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Abstract

An important decision facing retirement savers is how to allocate their savings across different assets. The decision includes the choice of how to divide investments between domestic and foreign holdings. This study uses return data from 1927-2005 to determine whether cross-border investing in the past would have been advantageous to retirement savers in eight large industrialized countries. By assumption investors can buy mutual fund shares in index funds for stocks and bonds in their home country and in any of seven foreign countries. The mutual funds' foreign holdings are not hedged to protect investors against currency fluctuations. The paper's goal is to determine whether workers in the eight countries would have obtained higher expected retirement incomes, with smaller risk of catastrophic investment shortfalls, if they invested part of their retirement savings in foreign stocks and bonds. Consistent with past theoretical and empirical findings, the results show that workers could have improved expected financial performance by investing in foreign as well as domestic equities. Remarkably, retirement savers in nearly all countries would have obtained higher average pensions with a 100% foreign allocation than with a 100% domestic allocation, even if they followed extremely naïve strategies in allocating equity investments across different foreign markets. For retirement savers in most countries, though not the United States, naïve overseas investment strategies would also have reduced the risk of catastrophically poor investment performance. In all countries, retirement savers who selected a global portfolio allocation along the efficient frontier could obtain better average pensions with lower risk of very small pensions than savers who restrict their investments to the domestic stock and bond funds.

1. Introduction

An important decision facing retirement savers is how to allocate their savings across domestic and foreign assets. Savers' investment decisions across broad investment classes, including stocks, bonds, and bills, have been intensively studied, both from a theoretical perspective and using empirical evidence on actual worker choices (see Holden and VanDerhei 2004 and the citations listed therein). It is much less common for analysts to examine the allocation of retirement savings across home-country and foreign holdings. Most economists and financial planners believe investors can obtain better returns with less risk by including overseas assets in their portfolios. They think that with a prudent mix of foreign and domestic holdings, workers should expect higher annual returns or, holding returns constant, smaller fluctuations in the value of their portfolios than would be the case if retirement savings were invested solely in domestic assets. Compared with the allocation predicted by standard portfolio theory, the overall household allocation to overseas investments seems remarkably small (French and Poterba 1991; Lewis 1999). Using estimates derived by three Federal Reserve economists, Campbell and Kräussl (2005) estimate that in 2003 only 14% of Americans' equity investments were foreign stocks (see also Thomas et al. 2004). This is far below the fraction that would be allocated under modern theories of optimal portfolio allocation. One explanation might be that savers are ignorant of the benefits of global investment diversification or have an exaggerated view of the risks associated with foreign holdings.

This study investigates whether cross-border investing would have been advantageous for retirement savers in the past. The analysis is based on empirical evidence on asset returns in a number of countries that have reliable historical time series data on nominal and real returns. The goal is to determine whether workers would obtain higher expected retirement incomes, with smaller risk of catastrophic investment shortfalls, if they invested part of their retirement savings in foreign stocks and bonds. The paper examines the performance of naïve investment strategies as well as investment portfolios on the efficient frontier. None of the investment portfolios are hedged to protect savers against the risk of currency fluctuations. The optimal allocation to foreign assets can differ for workers who are located in different countries. This paper assesses the risks and returns facing retirement savers in eight industrial countries: Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. By assumption, workers expect to retire in their home countries, so they will attempt to maximize the real

consumption they can obtain after foreign investments are converted into their home currencies. The research is a natural extension of earlier analysis of retirement savings strategies of workers in industrial countries who invest their savings solely in domestic stocks and bonds (Burtless 2003b). The paper also extends earlier research on the value to U.S. workers of investing in foreign as well as domestic stocks and bonds (Burtless 2006).

The following sections examine evidence on the likely success of defined-contribution pensions in providing retirement incomes to typical workers. Historical and simulated data on financial market performance are used to evaluate the financial risks facing contributors to a private system based on defined-contribution pension accounts. The paper provides evidence on these risks by considering the hypothetical pensions that workers in eight industrial countries would have received based on financial market performance between 1927 and 2005 if they had accumulated retirement savings under alternative investment strategies. The contributors to individual retirement accounts are assumed to have identical careers and to contribute a fixed percentage of their wages to private investment funds. When contributors reach retirement age, they convert their retirement savings into a level annuity. To make calculations that are comparable across time, across investment portfolios, and across countries, all contributors are assumed to have an identical career path of earnings and to face the same mortality risks after reaching retirement. Contributors differ only with respect to their nationality, the composition of their retirement portfolios, the level and timing of stock and bond purchases and sales, bond yields when they reach retirement, and price inflation. These differences occur because of the differing start and end dates of the workers' careers and because workers invest in different portfolios over the course of their careers.

2. Risk and Return in Defined-Contribution Pension Plans

The goal of a pension system is to replace labor earnings lost as a result of retirement, premature death, or disability. Most national public pension systems are unfunded and provide defined-benefit pensions. In contrast, private retirement programs are typically operated as funded programs. Many critics of unfunded public programs believe that these systems should be scrapped or scaled back in favor of a new retirement system based on funded, defined-contribution pensions. The U.S. employer-sponsored pension system has already seen a major shift toward defined-contribution plans. DC plans now cover two-thirds of the active participants in employer-sponsored plans, and they own more than 50% of the assets held by the

U.S. private pension system (EBRI 2002). Instead of contributing to a collective, pay-as-you-go retirement program, workers in defined-contribution plans build up retirement savings in individually owned and directed private accounts. Workers can withdraw their funds from the accounts when they become disabled or reach retirement age, and their heirs inherit any funds accumulated in the account if the worker dies before becoming disabled or reaching retirement age. At the time a worker starts to collect a pension, some or all of the funds in the worker's account may be converted into an annuity that lasts until the worker dies. In most plans, workers are free to decide how their contributions are invested, at least within broad limits.

This paper focuses on workers' benefits and returns under a pure defined-contribution system. A defined-contribution system allocates risks in a very different way than a collective, defined-benefit system. Under most public pension systems, workers born in the same year who have similar earnings records and have the same number of dependents receive similar retirement benefits. In contrast, workers participating in a private, defined-contribution system directly bear most or all of the risks connected with financial market fluctuations. Workers enrolled in these plans face a number of financial market risks. Two are particularly important. First, workers are exposed to the risk that real asset returns during the years of their pension accumulation will fall short of the historical average return on those assets. If workers obtain unexpectedly low returns on their retirement savings, they may enter old age with little savings to pay for retirement. Second, at the point when workers retire they may find it expensive to buy an annuity. Workers who want to ensure they will not outlive their assets will convert some or all of their retirement savings into an annuity around the time they retire. The market price at which an insurance company will sell annuities depends on several factors. One of the most important is the expected return on assets in which the company can invest its reserves. Workers can pay widely varying prices for annuities over time because of fluctuations in expected returns on insurance company reserves. If interest rates are low when a worker retires, the price of annuities will be high. Even workers with a large retirement nest egg might find it is too small to buy a comfortable annuity.

One way to evaluate the risks just mentioned is to calculate the real investment returns and pensions workers would have obtained if they had contributed to a defined-contribution plan in the past. To calculate returns and pension levels it is necessary to define a standard career path of earnings and pension contributions, calculate the assets that would be accumulated under

a chosen investment strategy, and estimate the real annuity workers could purchase with the assets accumulated at retirement. The calculations that follow are based on assumptions and a methodology I developed in previous papers (Burtless 2003a, 2003b, and 2006). I assume all workers have a full, 40-year career that begins at age 22 and ends at 62. In the absence of economy-wide wage growth, workers are assumed to have a lifetime path of real earnings that matches the age-earnings profile of employed U.S. men in 1995 (U.S. Census Bureau 1996, p. 34). In 1995, the earnings of 22-year-old American males were roughly one-fourth those of 45-year-olds, while earnings of 60-year-olds were 17% less than those of 45-year-olds. The career path of earnings is also affected by the growth of real wages in the wider economy, which for purposes of this exercise is assumed to be 1.5% a year, approximately the growth rate of U.S. real wages since World War II.

These assumptions regarding the career path of earnings mean that the pension estimates do not represent realistic predictions for workers in most countries or in many historical eras. In most countries, including the United States, real wages did not rise smoothly either before or after the Second World War. Japanese and Western European real wages rose faster than 1.5% a year during the early post-war decades, but they fell, sometimes precipitously, in the two decades before 1948. It would be interesting, though beyond the scope of this paper, to consider more realistic age-earnings profiles that reflect the actual course of economy-wide wages in some of the sample countries. This paper focuses on the variation in worker pensions that occurs because of differences in asset class returns and in the timing of returns over the course of a worker's career. For this kind of analysis, it is convenient to assume that all workers have an identical and plausible career path of earnings.

I calculate the value of savings at retirement using two main assumptions. Workers contribute to their pension plans on the first day of each year, and they follow a consistent investment strategy over their careers. In particular, workers are assumed to invest their retirement savings in some desired combination of standard assets – indexed stock and bond funds from a number of industrialized countries – according to a schedule that is determined at the beginning of their careers. In the present paper I assume the portfolio allocation to each asset remains fixed during a worker's career. Many financial planners urge savers to reduce their allocation to risky assets, especially equity funds and foreign investments, as they approach retirement. Some mutual fund companies offer target-retirement-year funds that gradually shift

assets out of equity funds and overseas investments and into bond funds and cash as investors approach the target retirement year. The implications of this kind of investment strategy for U.S. retirement savers are examined in Burtless (2006). In this paper I assume workers allocate a fixed percentage of their savings to each asset included in their portfolio at the start of their careers and then leave this portfolio allocation unchanged for the remainder of their careers. In particular, workers do not reallocate their investments in response to their actual experience of investment returns over the course of their careers.

All stock dividends during the year are reinvested in new stock purchases, and all bond interest payments are reinvested in a standard portfolio of long-term government bonds. If workers invest in a mixture of both stocks and bonds and purchase assets in a variety of countries, they re-balance their portfolios at the end of each year to maintain the preferred allocation of stocks and bonds as well as the desired allocation of assets across different countries. The income flows from assets in the retirement savings account are assumed to be free of individual income taxes at the time they are reinvested.[1]

Trading fees and fund management expenses reduce workers' returns on their investments below the theoretical return attainable in an ideal index fund. Investors or their agents must pay trading fees and commissions when buying and selling financial assets. Management fees are typically higher on funds invested abroad than on funds that are invested domestically. A low-cost U.S. mutual fund company, the Vanguard Group, charges an annual fee of 0.18% on funds invested in its major U.S. stock index fund. Money invested in its main U.S. government bond fund incurs an annual expense charge of 0.26%, and money invested in its developed country equity index fund is assessed 0.29% per year. Vanguard does not offer a mutual fund that invests solely in foreign government bond funds. Among 9 highly rated mutual

[1] This assumption is not realistic in the case of interest and dividend payments on overseas holdings. Many countries tax interest or dividend payments paid on assets held in mutual funds, even before interest and dividends are distributed to mutual fund shareholders. For the fiscal year ending on October 31, 2006, for example, the Vanguard stock index funds for Europe and for the developed Asia-Pacific region paid foreign taxes equal to 4.6% and 4.0%, respectively, of gross dividend income earned by the funds (Vanguard 2006, pp. 24 and 47). If dividend payments produce one-third of the total return on stock market investments, the implied tax withholding rate would reduce the annual gross real return on stocks from, say, 6.5% to about 6.4%. Of course, the contribution of dividends to stock returns varies from year to year. Without knowing the division of total returns between dividends and capital gains or the detailed tax policies of each country, I cannot adjust foreign returns for these taxes. Readers should be aware, however, that the returns on overseas investments reported here will somewhat overstate those returns compared to the returns that can be earned on domestic assets in the same investment class.

funds that specialize in overseas bond investments, the average annual management fee in 2005 was 0.66%. When calculating the net earnings on a worker's investment portfolio, I subtract these fees from gross estimated returns. It is likely my estimates understate the fees that would be paid by investors outside the United States. For example, the Australian subsidiary of Vanguard charges Australian investors 0.75% a year for managing an Australian stock index fund and 0.90% a year for fund expenses in an international stock index fund. The European subsidiary of Vanguard charges European investors 0.50% a year to invest in a Japanese stock index fund and 0.38% a year to invest in a U.S. stock index fund. U.S. retirement savers enjoy an advantage in fund management costs compared with foreign savers, and this advantage is not reflected in the calculations presented below. I assume retirement savers in all countries incur annual fees on domestic stock investments of 0.18% of funds invested. On domestic bond investments, the fee is 0.26%, on foreign stock investments it is 0.29%, and on foreign government bond investments it is 0.66%.

When workers attain age 62, I assume they convert their accumulations into a single-life annuity that is fixed in nominal terms. The annuity seller bases its price on the expected mortality experience of American males who reached age 65 in 1995, using mortality projections of the Social Security Actuary (Board of Trustees, OASDI, 2001). The Actuary's projections take account of gradual improvements in mortality experience that Americans are expected to enjoy over the next several decades. I assume the insurance company does not charge a load factor to cover its profit requirements or possible adverse selection among people applying to buy annuities. Thus, newly retired workers are assumed to purchase fair annuities.

In determining the sales price of an annuity, the insurance company assumes it will be able to invest the worker's funds at the long-term yield on domestic government bonds prevailing when the annuity is purchased. Since the annual annuity payment is fixed in nominal terms in the home-country currency, the insurance company uses the *nominal* domestic bond yield in this calculation. The insurance company does not adjust the nominal value of the annuity from year to year to reflect actual or expected changes in the price level. It would be worthwhile to calculate the value of a price-indexed annuity workers could purchase with their retirement savings. In many countries such annuities are not available, however. Even in countries where it is possible to buy indexed annuities, the historical experience with this kind of asset is too recent for us to calculate the price that would have been charged for a real annuity in

the past. Almost all industrial countries have experienced price inflation in the decades since 1940, so it is important to recognize that the real value of a level nominal annuity is likely to fall over the course of a worker's retirement.

A simple way to measure the success of a worker's investment plan is to estimate the internal real rate of return obtained on the worker's pension contributions, taking account of assumed fund management costs. Ideally, the rate of return would be calculated over the worker's full life, including years after retirement when the retired worker is drawing a pension. In this paper, however, I calculate only the return workers obtain through the accumulation phase of their career, that is, up to the age of retirement. Another way to measure the value of a pension is to calculate the pension replacement rate. The replacement rate is simply the worker's real annuity divided by his or her average real earnings near the end of a career. In this paper I measure final career earnings as the average real wage earned between ages 54 and 58, when lifetime earnings are at their peak. Figure 1 shows replacement rates of hypothetical U.S. workers who retired after 40-year careers that ended on January 1st of the years indicated along the horizontal axis. The workers are assumed to contribute 7% of their wages to the retirement savings account. The dark, upper line shows replacement rates in successive years for workers who invest in a portfolio of U.S. common stocks that earns the same gross return as the Standard and Poor's composite stock index.[2] The middle line shows replacement rates for workers who invest in a portfolio consisting one-half of U.S. equities and one-half of long U.S. government bonds. The bottom line displays replacement rates obtained by workers who invest all of their retirement savings in long-maturity government bonds. Replacement rates are measured at age 62, when workers first retire. For example, the first point along the top line shows the replacement rate of a worker who entered employment in 1927, contributed 7% of annual earnings to a retirement account invested in U.S. common stocks, and converted the retirement savings into a level annuity at the start of 1967.

For the 40 overlapping 40-year careers ending in 1967-2006, the average replacement rate based on a stock portfolio is almost 83%, within the range recommended by financial

[2] Data on consumer price inflation and on total nominal returns for stock and bond investments were obtained from Global Financial Data in April 2006 (www.globalfindata.com). Data on nominal exchange rates, which will be used in the analysis below, were obtained from the same source. Bond returns are measured for investments in government bonds which have a remaining maturity of at least 7 years or, in a few countries (including the United States), a somewhat longer maturity. Global Financial Data supplies financial information to financial planners, pension funds, and investment companies.

planners as an income goal in retirement. However, the standard deviation of replacement rates is 26%, implying that the range of income replacement provided by a portfolio that consists solely of U.S. stock market investments is quite large. A worker who receives the ninth decile replacement rate would receive a pension that initially replaces 119% of peak earnings, whereas a worker who receives the first decile replacement rate would collect a pension that replaces about half of this amount, or just 61% of peak earnings. The range of replacement rates is reduced if workers steadily invest a higher percentage of their retirement savings in U.S. government bonds. This strategy reduces the standard deviation of the replacement rate, but it also substantially cuts the expected pension. For example, with a 50-50 allocation to stocks and bonds the first decile replacement rate falls to just 34%. If the goal of a conservative investment strategy is to protect workers' pensions in very poor financial markets, the strategy of investing steadily in long government bonds offers poor protection against the risk of obtaining a small pension.

3. Investing Abroad

Investing in foreign assets as well as in home-country stocks and bonds can improve a worker's chances of earning a target rate of return. Depending on the risk and return characteristics of the overseas assets that are available to retirement savers, workers should be able to achieve a given rate of return with less risk than is possible when the retirement portfolio consists solely of domestic assets (Lewis 1999). In this section I evaluate alternative international investment strategies using historical annual return data covering the period from 1927 through 2005. Measured in U.S. dollars, the current market capitalization of companies traded in the stock markets of the eight countries covered by this study represents about 85% of total world stock market capitalization (http://www.djindexes.com/mdsidx/).

Risks and returns of domestic and foreign assets. Tables 1 and 2 show average returns and the standard deviation of returns on stock and bond investments in eight countries over the 1927-2005 period. The top panel in each table shows geometric mean returns, the middle panel shows average arithmetic returns, and the bottom panel shows the standard deviation of returns. Returns can be measured from the perspective of investors in each of the eight countries. The average return and standard deviation of returns obtained by investors on home-country investments are indicated in bold text. The other entries in the table are average returns or standard deviations for investors' holdings in overseas markets. After subtracting assumed fund

management costs, Australian investors obtained a geometric mean annual return of 7.3% on Australian stocks. Because of exchange rate movements, differences in Australian and Canadian price inflation, and differences in the assumed management costs of holding domestic and overseas securities, Canadian investors obtained 7.0% annual returns on their Australian stock market investments. This is slightly below the real return obtained by Australian investors who held the same asset (see Table 1).

From the point of view of a retirement saver, the relevant return is the real return measured in constant home country prices, for this is the return that determines how much retirement consumption can ultimately be financed out of money that is converted into foreign currency units and invested overseas. Unless exchange rates are fixed or overseas investments are hedged for currency risk, the gross real returns obtained by U.S. savers on investments in the Japanese stock market differ from those obtained by Japanese investors. The difference in gross returns is the result of fluctuations in the real U.S.-Japanese exchange rate, which in turn are determined by nominal exchange rate movements and changes in the price level in both Japan and the United States. Net returns for investors in the two countries will differ because the assumed fund management costs are lower for domestic than for overseas investments. From the point of view of home-country investors, the domestic stock market has offered the best geometric stock market return in Australia followed by the United States, Canada, the United Kingdom, France, Germany, and Japan. The poorest home-country stock return was obtained by Italian investors. When average returns are measured by the geometric mean, investors in all eight countries obtained the highest average return on their stock investments in Australia, followed by equity holdings in the United States, Canada, the United Kingdom, France, Italy, and Japan. German stock investments provided the lowest geometric mean return to investors in all eight countries, including German investors.

Table 1 shows sizable differences in real stock returns across countries. After subtracting fund management expenses, one dollar invested in the Australian stock market in January 1927 would have yielded about $253 to an Australian investor who survived to January 2006, whereas one lira invested in the Italian stock market in 1927 would have produced only 9.1 lira for an Italian investor in 2006. Investors in all countries have experienced periods in which equity returns were persistently above- or below-average. The persistence of equity returns is especially notable in Japan. Japanese investors enjoyed an extraordinary 15% annualized rate of

return on Japanese equities held between 1948 and 1989, but this outstanding performance was counterbalanced by negative 10% annual returns between 1927 and 1947 and negative 3% returns after 1989. Table 2 shows that Japanese investors also obtained very poor long-term returns on their bond investments, though real returns improved substantially after the mid-1970s. Investors in the four English-speaking countries earned the highest returns on their home-country bond investments, primarily because their governments have not defaulted on the public debt as a result of high inflation or major currency reform. Much of the variability in French, German, Italian, and Japanese bond returns can be traced to high inflation and currency reform in the immediate post-war period, when outstanding government bonds lost most of their value.

Tables 1 and 2 show evidence of a substantial equity premium in all eight countries. People who invested in home-country stocks obtained much higher returns than people who invested in home-country bonds. The equity premium ranged from a low of about 3 percentage points in Canada to a high of about 6 percentage points in Japan. Note that investors obtain the same equity premium on their investments in a foreign country as the premium received by investors in that same foreign country. Home-country bond returns have a smaller standard deviation than home-country stock market returns from the perspective of investors in all eight countries. Exchange-rate fluctuations magnify the standard deviations of overseas returns. Exchange-rate variability means that returns obtained on overseas bond investments often have a higher standard deviation than home-country stock market returns. From the perspective of U.S. investors, for example, the standard deviation on investments in French, German, Italian, or Japanese government bonds is greater than that on stock market investments in the United States. For many investors, the combination of low expected returns and high risk will make overseas bond investments unattractive.

Simple allocation strategies. If workers decide to invest some of their retirement savings in overseas assets, they must choose how to allocate their savings across foreign stocks and bonds and across holdings in seven foreign countries. A simple solution to this problem is to hold equal amounts of stocks or bonds in each of the seven foreign countries. The saver would then make two additional decisions: What proportion of total assets should be invested overseas? And what proportion should be allocated to stocks as opposed to bonds? This simple

solution to the asset allocation problem may be far from optimal, but the results highlight some of the advantages of investing retirement savings overseas.

A more sophisticated approach to allocating overseas holdings is to divide foreign investments in proportion to each country's GDP or to the relative size of each overseas stock and bond market. The paucity of historical data on foreign GDP and stock and bond market capitalization makes it difficult to simulate the long-term performance of these allocation strategies. It is possible, however, to track the performance of simple approximations of these strategies. A rough gauge of the size of industrial economies and national financial markets is their relative size in recent decades. To obtain information on relative GDP, I used IMF estimates of GDP measured in current prices and converted to U.S. dollars for years between 1980 and 2005 (http://www.imf.org/ external/pubs/ft/ weo/2006/01/data/dbcsubm.cfm). In that period the United States was the largest economy (43% of total GDP in the eight countries), followed by Japan (20%), Germany (10%), France (8%), the United Kingdom (7%), Italy (6%), Canada (4%), and Australia (2%). A similar procedure is followed to calculate the relative size of national financial markets. Using information on national stock market capitalization supplied by Dow Jones indexes (www.djindexes.com/mdsidx/), I calculated the relative size of each national stock market over the period from 1992-2005. On average, the most important stock market was that of the United States, which accounted for 56% of total stock market capitalization in the eight countries. In descending order of capitalization rank, the other countries were Japan (19%), the United Kingdom (11%), France (4%), Germany (4%), Canada (3%), Italy (2%), and Australia (2%).[3]

If workers decide to allocate some of their retirement savings to foreign investments, I initially assume they use one of three simple weighting schemes to determine what percentage of their foreign holdings will be allocated to each of the seven foreign countries: (a) equal country weights; (b) average GDP weights; or (c) the stock-market-capitalization weights described above. After making a decision on how to allocate their investments across the seven foreign

[3] These weightings differ somewhat from estimates by Global Financial Data covering a longer span of years. Global Financial Data's estimates cover a period that extends back to 1979 but ends in 2002. A notable difference between the two sets of estimates is the larger weighting of Japanese stocks and smaller weighting of U.K. stocks in a period that includes the boom in Japanese stock market prices during the 1980s. In 1987 Japanese equities were worth more than U.S. equities, and the market value of Japanese equities accounted for 46% of the value of all equity holdings in the eight sample countries. Unfortunately, I lack data on several countries' stock market capitalization in the years before 1979.

countries, workers make a separate choice of how to divide their assets between foreign and domestic investments. The share of the portfolio allocated to domestic assets may thus differ from the share implied by the weighting scheme that is used to allocate foreign asset holdings. An Australian worker with a home bias will allocate more than 2% of his portfolio to domestic (Australian) assets, even though he uses a GDP weighting scheme to allocate his foreign asset holdings to investments in the other seven countries. Workers must also decide how to divide their investments between stocks and bonds. Whatever their preferred allocation weights, I assume workers rebalance their foreign and domestic and stock and bond holdings at the beginning of every year to maintain their preferred portfolio allocations. With currently available information, I am not able to simulate the effects of annually changing the country weights to reflect new GDP weights or new financial market capitalization weights on the first trading day of a year.

Success of simple allocation strategies. My data on stock and bond returns, exchange rates, and inflation cover the period from 1927 through 2005. The observation period contains a total of 79 years, so it is straightforward to predict the pensions of 40 workers, namely, those who start their working careers at the beginning of successive years from 1927 to 1966 and begin their retirements between 1967 and 2006. Figure 2 shows the real internal rate of return that workers in the eight countries would have obtained if they had invested all their pension contributions in stock index funds. Workers are assumed to retire on December 31st and to start drawing pensions on January 1st of the following year, and returns are calculated for workers who begin their retirements between 1967 and 2006. Returns for each worker are calculated under two different investment strategies. The solid dark line shows returns on the worker's savings portfolio when all contributions are invested in domestic stocks. The lighter, broken line shows returns when all contributions are invested in foreign stocks and the portfolio contains an equal allocation to the stocks of each of the seven foreign countries.[4]

Dividing all overseas investments equally among countries represents a very naïve investment strategy. Except for Japanese savers, however, this strategy yields a portfolio that usually outperforms a 100% domestic stock portfolio. In the case of retirement savers in Canada

[4] I performed the same kind of calculations for workers who allocated part or all of their retirement savings in domestic and foreign bonds. These calculations are less interesting than the ones shown in Figure 2 because in almost all cases the strategy of allocating 100% of savings to domestic and/or foreign stocks dominates the strategy of investing part or all of savings in domestic or foreign bonds.

and Italy, the rate of return on pension contributions was higher on overseas investments than on domestic stock investments for all 40 workers retiring between 1967 and 2006. Workers in Australia, France, Germany, the United Kingdom, and the United States would usually also have fared better if they had invested abroad rather than in their home-country stock market. In contrast, Japanese workers who retired between 1972 and 1997 would have received much lower returns from an overseas investment portfolio compared with a portfolio consisting solely of Japanese stocks. Two factors contributed to the relatively poor performance of the overseas investment strategy. First, Japanese equity returns were exceptionally high over much of the period between 1948 and 1989, and they often outpaced equity returns in the other industrial countries. Second, the real Japanese exchange rate strengthened in many years of this period, reducing Japanese investors' returns on their overseas holdings.

An advantage of the overseas investment strategy is that the saver's portfolio contains a large number of assets whose returns move somewhat independently of one another. It is notable that the lowest returns displayed in Figure 2 are returns on portfolios that are invested solely in one asset type, domestic equities, rather than in multiple assets. French, Italian, and U.K. retirement savers who retired in selected years obtained zero or negative returns on their pension contributions, but in every case the low returns were obtained on a portfolio consisting solely of domestic stocks. Workers who invested 100% of their savings in foreign equities would never have obtained a real return below 2%.

Table 3 shows real returns earned on four stock portfolios for retirement savers who enter retirement at the beginning of successive years between 1967 and 2006. The first portfolio (column 1) consists of an index fund of the saver's home-country stock market. The other three portfolios are invested exclusively in foreign equities. The second portfolio (column 2) is divided equally among stock index funds of the seven foreign countries. The third and fourth portfolios are invested with country investment weights determined by foreign countries' GDP weights and stock market capitalization weights, respectively. The calculations are performed from the perspective of savers in each of the indicated countries, and returns are calculated in two ways. The top row of returns for each country shows geometric mean real returns for alternative portfolios over the full period from 1927 through 2005. No individual retirement saver would necessarily obtain these returns, however, because each saver contributes to a retirement savings plan for only 40 years rather than all 79 years. The second row of results for

each country shows the arithmetic average of the internal rates of return actually obtained by the 40 workers who retired between 1967 and 2006. The calculations show that, with one exception, average returns on the three foreign stock portfolios are always higher than the returns on a portfolio of home-country stocks.

The lone exception to this pattern are Japanese retirement savers who began collecting pensions between 1967 and 2006. These savers on average would have obtained higher returns on a domestic stock portfolio than on any of the foreign stock portfolios considered in the table. This result may seem surprising in light of the geometric mean return on the domestic stock portfolio compared with the three foreign stock portfolios during the 79 years starting in 1927. The foreign stock portfolios substantially outperformed the Japanese domestic portfolio over that period. The 79-year geometric return on an investment made on January 1, 1927, was 3.6% for domestic Japanese equities but 7.3% for a foreign portfolio divided equally among the seven other countries. The apparent discrepancy is caused by the timing of strong relative stock market performance in Japan compared with the other seven countries. For most of the workers who retired between 1967 and 2006, Japanese stock returns were exceptionally strong during the middle and later parts of their careers. Extremely low Japanese stock market returns during the 20 years before 1928 had comparatively small effects on the lifetime returns of workers who retired between 1967 and 1986 because most of their lifetime pension contributions were made in 1948 and later years, when Japanese stock returns were exceptionally high. For workers who retired in 1987 and later years, of course, poor returns before 1948 would have no effect on their pensions, because none of their contributions were made before 1948.

The impacts of low returns late in a worker's career are displayed in Figure 3. The assumption behind the calculations is that the geometric rate of return on financial assets during the worker's 40-year career is 7.0%. If the return were exactly 7.0% in each year of the worker's career, the internal rate of return on the worker's pension contributions would also be 7.0%. Suppose, however, that returns are 9.1% in 39 years of the career and -50% in exactly one year. The geometric mean return over the full career is still 7.0%. However, the worker's return on his contributions will depend crucially on which year is affected by very low returns. If the year of low returns occurs in the first working year, the return on lifetime contributions would be very close to 9.1%, because only a small percentage of total contributions is affected by that year of poor returns. On the other hand, if the low return occurs in the last year of a career, all of a

worker's lifetime contributions will be affected by the low return, and the internal rate of return on contributions will fall to 5.6%. The solid dark line shows how the worker's return declines as the year of poor investment returns occurs in successively later years of the career. Bear in mind that in each case the geometric mean return of annual investment returns is 7.0%. The worker, however, will not realize this rate of return on his own pension contributions because of the time pattern of contributions over the career.

A second line in the figure shows how the internal rate of return on a worker's contributions affects the pension replacement rate he obtains upon retirement. To calculate the pension, I assume the safe rate of return is always 5.0%, and this is the interest rate used by insurance companies to determine the price of an annuity. If the year of poor investment returns occurs in the first year of the worker's career, the retirement annuity will replace 114% of the worker's peak career earnings. If the year of poor returns occurs in the last year of a career, the annuity will replace just 53% of peak earnings. The replacement rate can thus fall by more than half depending on the exact timing of the year of poor returns.

The calculations displayed in Figure 3 help account for an apparent puzzle in Table 3. Japanese retirees between 1967 and 2005 usually obtained higher returns on their contributions when they invested all their retirement savings in Japanese stocks rather than foreign stocks, even though the mean return on foreign equities was higher than the mean return on Japanese equities over the full 79-year period in which workers were assumed to make contributions. The very poor stock returns that Japanese investors obtained in the 20 years before 1948 were returns that occurred early in simulated workers' careers, however. If those returns had occurred late in workers' careers, their impact on Japanese pensions would have been much more important. It is possible to create a sequence of annual returns so that each of the 79 observations of annual return is equally likely to occur in each year of a career – at the beginning, in the middle, and at the end. I have used this simulation procedure to calculate expected returns and the distribution of returns on workers' pension contributions over full careers.[5]

[5] In essence, observations are created or predicted for the years 2006-2044 based on the observed sequence of returns for 1927-1966. Each annual observation of market returns between 1927-2005 is thus used exactly 40 times, once to reflect returns in the first year of a worker's career, once to reflect returns in the second year, and so on up through the last year of a 40-year career. An alternative approach is to predict returns and pension accumulations using Monte Carlo simulation, though this would require the specification of the full time series correlation structure of stock and bond returns and exchange rate movements. That task is far beyond the scope of this paper.

Simulated pensions. Table 4 displays statistics on the simulated distribution of pension replacement rates for workers who contribute 7 percent of their annual earnings to a pension plan and follow six alternative investment strategies. Bear in mind that these results are based on return data covering 1927-2005, but they reflect the hypothetical pensions of many more workers than the 40 who retired between 1967 and 2006. The first three strategies allocate all retirement savings to stocks or bonds in the worker's home market. Three domestic allocations are considered: 100% bonds (column 1), 50% stocks and 50% bonds (column 2), and 100% home-country stocks. The next three strategies allocate all retirement savings to foreign stock holdings. Stock holdings are allocated across foreign countries using three simple strategies: equal country weights (column 4), foreign countries' GDP weights (column 5), and foreign countries' stock market capitalization weights (column 6).[6] For retirement savers in each country, the table shows estimates of the average replacement rate, the median replacement rate, and the 10^{th} percentile and 5^{th} percentile replacement rates. For workers who are concerned about how low their pensions might fall under unfavorable financial market conditions, the 10^{th}- and 5^{th}-percentile replacement rates are particularly important.

The risks and rewards of alternative domestic saving strategies were first displayed in Figure 1, which showed pension replacement rates for U.S. workers who placed their retirement savings in 100% bond, 100% stock, and 50% stock / 50% bond investment portfolios and retired between 1967 and 2005. U.S. retirement savers were clearly better off investing in stocks rather than in bonds if they maintained a fixed stock-bond portfolio over their careers. Table 4 shows that retirement savers in all eight countries obtain higher pensions when they invest a larger proportion of their savings in domestic stocks and a smaller proportion in domestic bonds. The out-performance of stocks over bonds is also apparent at the 5^{th} and 10^{th} percentiles of the replacement rate distribution. This implies that workers who wish to maintain a fixed portfolio allocation over their careers are better off investing all their savings in domestic stocks and none in home-country bonds.

The more interesting results in Table 4 compare pensions when all savings are invested abroad rather than in the domestic market. For all eight countries, including Japan, retirement savers are predicted to obtain higher average and median pensions if they invest in foreign

[6] As noted above, I also evaluated simple allocation strategies that included investments in foreign bonds. Since these allocation strategies were always dominated by 100% foreign stock allocations,

equities rather than in domestic stocks or bonds. This is true regardless of the allocation strategy used to distribute investments across different foreign stock markets. The simulations also suggest that the improvement in average and median pensions does not require a major sacrifice in pensions when financial market conditions are unfavorable. For retirement savers in Europe and Japan, the 5th percentile and 10th percentile pensions are actually higher under a 100% foreign investment strategy than when all savings are held either in domestic stocks or bonds. Except in the case of British savers, the improvement in 5th- and 10th-percentile pensions offers a powerful argument for investing abroad rather than domestically. If workers in these countries invest in the equity markets of several countries rather than just one, they are much less likely to suffer ruin because of severe slump in one market. Retirement savers in Australia, Canada, and the United States have little reason to invest abroad if a principal goal of their investment strategy is to avoid very small pensions. Investing in the domestic stock market offers retirement savers in these countries equal or better protection compared with following a naïve foreign investment strategy. Nonetheless, savers in these countries would have obtained higher average pensions if they invested in equities abroad rather than in their home markets.

On average workers who allocate their equity investments to foreign holdings do better than workers who hold all their savings in domestic equities. The eight-country average replacement rate for workers who invest solely in home-country equities is 70%. The average for workers who allocate all their savings to foreign equity holdings divided equally across seven foreign countries is 135%. Workers who invest in foreign equities in proportion to each country's GDP weight also obtain an average replacement rate of 135%, while those who invest in proportion to a country's stock market capitalization weight obtain an average replacement rate of 142%, more than twice the average rate obtainable under a 100%-domestic-equities strategy. For retirement savers in five of the eight countries, the higher average replacement rate does not increase the risk of receiving a very small pension. In fact, this risk is substantially reduced in half the countries.

Table 5 provides additional evidence about the value of foreign stock holdings for retirement savers who choose to hold only equities in their investment portfolios. I assume that workers follow one of three simple allocation strategies for dividing their foreign stocks across the seven foreign countries. In the first column, for example, foreign equity holdings are divided

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however, the results are not reported here.

equally across the seven foreign countries. A grid search is used to find the proportion of foreign stocks that maximizes each indicator of pension replacement rates for workers domiciled in each of the eight countries. The maximum pension replacement rates associated with a particular foreign allocation strategy are indicated in the three columns on the left. The fractions of the savers' portfolios that are invested in foreign equities under the indicated strategy are displayed in one of the three columns on the right. For example, an Australian saver who follows an equal-country-weighting strategy for his foreign stocks and who wants to maximize his simulated *average* replacement rate will invest about 85% of his portfolio in foreign stocks. On average, this portfolio will produce an estimated average replacement rate of 111% of the worker's final career wage. If the same investor instead wanted to maximize the *10^{th}-percentile* replacement rate, he would allocate 50% of his savings to his foreign stock holdings, and his estimated 10^{th}-percentile replacement rate would replace 77% of his final career wage. The results in Table 5 indicate that workers who follow simple overseas investment strategies and who want to maximize their predicted average pensions will always invest all or nearly all of their equity holdings in foreign stocks. Only a relatively small proportion of savings will be held in the domestic stock index fund. This conclusion is not sensitive to the weighting scheme a worker uses to allocate his foreign equity holdings across different foreign countries. Workers who are more interested in obtaining the maximum possible 5^{th}- or 10^{th}-percentile pension will usually allocate a smaller fraction of their equity portfolios to foreign stocks. Note that regardless of the saver's country of residence or investment goal, however, foreign equity holdings are always included in the preferred portfolio.

The evidence in Tables 4 and 5 is impressive. Retirement savers in all eight countries can obtain better expected average returns if they allocate some or all of their savings to overseas equity investments. However, under naïve investing strategies workers in three of the countries face a greater risk of experiencing investment shortfalls when all their retirement savings is invested in foreign stocks rather than in a portfolio of home-country stocks. For retirement savers in Australia, Canada, and the United States, this may help account for the relatively modest share of overseas investments in most households' portfolios (French and Poterba 1991; Lewis 1999; Campbell and Kräussl 2005). In the other five countries, very poor lifetime returns are more likely to occur when the worker holds a portfolio consisting solely of domestic assets. The risk of obtaining a very small pension is reduced when the worker holds a portfolio invested

solely in foreign equities. The implications of Tables 4 and 5 are plain. Workers in Europe and Japan should invest a substantial portion of their retirement equity holdings in foreign markets, even if their principal goal in choosing an investment strategy is to reduce the probability of a very small pension. Workers in all eight countries should invest heavily in foreign assets if they wish to improve their average or median pensions.

4. The Success of Efficient Portfolios

A large theoretical and empirical research literature has grown up around the issue of optimal portfolio allocation. The classical literature on asset allocation deals mainly with the problem of portfolio design when investors are making a single-period allocation and have good information on the expected returns and the variance and covariance of returns for potential assets that can be included in their portfolios (Markowitz 1952; Sharpe 1964). The retirement saver's investment problem is more complicated, because it requires investors to decide on a portfolio allocation strategy that will extend across forty or more years. At the same time, it is not obvious whether the historical data on nominal and real returns provide a reliable guide to estimating either the expected returns or the variance-covariance structure of returns of different international assets. As noted above, all investors who purchased and held Japanese stocks and bonds obtained abysmal returns on these investments between 1927 and 1948, but returns since the late 1940s have been much better. In calculating a saver's optimal portfolio allocation, it might seem reasonable to disregard all return data from 1948 and earlier years. On the other hand, if there is mean reversion in stock market prices, part of the return earned on Japanese equities after 1948 may simply reflect mean-reverting stock-price gains, and these should be discounted when translating 1949-2005 historical returns into an estimate of expected future returns.

A straightforward solution to the one-period allocation problem, as noted by Canner et al. (1997) and other economists, is for savers to hold just two assets: a safe asset, such as Treasury bills, and a single mutual fund which in turn holds all risky assets in proportion to their observed market weights. Risk averse investors should allocate more of their portfolios to the safe asset; risk-tolerant investors should allocate more of their portfolios to the risky mutual fund. However, investment firms do not offer a mutual fund that includes all marketable risky assets in the world or even a fund that includes all the risky assets available in a single country.

Efficient portfolios. Rather than try to calculate the historical returns of such a fund, I instead calculate the returns on diversified international portfolios that are located on the efficient frontier. An efficient portfolio represents an allocation across risky assets that offers investors the highest return for a given level of risk or, equivalently, offers the lowest risk for a given level of expected return. Markowitz (1952) first described the efficient frontier as the set of efficient portfolios. Using 1927-2005 information on the annual real returns of the eight countries' stock and bond fund indexes, I used standard optimization techniques to find efficient portfolios that offered a variety of levels of risk and expected return. In principle, the portfolio of any single investor may contain up to 16 assets, a stock and a bond index fund for the home country, up to seven equity index funds for seven foreign countries, and up to seven government bond index funds for the foreign countries. I assume that the allocation to any single asset will be no less than zero and no more than 100% of the total portfolio. That is, investors do not hold short positions in any of the assets. The calculations were performed from the perspective of investors in each of the eight countries.

Figure 4 shows the locations of the efficient frontier from the perspective of investors in different countries. The expected (arithmetic) return of each efficient portfolio is indicated on the vertical axis, and the standard deviation of returns is indicated on the horizontal axis. (The expected geometric returns will be lower.) Each panel in the figure shows four lines, with one line corresponding to the efficient frontier as viewed by investors in a particular country. Investors in the four English-speaking countries clearly had access to investment options that offered returns with smaller year-to-year variability over the 1927-2005 period. French, German, Italian, and Japanese investors could also obtain high returns, but only by exposing themselves to substantial risk of major financial loss.[7]

For investors in each country, I selected three efficient portfolios located at three positions along the efficient frontier. The portfolios were selected to reflect three levels of risk. The low-risk portfolio had a standard deviation of either 0.12 or the lowest standard deviation

[7] If return data for years before 1950 were excluded from the calculations, the efficient frontiers of investors in the eight countries would look more similar. The correspondence across countries is even stronger if we only include data for the most recent three decades. The closer correspondence of the risk-return tradeoff facing investors in different countries is presumably the result of increasing globalization. In particular, the trend almost certainly reflects the effects of declining barriers to cross-border capital flows.

included along the country's efficient frontier. The moderate-risk portfolio had a standard deviation of 0.16, and the portfolio with the highest risk had a standard deviation of 0.20.[8]

Table 6 shows the asset allocations in the efficient portfolios for investors in each of the eight countries. The top panel of the table shows asset holdings in the efficient portfolios which have the lowest risk. Each row of the table shows the portfolio allocation that would be chosen by an investor in the indicated country. For example, an Australian retirement saver holding the low-risk portfolio would hold 27% of total assets in Australian stocks and 13% of assets in Australian bonds. The other 60% of this investor's assets would be held in foreign stocks and bonds. The total allocation to stocks is 69%, with more than half of equity holdings invested in overseas markets. The low-risk efficient portfolios held by Australian, Canadian, U.K., and U.S. retirement savers place at least 60% of savings in equities and at least 50% in foreign stocks and bonds. In contrast, the investors holding the efficient low-risk portfolio in France, Germany, Italy, and Japan hold higher percentages of their savings as bonds. The French, German, and Japanese investors also allocate less of their savings to foreign holdings than investors in the English-speaking countries.

Not surprisingly, when investors move from the less risky to the riskier efficient portfolios, their allocations to equity holdings increase (see the middle and bottom panels in Table 6). Investors in the English-speaking countries who are willing to accept greater risk hold all or almost all of their savings in equity funds. The shift to a riskier portfolio also increases the proportion of assets that is invested abroad. Savers who hold foreign equities in their efficient portfolios typically favor equities in Australia, Japan, and the United States. They make smaller allocations to the stock funds of France and Germany. Canadian, Italian, and U.K. stock index funds are much less likely to be included in the efficient portfolio. Most investors who hold bonds in their efficient portfolios favor home-country bonds over foreign bonds. This is hardly surprising. By assumption, international investments in these portfolios are not hedged against the risk of currency fluctuations.[9] Exchange rate movements increase the standard deviation of

[8] I had to modify these constraints for Japanese investors, because the lowest standard deviation along Japan's efficient frontier is almost 0.16. I instead selected three efficient portfolios for Japan with standard deviations of 0.16, 0.18, and 0.20, corresponding to low, moderate, and comparatively high levels of investment risk.

[9] It would be useful to extend the analysis to include foreign assets that are hedged for currency risk. Calculating the fund management cost of such a strategy is well beyond the scope of this paper, however. Currency hedging should improve the attractiveness of holding foreign bonds in a portfolio, but it is not

annual returns on foreign assets, boosting the risks on foreign bonds in comparison with home-country bonds. Since the expected returns on bonds are modest, the home-country bond fund will usually appear more attractive to investors seeking lower risk investment options.

Investment outcomes. The success of the efficient portfolios in producing good retirement pensions is indicated in Table 7. The three right-hand columns show estimates of the predicted average, median, 10th percentile, and 5th percentile pension replacement rates that savers in each country obtain if they allocate their retirement savings to the portfolios shown in Table 6. For convenience, the two left-hand columns in Table 7 show the same distributional statistics for portfolio allocations described in the previous section. The first of these alternatives is 100% investment in a domestic stock index fund; the second, 100% foreign equity holdings with an equal allocation to the stocks of each foreign country. The latter represents a very naïve investment strategy but, as we have seen, it usually outperforms simple investment strategies in which foreign assets are excluded.

For retirement savers in each country, the low-risk, efficient portfolio produces better 10th percentile and 5th percentile pensions than the strategy of investing all savings in domestic equities (or in any fixed combination of domestic stocks and bonds). For investors in Australia, Canada, the United Kingdom, and the United States, the low-risk global portfolio also produces substantially better average pensions. For investors in these four countries, the globally diversified low-risk portfolio clearly dominates the strategy of investing all retirement savings in home country stocks and bonds. The gains are less clear for investors in France, Germany, Italy, and Japan. Although their worst-case pensions are better with a low-risk, globally diversified portfolio, their predicted average pensions are at least as high and usually higher if they invest all their savings in the domestic equity fund. Predicted average pensions are much higher for retirement savers who choose either the moderate risk or higher risk efficient portfolios. In addition, the 10th percentile and 5th percentile pensions are also higher under these allocation strategies than they are when investors choose the low-risk efficient portfolio. From the viewpoint of managing risk over a 40-year investment horizon, the moderate- and high-risk

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clear whether simple hedging strategies produce a consistent improvement in the performance of internationally diversified equity portfolios (see Glen and Jorion 1993; Abken and Shrikhande 1997). Campbell et al. (2006) propose sophisticated strategies for hedging currency risk in a global equity portfolio. As a practical matter, however, the great majority of international equity mutual funds do not hedge a large proportion of the currency risks in their portfolio.

efficient portfolios actually pose less risk of a catastrophic investment shortfall compared with the low-risk portfolio examined here. Note that the higher risk portfolios contain more equities and more foreign assets than the less risky portfolio. The evidence in Table 7 clearly suggests that, compared with investment strategies that focus solely on accumulation of domestic assets, investment plans with heavy weights on overseas equities can produce higher average pensions and better protection against extremely low pension payouts.

The efficient global portfolios in Table 6 were constructed under the assumption that the historical data on real returns between 1927 and 2005 provide accurate indicators of the expected returns and the variance-covariance structure of returns on asset holdings in different countries. The assumption is unlikely to be true. The covariance structure of international real returns is probably unstable, and the expectation of future asset returns might differ from average values in the more distant past. By using more recent return data to construct efficient portfolios, the predicted allocations to different foreign assets will vary. Appendix Tables A1 and A2 show efficient portfolios estimated using return data from the more recent past. Compared to the allocations shown in Table 6, these portfolios include a much heavier weight on U.K. equity investments. When all return data before 1975 are excluded in the construction of efficient portfolios, the allocation to Japanese stocks falls dramatically. This is not surprising, since Japanese equity returns have badly lagged returns in other industrial countries since the early 1990s. What is more interesting about these results is that the efficient portfolios always contain heavy allocations to foreign assets for investors in all eight countries, regardless of the analysis period used to construct efficient portfolios. While we have no way to know whether these results offer a reliable guide to future asset allocation, it is impressive that the efficient portfolios for all analysis periods, all risk profiles, and workers in all countries include major allocations to overseas assets.

5. Discussion

The analysis in this paper provides an indication of the potential gains workers can achieve from portfolio diversification that includes overseas stocks and bonds. Many previous analyses show that the inclusion of foreign holdings in a portfolio should increase investors' expected returns holding constant their investment risks. The results in this paper show that this finding also holds for retirement savers, who have a very long planning horizon and who make periodic additions to their pension accounts over lengthy careers. Workers can substantially

increase their expected pensions if they include foreign equities in their savings portfolios. Even under extremely naïve investing strategies, increasing workers' allocation to overseas assets will usually increase their expected pensions without raising the risk of catastrophically poor investment performance. For savers in many countries, though not Australia, Canada, or the United States, workers who followed naïve allocation strategies and invested *all* of their retirement savings in foreign equities could have substantially reduced their likelihood of obtaining a very poor pension. The rather exceptional position of retirement savers in Australia, Canada, and the U.S. is explained by the relative stability of their economies and financial markets over the past century. Like savers in the other industrial countries, they could increase their expected pensions by including foreign assets in their portfolios. But unlike savers in the other countries, it is unclear whether they can improve their worst-case pensions by following a naïve overseas investment strategy. Equity returns in their home markets were high enough so that a naïve overseas investment strategy might produce a worse outcome than the strategy of investing all savings in a domestic stock index fund.

Using standard optimization methods, it is possible to devise internationally diversified allocations that offer workers some protection against ruinous investment performance. A number of these portfolios offer workers in all eight countries better expected returns with lower risks than portfolios consisting only of domestic stocks and bonds. The exact portfolios described in the paper should be treated with caution, however. The efficient portfolios were selected based on knowledge about actual returns and the variance and covariance of returns over the simulation period. It is not obvious that these indicators of past financial market performance will provide a reliable guide to future performance. It is nonetheless striking that all of the efficient portfolios include a substantial allocation to foreign equities. This is true regardless of the worker's nationality and the span of years used to estimate efficient portfolios.

Even though workers on average can obtain good pensions under a defined-contribution system, this kind of pension generates wide variability in outcomes. Workers who follow an identical investment strategy can receive very unequal pensions depending on the exact years when they begin and end their careers. Although workers can increase their expected pensions by allocating part of their savings to foreign equities, it is not obvious from this analysis whether workers will perceive that their future pensions are less risky or more secure. Assuming U.S. workers deposit 7% of their annual pay into a retirement account that is invested in an "optimal"

and moderate-risk portfolio of foreign and domestic equities and bonds, recent experience suggests their initial pensions could range from a high of 116% of their peak career earnings down to just 53% of peak earnings. These are the actual replacement rates 62-year-old American workers would have obtained in 2000 and 2003 if their careers and contribution patterns matched the assumptions of this paper and their investment allocation matched the moderate-risk global portfolio shown in Table 6. To be sure, this startling difference between the replacement rates of workers retiring three years apart is smaller than the difference that would have occurred if both workers had invested all their savings in a U.S. equity fund. An important question in thinking about the role of defined-contribution pensions is whether this kind of pension variability is acceptable to most workers.

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Table 1. Real Annual Equity Returns Measured from the Perspective of Investors in Eight Countries, 1927-2005

Percent

Investor's country of residence	Country in which funds are invested							
	Australia	**Canada**	**France**	**Germany**	**Italy**	**Japan**	**UK**	**USA**
				Geometric returns				
Australia	**7.3**	6.5	5.2	1.9	3.6	3.9	6.1	6.9
Canada	7.0	**6.5**	5.0	1.7	3.5	3.7	6.0	6.8
France	6.3	5.7	**4.5**	1.1	2.9	3.1	5.4	6.1
Germany	9.6	9.0	7.6	**4.3**	6.0	6.3	8.6	9.3
Italy	6.2	5.6	4.2	1.0	**2.8**	2.9	5.2	6.0
Japan	6.7	6.1	4.7	1.4	3.2	**3.6**	5.7	6.4
UK	6.9	6.3	4.9	1.7	3.4	3.7	**6.0**	6.7
USA	6.9	6.3	4.9	1.6	3.4	3.6	5.9	**6.7**
				Arithmetic returns				
Australia	**8.0**	7.2	9.0	16.4	7.0	9.1	7.5	8.0
Canada	8.0	**7.1**	8.8	13.8	6.9	9.4	7.6	7.6
France	12.0	10.6	**7.3**	12.5	7.6	12.3	10.5	10.6
Germany	16.5	16.3	14.6	**8.4**	11.4	12.1	14.9	16.3
Italy	8.9	8.0	7.9	13.5	**5.4**	10.5	8.2	8.4
Japan	12.6	12.8	13.5	21.9	8.6	**7.8**	11.1	13.5
UK	8.1	7.4	8.7	15.2	6.1	8.9	**7.2**	8.0
USA	8.1	7.3	8.8	13.9	6.9	9.7	7.7	**7.7**
				Standard deviation of returns				
Australia	**18.0**	17.7	34.8	111.9	33.2	31.0	21.6	20.5
Canada	19.7	**17.6**	34.4	87.6	32.8	32.7	23.2	18.7
France	49.0	44.5	**29.5**	67.3	37.2	42.7	42.6	41.2
Germany	52.8	59.7	49.0	**30.2**	41.1	38.6	47.5	57.7
Italy	28.5	26.7	36.1	85.3	**26.6**	36.8	28.5	26.7
Japan	54.0	62.0	53.1	157.2	37.4	**30.7**	47.7	62.4
UK	20.7	19.5	35.0	103.2	28.1	31.4	**20.4**	20.9
USA	21.6	20.2	34.2	86.9	33.0	34.4	24.5	**19.4**

Source: Author's tabulations of annual composite stock return, inflation, and exchange rate data from eight industrial countries, 1927-2005, as explained in the text. Data supplied by Global Financial Data (http://www.globalfinancialdata.com). The tabulations reflect returns net of assumed trading fees and fund management costs, as explained in the text.

Table 2. Real Annual Long Government Bond Returns Measured from the Perspective of Investors in Eight Countries, 1927-2005

Percent

Investor's country of residence	Country in which funds are invested							
	Australia	**Canada**	**France**	**Germany**	**Italy**	**Japan**	**UK**	**USA**
				Geometric returns				
Australia	**2.6**	3.1	-0.7	-1.8	-0.9	-2.6	2.3	1.7
Canada	2.1	**3.3**	-0.8	-2.0	-1.1	-2.7	2.2	1.6
France	1.4	2.3	**-0.9**	-2.6	-1.7	-3.4	1.5	0.9
Germany	4.5	5.4	1.6	**0.9**	1.3	-0.3	4.6	4.0
Italy	1.3	2.2	-1.5	-2.7	**-1.4**	-3.5	1.4	0.8
Japan	1.7	2.6	-1.3	-2.3	-1.5	**-2.5**	1.8	1.2
UK	2.0	2.9	-0.8	-2.0	-1.1	-2.8	**2.5**	1.5
USA	1.9	2.8	-0.9	-2.1	-1.2	-2.8	2.0	**1.8**
				Arithmetic returns				
Australia	**2.2**	3.0	2.8	4.8	1.5	1.4	2.3	2.0
Canada	2.0	**2.8**	2.2	3.8	1.2	1.3	2.1	1.1
France	5.4	6.5	**-0.6**	3.6	0.3	5.0	4.3	4.3
Germany	9.3	10.6	8.1	**2.5**	5.6	4.5	8.6	8.4
Italy	2.7	3.6	-0.2	3.2	**-0.4**	2.5	2.3	2.0
Japan	6.5	7.5	7.1	7.6	5.4	**-0.7**	6.3	5.8
UK	2.0	3.1	1.8	4.0	0.6	1.0	**1.8**	1.7
USA	2.3	2.5	2.1	3.7	1.2	1.1	2.2	**1.2**
				Standard deviation of returns				
Australia	**11.1**	13.7	25.9	48.8	24.7	23.2	13.5	16.7
Canada	14.2	**9.3**	22.9	38.8	23.2	23.3	13.6	10.0
France	41.8	46.1	**14.6**	35.0	20.9	44.4	32.2	39.2
Germany	44.8	50.1	49.5	**13.8**	39.5	31.3	42.0	45.0
Italy	22.3	23.4	17.9	37.8	**17.1**	28.9	18.2	21.5
Japan	49.0	49.7	49.0	70.5	45.0	**18.7**	46.5	47.3
UK	14.1	15.4	23.1	44.4	21.8	22.5	**7.8**	15.0
USA	17.1	11.0	22.6	39.1	23.8	23.3	14.7	**8.4**

Source: Author's tabulations of annual government bond return, inflation, and exchange rate data from eight industrial countries, 1927-2005, as explained in the text. Data supplied by Global Financial Data (http://www.globalfinancialdata.com). The tabulations reflect returns net of assumed trading fees and fund management costs, as explained in the text.

Table 3. Real Annual Rates of Return on Alternative Stock Portfolios for Workers Retiring after Forty-Year Careers in Eight Countries

		100% Foreign Equities		
	100% Domestic Equities	Equal country weights	GDP country weights	Stock market weights
Country / Estimated return	(1)	(2)	(3)	(4)
Australia				
Geometric mean return, 1927-2005	7.3%	7.8%	8.1%	7.9%
Avg. IRR on pensions, 1967-2006	6.6%	8.0%	8.5%	8.2%
Canada				
Geometric mean return, 1927-2005	6.5%	7.8%	8.0%	7.8%
Avg. IRR on pensions, 1967-2006	5.5%	8.9%	9.2%	8.9%
France				
Geometric mean return, 1927-2005	4.5%	7.1%	7.3%	7.1%
Avg. IRR on pensions, 1967-2006	4.7%	7.9%	8.3%	7.9%
Germany				
Geometric mean return, 1927-2005	4.3%	10.0%	10.2%	10.2%
Avg. IRR on pensions, 1967-2006	5.8%	7.7%	8.3%	8.3%
Italy				
Geometric mean return, 1927-2005	2.8%	7.3%	7.3%	7.0%
Avg. IRR on pensions, 1967-2006	2.4%	7.9%	8.2%	7.7%
Japan				
Geometric mean return, 1927-2005	3.6%	7.3%	7.2%	7.0%
Avg. IRR on pensions, 1967-2006	7.8%	5.2%	5.3%	5.0%
UK				
Geometric mean return, 1927-2005	6.0%	7.8%	7.9%	7.7%
Avg. IRR on pensions, 1967-2006	6.4%	7.7%	8.3%	8.0%
USA				
Geometric mean return, 1927-2005	6.7%	7.6%	7.5%	7.5%
Avg. IRR on pensions, 1967-2006	6.7%	8.4%	9.8%	10.0%

Source: Author's tabulations of annual composite stock return, inflation, and exchange rate data from eight industrial countries, 1927-2005, as explained in the text. Data supplied by Global Financial Data (http://www.globalfinancialdata.com). The tabulations reflect returns net of assumed trading fees and fund management costs, as explained in the text.

Table 4. Distribution of Pension Replacement Rates under Alternative Domestic and Naïve Foreign Investment Strategies for Retirement Savers in Eight Countries

Percent

	All savings invested domestically			All savings invested in foreign stocks		
	All bonds	50% stocks / 50% bonds	All stocks	Equal country weights	GDP country weights	Stock market weights
Australia						
Average	41	62	89	110	109	118
Median	34	63	86	103	108	113
10th Percentile	19	34	58	59	57	59
5th Percentile	18	33	57	55	54	53
Canada						
Average	42	58	73	112	109	119
Median	37	50	68	114	118	120
10th Percentile	23	43	53	50	47	48
5th Percentile	23	37	51	33	33	33
France						
Average	33	48	60	98	95	104
Median	25	38	52	94	94	100
10th Percentile	6	16	25	46	41	42
5th Percentile	3	9	18	38	36	36
Germany						
Average	36	46	57	314	317	313
Median	41	50	55	161	139	142
10th Percentile	8	19	34	65	67	67
5th Percentile	5	11	17	58	63	61
Italy						
Average	37	44	48	105	97	109
Median	23	32	47	113	103	119
10th Percentile	5	12	18	50	43	45
5th Percentile	3	8	15	38	34	34
Japan						
Average	27	46	85	122	112	124
Median	27	46	62	81	79	79
10th Percentile	5	11	18	32	31	33
5th Percentile	2	3	5	29	28	28
United Kingdom						
Average	34	51	71	116	114	124
Median	32	48	70	89	92	97
10th Percentile	22	33	40	51	46	47
5th Percentile	21	31	36	44	43	40
United States						
Average	28	47	76	100	126	126
Median	25	46	69	91	102	102
10th Percentile	15	31	41	46	38	38
5th Percentile	15	30	34	33	16	18

Source: Author's simulations using stock and bond return, inflation, and exchange rate data, 1927-2005, as explained in the text. Return, exchange rate, and inflation data supplied by Global Financial Data.

Table 5. Distribution of Pension Replacement Rates When All Savings Are Invested in Alternative Equity Portfolios

Percent

	Maximum attainable replacement rate with foreign and domestic stocks			Percent of savings invested abroad to attain best replacement rate		
	Equal country weights	GDP country weights	Stock market weights	Equal country weights	GDP country weights	Stock market weights
Australia						
Average	111	118	109	85	100	90
Median	109	113	109	80	100	75
10th Percentile	77	77	74	50	43	30
5th Percentile	72	75	69	50	45	35
Canada						
Average	112	119	109	100	100	100
Median	114	120	118	100	100	100
10th Percentile	60	58	58	30	25	20
5th Percentile	57	54	55	35	28	25
France						
Average	98	104	95	100	100	100
Median	94	102	99	95	90	90
10th Percentile	54	52	51	75	60	65
5th Percentile	43	39	40	85	73	75
Germany						
Average	352	363	370	85	85	85
Median	162	143	143	95	88	90
10th Percentile	69	74	72	80	85	80
5th Percentile	64	66	67	85	90	90
Italy						
Average	105	109	97	100	100	100
Median	113	119	103	100	100	100
10th Percentile	53	49	49	85	68	65
5th Percentile	38	35	35	90	85	80
Japan						
Average	122	126	114	95	90	85
Median	94	97	93	35	40	40
10th Percentile	40	42	44	85	75	65
5th Percentile	36	37	40	70	78	75
United Kingdom						
Average	116	124	114	100	100	100
Median	96	101	99	85	63	60
10th Percentile	51	48	48	100	80	65
5th Percentile	45	42	44	65	50	60
United States						
Average	100	126	126	100	100	100
Median	95	105	109	70	48	65
10th Percentile	49	45	44	60	50	25
5th Percentile	43	39	37	45	30	20

Source: Author's simulations using stock and bond return, inflation, and exchange rate data, 1927-2005, as explained in the text. Return, exchange rate, and inflation data supplied by Global Financial Data.

Table 6. Portfolio Allocations along Efficient Frontier for Retirement Savers in Eight Countries, Based on Return Data for 1927-2005

Percent of portfolio

Portfolio / **Location of retirement saver**	***Stock investments located in --***								***Bond investments located in --***								**% of portfolio in stocks**	**% of portfolio foreign**
	Australia 1	**Canada** 2	**France** 3	**Germany** 4	**Italy** 5	**Japan** 6	**UK** 7	**USA** 8	**Australia** 9	**Canada** 10	**France** 11	**Germany** 12	**Italy** 13	**Japan** 14	**UK** 15	**USA** 16		
Lower risk portfolio																		
Australia	27	8	2			17		15	13	18							69	60
Canada	26		2	3		15		24		31							69	69
France		3	2	1		1					79				15		7	20
Germany				1	1	12						80	3		3		14	19
Italy		6			4				1	5	36		23		22	4	10	73
Japan					8	11								68		14	19	21
UK	22		4	2		16		22							34		66	66
USA	22		3	2		11		22		13						26	60	52
Moderate risk portfolio																		
Australia	42		4	2		22		29									100	58
Canada	35		4	5		18		35		2							98	98
France	2		12	5		13		10			58						42	30
Germany	3		1	17		22		9				47					53	35
Italy	20	5		2	7	9		13			38				6		56	93
Japan	11		2		8	29		4						45			55	26
UK	31		6	3		20	4	29							7		93	89
USA	27		5	4		15		34		15							85	66
Higher risk portfolio																		
Australia	37		8	9		30		16									100	63
Canada	38		8	12		29		13									100	100
France			21	8		21		13			38						62	41
Germany	8		2	29		28		10				23					77	48
Italy	27		8	5	2	16		22			21						79	98
Japan	11		4		7	39	1	6						32			68	29
UK	40		8	10		27		16									100	100
USA	35		7	10		25		24									100	76

Source: Author's tabulations of stock and bond return, inflation, and exchange rate data, 1975-2005, as explained in the text. Return data supplied by Global Financial Data. Blank cells contain less than 0.5% of saver's portfolio.

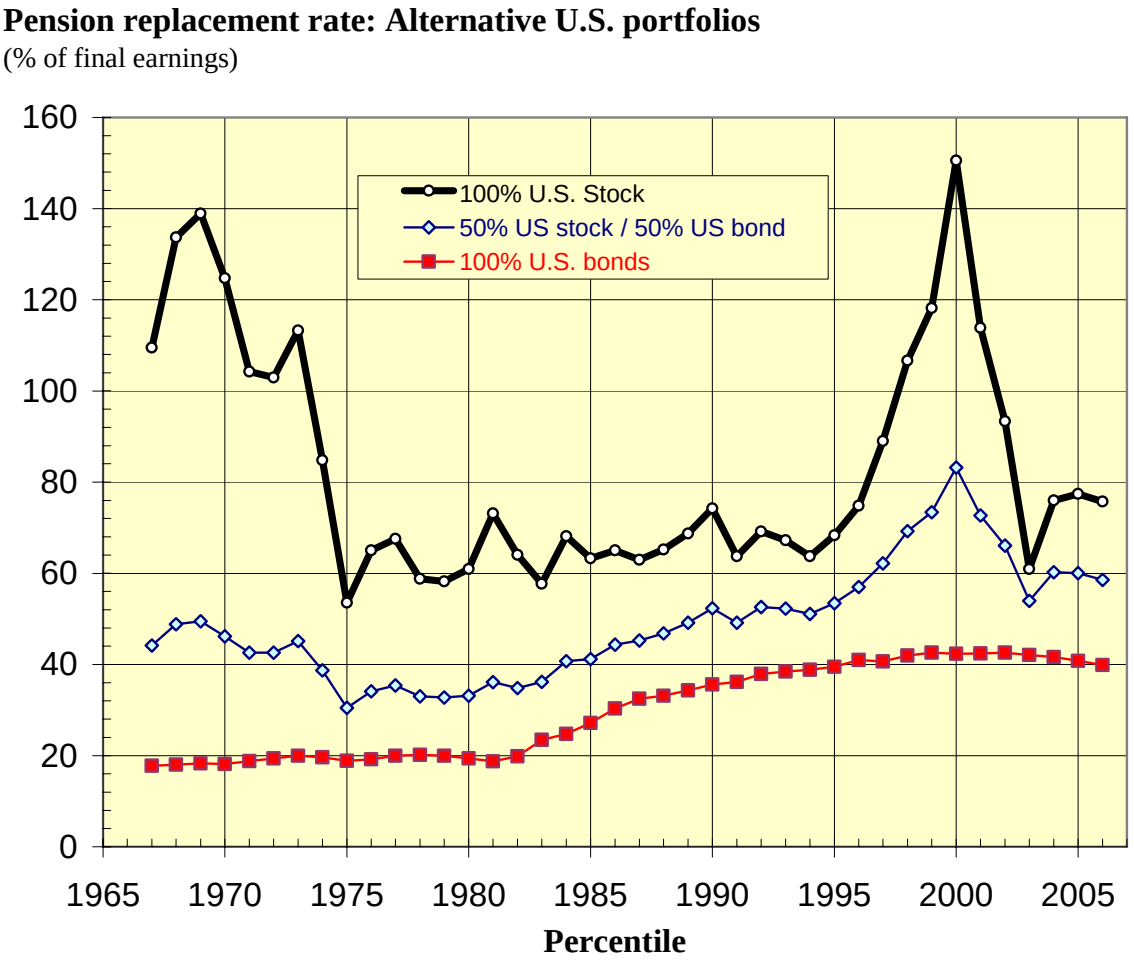
Table 7. Distribution of Pension Replacement Rates under Alternative Domestic and Global Investment Strategies for Retirement Savers in Eight Countries

Percent

	Simple investment portfolios		Global portfolios on efficient frontier		
	100% domestic stocks	100% foreign stocks allocated equally across countries	Lower risk	Moderate risk	Higher risk
Australia					
Average	62	110	81	133	164
Median	63	103	81	123	155
10th Percentile	34	59	60	91	103
5th Percentile	33	55	54	83	78
Canada					
Average	58	112	95	141	190
Median	50	114	94	138	187
10th Percentile	43	50	77	101	94
5th Percentile	37	33	74	85	79
France					
Average	48	98	37	57	75
Median	38	94	38	62	73
10th Percentile	16	46	20	37	57
5th Percentile	9	38	16	31	51
Germany					
Average	46	314	46	76	115
Median	50	161	48	75	102
10th Percentile	19	65	33	58	71
5th Percentile	11	58	30	56	57
Italy					
Average	44	105	38	62	90
Median	32	113	35	62	88
10th Percentile	12	50	19	43	67
5th Percentile	8	38	18	40	64
Japan					
Average	46	122	32	46	54
Median	46	81	31	45	57
10th Percentile	11	32	26	35	35
5th Percentile	3	29	25	33	33
United Kingdom					
Average	51	116	81	120	162
Median	48	89	78	107	157
10th Percentile	33	51	63	70	64
5th Percentile	31	44	57	59	56
United States					
Average	47	100	69	101	155
Median	46	91	68	97	158
10th Percentile	31	46	57	79	79
5th Percentile	30	33	55	71	70

Source: Author's simulations using stock and bond return, inflation, and exchange rate data, 1927-2005, as explained in the text. Return, exchange rate, and inflation data supplied by Global Financial Data.

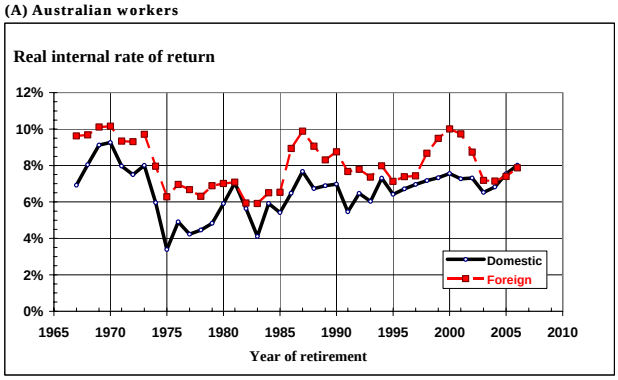
Figure 1. Replacement Rates of Full-Career U.S. Workers after Steady Investment in Alternative Portfolios Invested Domestically, 1927-2005



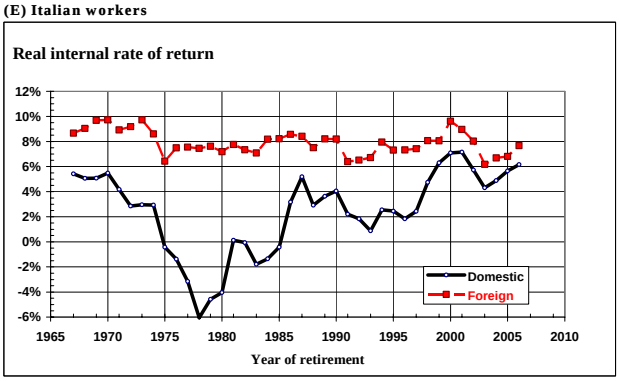
Source: Author's tabulations of annual composite U.S. stock and bond return data, 1927-2005, as explained in the text. Data supplied by Global Financial Data (http://www.globalfinancialdata.com).

Figures 2a - 2h. Real Internal Rate of Return on Pension Fund Contributions for Workers Investing in Domestic and Equal-Weight Foreign Stock Portfolios for Retirements Occuring in 1967-2005

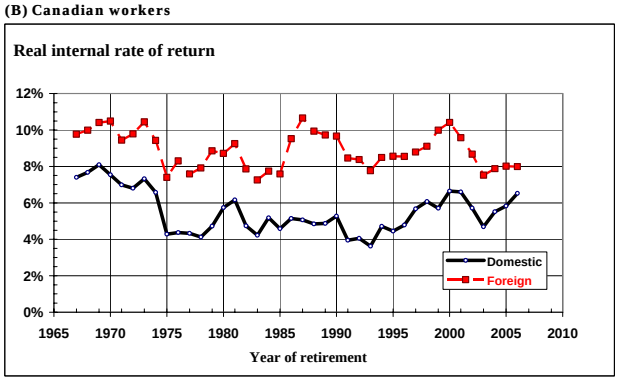
(A) Australian workers



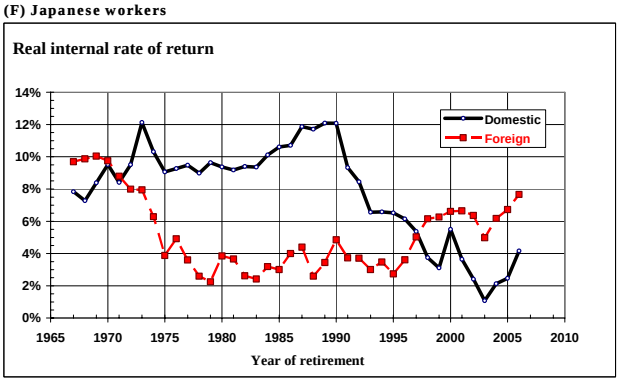
(E) Italian workers



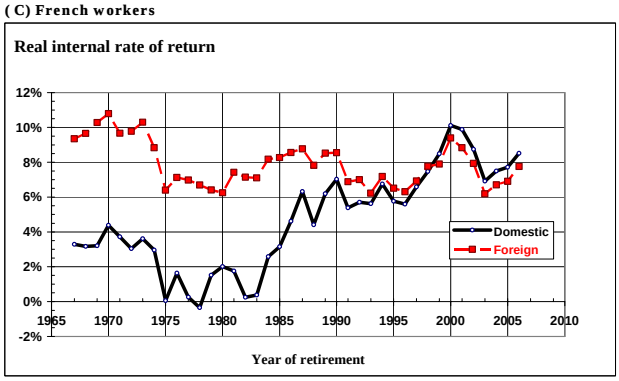
(B) Canadian workers



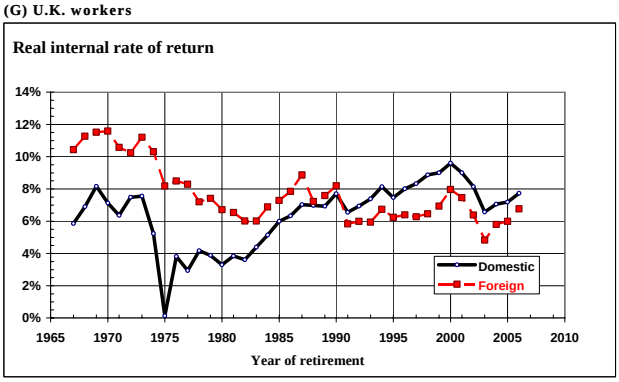
(F) Japanese workers



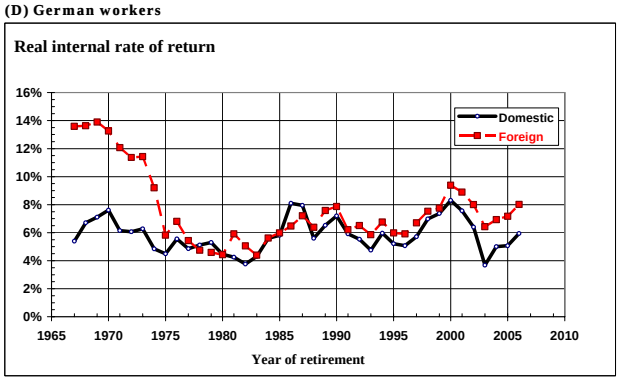
(C) French workers



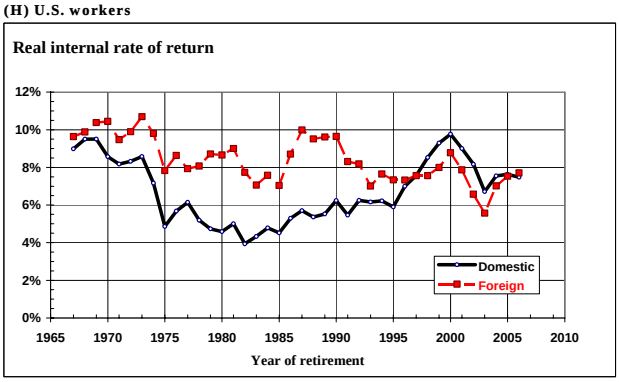
(G) U.K. workers



(D) German workers

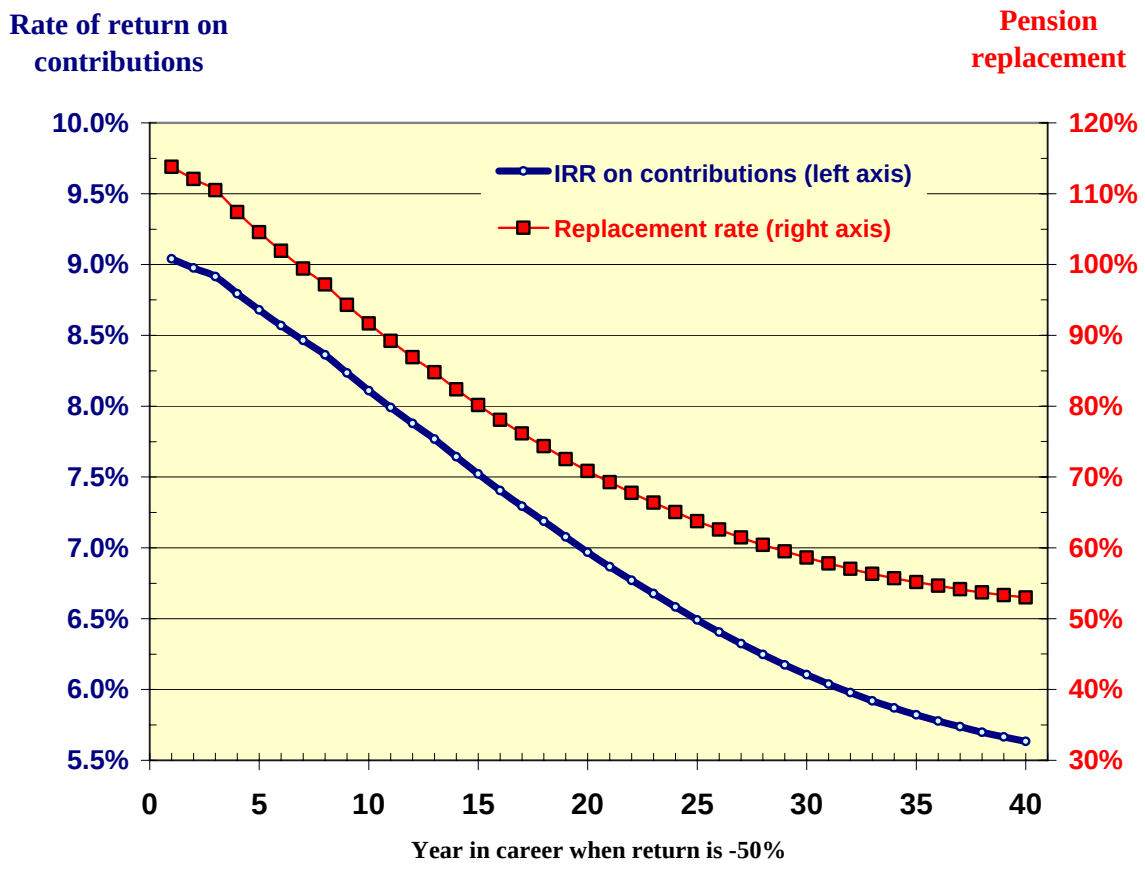


(H) U.S. workers



Source: Author's tabulations as explained in the text based on data supplied by Global Financial Data. Workers are assumed to contribute for 40 years to either a domestic stock portfolio or a foreign stock portfolio that has an equal allocation to equities in each of the seven foreign countries. Workers retire on January 1st of the years indicated on the X-axis.

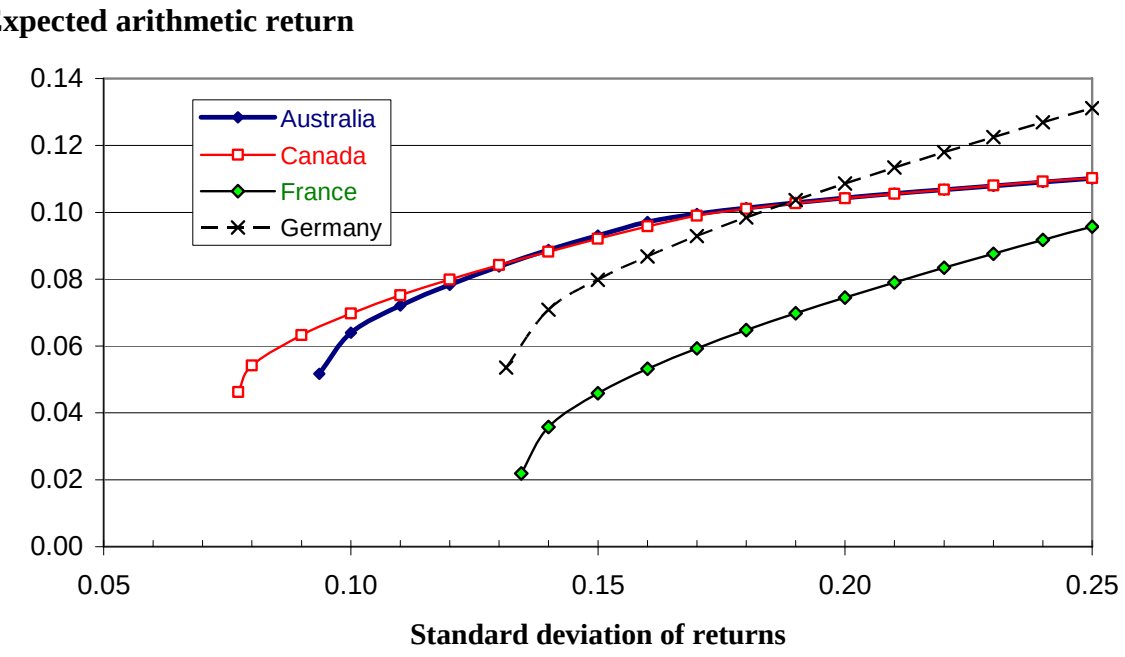
Figure 3. Impact of One Year of Poor Returns on Pension Replacement Rate and Internal Rate of Return of a Full-Career Worker

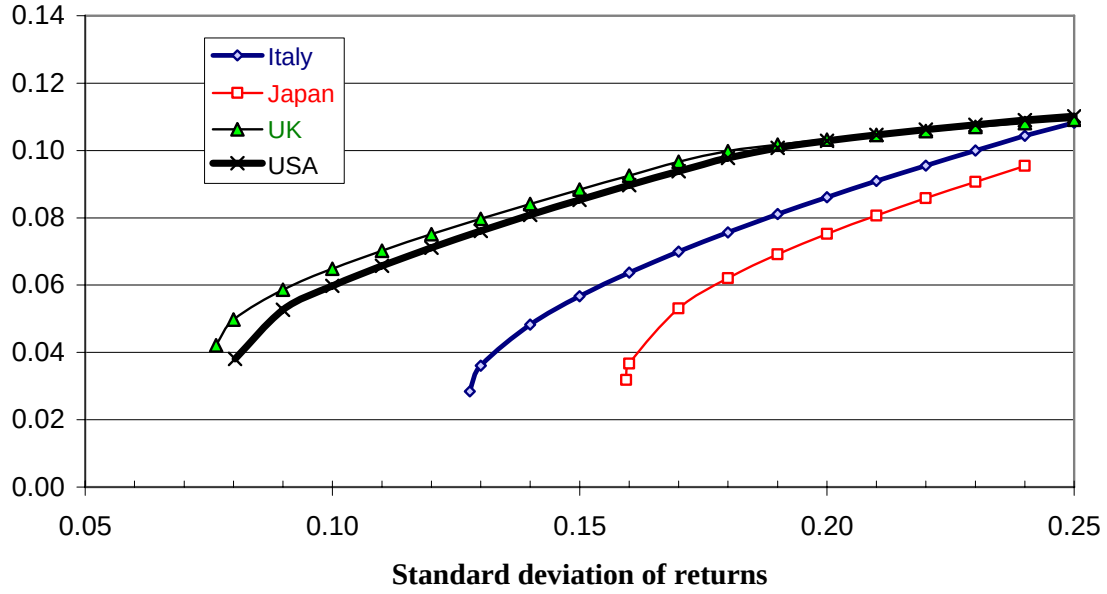


Note: The geometric mean return during the 40-year career is 7.0%. In one year of the worker's career, the return is minus 50%; in the other 39 years it is 9.1%. This chart shows the impact of varying the year in the worker's career when the low return occurs.

Source: Author's calculations as explained in text.

Figure 4. Efficient Frontiers for Globally Diversified Stock and Bond Portfolios from the Perspective of Investors in Eight Countries





Source: Author's calculations using annual composite stock and bond return data, inflation data, and exchange rate data covering 1927-2005, as explained in the text. Data supplied by Global Financial Data (http://www.globalfinancialdata.com).

Appendix Table A1. Portfolio Allocations along Efficient Frontier for Retirement Savers in Eight Countries, Based on Return Data for 1950-2005

Percent of portfolio

Portfolio /	***Stock investments located in --***								***Bond investments located in --***								**% of**	**% of**
Location of retirement saver	**Australia** 1	**Canada** 2	**France** 3	**Germany** 4	**Italy** 5	**Japan** 6	**UK** 7	**USA** 8	**Australia** 9	**Canada** 10	**France** 11	**Germany** 12	**Italy** 13	**Japan** 14	**UK** 15	**USA** 16	**portfolio in stocks**	**portfolio foreign**
Lower risk portfolio																		
Australia	8	16				18			30			26			1		43	61
Canada	13	14				16		11		16		30					54	70
France	8			7		14	9	2				60					40	100
Germany	4			9		23	2	2				60					40	30
Italy	11		2	3	2	16	4	3				55			5		40	98
Japan	11			3		22	4	1				35		24			41	54
UK	7	1		4		19	5	3				23			38		39	58
USA	15	4				11		17				29			9	14	47	69
Moderate risk portfolio																		
Australia	23	1				30	1	16				29					71	77
Canada	18			3		27	2	27				23					77	100
France	5			13		25	16	3				37					63	100
Germany	1			15		33	8	3				40					60	45
Italy	8			10		28	12	4				37					63	100
Japan	9			9		35	13	3				18		14			68	51
UK	8			5		26	17	5				33			6		61	77
USA	16			3		23	5	26				28					72	74
Higher risk portfolio																		
Australia	17			5		43	11	19				5					95	83
Canada	15			9		38	10	25				3					97	100
France	3			19		35	22	3				18					82	100
Germany				21		41	14	3				21					79	59
Italy	5			16		38	18	5				17					83	100
Japan	7			14		45	20	5				3		6			91	49
UK	5			10		37	24	7				17					83	76
USA	13			9		34	12	23				8					92	77

Source: Author's tabulations of stock and bond return, inflation, and exchange rate data, 1975-2005, as explained in the text. Return data supplied by Global Financial Data. Blank cells contain less than 0.5% of saver's portfolio.

Appendix Table A2. Portfolio Allocations along Efficient Frontier for Retirement Savers in Eight Countries, Based on Return Data for 1975-2005

Percent of portfolio

Portfolio /	***Stock investments located in --***								***Bond investments located in --***								**% of**	**% of**
Location of	**Australia**	**Canada**	**France**	**Germany**	**Italy**	**Japan**	**UK**	**USA**	**Australia**	**Canada**	**France**	**Germany**	**Italy**	**Japan**	**UK**	**USA**	**portfolio**	**portfolio**
retirement saver	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	**in stocks**	**foreign**
Lower risk portfolio																		
Australia	11	7				10	13	3	48	1		1			6		44	41
Canada	9	9				4	21	14	7	34							58	57
France	6		7		5		27					52			3		45	93
Germany	4		7		2	3	16	5				58			3		39	42
Italy	6		3		5	2	18	4				35	10		17		39	86
Japan	4				4	9	29	7				7		39			54	51
UK	13				5	1	24	7				4			47		49	29
USA	10					1	14	24	5						15	25	50	46
Moderate risk portfolio																		
Australia	20					8	32	14	26								74	54
Canada	16					4	33	30		16							84	84
France	2		15		2		46	3				33					67	85
Germany	2		15			1	31	8				42					58	58
Italy	6		10		4		40	7				30	4				67	92
Japan	3		6		1	10	46	8						27			73	63
UK	13		2		5		44	11				4			22		74	34
USA	13					1	30	39				6			5	5	83	56
Higher risk portfolio																		
Australia	26					7	45	19	3								97	71
Canada	15		4				51	30									100	100
France			20				61	5				14					86	80
Germany			21				45	9				24					76	76
Italy	2		19				55	11				13					87	100
Japan	1		10			13	63	6						8			92	80
UK	12		4		5		63	13				3					97	37
USA	9		5				53	33									100	67

Source: Author's tabulations of stock and bond return, inflation, and exchange rate data, 1975-2005, as explained in the text. Return data supplied by Global Financial Data. Blank cells contain less than 0.5% of saver's portfolio.

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