eAppendix

The “long-run average cost” (LAC) and the “long-run average cost net of cost offsets” (LACnet) concepts can be formulated mathematically as follows. Define a “drug” as a dosage or formulation sold by a particular manufacturer. Further, define t as the number of periods after the molecule’s loss of exclusivity. Define p_{jt} as the real transaction cost of buying drug j, t periods from the loss of exclusivity date. Define N_{jt} as the quantity (fills or users) of drug j utilized in period t.

Before we define the LAC, we begin by defining the average market price of the molecule sold in period t. We compute this by observing all prices paid for the molecule in period t and calculating the market-share weighted average of all these prices, as in

$$P_t \equiv \left\{ \sum_j \frac{N_{jt}}{\sum_j N_{jt}} \frac{p_{jt}}{p_{j0}} \right\}.$$

This expression gives us the average price at a point in time. We calculate LAC as the weighted average of these market prices P_t, weighted according to how much of the drug was used in each period, and appropriately discounted. Define the one-year discount factor as β, in the sense that consumption delayed by one year is worth $\beta < 1$ as much as consumption enjoyed today. LAC is then given by:

$$LAC = \sum_t \sum_j p_{jt} \frac{\beta^t N_{jt}}{\sum_j \sum_t \beta^t N_{jt}}$$

We assume that the social discount factor is equal to the real rate of interest. Essentially, this assumes that society discounts consumption at the same rate that it discounts money overall. The long-run real interest rate has been estimated at 3%, so we use ($\beta = 1 - 0.03 = 0.97$) as our one-year discount factor.

We next incorporated medical cost offsets to our analysis. Defining c_{jt} as the costoffset associated with drug j in period t. Even though it would be desirable to estimate this term for every point in the drug’s lifecycle, the variation in cos -offsets over time is not reliably estimated in the existing literature. Therefore, we make the simplifying assumption that medical cost offsets are constant in absolute value. We focus on estimating the average value of medical costs saved per prescription filled. Defining this cost offset parameter as *c*, the LAC-net for the molecule is then defined as:

$$LAC_{\mathbf{net}} = \sum_t \left[\sum_j (p_{jt} - c) \frac{\beta^t N_{jt}}{\sum_j \sum_t \beta^t N_{jt}} \right].$$

Notice that cost offsets were treated equivalently to price reductions in the sense that a permanent one dollar increase in the price has the same effects as a one dollar cost offset. Also, the LAC (or LAC-net) is intimately connected to the long-term value of a new molecule. In particular, if LAC for a particular drug *j* exceeds the value per unit of that drug, the drug then generates positive value to patients, and vice-versa. Defining v_j as the monetized value of each unit of drug, *j* yields the following equations*:*

The consumer surplus associated with the use of drug *j* is equal to:

$$CS_j = \sum_t \beta^t v_j N_{jt} - \sum_t \beta^t p_{jt} N_{jt}$$

Observe that $CS_j > 0$ if and only if:

$$v_j > \frac{\sum_t \beta^t p_{jt} N_{jt}}{\sum_t \beta^t N_{jt}} = \sum_t p_{jt} \frac{\beta^t N_{jt}}{\sum_t \beta^t N_{jt}} \equiv LAC_j$$

Thus, whether or not patients benefit from drug *j* depends not on the price at launch, but rather on a measure of the lifetime price of that drug, known as LAC_j. Finally, note one useful feature of the lifetime price —it is insensitive to how we normalize the measurement of time. That is, the point at which we begin discounting has no effect.[8]