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Operating Costs and Aging of Air Force Aircraft

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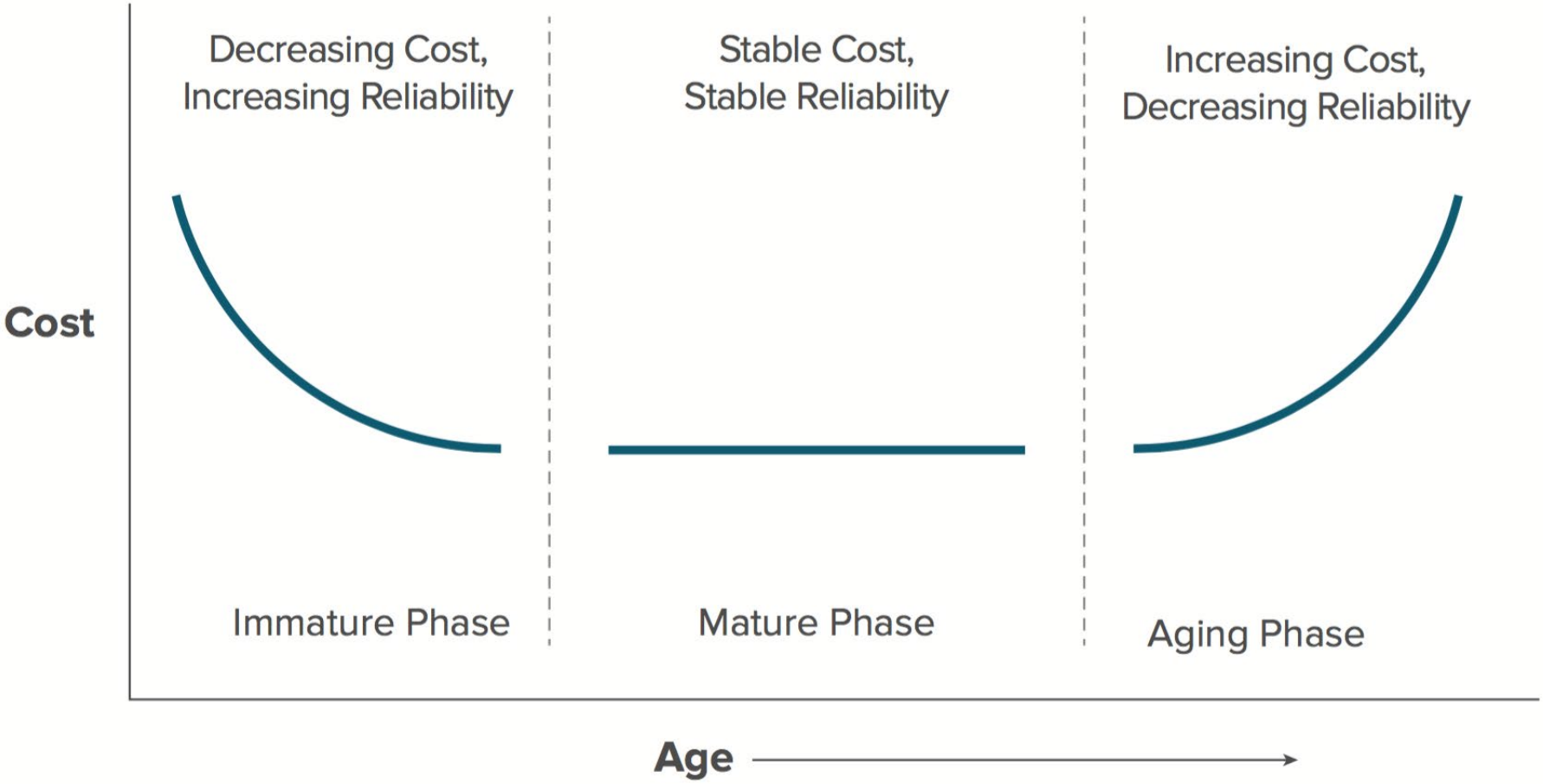
Material in this presentation comes from Congressional Budget Office, *Operating Costs of Aging Air Force Aircraft* (September 2018), www.cbo.gov/publication/54113.

Aircraft operating costs are about double acquisition costs and are thought to depend, at least in part, on age.

Aircraft Operating Costs Are Expected to Decline Initially, Plateau, and Then Increase During a Final Phase of Their Life Cycle



Source: K.R. Sperry and K.E. Burns, *Life Cycle Cost Modeling and Simulation to Determine the Economic Service Life of Aging Aircraft* (October 2001).

Estimates of the operating **cost growth** associated with age using data from the 1990s found little or no association (0 to 3 percent per year), whereas estimates using data from the 2000s found significant real growth as aircraft age (3 to 8 percent per year).

CBO looked to see if there are factors that could explain the higher operating cost growth rates in the recent past.

CBO's Results Explain Divergent Findings From Previous Studies

- Studies based on 1990s data found little or no operating cost growth associated with age
  - LMI (2003) found no age effect
  - CBO (2001) found growth of 1 to 3 percent per year

- Studies based on 2000s data found larger operating cost growth associated with age
  - Keating and Arena (2016) found real growth mostly in the 4 to 8 percent per year range
  - CBO's current study found real growth mostly in the 3 to 6 percent per year range (based on a similar model with age as the only explanatory variable)

See Logistics Management Institute, *The Relationship Among Cost, Age, and Usage of Weapon Systems* (January 2003); Congressional Budget Office, *The Effects of Aging on the Costs of Operating and Maintaining Military Equipment* (August 2001), Appendix B, www.cbo.gov/publication/13213; and Edward G. Keating and Mark V. Arena, "Defense Inflation: What Has Happened, Why Has It Happened, and What Can Be Done About It?" *Defense and Peace Economics*, vol. 27, no. 2 (April 2016), pp. 176–183.

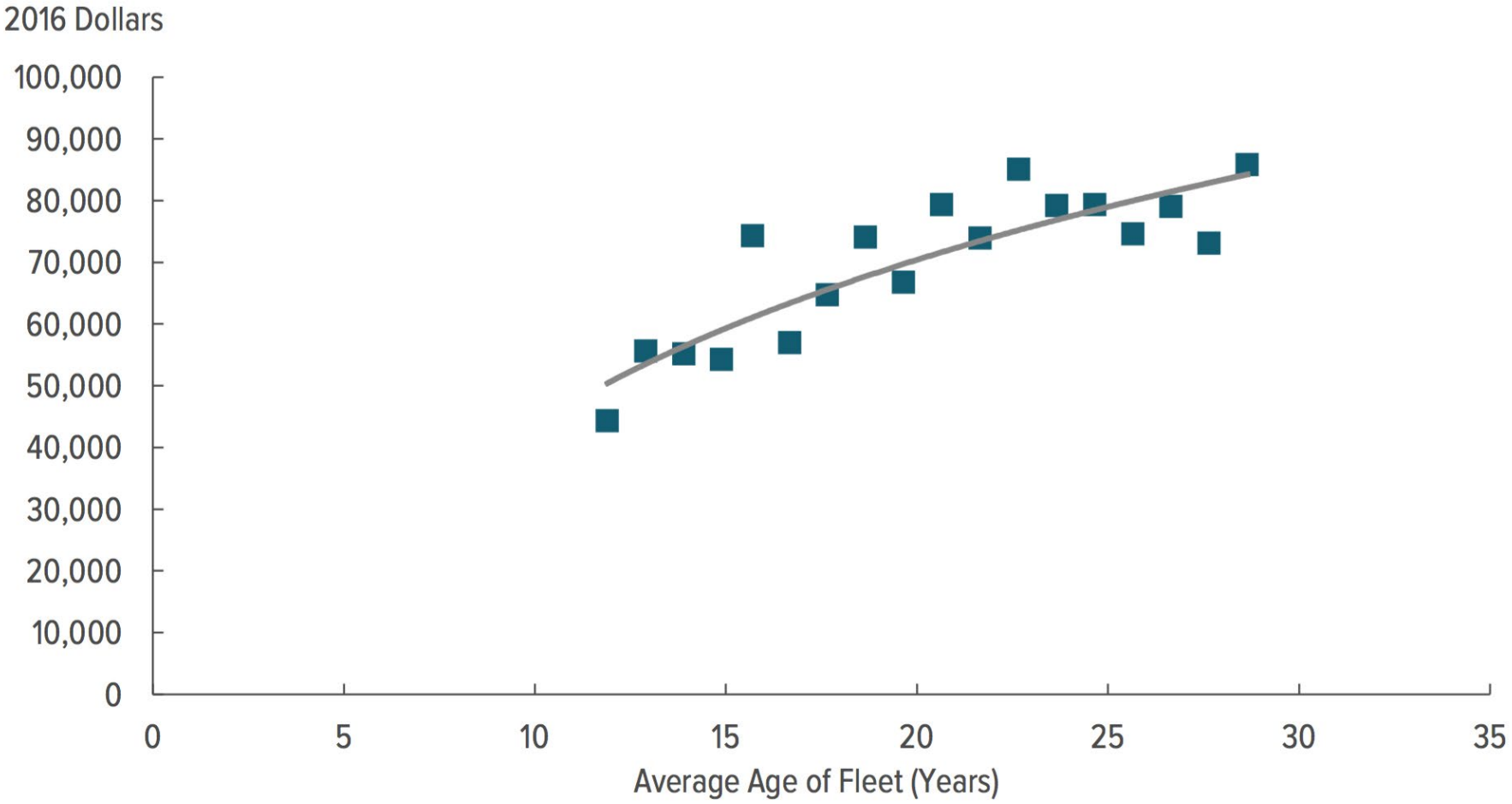
CBO's current study reconciles past studies from different eras by using the size of the Air Force's budget as an additional explanatory variable.

CBO Explored Factors That Could Explain the High Recent Growth in Operating Costs

- CBO used linear regression models to explain the costs per flying hour
- The first model used only age of aircraft as an explanatory variable
- The second model used both age of aircraft and the size of the Air Force's budget as explanatory variables
- CBO used annual AFTOC data from 1999 to 2016 for the B-1, B-52, C-5, C-17, C-130, F-15 A-D, F-15E, F-16, F-22A, HH-60G, KC-135, RQ-4, and U-2; most data are from the mature and aging phases of an aircraft's life cycle

The model that did not account for the budget found results comparable to those from prior research that also used data from the 2000s.

Illustrating CBO's Analysis: B-1 Costs per Flying Hour Generally Increased as the System Aged

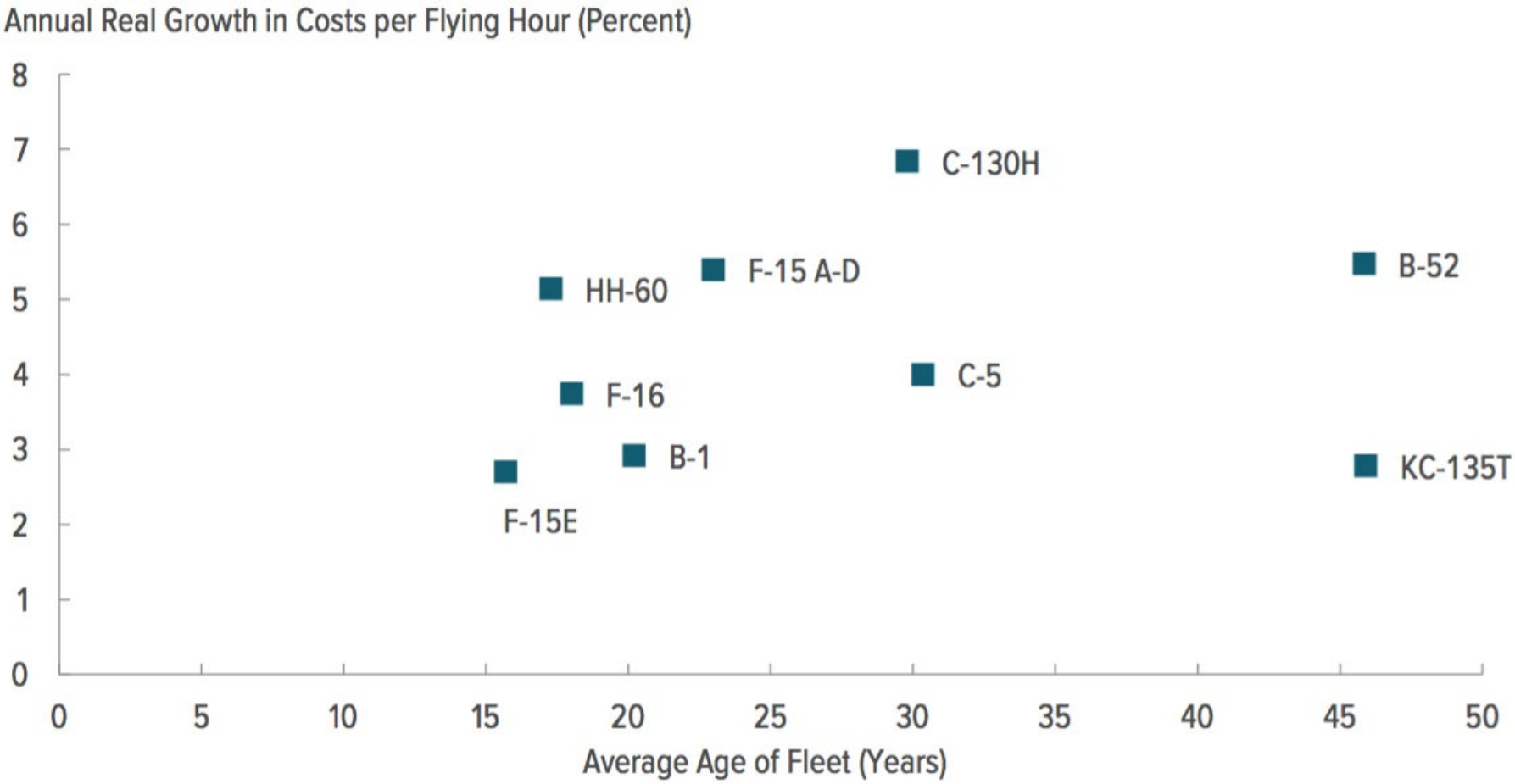


The simple models shows costs rising at about 3 percent per year of age.

Source: Congressional Budget Office, using data from the Air Force.

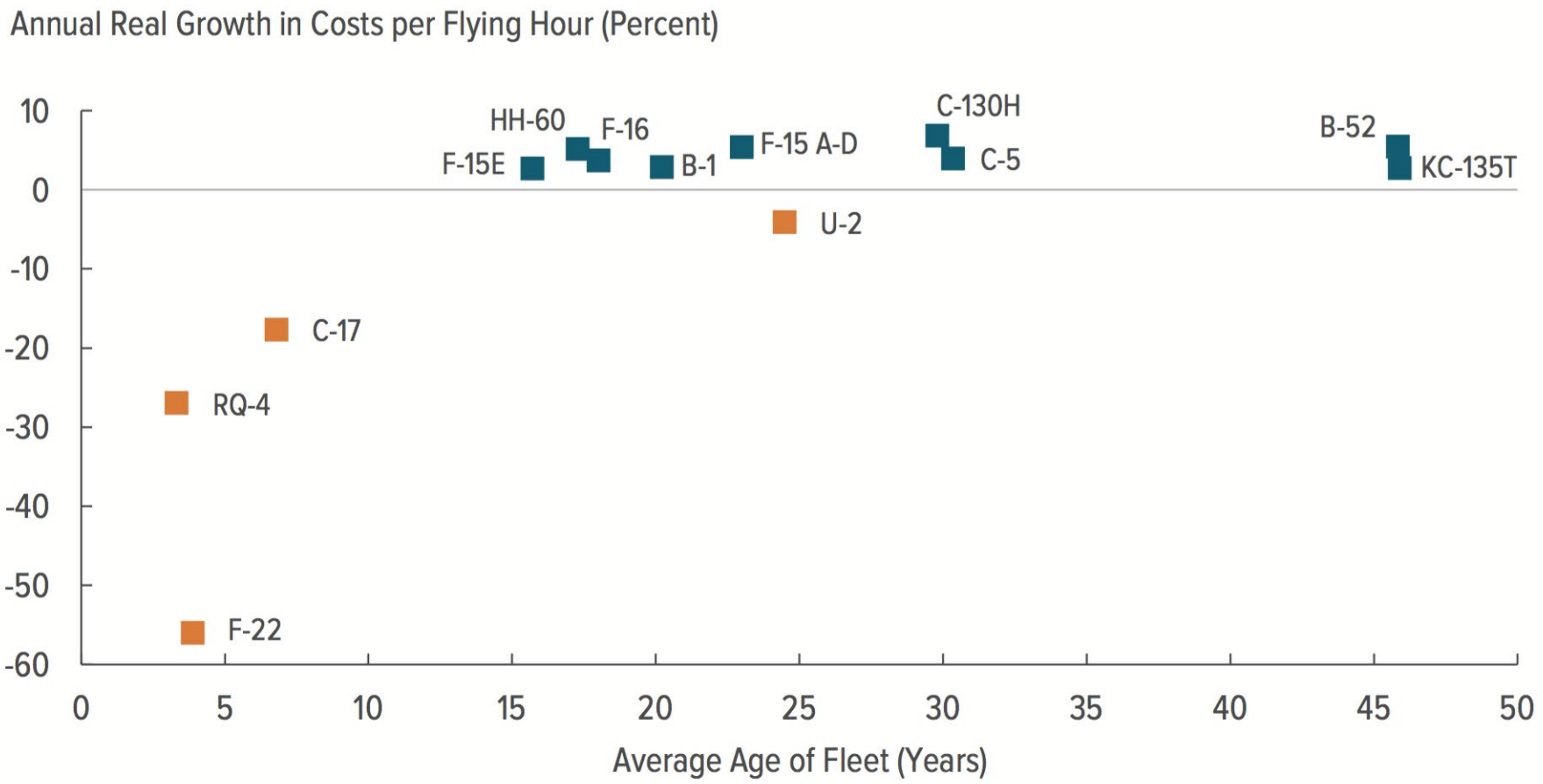
Estimates that did not account for the Air Force's budget show an additional year of age is associated with increases in costs per flying hour, mostly in the range of 3 to 6 percent.

Many Air Force Systems Experienced Sizable But Highly Varying Rates of Increase in Costs



Some aircraft are still in the immature phase and experienced declining costs.

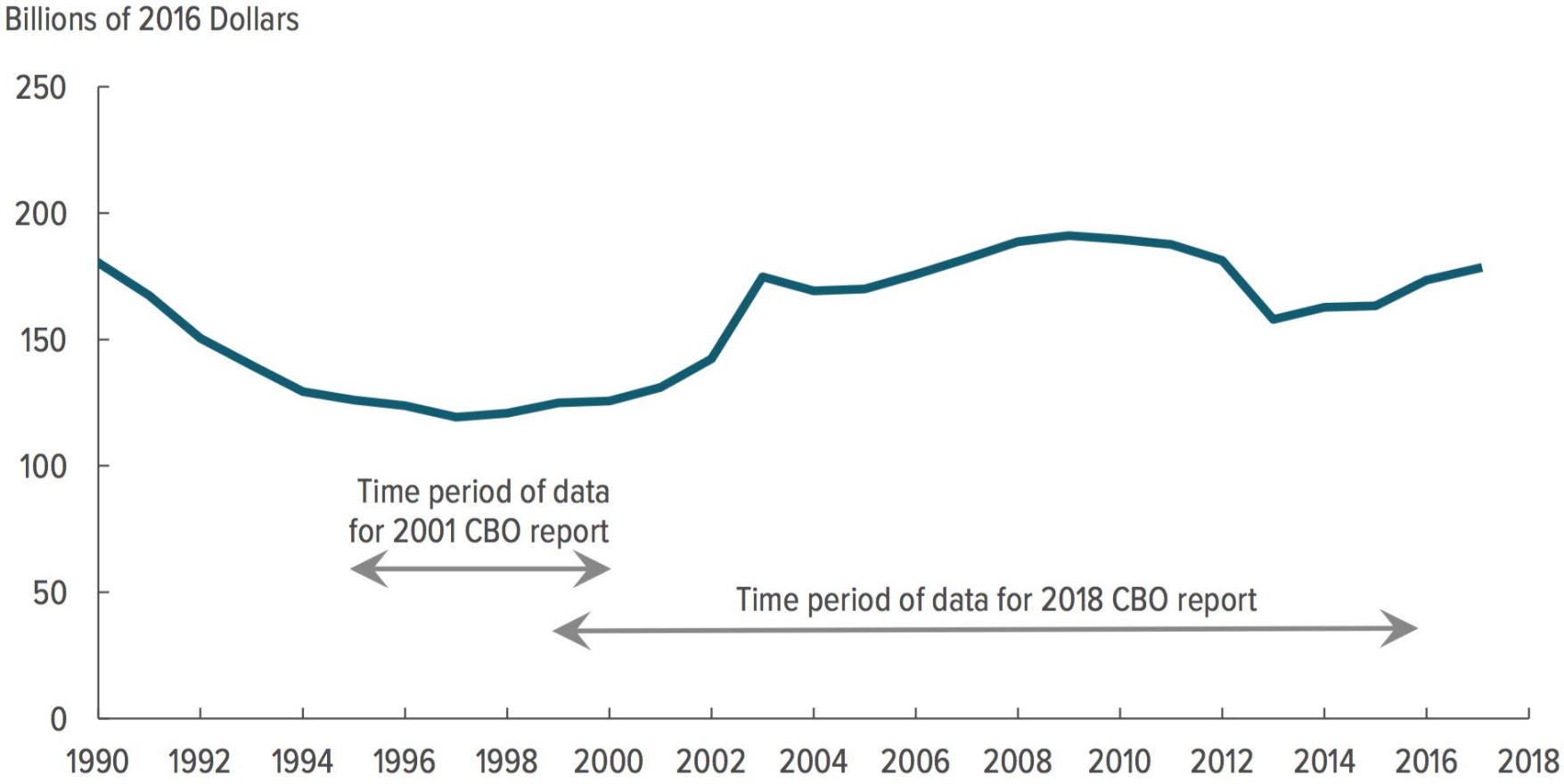
Some Younger Air Force Fleets Experienced Declining Costs per Flying Hour as They Aged



The Air Force's total budget increased significantly between 2000 and 2016.

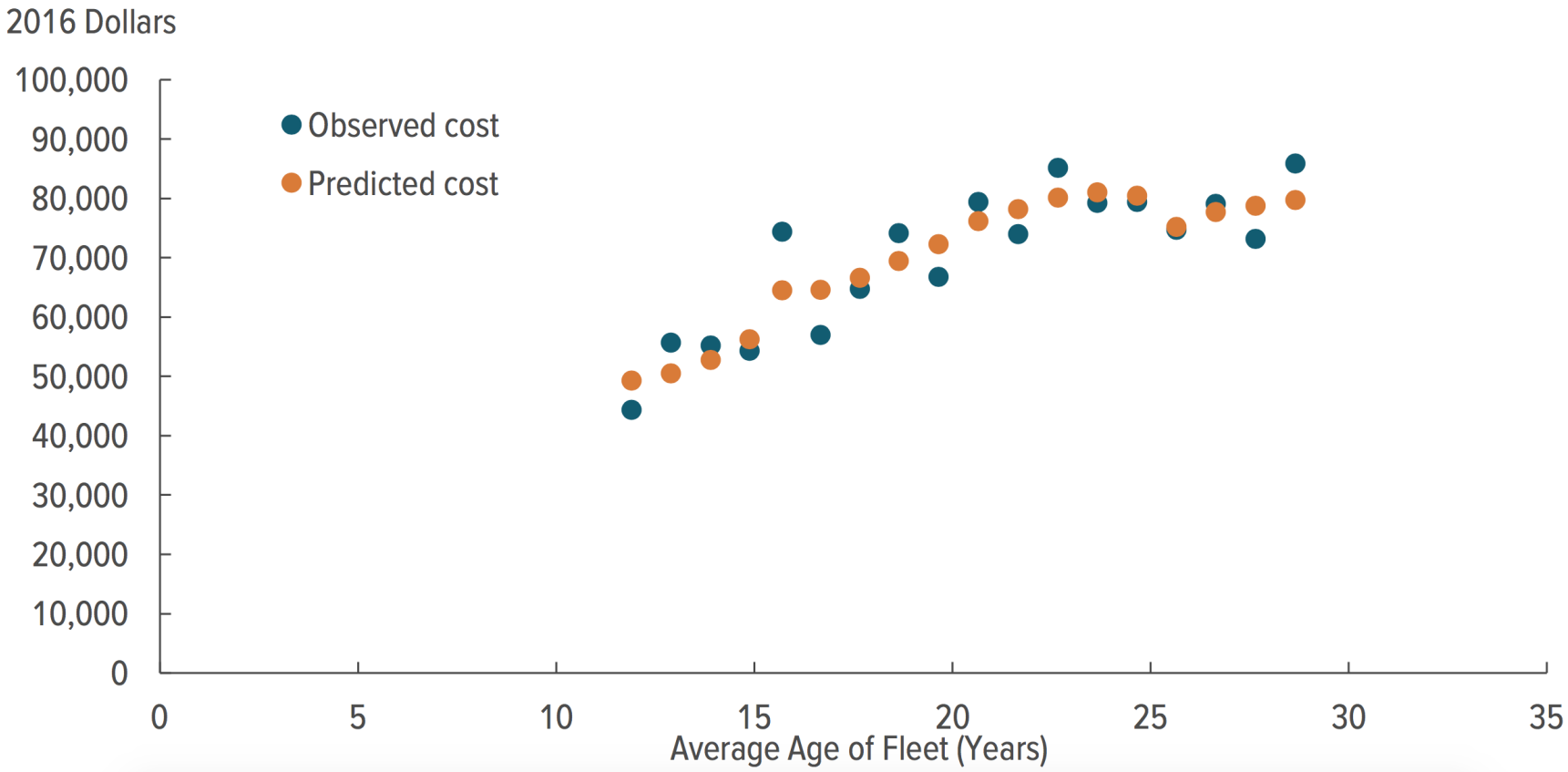
Accounting for that change in budget reduced the association between cost and aircraft age by up to half in the 2000s.

The Air Force's Total Budget Increased Markedly in Real Terms Between 2000 and 2010



The model that accounted for the size of the Air Force's budget found growth rates that were more consistent with those of models based on 1990s data.

The B-1 Model That Included the Air Force's Budget Found a Lower Rate of Growth From Aging

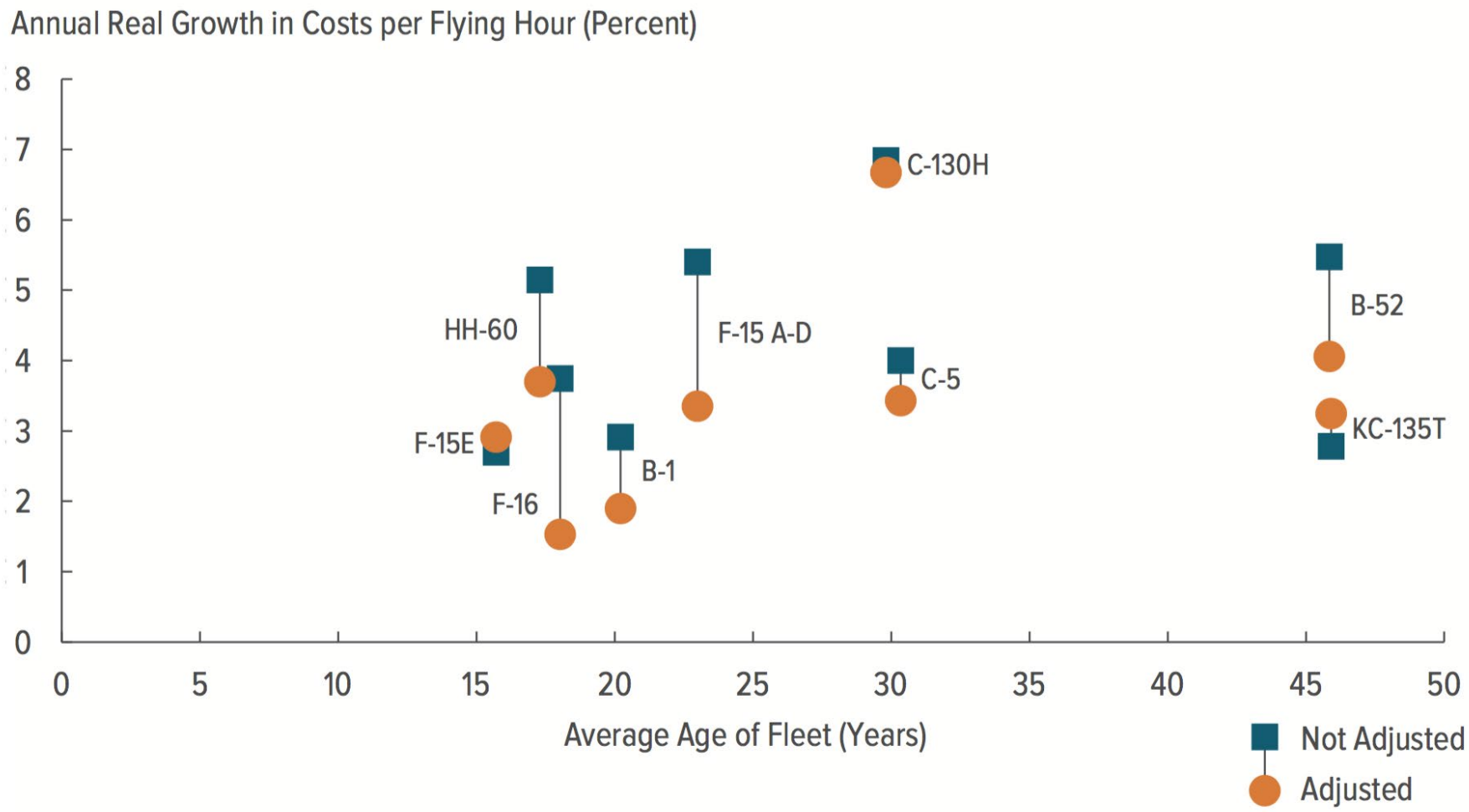


The second model decreases the estimated age effect from 3 percent to 2 percent.

The model that accounted for the Air Force's budget found that the association between aging and cost growth was mostly in the 2 to 4 percent range.

Other factors (such as mission capable rates and the number of hours flown) had smaller associations or were insignificant.

Including the Air Force's Total Budget Generally Reduced the Estimated Age Effect



Additional Information on CBO's Analytical Approach

How CBO Explored Factors That Could Explain the High Recent Growth

1. Measure simple association:

$$\ln\left(\frac{Cost_t}{FH_t}\right) = \alpha + \beta \times Age_t$$

2. Use an enhanced regression accounting for the budget:

$$\ln\left(\frac{Cost_t}{FH_t}\right) = \alpha + \beta \times Age_t + \gamma \times Budget_t$$

3. Examine various aircraft types:
   - B-1, B-52, C-5, C-17, C-130, F-15 A-D, F-15E, F-16, F-22A, HH-60G, KC-135, RQ-4, and U-2
   - Use annual AFTOC data from 1999 to 2016 (most data are from the mature or aging phases of an aircraft's life cycle)

Cost = annual operating cost; FH=flying hours, age = average age, in years; t=year; budget = Air Force Total Obligation Authority.

Regression Results for the Simple and Enhanced Models

	Estimated Coefficient for the Simple Model (Standard Error)		Estimated Coefficient for the Enhanced Model (Standard Error)		
Aircraft	**Intercept**	**Age**	**Intercept**	**Age**	**Air Force Budget[a]**
			Aircraft in the Aging Phase		
B-1	10.55 **	**0.029** **	10.13 **	**0.019** **	3.94 **
	(0.10)	(0.005)	(0.13)	(0.004)	(1.00)
B-52	8.47 **	**0.055** **	8.25 **	**0.041** **	5.52 **
	(0.33)	(0.007)	(0.26)	(0.007)	(1.54)
C-130H	8.44 **	**0.068** **	8.37 **	**0.067** **	6.51 **
	(0.10)	(0.005)	(0.18)	(0.006)	(1.39)
C-5	9.88 **	**0.040** **	8.83 **	**0.034** **	7.61 **
	(0.21)	(0.007)	(0.40)	(0.006)	(2.54)
F-15 A-D	8.94 **	**0.054** **	8.53 **	**0.034** **	5.92 **
	(0.14)	(0.006)	(0.14)	(0.006)	(1.16)
F-15E	9.93 **	**0.027** **	10.01 **	**0.029** **	3.10 *
	(0.13)	(0.008)	(0.14)	(0.010)	(1.65)
F-16	9.11 **	**0.037** **	8.21 **	**0.015** **	8.38 **
	(0.18)	(0.010)	(0.23)	(0.009)	(1.59)
HH-60	9.22 **	**0.051** **	8.58 **	**0.037** **	5.63 *
	(0.16)	(0.009)	(0.27)	(0.009)	(2.07)
KC-135T	8.36 **	**0.028** **	8.43 **	**0.032** **	-1.82
	(0.25)	(0.005)	(0.25)	(0.006)	(1.45)
U-2	8.36 **	**-0.041** **	11.98 **	**0.034** **	-2.88
	(0.25)	(0.007)	(0.24)	(0.008)	(1.84)
			Aircraft in the Immature Phase		
C-17	18.83 **	**-0.177** **	8.79 **	**-0.099** **	-6.42
	(0.08)	(0.011)	(1.10)	(0.015)	(1.83)
F-22	15.05 **	**-0.561** **	29.83 **	**-0.744** **	-83.00 *
	(0.79)	(0.176)	(5.90)	(0.162)	(32.63)
RQ-4	12.28 **	**-0.273** **	3.35	**-0.349**	51.76
	(0.68)	(0.188)	(7.14)	(0.395)	(36.58)

* = p value of less of than 0.1; ** = p value of less than 0.01. The dependent variable is ln(Cost/Flying Hour).