

Oh, That New Car Smell!

When do Ownership Costs justify a New Car's Expense?

Each year, you face an awful decision: sell your car and buy a new one;

$$-C_{\text{bought}} + C_{\text{old}} - C_{\text{transact}} - C_{\text{maint}|b't} - C_{\text{failure}|b't} + \delta V_{\text{bought}+1}$$

You pay a huge amount for your new(er) ride, Get something back for the old one, less transaction costs enjoying lower maintenance costs & minimal failure risk, knowing that in a year you'll have an almost-as-new car.

Or keep your car, facing increased maintenance costs and risk of failure.

$$-C_{\text{maint}|old} - C_{\text{failure}|old} + \delta V_{\text{old}+1}$$

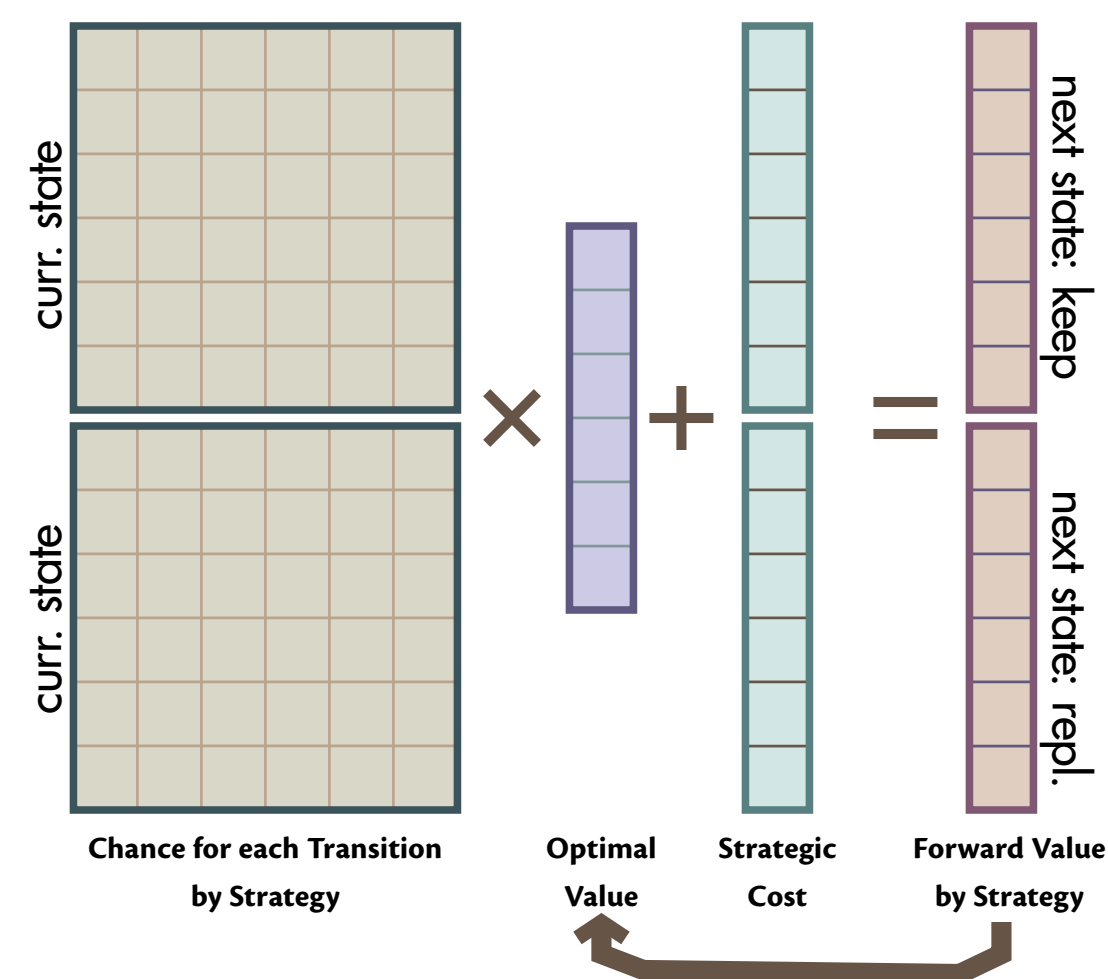
or suffer high maintenance costs and failure rate, choosing again next year with an even older car

Either way, your car is in no way a positive-dollar-value asset, but rather a life sentence of penury and obligation to minimize (Optimal Control!)

$$V_a = \max \begin{cases} -C_{a,I} + \delta P_{a \rightarrow b, I} \cdot V_b & \text{strategy I} \\ -C_{a,II} + \delta P_{a \rightarrow b, II} \cdot V_b & \text{strategy II} \\ \vdots \\ -C_{a,N} + \delta P_{a \rightarrow b, N} \cdot V_b & \text{strategy N} \end{cases}$$

V_a Optimal Value (better guess): Total Lifetime Forward Value of a car in state a .
 $C_{a,s}$ Strategic Cost: Costs incurred by following strategy s from state a
 δ Discount Factor: Converts next year's dollars into this year's.
 $P_{a \rightarrow b, s}$ Transition Matrix: chance for entering each forward state b under strategy s
 V_b Optimal Value (lucky guess): state b 's forward value if yo,adopt an optimal strategy.

Each year's decision depends on the following year's value, which then depends on that next decision and its value, depends on that next decision and its value, depends on that next decision and its value, ...

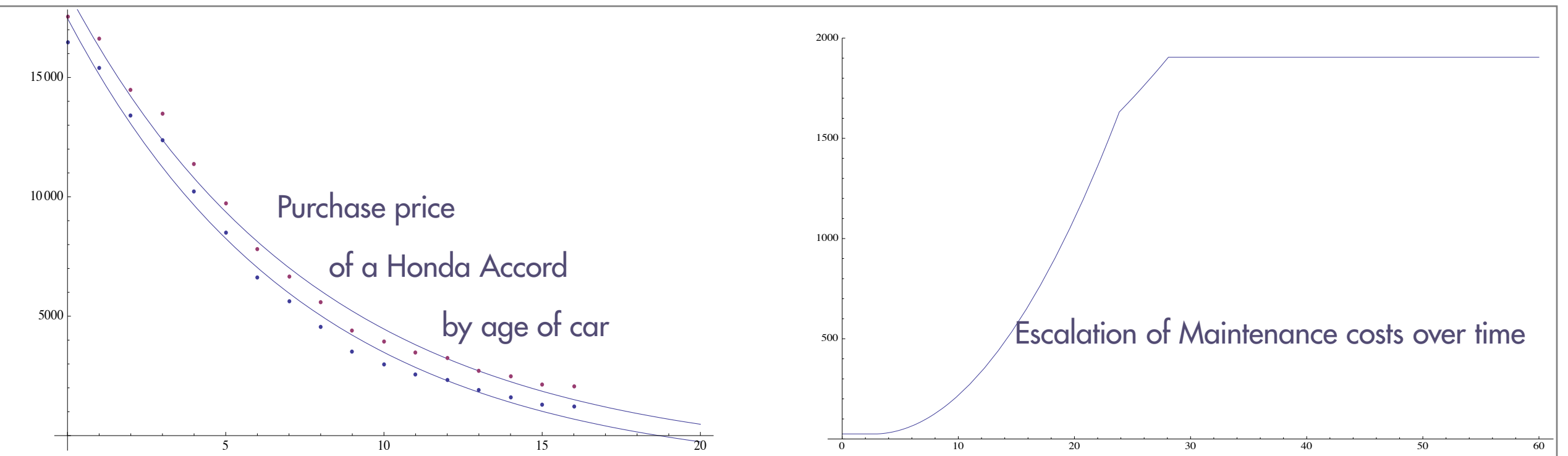


The optimal strategy is to choose, for each year, the cell in the "forward value" (RHS) vector that gives the best (least bad) future value.

- * This shows 2 choices: buy a one-year-old 'new' car, or keep your old one. We let you buy in at any year: the stack of matrices is really 100 high.
- * Why is the transition matrix a table of numbers and not a simple mapping? Risk! Your strategy says the state you'd like to enter (say, turning your 5-yr old car into a 6-yr old car), but real life can intervene and present you with no car at all (the $+C_{\text{old}}$ above is coerced to zero, modeled with an extra state).

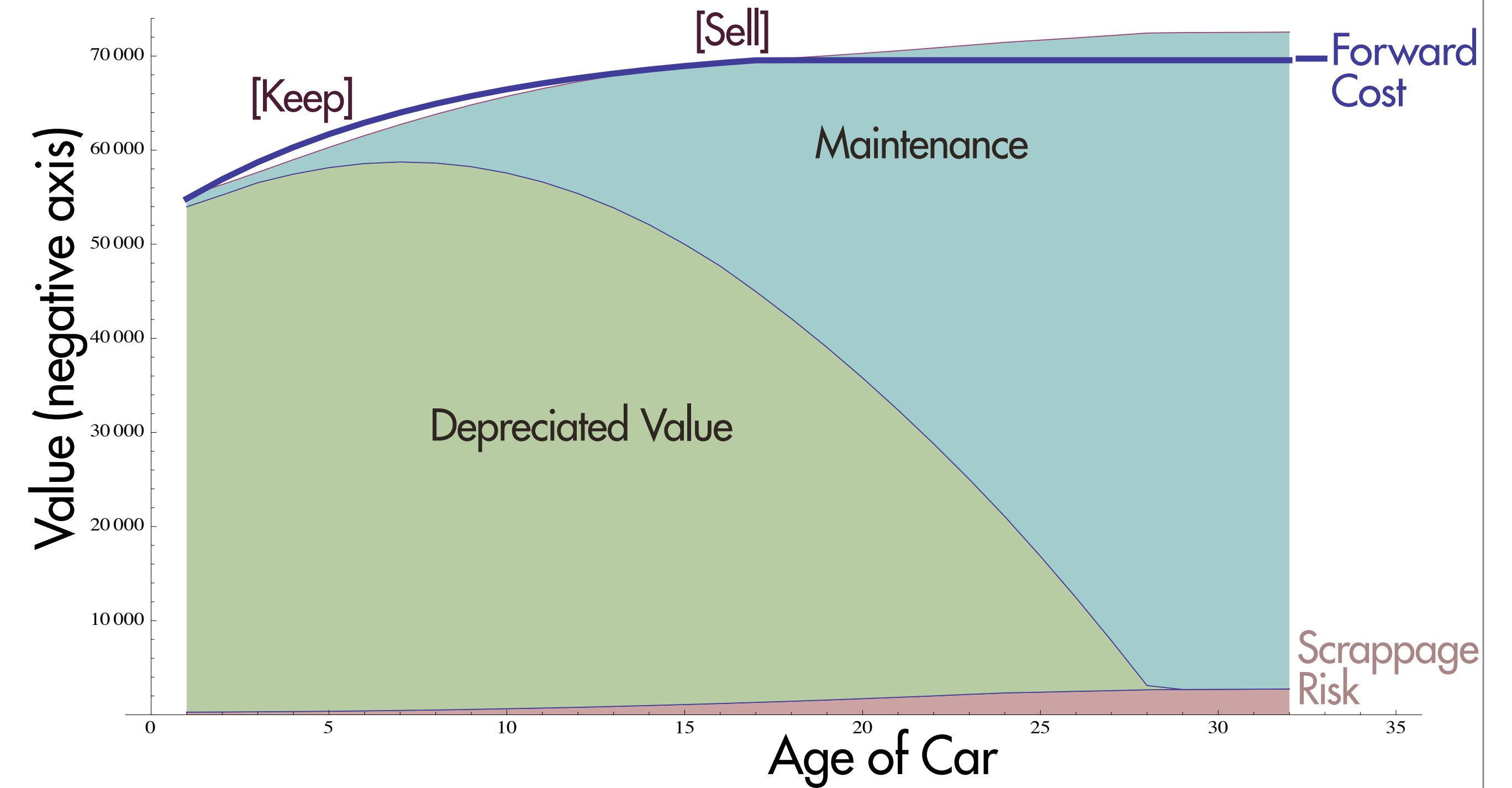
Each time we solve this forward equation, our estimate improves.

(This, like most sensibly-constructed optimal control problems, is guaranteed to converge.)

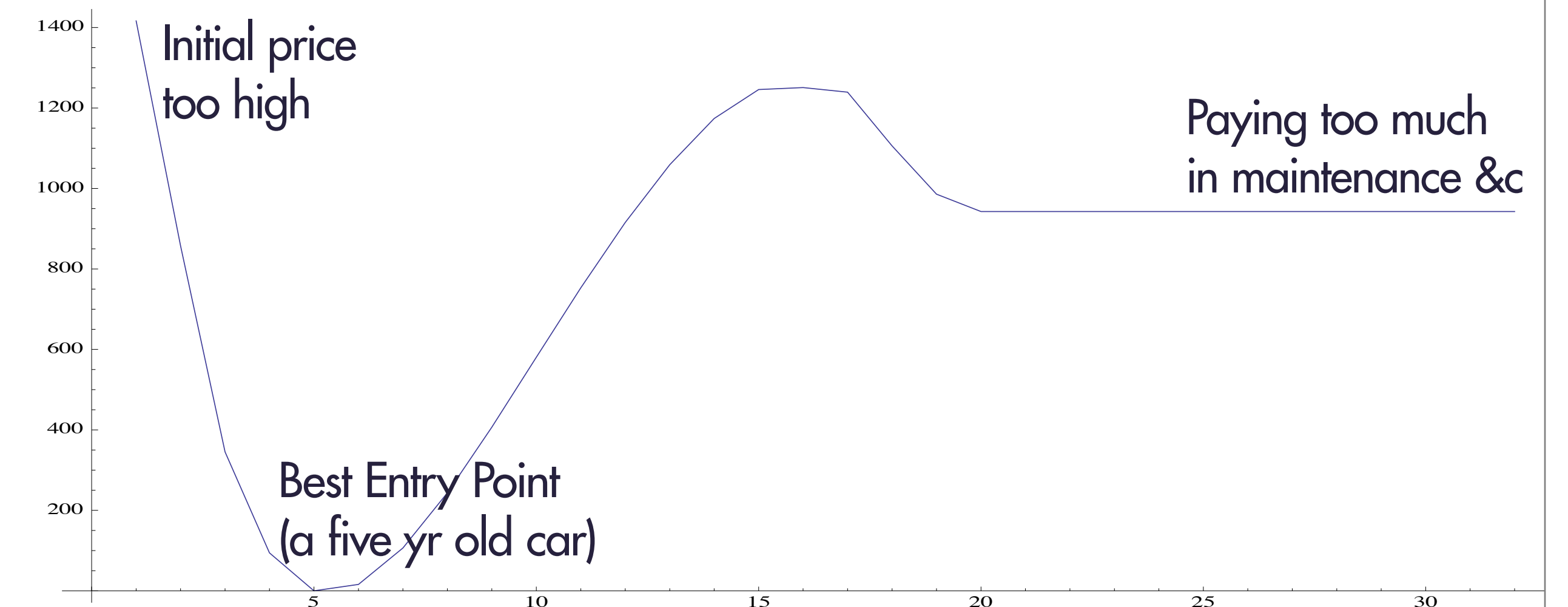


Assumed: Scrappage rate ~ 5% of Failure rate; Lost Wages: 1/3 day/failure @ \$36,000/yr; Transaction costs: undersell to dealer, or spend time meeting buyers instead of work or fun.

Sell when Real Yearly Costs exceed Forward Cost of Ownership



Re-enter the market where the Forward-Current Gap is Largest



Akerlof, George A., "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism. The Quarterly Journal of Economics, The MIT Press., 1970. Judd, Kenneth L., Numerical Methods in Economics, The MIT Press., 2002. Miranda, Mario J. and Fackler, Paul L., Applied Computational Economics and Finance, The MIT Press., 2002. "Are Lemons Really Hot Potatoes?," Stern, Hartmann and Engers "Automobile Maintenance Costs, Used Cars, and Adverse Selection," Stern, Hartmann and Engers "Mileage Drives Used Car Prices," Stern, Hartmann and Engers <http://www.people.virginia.edu/~sns5r/resint/empiofstf/empio.html> Graph of Death Rates for Imports and for Domestic taken from 5 Stern's website: http://www.people.virginia.edu/~sns5r/resint/empiofstf/selection_giffiles/deathpaths/