

● The Nordhaus Model

Nordhaus¹⁵ assumes that once a unique innovator in the competitive innovation industry is granted a patent, the patent confers complete appropriability of the rents. Nordhaus considers nondrastic process innovations that reduce the cost of producing an existing good. There is a positive relationship between R&D expenditures and the output of innovations, and, consequently, an inverse relationship between R&D expenditures and unit production cost. As the innovative effort increases, the incremental returns to R&D, though positive, begin to diminish. Increased R&D brings about a reduction in the unit cost of production of the good. A social welfare or net surplus function, defined as consumers' surplus plus producers' surplus minus resource cost, is formulated for the purpose of determining the optimal patent term. The welfare function is maximized, subject to the profit maximizing innovator's choice of the level of R&D. Welfare maximization results in a solution that yields the optimal patent term as determined by a number of factors.¹⁶

There are three important factors in Nordhaus' social welfare maximizing calculus of optimal patent life: (1) the responsiveness of demand to price changes; (2) the "ease" or "difficulty" of achieving cost reducing innovations; and (3) the gains from competitive imitation.

There are three major conclusions from Nordhaus' model. First, the greater the responsiveness of demand to price reductions, the shorter the optimal patent term. As the demand responsiveness increases, the area of the welfare triangle (the area ABD in Figure 1 above) increases, making society less and less willing to postpone its capture. Second, the easier it is to achieve a given cost reduction, the shorter the optimal patent term will be. When big cost reductions are likely, whether the allowed patent term is modest or long, society is less willing to postpone the realization of its net welfare surplus to motivate still more cost reduction than it would be if the cost savings under comparable patent term conditions and research investments were modest. Third, the smaller the cost reduction induced by an increase in patent term which reduces society's welfare gain by deferring competitive imitation, the shorter the optimal patent term. Nordhaus finds that for easy innovations the socially optimal patent term is shorter than 8 years, whereas for difficult innovations even a 20 year patent term is insufficient.

¹⁵ William D. Nordhaus, 1969, *op. cit.*

¹⁶ A formal analysis of the Nordhaus model is presented in Annex A.