























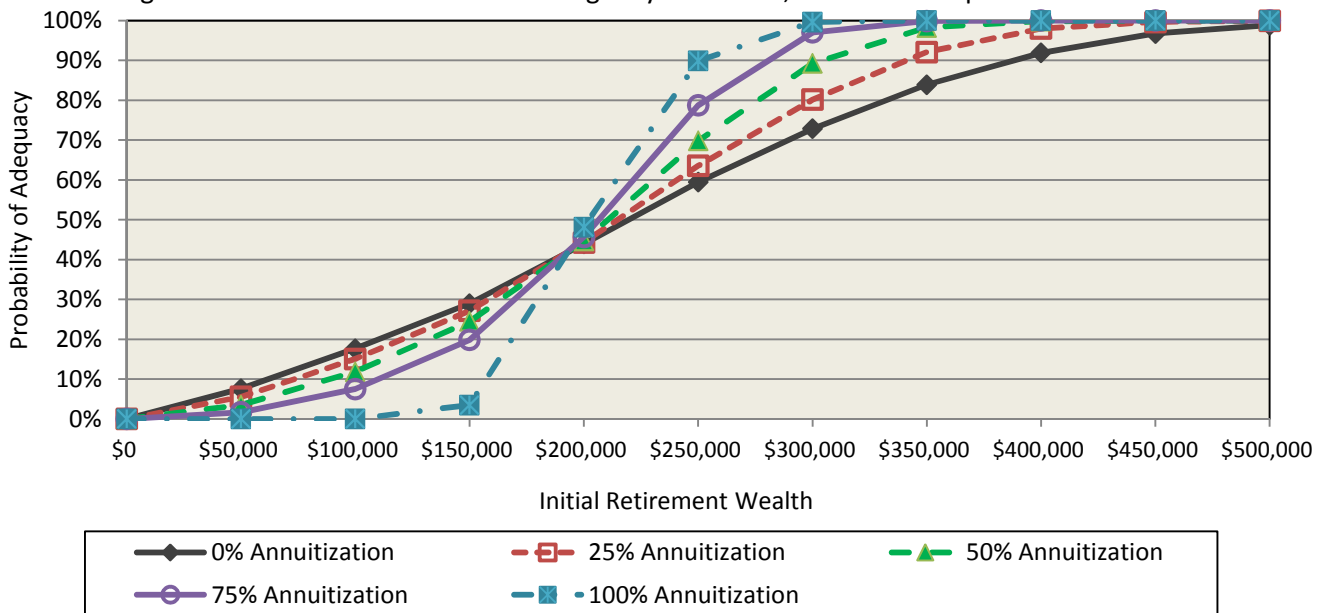


Figure 4 (cont'd.)

**C. Impact of Initial Retirement Wealth on the Probability of Retirement Income "Adequacy," by Annuitization**  
5% Equity Allocation

For: Males Retiring at Age 65 in the *Highest Income Category*

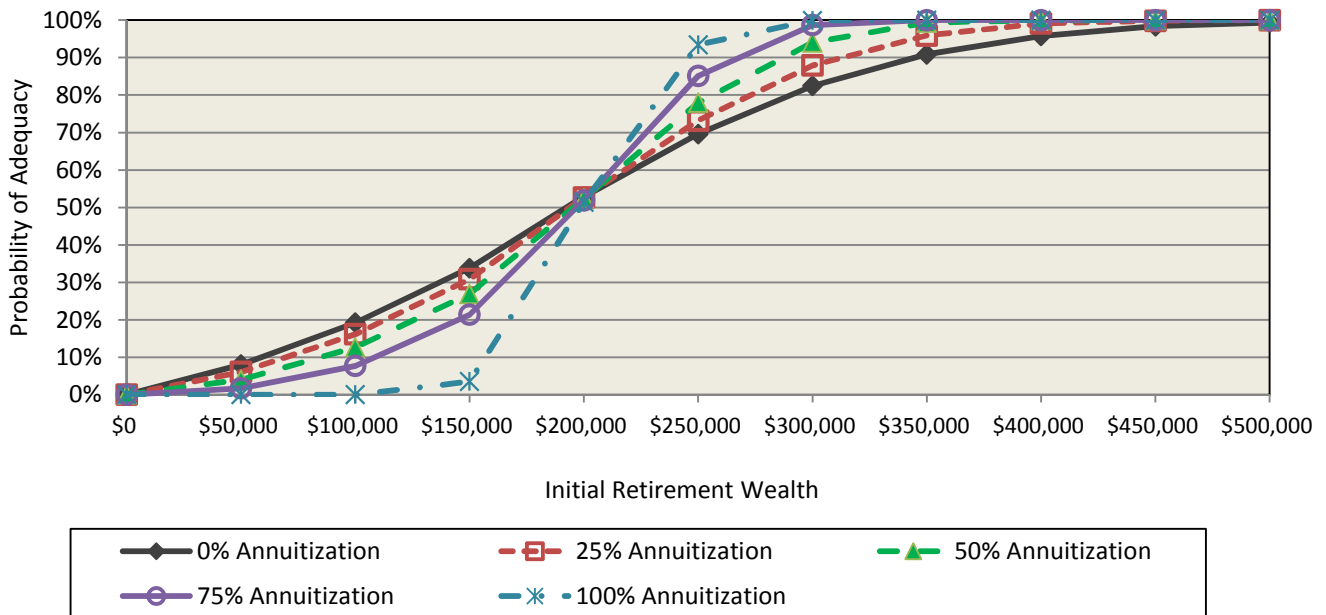
Building Block 2: investment income and longevity stochastic, health care expenses deterministic



**D. Impact of Initial Retirement Wealth on the Probability of Retirement Income "Adequacy," by Annuitization**  
50% Equity Allocation

For: Males Retiring at Age 65 in the *Highest Income Category*

Building Block 2: investment income and longevity stochastic, health care expenses deterministic



Source: Simulations from Ballpark E\$estimate Monte Carlo, Employee Benefit Research Institute.

- **Lowest-Income Category**

Probability of Adequate Retirement Income	Replacement Rate Needed Under		
	Building Block 1	Building Block 2	Building Block 3
50%	121.3%	123.1%	152.2%
75%	130.9	153.5	216.5
90%	140.9	183.1	302.9

- **Highest-Income Category**

Probability of Adequate Retirement Income	Replacement Rate Needed Under		
	Building Block 1	Building Block 2	Building Block 3
50%	33.0%	33.4%	36.3%
75%	34.7	39.0	46.6
90%	36.5	44.5	60.7

Replacement rates needed to meet a 50 percent probability of retirement income adequacy do not vary significantly across three building blocks. However, when a retiree targets a 90 percent adequacy, the replacement rate for that adequacy dramatically increases under Building Block 3. For example, a retiree in the lowest-income category needs a replacement rate of 183.1 percent under Building Block 2, which is about a 30 percent increase over the rate of the Building Block 1. However, when the retiree is under Building Block 3, he needs a replacement rate of 302.9 percent, which is a 65 percent increase over the rate of Building Block 2. A similar pattern is also found for a retiree in the highest-income category.

As presented in Figure 4 (Building Block 2), Figure 8 also demonstrates the value of purchasing an immediate annuity at retirement to reach a higher probability of retirement income adequacy. However, the retiree who wants to achieve the same target retirement adequacy under Building Block 3 now needs more initial retirement wealth to cover potential catastrophic long-term care costs. For example, if a retiree in the lowest-income category who adopts a full annuitization and a 5 percent equity allocation targets a 90 percent chance of adequacy, he needs an initial retirement wealth of \$224,000 under Building Block 2 (Panel A of Figure 4).<sup>15</sup> However, if the retiree is under Building Block 3, he needs an initial retirement wealth of \$542,000 to get the same probability of adequacy (Panel A of Figure 8). Similar results are also found for a retiree in the highest-income category (Panel C of Figure 4 vs. Panel C of Figure 8).

An optimal level of annuitization in Building Block 3 varies in different equity allocations as well as target retirement income adequacy. Figures 9 and 10 present replacement rates required for a certain chance of adequacy by different degrees of annuitization and equity allocations. Compared with Building Block 2 (Figures 5 and 6), Building Block 3 needs a higher replacement rate to meet a target retirement adequacy. In addition, equity allocations under Building Block 3 become more crucial than those under Building Block 2, because of the potential catastrophic long-term care costs. For example, when a retiree who desires a 90 percent chance of adequacy chooses a full annuitization under Building Block 2, equity allocations do not matter relatively: The difference between the highest and lowest replacement rates is only 3.2 percentage points under Building Block 2 (Panel C of Figure 5). However, when the retiree is under Building Block 3, the difference increases to 20.8 percentage points (Panel C of Figure 9).

Figure 11 demonstrates different optimal level of annuitization by income category as well as equity allocation and target retirement income adequacy. Different from Building Block 2 (Figure 7), the results of Building Block 3 show that a 95 percent equity allocation is optimal in any degree of annuitization except no annuitization. The same optimal

equity allocation is found across income categories. Thus, the high equity allocation under Building Block 3 would be sufficient to cover potentially catastrophic long-term care costs.

### **Immediate and Longevity Annuities: Building Blocks 2 and 3**

To examine retirement income adequacy against longevity risk, two types of annuities are considered: immediate and longevity annuities. Longevity annuities are basically immediate annuity contracts without the initial payments (Scott, 2007). For example, a longevity annuity purchased at age 65 starts to distribute payments at age 85; an immediate annuity purchased at age 65 begins payments at age 65.

For this analysis, a male retiring at age 65 is assumed to purchase an immediate annuity at a price quoted at the end of 2009 from [www.immediateannuities.com](http://www.immediateannuities.com) or a longevity annuity commencing payments at age 85 at a price quoted as of 9/18/2009 in MetLife's *Longevity Income Guarantee*.<sup>16</sup> For example, a \$50,000 premium for an immediate annuity (the immediate annuity price) is assumed to purchase annual payments of \$3,791, and the same premium for a longevity annuity (the longevity annuity price) would make annual payments of \$39,501 starting at age 85.

### **Retirement Income Adequacy Under Building Block 2**

Figures 12 and 13 demonstrate that if a retiree in the lowest or the highest income category targets a 90 percent chance of adequacy, he should *fully* annuitize the initial retirement wealth with an immediate annuity regardless of equity allocations. The lowest multiple of final earnings is found in a full annuitization (or 100 percent annuitization of the assets). The full annuitization with an immediate annuity is consistent with the findings of Scott, Watson, and Hu (2006) and Gong and Webb (2010). They state that retirees interested in fully annuitizing their assets should select an immediate annuity instead of a longevity annuity.<sup>17</sup> Pashchenko (2010) also documented that full annuitization would be optimal in the case of deterministic health care costs.

As for a longevity annuity, in contrast, the figures show that a retiree would be able to reach a 90 percent probability of adequacy by allocating only about 15 to 20 percent of his initial retirement wealth to a longevity annuity.<sup>18</sup> The lowest multiple of final earnings is found in a range of 15–20 percent annuitization with a longevity annuity.<sup>19</sup> An allocation of the small fraction of the initial retirement wealth to the longevity annuity would enable the retiree to preserve liquidity. Thus, the longevity annuity may overcome a potentially important psychological barrier to annuitization (Gong and Webb, 2010).

In addition, the figures show that the positive effects of immediate and longevity annuities on retirement income adequacy are stronger for retirees in the lowest-income category than for those in the highest-income category. The slopes of immediate and longevity annuities for a retiree in the lowest-income category (Figure 12) are steeper than those for his counterpart in the highest-income category (Figure 13). For example, a retiree with no annuitization and a 50 percent equity allocation in the lowest-income category (Panel C of Figure 12) needs 18.3 *times* final earnings to get a 90 percent chance of adequacy. If the retiree fully annuitizes his retirement wealth with an immediate annuity or allocates about a 20 percent of his retirement wealth to a longevity annuity, he needs 12.9 or 15.3 *times* final earnings, each of which saves 5.4 or 3.0 *times* his final earnings, respectively.

However, if a retiree in the highest-income category annuitizes in the same way as his counterpart in the lowest-income category, he needs 2.3 or 2.7 *times* final earnings (Panel C of Figure 13), each of which saves 1.0 or 0.6 *times* final earnings, respectively. These savings are relatively small compared with the savings for the retiree in the lowest-income category. In sum, Figures 12 and 13 demonstrate that retirees in the lowest-income category who desire a 90 percent chance of adequacy are likely to be relatively much better off annuitizing than those in the highest-income category.

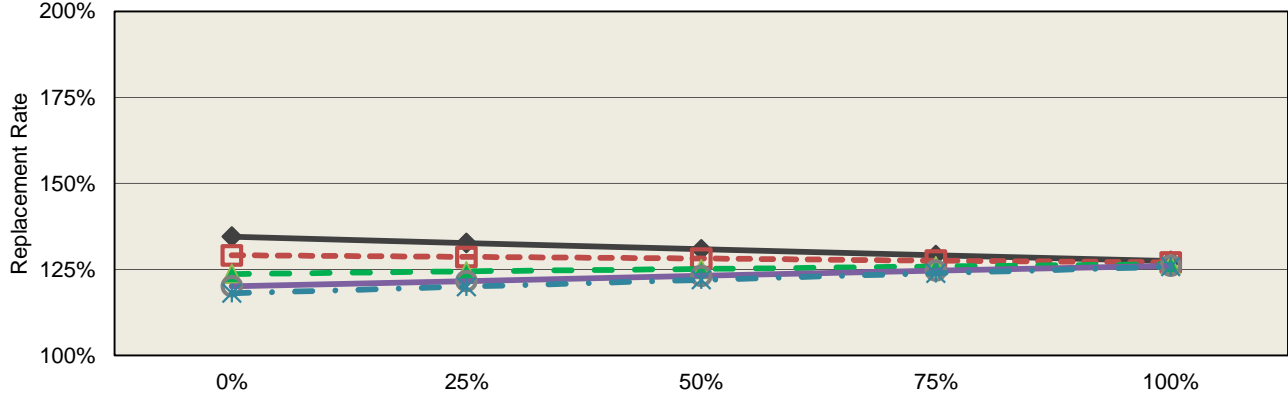
For a retiree in Building Block 2, Figure 14 presents final earnings multiples for a 90 percent chance of adequacy by equity allocation and the degree of annuitization with the longevity annuity. A retiree in the lowest-income category is able to achieve the 90 percent adequacy with a combination of a 30–40 percent equity allocation and a 20 percent allocation to the longevity annuity (Panel A). Similarly, a retiree in the highest-income category can reach the target adequacy with a combination of a 35 percent equity allocation and a 20 percent allocation to a longevity annuity (Panel B).

Figure 5

**A. Replacement Rates Required for a 50% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Lowest Income Category*

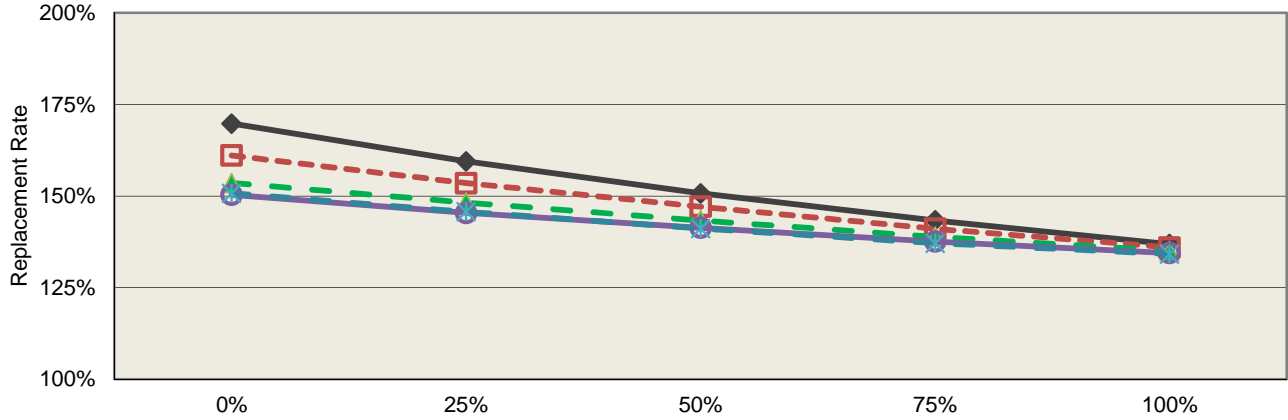
Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



**B. Replacement Rates Required for a 75% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Lowest Income Category*

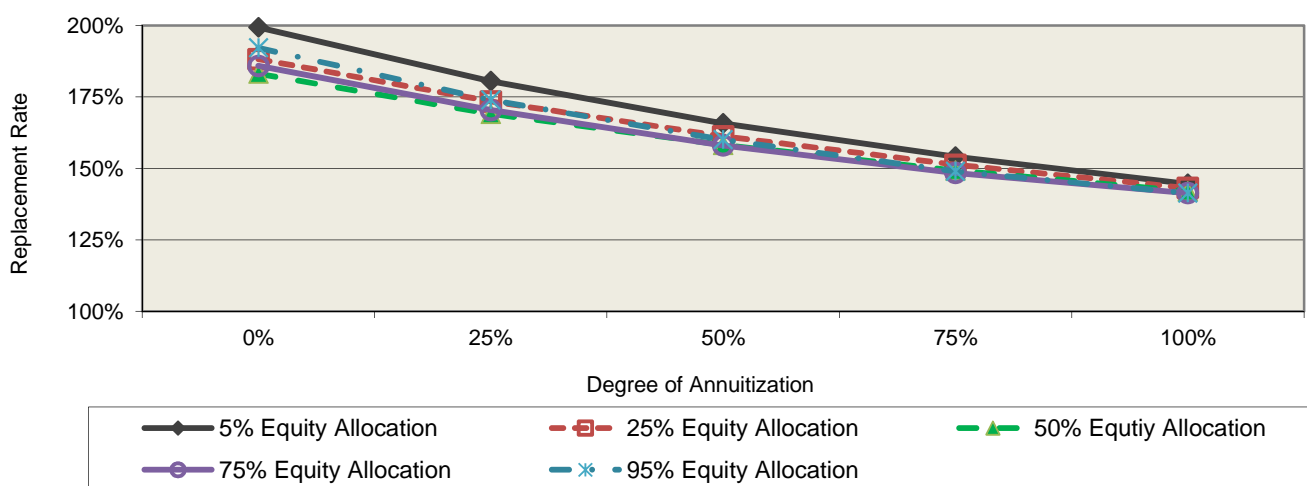
Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



**C. Replacement Rates Required for a 90% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Lowest Income Category*

Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



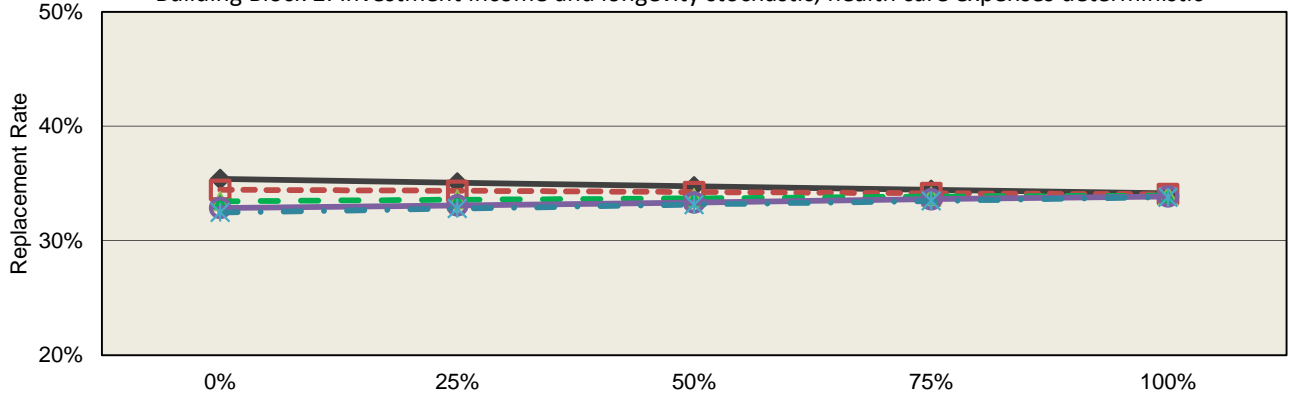
Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

Figure 6

**A. Replacement Rates Required for a 50% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Highest Income Category*

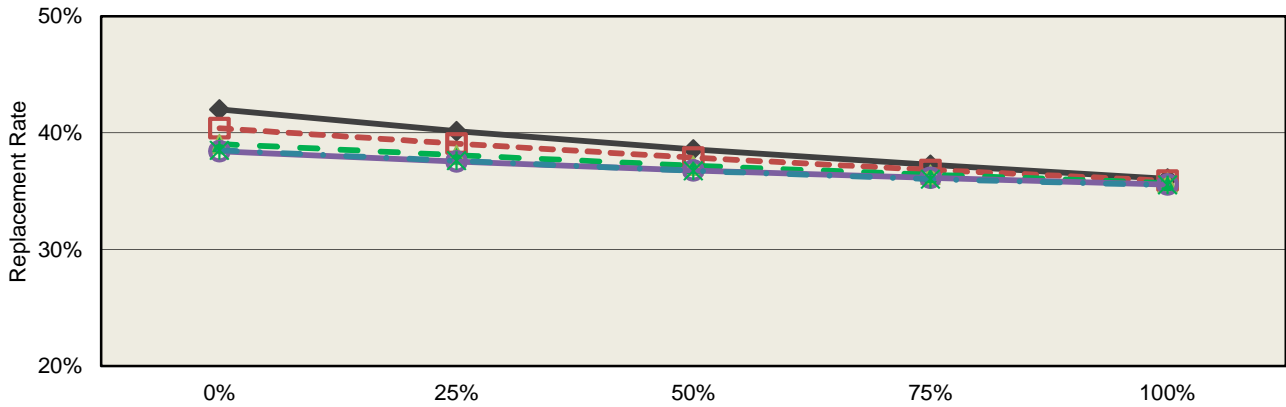
Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



**B. Replacement Rates Required for a 75% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Highest Income Category*

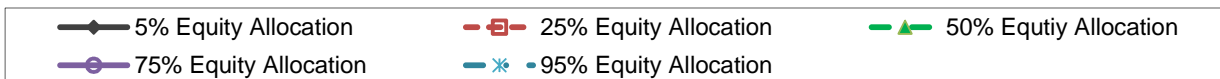
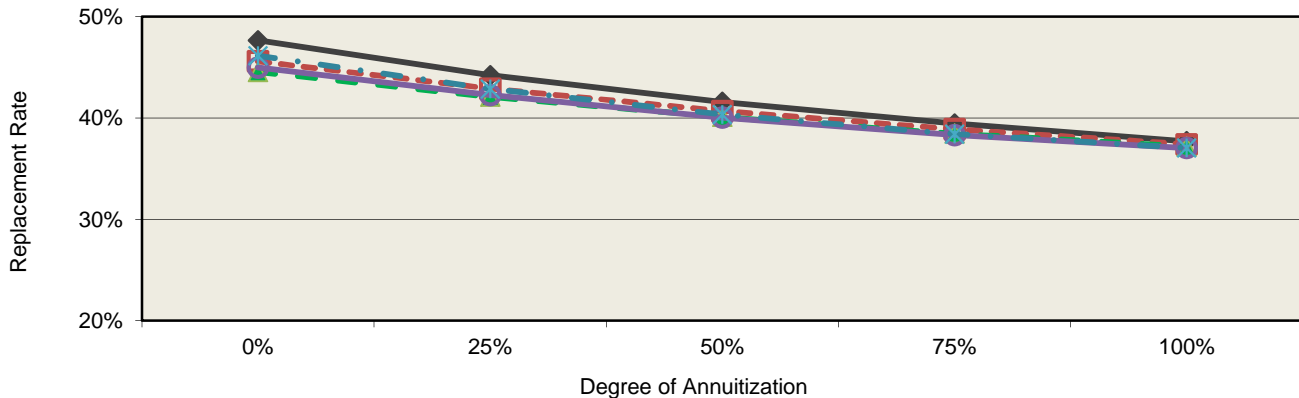
Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



**C. Replacement Rates Required for a 90% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Highest Income Category*

Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

Figure 7

### Impact of Final Earnings on Probability of "Adequate" Retirement Income, by Income Category, Equity Allocation, and Annuitization

For: Males Retiring at Age 65

Building Block 2: Investment income and longevity stochastic, health care expenses deterministic

Income Category	Probability of Adequacy	% of Equity Investment					Probability of Adequacy	Annuitization						
		5%	25%	50%	75%	100%		0%	25%	50%	75%	100%		
<b>1</b>	50%	5%	11.9	11.7	11.4	11.2	11.0	50%	5%	2.7	2.6	2.5	2.5	2.5
		25%	11.2	11.1	11.1	11.0	10.9		25%	2.5	2.5	2.5	2.5	2.5
		50%	10.5	10.6	10.7	10.8	10.8		50%	2.4	2.4	2.4	2.4	2.4
		75%	10.0	10.2	10.4	10.6	10.8		75%	2.3	2.3	2.3	2.4	2.4
		95%	9.7	10.0	10.2	10.5	10.7		95%	2.2	2.2	2.3	2.4	2.4
	75%	5%	16.6	15.2	14.0	13.1	12.2	75%	5%	3.8	3.5	3.2	3.0	2.8
		25%	15.4	14.4	13.6	12.8	12.1		25%	3.5	3.3	3.1	2.9	2.8
		50%	14.4	13.7	13.1	12.5	12.0		50%	3.3	3.1	3.0	2.8	2.7
		75%	14.0	13.3	12.8	12.3	11.9		75%	3.2	3.0	2.9	2.8	2.7
		95%	14.0	13.4	12.8	12.2	11.9		95%	3.2	3.0	2.9	2.8	2.7
<b>2</b>	50%	5%	20.4	18.0	16.0	14.5	13.2	50%	5%	4.7	4.1	3.7	3.3	3.1
		25%	19.0	17.0	15.4	14.1	13.0		25%	4.4	3.9	3.6	3.3	3.0
		50%	18.3	16.5	15.0	13.8	12.9		50%	4.2	3.8	3.5	3.2	3.0
		75%	18.7	16.6	15.0	13.7	12.8		75%	4.3	3.8	3.4	3.2	2.9
		95%	19.5	17.1	15.3	13.8	12.8		95%	4.5	3.9	3.5	3.2	2.9
	75%	5%	3.9	3.8	3.8	3.7	3.6	75%	5%	2.1	2.1	2.0	2.0	1.9
		25%	3.7	3.7	3.6	3.6	3.6		25%	2.0	2.0	2.0	1.9	1.9
		50%	3.4	3.5	3.5	3.5	3.6		50%	1.9	1.9	1.9	1.9	1.9
		75%	3.3	3.3	3.4	3.5	3.5		75%	1.8	1.8	1.8	1.9	1.9
		95%	3.2	3.3	3.4	3.4	3.5		95%	1.7	1.8	1.8	1.9	1.9
<b>3</b>	50%	5%	5.5	5.1	4.7	4.4	4.1	50%	5%	3.0	2.7	2.5	2.4	2.2
		25%	5.1	4.8	4.5	4.3	4.0		25%	2.8	2.6	2.4	2.3	2.2
		50%	4.8	4.6	4.3	4.2	4.0		50%	2.6	2.5	2.3	2.2	2.2
		75%	4.6	4.4	4.2	4.1	4.0		75%	2.5	2.4	2.3	2.2	2.1
		95%	4.7	4.4	4.2	4.1	3.9		95%	2.5	2.4	2.3	2.2	2.1
	75%	5%	6.9	6.1	5.4	4.9	4.5	75%	5%	3.7	3.3	2.9	2.6	2.4
		25%	6.4	5.7	5.2	4.8	4.4		25%	3.5	3.1	2.8	2.6	2.4
		50%	6.1	5.5	5.1	4.7	4.3		50%	3.3	3.0	2.7	2.5	2.3
		75%	6.2	5.6	5.0	4.6	4.3		75%	3.4	3.0	2.7	2.5	2.3
		95%	6.5	5.7	5.1	4.6	4.3		95%	3.5	3.1	2.8	2.5	2.3
<b>4</b>	50%	5%	3.9	3.8	3.8	3.7	3.6	50%	5%	2.1	2.1	2.0	2.0	1.9
		25%	3.7	3.7	3.6	3.6	3.6		25%	2.0	2.0	2.0	1.9	1.9
		50%	3.4	3.5	3.5	3.5	3.6		50%	1.9	1.9	1.9	1.9	1.9
		75%	3.3	3.3	3.4	3.5	3.5		75%	1.8	1.8	1.8	1.9	1.9
		95%	3.2	3.3	3.4	3.4	3.5		95%	1.7	1.8	1.8	1.9	1.9
	75%	5%	5.5	5.1	4.7	4.4	4.1	75%	5%	3.0	2.7	2.5	2.4	2.2
		25%	5.1	4.8	4.5	4.3	4.0		25%	2.8	2.6	2.4	2.3	2.2
		50%	4.8	4.6	4.3	4.2	4.0		50%	2.6	2.5	2.3	2.2	2.2
		75%	4.6	4.4	4.2	4.1	4.0		75%	2.5	2.4	2.3	2.2	2.1
		95%	4.7	4.4	4.2	4.1	3.9		95%	2.5	2.4	2.3	2.2	2.1
90%	5%	6.9	6.1	5.4	4.9	4.5	90%	5%	3.7	3.3	2.9	2.6	2.4	
	25%	6.4	5.7	5.2	4.8	4.4		25%	3.5	3.1	2.8	2.6	2.4	
	50%	6.1	5.5	5.1	4.7	4.3		50%	3.3	3.0	2.7	2.5	2.3	
	75%	6.2	5.6	5.0	4.6	4.3		75%	3.4	3.0	2.7	2.5	2.3	
	95%	6.5	5.7	5.1	4.6	4.3		95%	3.5	3.1	2.8	2.5	2.3	

Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

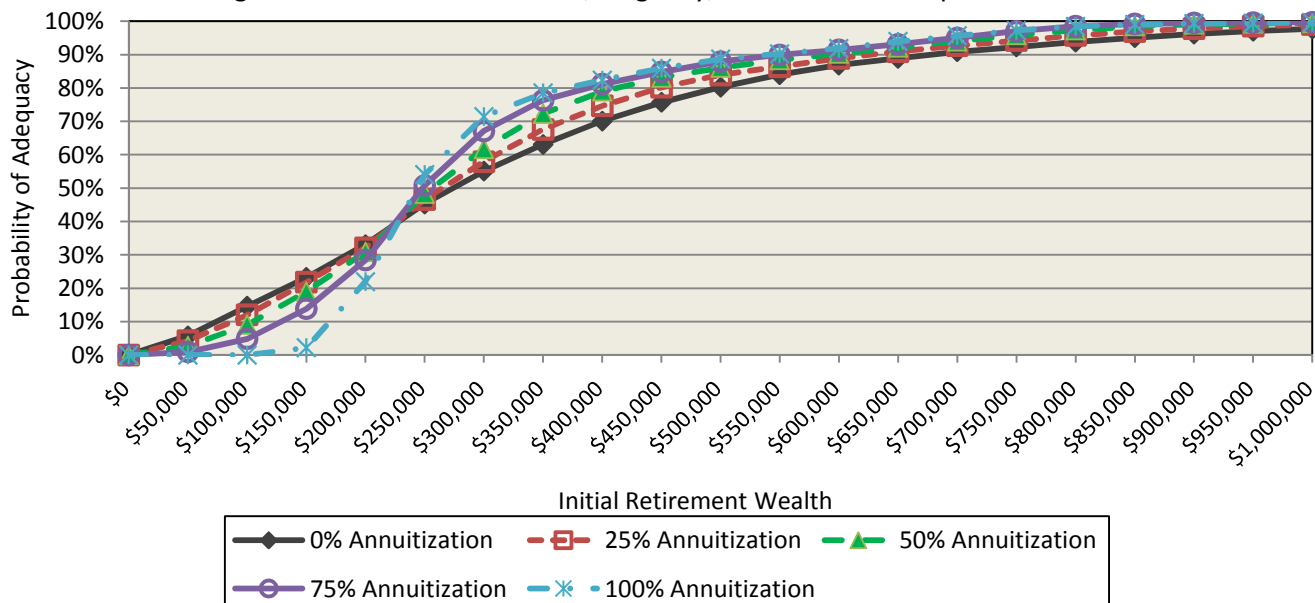
Figure 8

### A. Impact of Initial Retirement Wealth on the Probability of Retirement Income "Adequacy," by Annuitization

5% Equity Allocation

For: Males Retiring at Age 65 in the *Lowest Income Category*

Building Block 3: investment income, longevity, and health care expenses stochastic

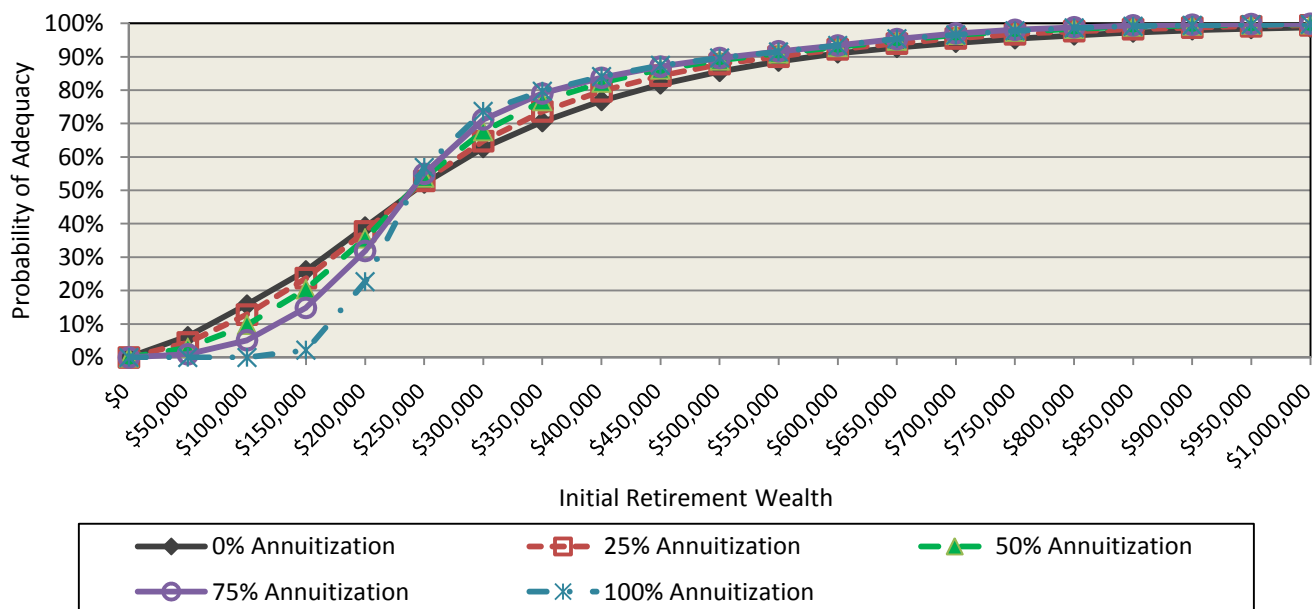


### B. Impact of Initial Retirement Wealth on the Probability of Retirement Income "Adequacy," by Annuitization

50% Equity Allocation

For: Males Retiring at Age 65 in the *Lowest Income Category*

Building Block 3: investment income, longevity, and health care expenses stochastic



Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

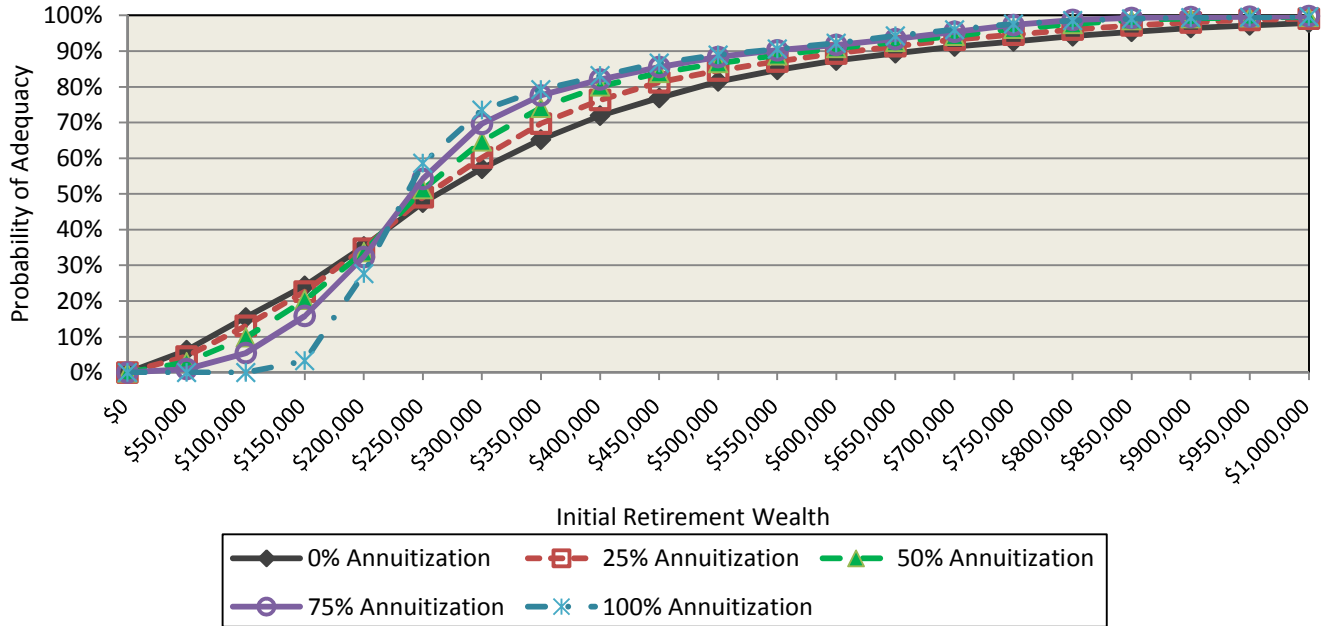
Figure 8 (cont'd.)

**C. Impact of Initial Retirement Wealth on the Probability of Retirement Income "Adequacy," by Annuitization**

5% Equity Allocation

For: Males Retiring at Age 65 in the *Highest Income Category*

Building Block 3: investment income, longevity, and health care expenses stochastic

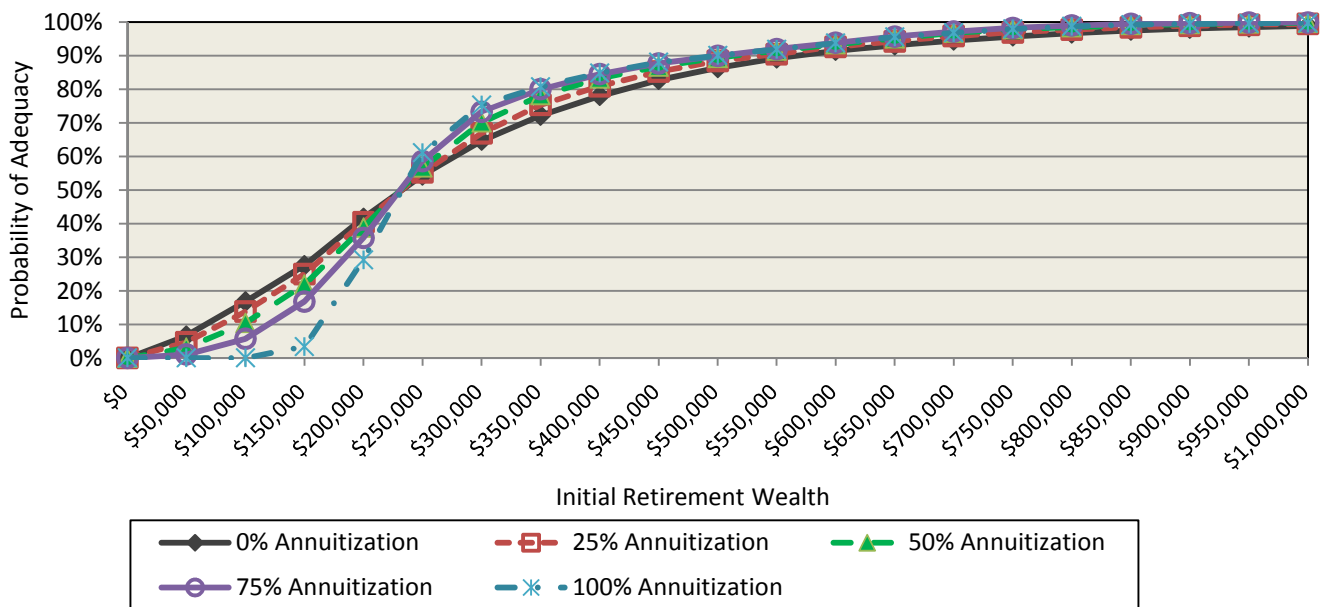


**D. Impact of Initial Retirement Wealth on the Probability of Retirement Income "Adequacy," by Annuitization**

50% Equity Allocation

For: Males Retiring at Age 65 in the *Highest Income Category*

Building Block 3: investment income, longevity, and health care expenses stochastic



Source: Simulations from Ballpark E\$timate Monte Carlo, Employee Benefit Research Institute.

### Retirement Income Adequacy Under Building Block 3

Figures 15 and 16 demonstrate final earnings multiples for a 90 percent chance of adequacy, when retirees in the low- and high-income category are under Building Block 3, which includes long-term care costs. Unlike Figures 12 and 13 (Building Block 2), the figures show that an optimal level (equivalent to the lowest multiple of final earnings) of annuitization with an immediate annuity is not full annuitization. The retiree in the lowest- or the highest-income category should annuitize 80–90 percent of the initial retirement, not 100 percent, to optimally achieve a 90 percent chance of adequacy. Less than full annuitization with an immediate annuity would be optimal for a retiree under Building Block 3, because the retiree should hold part of his initial retirement wealth to finance the unexpected long-term care costs. This result is consistent with the findings of Peijnenburg, et al. (2010) and Pashchenko (2010). They documented that if medical expenses are sizable early in retirement or uncertain, full annuitization with an immediate annuity is not optimal.

For a retiree who utilizes a longevity annuity, the figures show that a retiree in the lowest- or highest-income category can optimally reach a 90 percent probability of adequacy by allocating about 20–35 percent of his initial retirement wealth to the longevity annuity. Not surprisingly, the retiree in Building Block 3 who has to cope with unexpected long-term care costs needs a larger allocation to a longevity annuity than a counterpart in Building Block 2. In addition, similar to Building Block 2, the positive effects of immediate and longevity annuities on retirement adequacy are larger in the lowest-income category than in the highest-income category.

As presented in Figure 14, Figure 17 demonstrates final earnings multiples for a 90 percent chance of adequacy by equity allocation and the degree of annuitization with the longevity annuity in detail. Retirees in the lowest (Panel A) and highest (Panel B) income categories are able to optimally achieve the 90 percent adequacy with a combination of a 70 percent equity allocation and a 25 percent allocation to the longevity annuity. Both the equity allocation and the allocation to the longevity are larger than the optimal allocations to equities and the longevity annuity under Building Block 2 (a 35 percent equity allocation and a 20 percent allocation to longevity annuity). The results indicate that, in order to cover the unexpected catastrophic long-term care costs, a retiree who desires a 90 percent chance of adequacy needs to increase his allocation to both equities and longevity annuity.

### Conclusion

This analysis updates the previous *Issue Brief* (VanDerhei, 2006) with recent information/estimates on retirement and health care expenditures. The 2006 *Issue Brief* showed that adequate replacement rates depend not only on different types of risk (such as investment income, longevity, and long-term care risk) but also on asset allocation and percentage of annuitization. As in the previous study, this *Issue Brief* has demonstrated that retirement income adequacy depends on the three different types of risk, asset allocation, and percentage of annuitization.

For example, a retiree in the lowest-income category who desires a 90 percent chance of adequacy (or a non-negative balance at the end of the simulated life-path) but no annuitization needs 12.4 *times* final earnings with a 5 percent equity allocation under Building Block 1, which assumes stochastic investment income but deterministic longevity and health care expenses. However, if he faces longevity risk as well as investment (Building Block 2), a multiple of final earnings necessary for the 90 percent chance goes up, to 20.4. Further, if he needs to cope with potential catastrophic long-term care costs (Building Block 3), the multiple of final earnings multiple dramatically increases to 40.2. In addition, the multiple of final earnings needed to reach the target adequacy depends on different equity allocations and degrees of annuitization.

Several studies on longevity annuities (e.g., Webb, Gong, and Sun, 2007; Scott, 2008) show that a modest allocation of retirement wealth to a longevity annuity can deliver as large a benefit as a significant allocation to an immediate annuity. This *Issue Brief* compares the impact of immediate and longevity annuities on retirement income adequacy, assuming that a retiree would face long-term health care risk as well as longevity risk.

Simulation results of Building Block 2, which reflects stochastic investment income and longevity risk but deterministic health care costs, show that a retiree who desires to reach a 90 percent chance of adequacy should allocate

15–20 percent of his initial retirement wealth to a longevity annuity with a 30–40 percent equity allocation. In addition, the positive effects of longevity annuities are stronger for retirees in the lowest-income category than for those in the highest-income category.

Regarding retirement income adequacy under Building Block 3, which reflects stochastic investment income, longevity, and health care costs, simulation results demonstrate that the retiree who desires a 90 percent chance of adequacy should increase the allocation of his retirement wealth to a longevity annuity (25 percent) and equities (70 percent). The results indicate that in order to cover unexpected catastrophic long-term care costs, the retiree needs to increase the allocation of his initial retirement wealth to both a longevity annuity and the equities in his portfolio.

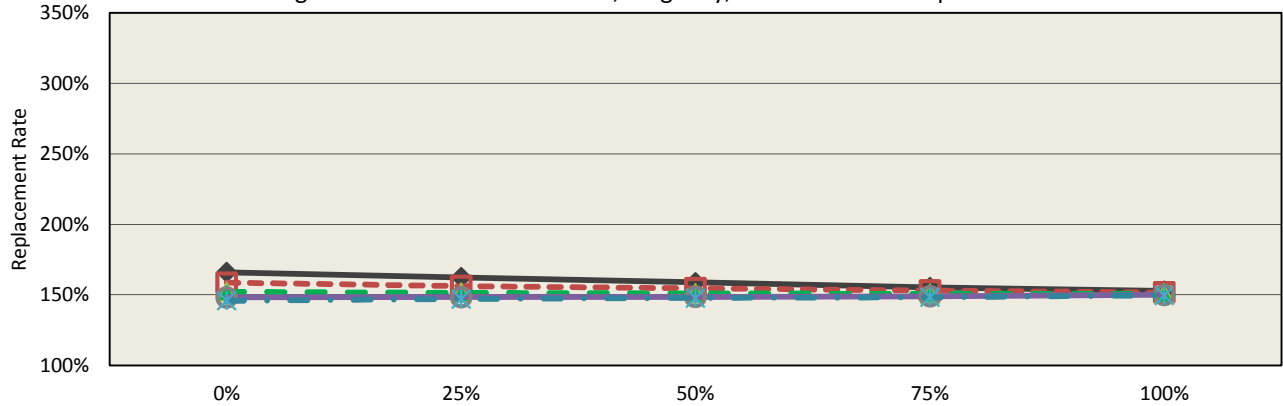
As mentioned in the introduction, there is one caveat to the simulation results. The simulations of the *Issue Brief* were conducted for a male retiring at age 65 with specific assumptions on the long-term capital market and investment expenses, the long-term inflation rate, and the mortality table. Therefore, future research will include an analysis of retirement income adequacy for a female or a household with alternative assumptions on the long-term capital market, inflation (e.g., stochastic inflation), and mortality.

Figure 9

**A. Replacement Rates Required for a 50% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Lowest Income Category*

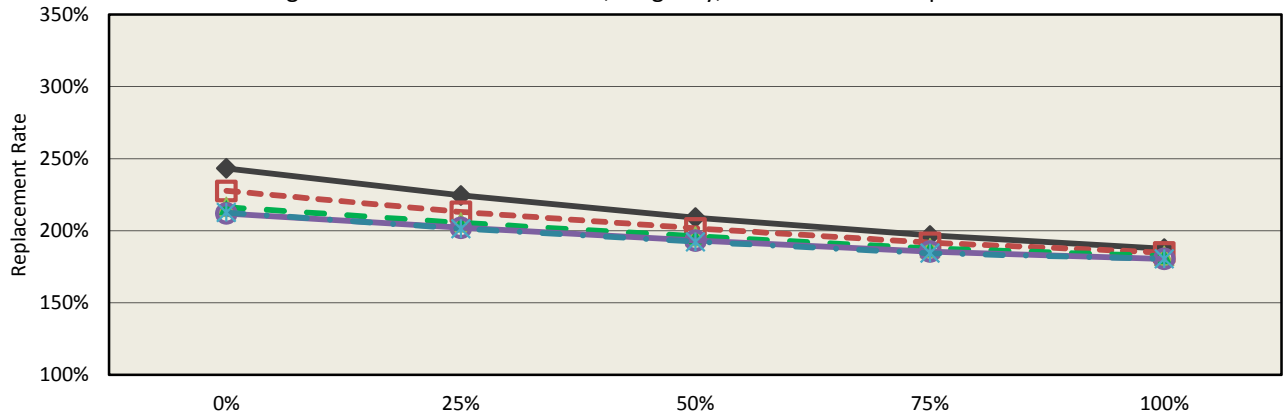
Building Block 3: Investment income, longevity, and health care expenses stochastic



**B. Replacement Rates Required for a 75% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Lowest Income Category*

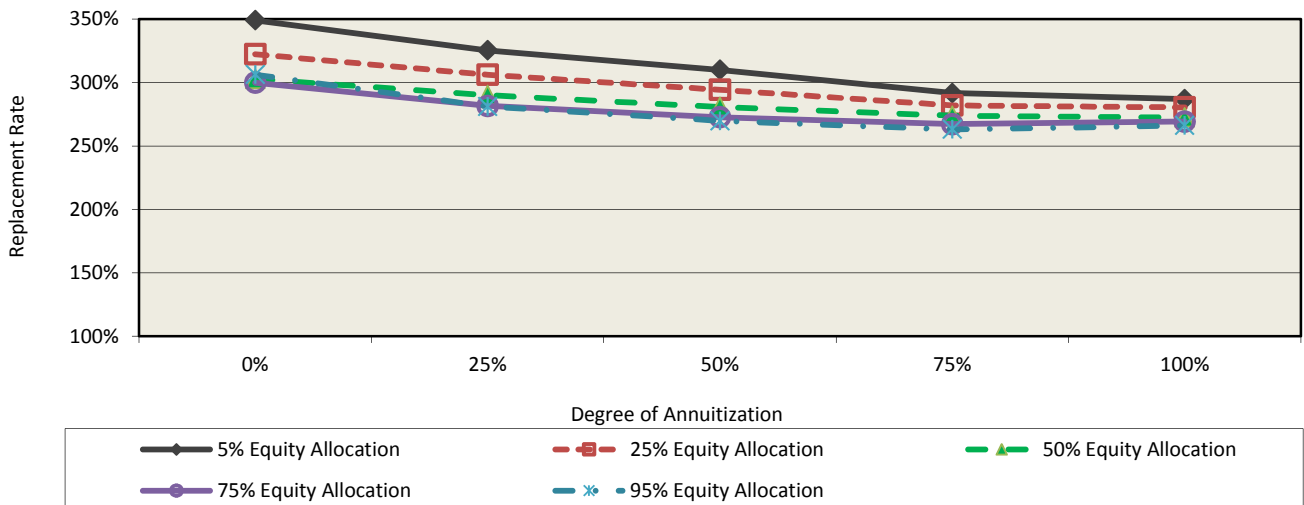
Building Block 3: Investment income, longevity, and health care expenses stochastic



**C. Replacement Rates Required for a 90% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Lowest Income Category*

Building Block 3: Investment income, longevity, and health care expenses stochastic



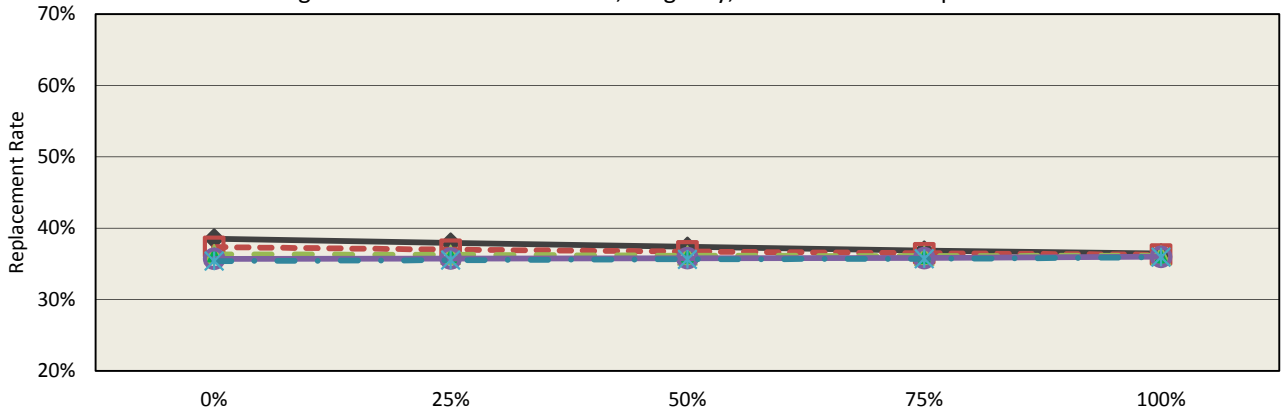
Source: Simulations from Ballpark E\$timate Monte Carlo, Employee Benefit Research Institute.

Figure 10

**A. Replacement Rates Required for a 50% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Highest Income Category*

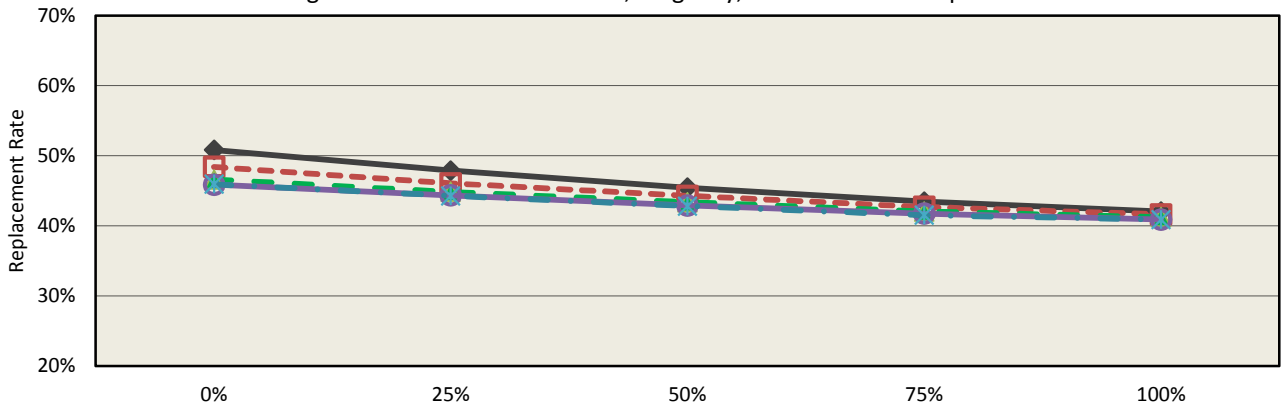
Building Block 3: Investment income, longevity, and health care expenses stochastic



**B. Replacement Rates Required for a 75% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Highest Income Category*

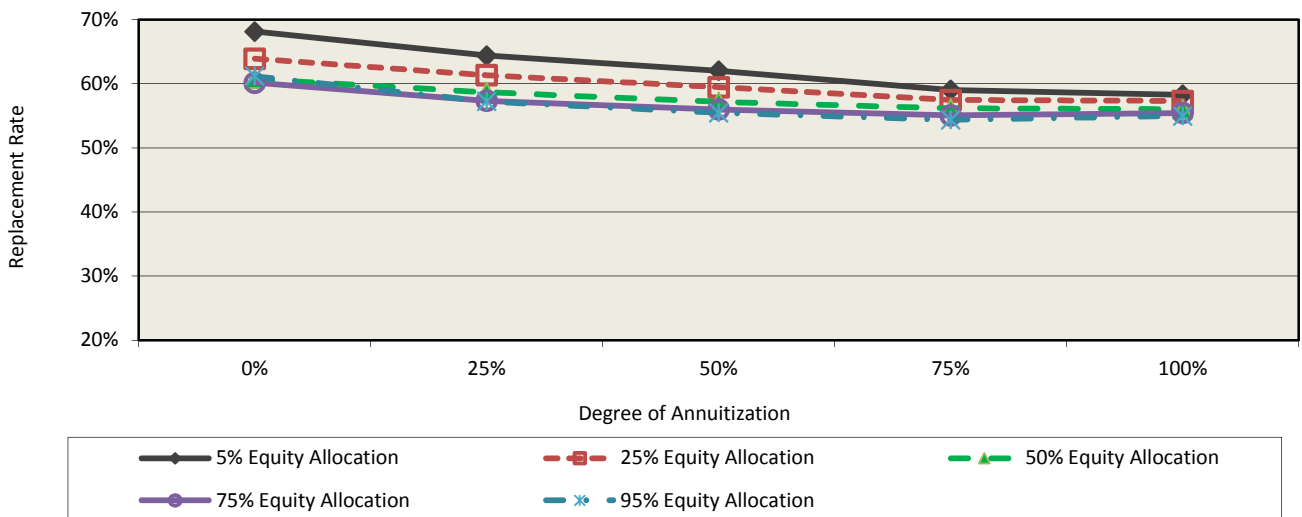
Building Block 3: Investment income, longevity, and health care expenses stochastic



**C. Replacement Rates Required for a 90% Chance of "Adequacy"**

For: Males Retiring at Age 65 in the *Highest Income Category*

Building Block 3: Investment income, longevity, and health care expenses stochastic



Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

**Figure 11**  
**Impact of Final Earnings on Probability of "Adequate" Retirement Income,**  
**by Income Category, Equity Allocation, and Annuitization**

For: Males Retiring at Age 65

Building Block 3: Investment income, longevity, and health care expenses stochastic

Income Category	Probability of % of Equity Adequacy	% of Equity Investment	Annuitization					Income Category	Probability of % of Equity Adequacy	% of Equity Investment	Annuitization				
			0%	25%	50%	75%	100%				0%	25%	50%	75%	100%
1	50%	5%	16.1	15.6	15.1	14.6	14.3	3	50%	5%	3.7	3.6	3.5	3.4	3.3
		25%	15.1	14.8	14.6	14.4	14.2			25%	3.5	3.4	3.4	3.3	3.3
		50%	14.2	14.1	14.1	14.1	14.1			50%	3.3	3.3	3.3	3.3	3.3
		75%	13.7	13.7	13.8	13.8	14.0			75%	3.2	3.2	3.2	3.2	3.2
		95%	13.4	13.6	13.7	13.7	13.9			95%	3.1	3.1	3.2	3.2	3.2
	75%	5%	26.3	23.8	21.8	20.1	18.9	75%	75%	5%	6.3	5.7	5.2	4.8	4.6
		25%	24.2	22.3	20.8	19.4	18.5			25%	5.8	5.4	5.0	4.7	4.5
		50%	22.7	21.3	20.0	18.9	18.2			50%	5.5	5.1	4.8	4.5	4.4
		75%	22.1	20.8	19.6	18.6	18.0			75%	5.3	5.0	4.7	4.5	4.3
		95%	22.2	20.7	19.5	18.5	18.0			95%	5.3	5.0	4.7	4.4	4.3
90%	5%	40.2	37.1	35.1	32.6	32.0	90%	90%	5%	10.4	9.7	9.1	8.5	8.4	
	25%	36.7	34.5	33.0	31.4	31.2			25%	9.5	9.0	8.6	8.2	8.2	
	50%	34.1	32.4	31.2	30.3	30.1			50%	8.8	8.4	8.1	7.8	7.9	
	75%	33.7	31.3	30.1	29.4	29.7			75%	8.6	8.0	7.8	7.6	7.7	
	95%	34.5	31.2	29.7	28.9	29.3			95%	8.7	8.0	7.7	7.4	7.6	
2	50%	5%	5.8	5.6	5.4	5.3	5.2	4	50%	5%	2.5	2.4	2.4	2.3	2.2
		25%	5.4	5.3	5.2	5.1	5.1			25%	2.4	2.3	2.3	2.3	2.2
		50%	5.1	5.1	5.0	5.0	5.0			50%	2.2	2.2	2.2	2.2	2.2
		75%	4.9	4.9	4.9	4.9	5.0			75%	2.2	2.2	2.2	2.2	2.2
		95%	4.8	4.9	4.9	4.9	5.0			95%	2.1	2.1	2.1	2.2	2.2
	75%	5%	10.0	9.0	8.2	7.6	7.3	75%	75%	5%	4.1	3.8	3.4	3.2	3.0
		25%	9.1	8.5	7.8	7.4	7.1			25%	3.8	3.5	3.3	3.1	2.9
		50%	8.6	8.1	7.6	7.2	7.0			50%	3.6	3.4	3.2	3.0	2.9
		75%	8.4	7.9	7.4	7.1	6.8			75%	3.5	3.3	3.1	2.9	2.8
		95%	8.4	7.8	7.4	7.0	6.8			95%	3.5	3.3	3.1	2.9	2.8
90%	5%	16.8	15.7	14.8	13.9	13.7	90%	90%	5%	6.4	5.9	5.6	5.2	5.1	
	25%	15.4	14.6	13.9	13.2	13.3			25%	5.9	5.5	5.3	5.0	5.0	
	50%	14.3	13.6	13.1	12.7	12.8			50%	5.5	5.2	5.0	4.9	4.8	
	75%	13.8	13.1	12.7	12.3	12.6			75%	5.4	5.0	4.8	4.7	4.8	
	95%	14.0	12.9	12.4	12.1	12.4			95%	5.5	5.0	4.8	4.6	4.7	

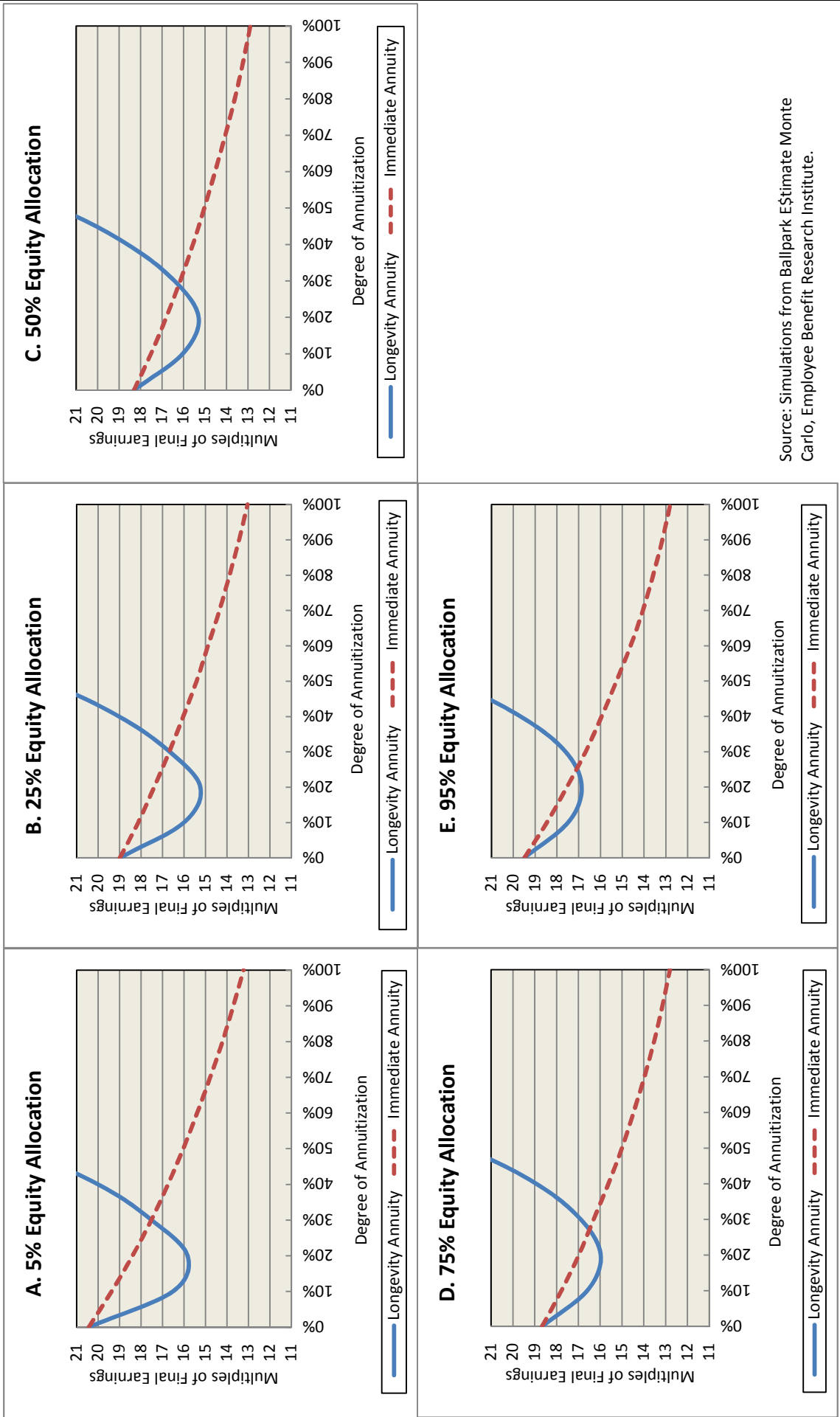
Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

Figure 12

## Multiple of Final Earnings for a 90% Chance of Adequacy: Immediate and Longevity Annuities

For: Males Retiring at Age 65 in the *Lowest Income Category*

Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



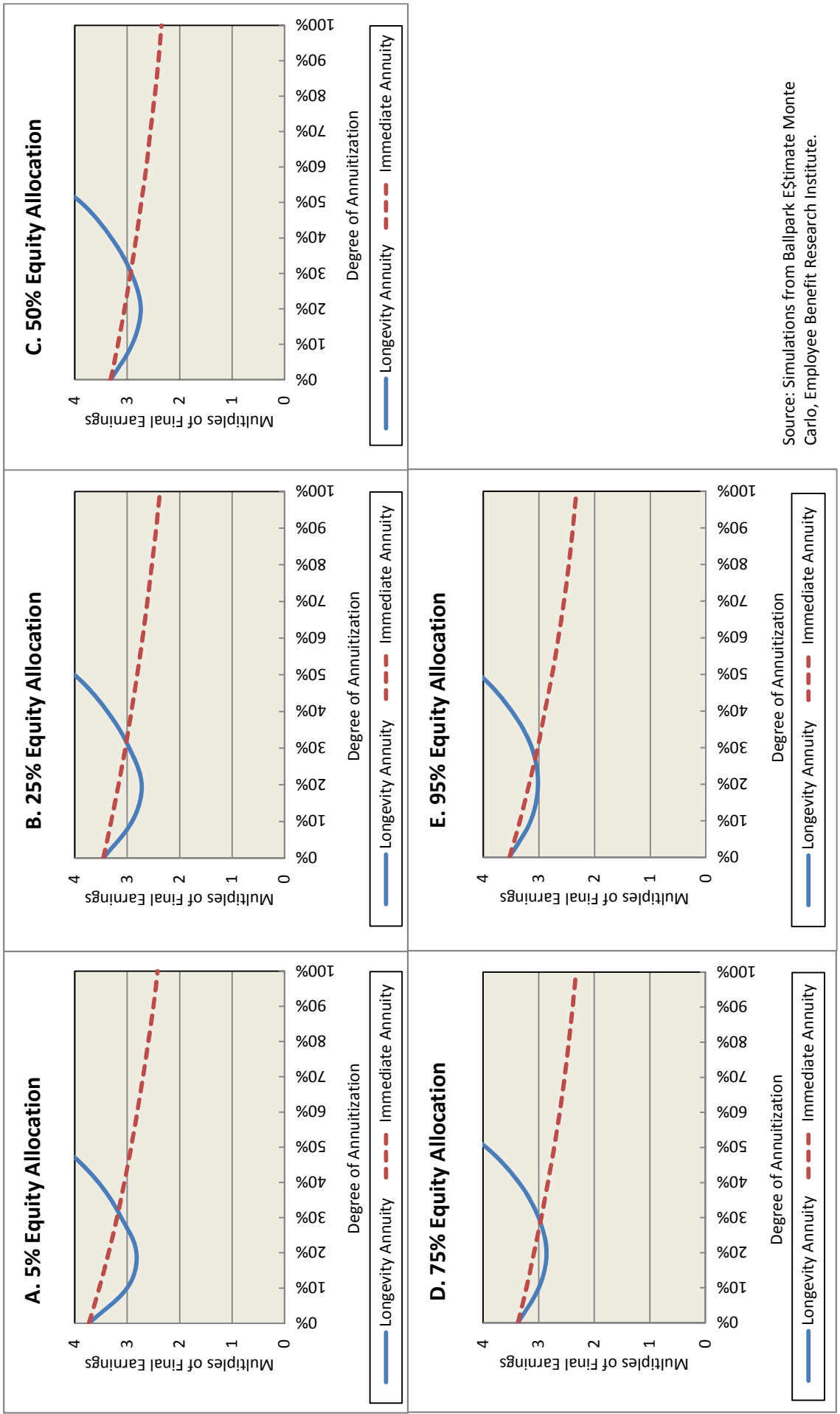
Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

Figure 13

### Multiple of Final Earnings for a 90% Chance of Adequacy: Immediate and Longevity Annuities

For: Males Retiring at Age 65 in the *Highest Income Category*

Building Block 2: Investment income and longevity stochastic, health care expenses deterministic



Source: Simulations from Ballpark EStimate Monte Carlo, Employee Benefit Research Institute.

Figure 14

**Multiple of Final Earnings for a 90% Chance of Adequacy,  
by Equity Allocation and Annuitization With Longevity Annuity**

Building Block 2: Investment income and longevity stochastic, health care expenses deterministic

**A. Males retiring at age 65 in the *lowest income category*: Final earnings of \$16,932**

		Annuitization With Longevity Annuity						
		0%	5%	10%	15%	20%	25%	30%
Equity Allocation	5%	20.43	18.16	16.51	15.63	15.83	16.54	17.51
	10%	19.99	17.87	16.33	15.47	15.62	16.30	17.25
	15%	19.64	17.63	16.17	15.36	15.44	16.12	17.01
	20%	19.28	17.42	16.06	15.27	15.34	15.92	16.80
	25%	18.99	17.22	16.01	15.24	15.24	15.80	16.65
	30%	18.75	17.13	15.98	15.22	15.18	15.71	16.54
	35%	18.57	17.04	15.95	15.24	15.18	15.62	16.45
	40%	18.40	17.04	15.95	15.27	15.18	15.62	16.42
	45%	18.28	17.04	15.98	15.33	15.21	15.65	16.39
	50%	18.28	17.04	16.03	15.40	15.30	15.68	16.42
	55%	18.28	17.07	16.09	15.50	15.39	15.74	16.45
	60%	18.34	17.13	16.18	15.62	15.53	15.86	16.51
	65%	18.43	17.25	16.30	15.77	15.65	15.95	16.63
	70%	18.52	17.36	16.45	15.92	15.80	16.09	16.77
	75%	18.67	17.53	16.60	16.09	15.98	16.21	16.89
	80%	18.84	17.69	16.77	16.30	16.15	16.42	17.04
	85%	19.05	17.87	16.97	16.51	16.36	16.60	17.19
90%	19.25	18.04	17.22	16.74	16.63	16.77	17.39	
95%	19.49	18.31	17.48	16.98	16.86	17.01	17.60	

**B. Males retiring at age 65 in the *highest income category*: Final earnings of \$103,584**

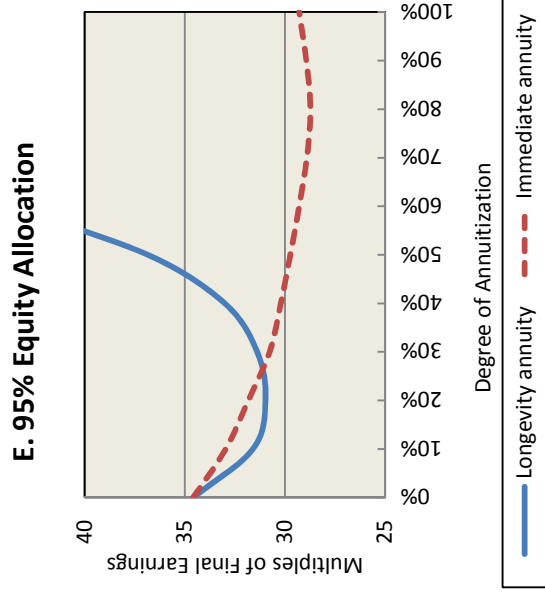
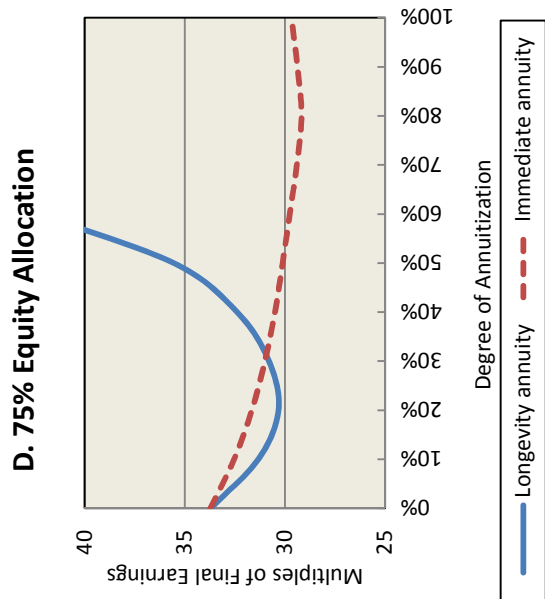
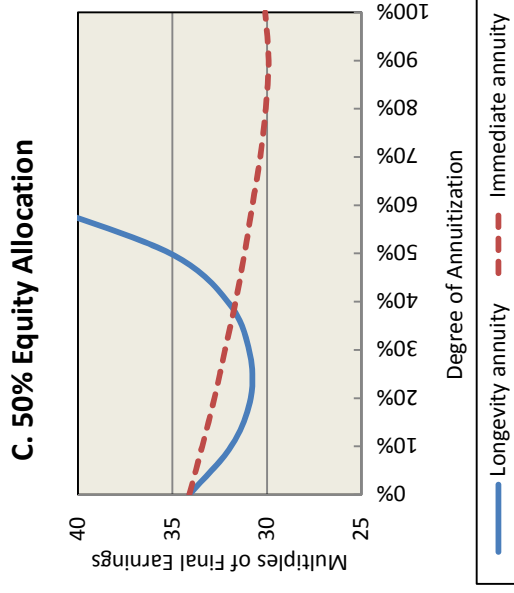
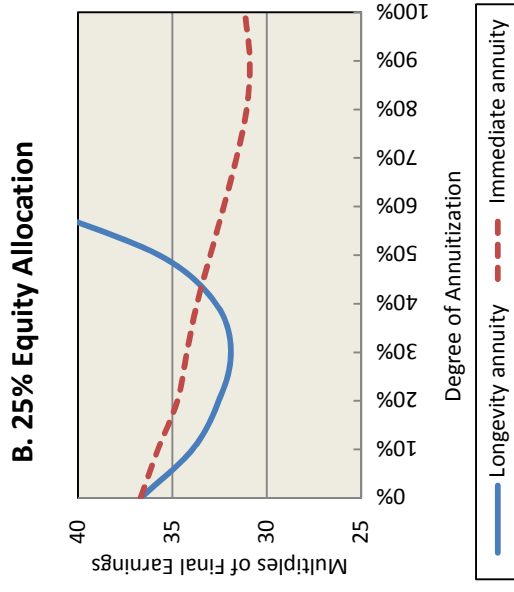
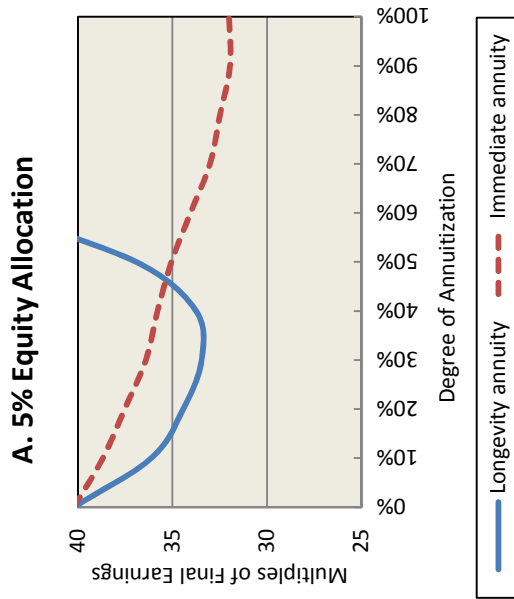
		Annuitization With Longevity Annuity						
		0%	5%	10%	15%	20%	25%	30%
Equity Allocation	5%	3.73	3.31	3.00	2.83	2.82	2.95	3.11
	10%	3.64	3.25	2.97	2.80	2.79	2.91	3.07
	15%	3.58	3.21	2.94	2.78	2.76	2.87	3.02
	20%	3.51	3.17	2.92	2.76	2.74	2.84	2.99
	25%	3.46	3.13	2.91	2.75	2.72	2.82	2.96
	30%	3.41	3.11	2.90	2.75	2.72	2.79	2.93
	35%	3.37	3.09	2.89	2.75	2.71	2.79	2.92
	40%	3.35	3.09	2.89	2.76	2.72	2.79	2.92
	45%	3.33	3.09	2.90	2.77	2.73	2.79	2.92
	50%	3.32	3.09	2.91	2.78	2.74	2.79	2.92
	55%	3.32	3.10	2.92	2.79	2.76	2.80	2.93
	60%	3.32	3.10	2.93	2.81	2.78	2.82	2.93
	65%	3.34	3.12	2.95	2.84	2.80	2.85	2.96
	70%	3.35	3.14	2.97	2.86	2.82	2.87	2.98
	75%	3.37	3.17	3.00	2.89	2.86	2.89	3.00
	80%	3.41	3.20	3.03	2.93	2.89	2.92	3.03
	85%	3.44	3.23	3.07	2.97	2.93	2.95	3.06
90%	3.49	3.27	3.10	3.01	2.97	2.99	3.09	
95%	3.53	3.31	3.15	3.06	3.02	3.04	3.13	

Source: Simulations from Ballpark E\$timite Monte Carlo, Employee Benefit Research Institute.

Figure 15

## Multiple of Final Earnings for a 90% Chance of Adequacy: Immediate and Longevity Annuities

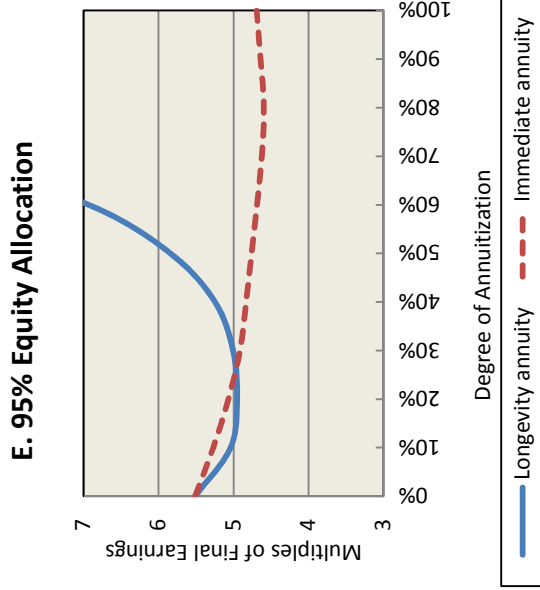
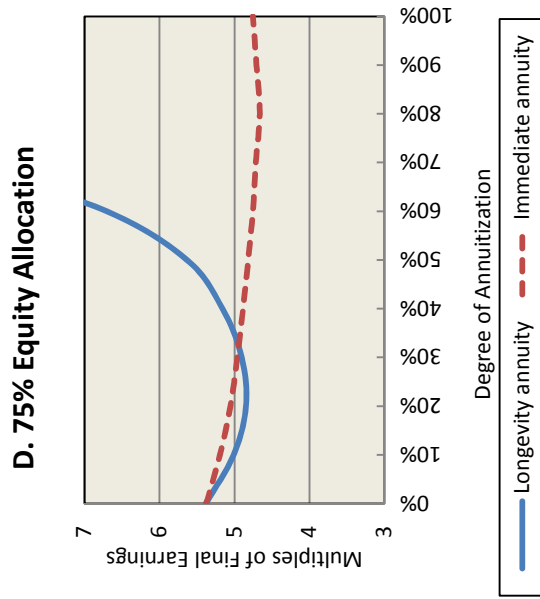
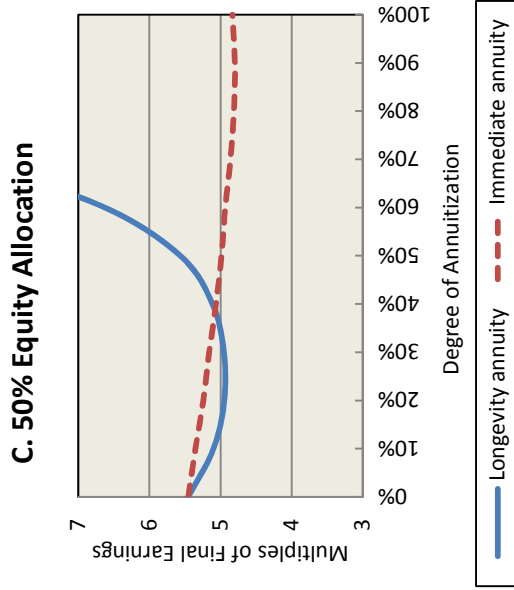
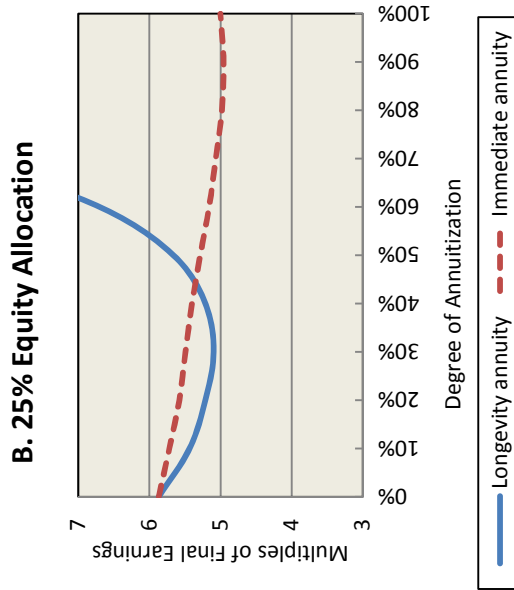
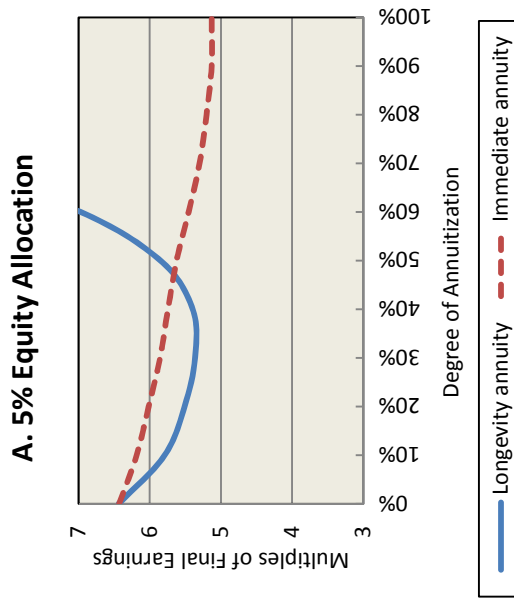
For: Males Retiring at Age 65 in the *Lowest Income Category*  
 Building Block 3: Investment income, longevity, and health care expenses stochastic



Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

# Figure 16 Multiple of Final Earnings for a 90% Chance of Adequacy: Immediate and Longevity Annuities

For: Males Retiring at Age 65 in the *Highest Income Category*  
Building Block 3: Investment income, longevity, and health care expenses stochastic



Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

Figure 17

**Multiple of Final Earnings for a 90% Chance of Adequacy,  
by Equity Allocation and Annuitization With Longevity Annuity**

Building Block 3: Investment income, longevity, and health care expenses stochastic

**A. Males retiring at age 65 in the *lowest income category*: Final earnings of \$16,932**

Annuitization With Longevity Annuity

		0%	5%	10%	15%	20%	25%	30%	35%	40%
Equity Allocation	5%	40.22	37.65	36.12	34.93	34.43	33.75	33.46	33.43	33.75
	10%	39.16	37.03	35.41	34.43	33.69	33.43	33.04	33.01	33.34
	15%	38.18	36.29	34.82	33.78	33.25	32.90	32.60	32.78	32.98
	20%	37.47	35.70	34.31	33.28	32.81	32.51	32.28	32.54	32.87
	25%	36.68	35.14	33.93	32.82	32.54	32.10	31.89	32.19	32.69
	30%	35.94	34.61	33.40	32.39	32.16	31.77	31.60	32.04	32.54
	35%	35.44	34.02	33.01	32.07	31.77	31.45	31.36	31.83	32.34
	40%	35.11	33.58	32.66	31.80	31.39	31.18	31.21	31.63	32.25
	45%	34.58	33.10	32.25	31.48	31.15	30.80	31.15	31.51	32.07
	50%	34.11	32.90	31.89	31.30	30.86	30.62	30.95	31.36	32.07
	55%	33.78	32.57	31.63	31.04	30.59	30.53	30.74	31.30	31.92
	60%	33.63	32.36	31.48	30.93	30.34	30.34	30.70	31.24	32.07
	65%	33.56	32.22	31.39	30.73	30.34	30.34	30.65	31.34	32.08
	70%	33.69	32.13	31.39	30.58	30.34	30.32	30.68	31.39	32.25
	75%	33.72	32.10	31.33	30.62	30.33	30.33	30.80	31.45	32.39
	80%	33.66	32.10	31.36	30.71	30.47	30.50	30.83	31.57	32.48
	85%	33.81	32.22	31.33	30.83	30.53	30.71	30.98	31.80	32.63
90%	34.20	32.34	31.42	31.07	30.83	30.80	31.21	31.92	32.84	
95%	34.56	32.93	31.60	31.15	30.98	31.01	31.39	32.25	33.01	

**B. Males retiring at age 65 in the *highest income category*: Final earnings of \$103,584**

Annuitization With Longevity Annuity

		0%	5%	10%	15%	20%	25%	30%	35%	40%
Equity Allocation	5%	6.43	6.03	5.79	5.60	5.51	5.41	5.36	5.37	5.40
	10%	6.26	5.92	5.68	5.52	5.40	5.35	5.29	5.29	5.33
	15%	6.12	5.81	5.58	5.42	5.33	5.28	5.22	5.24	5.29
	20%	6.00	5.72	5.51	5.32	5.26	5.22	5.16	5.21	5.26
	25%	5.87	5.63	5.44	5.26	5.21	5.14	5.10	5.16	5.21
	30%	5.75	5.54	5.35	5.20	5.15	5.09	5.05	5.12	5.20
	35%	5.66	5.45	5.30	5.13	5.10	5.04	5.02	5.08	5.18
	40%	5.62	5.38	5.24	5.09	5.03	4.99	4.98	5.05	5.15
	45%	5.55	5.30	5.16	5.05	5.00	4.93	4.97	5.03	5.12
	50%	5.45	5.26	5.10	5.00	4.95	4.90	4.95	5.01	5.11
	55%	5.40	5.22	5.06	4.98	4.89	4.88	4.90	5.00	5.10
	60%	5.36	5.18	5.04	4.95	4.86	4.87	4.90	4.99	5.10
	65%	5.37	5.16	5.03	4.91	4.86	4.85	4.90	5.00	5.12
	70%	5.38	5.14	5.02	4.89	4.85	4.84	4.88	5.01	5.14
	75%	5.38	5.13	5.01	4.89	4.85	4.85	4.90	5.02	5.16
	80%	5.36	5.12	5.02	4.89	4.86	4.87	4.91	5.04	5.17
	85%	5.39	5.14	5.02	4.92	4.87	4.90	4.95	5.07	5.20
90%	5.45	5.16	5.02	4.94	4.90	4.92	4.97	5.10	5.22	
95%	5.51	5.23	5.04	4.98	4.95	4.94	5.01	5.13	5.25	

Source: Simulations from Ballpark Estimate Monte Carlo, Employee Benefit Research Institute.

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## Endnotes

<sup>1</sup> Four final earnings categories are constructed based on the 2008 Current Population Survey (CPS).

<sup>2</sup> Net housing wealth, another income source to cover retirement expenditures, is not considered in this analysis. However, it would affect an optimal degree of annuitization, which depends on the assumption of liquidity of housing wealth (see, e.g., Pashchenko (2010)).

<sup>3</sup> The maximum income version of a longevity annuity means that the longevity annuity contract does not provide a death benefit or any withdrawal option before age 85.

<sup>4</sup> From JP Morgan's long-term capital market assumptions, U.S. large cap is used for U.S. equity, EAFE unhedged for Non-U.S. equity, and U.S. aggregate for fixed income. Specifically, the three classes are assumed to have the following returns, volatility, and correlations:

	Expected returns	Volatility	Correlations		
			U.S. equity	Non-U.S. equity	Fixed income
U.S. equity	7.50%	16.25%	1		
Non-U.S. equity	7.75	18.00	0.87	1	
Fixed income	4.50	3.75	-0.03	0.07	1

<sup>5</sup> Based on a report on fees and expenses of mutual funds by Investment Company Institute (Collins, 2010), the *Issue Brief* uses 0.99 percent (the average fees and expenses for stock funds in 2009) as the investment expense for equities and 0.75 percent (the average fees and expenses for bond funds) as the investment expense for fixed income assets.

<sup>6</sup> The 2001 CSO mortality table was introduced by the Society of Actuaries and adopted by the National Association of Insurance Commissioners for life insurance companies to use in underwriting insurance (American Council of Life Insurers, 2009). The forthcoming *Notes* will consider a different mortality table, annuity 2000 mortality table, and compare simulation results with those presented in this article.

<sup>7</sup> A 3.5 percent and a 7.0 percent of growth rates are the average estimated growth rates of Medicare Part B and Part D premiums for 2009–2018, respectively (for more details, see the *2009 Annual Report of the Board of Trustees of the Federal Hospital Insurance and Federal Supplementary Medical Insurance Trust Funds*).

<sup>8</sup> The annual Medigap premium of \$1,479 is the average of the premiums collected from a website of AARP Medicare Supplement Insurance by states.

<sup>9</sup> Out-of-pocket expenditures are \$790 for Category 1, \$833 for Category 2, \$1,012 for Category 3, and \$1,768 for Category 4 in 2008 dollars. For the *Issue Brief*, all the 2008 values were brought forward to 2009 by decreasing the values by 0.4 percent, because annual inflation of 2009 was –0.4 percent.

<sup>10</sup> Actual price quotes at the end of 2009 from the website of [www.immediateannuities.com](http://www.immediateannuities.com) are used as the prices of an immediate annuity.

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<sup>11</sup> NNHS and NHHCS are nationwide sample surveys conducted by the National Center of Health Statistics. The NNHS is a survey of nursing homes, their current residents and discharges, while the NHHCS a survey of home health and hospice care agencies, their current and discharge patients (VanDerhei and Copeland, 2010).

<sup>12</sup> A transition process used in Building Block 3 is well described in Appendix of the July 2010 *Issue Brief* (VanDerhei and Copeland, 2010).

<sup>13</sup> Conditional future states given the current state are randomly generated from the multinomial distribution with parameters equal to the elements of the transition probability matrix at each age.

<sup>14</sup> The *Issue Brief* uses the median monthly cost of nursing home care, which was \$6,444 for the first 30 days and thereafter \$5,434 in 2009 dollars, and the mean monthly cost of home health care, which was \$1,038 in 2009 dollars.

<sup>15</sup> A 5 percent equity allocation indicates that if the sum of the annuitized income from a full annuitization of the initial retirement wealth and amounts paid from Social Security exceeds the simulated expenditures for the year, 5 percent of any excess amount is invested in equities and 95 percent in fixed income assets.

<sup>16</sup> The forthcoming *Notes* will consider different prices of immediate and longevity annuities and compare simulation results with those presented in this article.

<sup>17</sup> In the presence of actuarial unfairness—that is, the expected value of the annuity income, which is discounted by an interest rate and annual survival probabilities, is less than the premium paid; However, Gong and Webb (2010) argue that the retiree would prefer a longevity annuity to the full annuitization with an immediate annuity.

<sup>18</sup> This result is very much in line with the estimation of Webb, Gong, and Sun (2007) that a household would need to allocate about 15 percent of its age 60 wealth to a longevity annuity with payments commencing at age 85.

<sup>19</sup> The exact optimal allocation to the longevity annuity, however, depends on equity allocations of the remaining wealth.

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