to pay again would be having to deal with expressions more complicated than those discussed here.

4. Assessment

The main financial concern of retirees arguably is being able to sustain their desired standard of living in retirement, including a bequest they may want to leave. A financial plan certainly helps to alleviate this concern, albeit not completely for a simple reason, namely, these plans never go as expected. For this reason, as retirement unfolds, retirees would be wise to evaluate the sustainability of their plan and consider whether adjustments need to be made.

To that purpose, this article offers retirees and financial planners two tools, the sustainability test and the sustainable withdrawal. The former can be used to periodically test whether the strategy in place is expected to sustain all the withdrawals and bequest planned; the latter can be used to periodically determine the inflation-adjusted withdrawal that is expected to leave the retirement portfolio with the target bequest. Unlike other evaluation tools, such as the failure rate, these two tools can be used *during* retirement for *periodic* evaluations.

This article also provides an empirical perspective on both tools, using a comprehensive database of 22 countries over a 120-year sample period. For a base case consisting of a balanced 60-40 stock-bond portfolio and a 4% initial withdrawal rate, the evidence shows, on average across all the countries in the sample, a failure rate of 30.7% and an unsustainability rate of 51.5%. Needless to say, these figures vary considerably across countries, as they do across initial withdrawal rates and asset allocations.

The evidence also shows that the base-case strategy first becomes unsustainable on average 8 years into the retirement period, and that in 47.6% (19.2%) of those times the decrease in withdrawals that would restore sustainability is at least as large as 10% (20%). It also shows that retirees in some countries had much better experiences than those in other countries, and that the former also had to bear less uncertainty as measured by the difference between good and bad retirement periods.

Retirees should always keep in mind that plans are unlikely to work as expected and that adjustments may need to be made along way. The only way to detect departures from what was planned is to periodically monitor a financial plan using tools that provide an early signal of trouble down the road. The two tools featured in this article can hopefully help retirees and financial planners to deal with this problem.

Appendix

Exhibit A1: Summary Statistics – 1900-2019

This exhibit shows, for the series of annual returns, the geometric mean return (MR), standard deviation (SD), lowest return (Min) highest return (Max), and equity risk premium (ERP) defined as the difference between the mean returns reported for stocks and bonds. All returns are real (adjusted by each country's inflation rate), in local currency (except for the World market, in dollars), and account for capital gains/losses and cash flows (dividends or coupons). All figures in %.

	Stocks				Bonds				ERP
	MR	SD	Min	Max	MR	SD	Min	Max	
Australia	6.8	17.4	−42.5	51.5	1.8	13.0	−26.6	62.2	5.0
Austria	1.0	30.4	−59.6	132.7	−3.5	53.1	−94.7	484.8	4.5
Belgium	2.6	23.2	−48.9	105.1	0.5	14.8	−45.6	62.3	2.1
Canada	5.7	16.8	−33.8	55.2	2.2	10.2	−25.9	41.7	3.5
Denmark	5.6	20.6	−49.2	107.8	2.1	12.8	−27.6	63.6	3.5
Finland	5.5	29.4	−60.8	161.7	0.3	13.4	−69.5	30.2	5.2
France	3.4	22.8	−41.5	66.1	0.3	12.8	−43.5	35.9	3.1
Germany	3.3	31.2	−90.8	154.6	−1.2	15.4	−95.0	62.5	4.5
Ireland	4.4	22.8	−65.4	68.4	1.7	14.8	−34.1	61.2	2.6
Italy	2.2	28.2	−72.9	120.7	−0.9	14.6	−64.3	35.5	3.1
Japan	4.2	29.1	−85.5	121.1	−0.8	19.3	−77.5	69.8	5.0
Netherlands	5.1	21.1	−50.4	101.6	1.8	9.6	−18.1	32.8	3.3
N. Zealand	6.4	19.1	−54.7	105.3	2.3	8.9	−23.7	34.1	4.2
Norway	4.4	26.4	−53.6	166.9	1.8	11.8	−48.0	62.1	2.6
Portugal	3.6	33.8	−76.6	151.8	−1.3	18.0	−45.1	90.6	5.0
S. Africa	7.1	21.8	−52.2	102.9	1.9	10.3	−32.6	37.1	5.2
Spain	3.6	21.6	−43.3	99.4	2.0	12.4	−30.2	53.2	1.6
Sweden	6.0	20.9	−42.5	67.5	2.7	12.5	−37.0	68.2	3.2
Switzerland	4.6	19.3	−37.8	59.4	2.4	9.3	−21.4	56.1	2.3
UK	5.5	19.5	−56.6	99.3	1.9	13.4	−29.9	59.4	3.6
USA	6.5	19.8	−38.6	55.8	2.0	10.3	−18.1	35.2	4.5
World	5.2	17.3	−41.5	67.6	2.0	10.9	−31.6	46.0	3.2

Exhibit A2: Sustainability Test – All Countries

This exhibit shows, for stock-bond (S-B) allocations between 80-20 and 20-80, and for individual withdrawal rates (IWR) between 3% and 5% with subsequent withdrawals adjusted by inflation, the failure rate (*F*), the unsustainability rate (*U*), the average year during the retirement period in which a strategy became unsustainable (*Y*), and the proportion of times the sustainability test led to a decrease in the sustainable withdrawal of at least 10% (*D*10) and at least 20% (*D*20). All figures in percentage except for *Y* (in years).

IWR/S-B	*F*	*U*	*Y*	*D*10	*D*20
Australia					
3 / 80-20	1.1	2.2	5.5	100.0	50.0
3 / 60-40	1.1	4.4	8.3	50.0	0.0
3 / 40-60	7.7	16.5	9.1	13.3	0.0
3 / 20-80	22.0	40.7	10.3	45.9	16.2
4 / 80-20	7.7	13.2	5.3	50.0	16.7
4 / 60-40	18.7	34.1	9.2	54.8	12.9
4 / 40-60	34.1	50.5	9.0	50.0	28.3
4 / 20-80	52.7	72.5	8.5	43.9	9.1
5 / 80-20	28.6	44.0	7.8	55.0	27.5
5 / 60-40	36.3	53.8	7.3	44.9	18.4
5 / 40-60	53.8	76.9	6.7	35.7	11.4
5 / 20-80	62.6	100.0	0.0	0.0	0.0
Belgium					
3 / 80-20	26.4	41.8	8.1	55.3	34.2
3 / 60-40	27.5	39.6	8.4	55.6	30.6
3 / 40-60	30.8	40.7	8.8	70.3	29.7
3 / 20-80	34.1	45.1	8.6	46.3	24.4
4 / 80-20	49.5	74.7	4.9	47.1	17.6
4 / 60-40	50.5	75.8	4.8	37.7	11.6
4 / 40-60	52.7	76.9	4.0	41.4	8.6
4 / 20-80	57.1	100.0	0.0	0.0	0.0
5 / 80-20	68.1	100.0	0.0	0.0	0.0
5 / 60-40	70.3	100.0	0.0	0.0	0.0
5 / 40-60	73.6	100.0	0.0	100.0	0.0
5 / 20-80	75.8	100.0	0.0	100.0	100.0
Denmark					
3 / 80-20	0.0	0.0	N/A	N/A	N/A
3 / 60-40	0.0	1.1	4.0	0.0	0.0
3 / 40-60	0.0	16.5	11.1	53.3	6.7
3 / 20-80	8.8	38.5	13.0	40.0	22.9
4 / 80-20	2.2	25.3	10.6	39.1	4.3
4 / 60-40	14.3	41.8	10.8	28.9	2.6
4 / 40-60	41.8	60.4	10.6	21.8	10.9
4 / 20-80	57.1	70.3	7.5	28.1	3.1
5 / 80-20	42.9	64.8	7.4	37.3	6.8
5 / 60-40	59.3	75.8	6.9	26.1	10.1
5 / 40-60	67.0	79.1	4.9	16.7	1.4
5 / 20-80	71.4	100.0	0.0	0.0	0.0

IWR/S-B	*F*	*U*	*Y*	*D*10	*D*20
Austria					
3 / 80-20	30.8	61.5	6.6	69.6	33.9
3 / 60-40	34.1	50.5	5.8	71.7	37.0
3 / 40-60	38.5	50.5	5.8	89.1	69.6
3 / 20-80	45.1	63.7	4.6	74.1	63.8
4 / 80-20	45.1	81.3	3.7	55.4	33.8
4 / 60-40	42.9	79.1	3.9	56.9	44.4
4 / 40-60	49.5	100.0	0.0	0.0	0.0
4 / 20-80	48.4	100.0	0.0	100.0	100.0
5 / 80-20	63.7	100.0	0.0	100.0	0.0
5 / 60-40	60.4	100.0	0.0	100.0	0.0
5 / 40-60	60.4	100.0	0.0	100.0	100.0
5 / 20-80	62.6	100.0	0.0	100.0	100.0
Canada					
3 / 80-20	0.0	0.0	N/A	N/A	N/A
3 / 60-40	0.0	3.3	8.0	33.3	0.0
3 / 40-60	0.0	15.4	11.5	35.7	0.0
3 / 20-80	2.2	24.2	10.7	45.5	0.0
4 / 80-20	0.0	19.8	8.7	33.3	0.0
4 / 60-40	1.1	29.7	9.1	33.3	0.0
4 / 40-60	16.5	35.2	9.7	40.6	6.3
4 / 20-80	41.8	58.2	8.9	22.6	0.0
5 / 80-20	30.8	45.1	5.9	48.8	14.6
5 / 60-40	35.2	53.8	5.7	38.8	6.1
5 / 40-60	49.5	69.2	4.7	27.0	4.8
5 / 20-80	63.7	81.3	2.3	16.2	1.4
Finland					
3 / 80-20	24.2	36.3	8.1	75.8	60.6
3 / 60-40	31.9	38.5	8.7	80.0	65.7
3 / 40-60	34.1	39.6	8.3	61.1	36.1
3 / 20-80	38.5	42.9	8.0	79.5	53.8
4 / 80-20	35.2	45.1	7.4	70.7	48.8
4 / 60-40	36.3	47.3	7.4	67.4	32.6
4 / 40-60	40.7	52.7	7.5	62.5	45.8
4 / 20-80	45.1	67.0	6.9	32.8	19.7
5 / 80-20	39.6	65.9	6.4	61.7	31.7
5 / 60-40	44.0	68.1	6.1	53.2	30.6
5 / 40-60	53.8	81.3	4.1	36.5	17.6
5 / 20-80	67.0	100.0	0.0	100.0	0.0

(*Continues*)

Exhibit A2: Sustainability Test – All Countries (Cont.)

IWR/S-B	*F*	*U*	*Y*	*D*10	*D*20	IWR/S-B	*F*	*U*	*Y*	*D*10	*D*20
France						*Germany*					
3 / 80-20	28.6	46.2	9.2	54.8	21.4	3 / 80-20	37.4	51.6	9.3	70.2	55.3
3 / 60-40	35.2	48.4	10.5	59.1	18.2	3 / 60-40	41.8	50.5	9.4	73.9	56.5
3 / 40-60	45.1	51.6	10.9	51.1	23.4	3 / 40-60	45.1	50.5	9.3	73.9	50.0
3 / 20-80	51.6	52.7	8.4	39.6	20.8	3 / 20-80	46.2	50.5	8.3	60.9	52.2
4 / 80-20	53.8	78.0	7.2	50.7	12.7	4 / 80-20	51.6	72.5	6.0	45.5	24.2
4 / 60-40	54.9	76.9	6.4	37.1	7.1	4 / 60-40	50.5	72.5	5.3	47.0	21.2
4 / 40-60	56.0	78.0	5.5	38.0	7.0	4 / 40-60	51.6	81.3	3.9	41.9	24.3
4 / 20-80	54.9	83.5	3.0	27.6	10.5	4 / 20-80	51.6	100.0	0.0	100.0	0.0
5 / 80-20	69.2	87.9	3.2	53.8	22.5	5 / 80-20	61.5	100.0	0.0	0.0	0.0
5 / 60-40	68.1	100.0	0.0	0.0	0.0	5 / 60-40	61.5	100.0	0.0	0.0	0.0
5 / 40-60	67.0	100.0	0.0	100.0	0.0	5 / 40-60	61.5	100.0	0.0	100.0	0.0
5 / 20-80	67.0	100.0	0.0	100.0	0.0	5 / 20-80	63.7	100.0	0.0	100.0	100.0
Ireland						*Italy*					
3 / 80-20	11.0	25.3	9.0	21.7	4.3	3 / 80-20	42.9	65.9	8.2	73.3	36.7
3 / 60-40	13.2	30.8	10.0	46.4	3.6	3 / 60-40	50.5	64.8	7.9	57.6	32.2
3 / 40-60	19.8	38.5	9.5	48.6	8.6	3 / 40-60	56.0	68.1	8.5	58.1	33.9
3 / 20-80	34.1	57.1	10.1	38.5	19.2	3 / 20-80	64.8	71.4	7.6	67.7	36.9
4 / 80-20	27.5	54.9	7.9	58.0	34.0	4 / 80-20	63.7	80.2	5.9	56.2	35.6
4 / 60-40	34.1	59.3	7.2	51.9	27.8	4 / 60-40	67.0	80.2	5.4	50.7	26.0
4 / 40-60	47.3	64.8	6.4	49.2	27.1	4 / 40-60	71.4	100.0	0.0	0.0	0.0
4 / 20-80	60.4	74.7	5.2	26.5	17.6	4 / 20-80	74.7	100.0	0.0	100.0	0.0
5 / 80-20	48.4	75.8	4.6	46.4	18.8	5 / 80-20	72.5	100.0	0.0	100.0	0.0
5 / 60-40	54.9	79.1	4.1	30.6	12.5	5 / 60-40	73.6	100.0	0.0	100.0	0.0
5 / 40-60	63.7	80.2	2.5	30.1	5.5	5 / 40-60	76.9	100.0	0.0	100.0	100.0
5 / 20-80	68.1	100.0	0.0	0.0	0.0	5 / 20-80	82.4	100.0	0.0	100.0	100.0
Japan						*Netherlands*					
3 / 80-20	31.9	37.4	11.7	85.3	79.4	3 / 80-20	0.0	1.1	10.0	0.0	0.0
3 / 60-40	28.6	34.1	11.5	90.3	90.3	3 / 60-40	0.0	1.1	11.0	100.0	0.0
3 / 40-60	29.7	38.5	11.4	74.3	65.7	3 / 40-60	0.0	12.1	10.6	0.0	0.0
3 / 20-80	30.8	50.5	9.5	65.2	50.0	3 / 20-80	15.4	41.8	13.8	18.4	0.0
4 / 80-20	38.5	44.0	9.6	65.0	57.5	4 / 80-20	19.8	39.6	8.0	52.8	8.3
4 / 60-40	36.3	51.6	8.3	63.8	42.6	4 / 60-40	22.0	46.2	10.2	35.7	4.8
4 / 40-60	34.1	59.3	7.1	44.4	29.6	4 / 40-60	39.6	53.8	8.6	36.7	2.0
4 / 20-80	37.4	100.0	0.0	0.0	0.0	4 / 20-80	52.7	64.8	6.9	20.3	0.0
5 / 80-20	42.9	60.4	6.6	74.5	32.7	5 / 80-20	46.2	63.7	6.6	51.7	8.6
5 / 60-40	41.8	100.0	0.0	0.0	0.0	5 / 60-40	46.2	67.0	5.1	27.9	1.6
5 / 40-60	42.9	100.0	0.0	100.0	0.0	5 / 40-60	57.1	78.0	4.0	23.9	0.0
5 / 20-80	53.8	100.0	0.0	100.0	100.0	5 / 20-80	64.8	100.0	0.0	0.0	0.0
New Zealand						*Norway*					
3 / 80-20	0.0	1.1	4.0	100.0	0.0	3 / 80-20	8.8	20.9	8.7	42.1	15.8
3 / 60-40	0.0	1.1	10.0	0.0	0.0	3 / 60-40	8.8	22.0	10.5	35.0	5.0
3 / 40-60	0.0	4.4	8.8	0.0	0.0	3 / 40-60	12.1	22.0	10.7	65.0	5.0
3 / 20-80	3.3	14.3	10.2	23.1	0.0	3 / 20-80	19.8	35.2	13.6	56.3	43.8
4 / 80-20	2.2	11.0	7.8	50.0	10.0	4 / 80-20	37.4	61.5	10.5	50.0	23.2
4 / 60-40	3.3	15.4	9.6	35.7	0.0	4 / 60-40	47.3	67.0	10.6	41.0	23.0
4 / 40-60	20.9	36.3	10.6	24.2	0.0	4 / 40-60	52.7	68.1	9.6	40.3	25.8
4 / 20-80	46.2	65.9	10.6	15.0	0.0	4 / 20-80	60.4	71.4	7.4	16.9	7.7
5 / 80-20	20.9	42.9	7.6	43.6	10.3	5 / 80-20	60.4	75.8	6.0	36.2	24.6
5 / 60-40	33.0	59.3	7.7	33.3	0.0	5 / 60-40	59.3	74.7	5.3	27.9	16.2
5 / 40-60	50.5	72.5	7.9	15.2	0.0	5 / 40-60	64.8	78.0	3.7	23.9	5.6
5 / 20-80	67.0	81.3	3.4	17.6	0.0	5 / 20-80	68.1	100.0	0.0	0.0	0.0

(*Continues*)

Exhibit A2: Sustainability Test – All Countries (Cont.)

IWR/S-B	*F*	*U*	*Y*	*D*10	*D*20	IWR/S-B	*F*	*U*	*Y*	*D*10	*D*20
Portugal						*S. Africa*					
3 / 80-20	29.7	56.0	10.5	68.6	41.2	3 / 80-20	0.0	1.1	11.0	100.0	0.0
3 / 60-40	42.9	57.1	10.4	73.1	61.5	3 / 60-40	0.0	1.1	11.0	100.0	0.0
3 / 40-60	49.5	60.4	9.7	63.6	47.3	3 / 40-60	0.0	4.4	10.3	50.0	25.0
3 / 20-80	54.9	74.7	8.2	50.0	30.9	3 / 20-80	2.2	17.6	10.8	56.3	12.5
4 / 80-20	49.5	69.2	7.9	57.1	41.3	4 / 80-20	2.2	15.4	9.4	50.0	14.3
4 / 60-40	52.7	70.3	6.4	50.0	23.4	4 / 60-40	5.5	28.6	9.8	34.6	15.4
4 / 40-60	54.9	81.3	4.8	44.6	21.6	4 / 40-60	15.4	42.9	9.4	28.2	17.9
4 / 20-80	67.0	100.0	0.0	100.0	0.0	4 / 20-80	40.7	64.8	8.8	16.9	11.9
5 / 80-20	57.1	80.2	3.7	50.7	27.4	5 / 80-20	20.9	48.4	8.5	45.5	22.7
5 / 60-40	60.4	100.0	0.0	0.0	0.0	5 / 60-40	29.7	53.8	7.7	38.8	24.5
5 / 40-60	69.2	100.0	0.0	100.0	0.0	5 / 40-60	50.5	63.7	5.9	20.7	8.6
5 / 20-80	78.0	100.0	0.0	100.0	100.0	5 / 20-80	69.2	83.5	2.8	25.0	2.6
Spain						*Sweden*					
3 / 80-20	22.0	33.0	12.1	46.7	20.0	3 / 80-20	7.7	14.3	8.3	46.2	15.4
3 / 60-40	20.9	29.7	11.5	37.0	18.5	3 / 60-40	2.2	13.2	8.8	33.3	8.3
3 / 40-60	22.0	31.9	11.5	51.7	24.1	3 / 40-60	0.0	13.2	8.7	41.7	0.0
3 / 20-80	30.8	40.7	10.5	54.1	16.2	3 / 20-80	3.3	17.6	10.3	31.3	0.0
4 / 80-20	38.5	68.1	7.5	46.8	14.5	4 / 80-20	17.6	28.6	9.6	53.8	30.8
4 / 60-40	40.7	64.8	7.4	42.4	20.3	4 / 60-40	15.4	29.7	10.8	51.9	33.3
4 / 40-60	52.7	67.0	7.2	41.0	14.8	4 / 40-60	15.4	40.7	11.1	43.2	27.0
4 / 20-80	61.5	72.5	6.4	25.8	7.6	4 / 20-80	39.6	67.0	10.9	24.6	11.5
5 / 80-20	70.3	87.9	4.1	37.5	11.3	5 / 80-20	33.0	50.5	7.3	43.5	26.1
5 / 60-40	73.6	89.0	4.4	29.6	7.4	5 / 60-40	40.7	58.2	8.0	30.2	9.4
5 / 40-60	76.9	90.1	3.6	31.7	8.5	5 / 40-60	61.5	73.6	7.7	26.9	6.0
5 / 20-80	75.8	100.0	0.0	0.0	0.0	5 / 20-80	68.1	80.2	4.2	15.1	4.1
Switzerland						*UK*					
3 / 80-20	8.8	24.2	9.6	50.0	22.7	3 / 80-20	0.0	20.9	9.7	68.4	26.3
3 / 60-40	3.3	20.9	10.3	47.4	10.5	3 / 60-40	0.0	24.2	9.8	50.0	27.3
3 / 40-60	1.1	19.8	10.0	72.2	11.1	3 / 40-60	3.3	31.9	8.4	37.9	10.3
3 / 20-80	0.0	20.9	10.3	68.4	21.1	3 / 20-80	22.0	45.1	9.7	48.8	12.2
4 / 80-20	26.4	37.4	7.6	50.0	17.6	4 / 80-20	17.6	41.8	7.9	44.7	23.7
4 / 60-40	24.2	37.4	7.8	73.5	20.6	4 / 60-40	22.0	46.2	7.8	71.4	33.3
4 / 40-60	23.1	38.5	7.4	45.7	8.6	4 / 40-60	30.8	56.0	7.7	54.9	33.3
4 / 20-80	27.5	46.2	7.4	26.2	2.4	4 / 20-80	56.0	70.3	7.5	40.6	12.5
5 / 80-20	41.8	64.8	4.3	25.4	3.4	5 / 80-20	30.8	59.3	5.8	48.1	24.1
5 / 60-40	41.8	65.9	4.2	21.7	0.0	5 / 60-40	40.7	65.9	5.2	38.3	11.7
5 / 40-60	48.4	74.7	4.0	20.6	0.0	5 / 40-60	58.2	75.8	3.3	39.1	14.5
5 / 20-80	68.1	100.0	0.0	0.0	0.0	5 / 20-80	63.7	100.0	0.0	0.0	0.0

Exhibit A3: Sustainable Withdrawals – All Countries

This exhibit shows, for stock-bond (S-B) allocations between 80-20 and 20-80, the average (Avg), minimum (Min), and maximum (Max) sustainable withdrawal given by expression (2), all as defined in the text. All figures in real (inflation-adjusted) units of local currency.

S-B	Avg	Min	Max	S-B	Avg	Min	Max
Australia				*Austria*			
80-20	75.0	40.2	120.0	80-20	59.7	21.3	123.0
60-40	69.2	35.8	107.3	60-40	60.8	22.5	119.5
40-60	63.4	31.3	98.5	40-60	59.3	21.2	120.9
20-80	57.5	26.7	92.4	20-80	54.9	17.0	124.5
Belgium				*Canada*			
80-20	60.0	24.9	115.5	80-20	69.8	44.4	99.1
60-40	56.5	25.2	103.8	60-40	64.9	41.1	90.3
40-60	52.7	24.8	95.3	40-60	60.4	36.6	85.9
20-80	48.4	23.7	88.2	20-80	56.2	30.7	83.4
Denmark				*Finland*			
80-20	63.2	35.4	99.1	80-20	81.6	29.9	201.3
60-40	60.4	32.7	94.1	60-40	73.1	28.7	157.6
40-60	57.2	29.8	89.5	40-60	63.5	26.8	124.5
20-80	53.6	26.6	84.8	20-80	53.0	24.0	100.1
France				*Germany*			
80-20	64.1	23.2	129.5	80-20	72.4	22.0	129.2
60-40	61.8	22.9	120.7	60-40	63.4	21.6	110.8
40-60	58.8	22.2	113.7	40-60	56.2	19.9	103.1
20-80	55.1	20.9	109.6	20-80	50.0	17.5	99.1
Ireland				*Italy*			
80-20	72.1	30.8	130.0	80-20	52.9	18.0	100.0
60-40	67.1	28.9	115.9	60-40	49.3	17.6	90.0
40-60	61.7	26.4	105.5	40-60	45.9	17.0	83.4
20-80	56.1	23.3	96.9	20-80	42.4	16.2	78.8
Japan				*Netherlands*			
80-20	83.5	29.7	182.9	80-20	74.2	35.3	141.0
60-40	72.3	28.9	142.8	60-40	66.5	35.4	113.7
40-60	63.5	26.0	116.9	40-60	59.4	32.3	92.8
20-80	56.4	21.2	106.0	20-80	52.7	28.5	81.3
New Zealand				*Norway*			
80-20	66.8	40.4	105.1	80-20	63.6	29.1	111.0
60-40	63.0	37.5	90.2	60-40	61.9	28.8	102.4
40-60	58.9	34.2	84.7	40-60	59.0	27.9	93.5
20-80	54.4	30.4	78.8	20-80	54.9	25.8	83.8
Portugal				*S. Africa*			
80-20	69.7	23.4	136.9	80-20	78.6	42.1	134.3
60-40	60.2	21.5	107.5	60-40	69.2	39.4	114.6
40-60	50.5	18.7	85.0	40-60	60.4	35.7	97.0
20-80	40.8	15.4	68.2	20-80	52.1	29.3	81.1
Spain				*Sweden*			
80-20	62.5	24.6	113.0	80-20	76.9	38.6	140.7
60-40	57.8	25.4	96.7	60-40	70.4	35.7	119.1
40-60	52.9	25.3	84.1	40-60	64.4	32.4	106.5
20-80	48.0	24.4	74.8	20-80	58.9	29.2	98.9
Switzerland				*UK*			
80-20	62.9	36.1	106.2	80-20	75.2	34.8	123.7
60-40	58.6	35.8	88.9	60-40	68.9	32.4	108.1
40-60	54.4	34.8	76.5	40-60	63.0	29.7	97.8
20-80	50.2	32.9	67.0	20-80	57.4	26.4	92.7

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