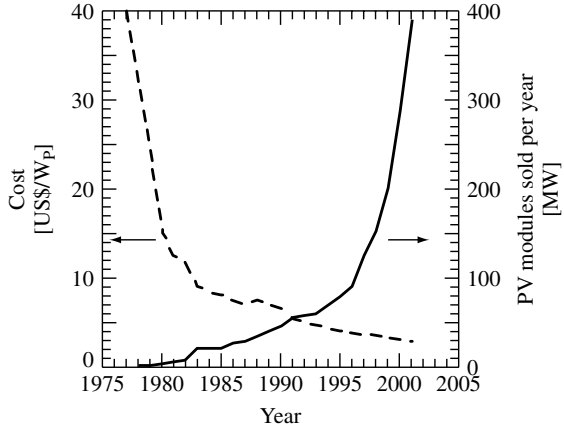

Figure 1.5 Historical trends of cost per Watt for solar cells and volume of production. Data from various sources. Beware: these costs are for PV modules not completed systems, which typically increase by a factor of 2 to 3

costs are spread over the relatively few units sold. The high price excludes most buyers except unique niche applications (i.e. remote telecommunications transmitters, where the unique properties of photovoltaics makes it the most appropriate source of electricity) government-sponsored programs (i.e. satellites, weather monitoring stations, military outposts and also human development programs in remote areas including water pumping), and curious wealthy pioneers (i.e. private homes in the mountains for environmentally concerned millionaires). As volume production increases, costs fall as economies of scale take over. The technology is now within economic reach of wider markets and demand grows rapidly as people with moderate incomes can afford the product. Eventually, the decrease in price slows, and it becomes harder to improve the cost and performance of a given product. But each small decrease in cost opens up larger markets and applications. Once a certain price is reached, a massive new market will open up with ample opportunity for investors to finance new manufacturing capacity.

This relation between cumulative production of PV modules in MW_P *(M)* and price in $/$W_P$ *(p)* can be described by an experience curve, which is characterized by a parameter E called the experience exponent [51, 52] or

$$\frac{p(t)}{p_0} = \left[\frac{M(t)}{M_0}\right]^{-E} \tag{1.1}$$

where M_0 and p_0 are the cumulative market and the price at an arbitrary initial time $t = 0$ (that we can take at the beginning of the early commercialization). The experience curve for photovoltaics is shown in Figure 1.6 where lowest price per W_P for a given year is plotted against the cumulative module production up to that year. When graphed as a log–log plot, it is the slope that is of significance since it defines the experience factor given as $1–2^{-E}$. This quantity indicates how much costs are reduced for every doubling of cumulative production. Figure 1.6 presents an exponent $E = 0.30$ which gives an experience factor of 0.19. Thus, prices have fallen 19% for every doubling in