products is sparking renewed interest and investment in the vaccine industry, which had appeared moribund in the 1980s. As one example of this, Chiron's position in the vaccine industry seemed to have been a major factor in Novartis decision to acquire the company in 2005 (6). A second example of growing interest is provided by Pfizer, which had no meaningful presence in the vaccine business until it bought PowderMed Limited, a company focused on DNA vaccine delivery, in 2006 (7).

The remainder of the industry's revenue is attributable to two groups of suppliers: niche players in industrial countries and emerging country suppliers. A small number of primarily domestic suppliers in Europe, North America, and Japan play a minor role in serving small niche markets, for example, for biodefense or travel products. Emerging country suppliers are having a significant impact, serving their domestic markets and other low- and middle-income countries. Eight emerging country suppliers are currently World Health Organization (WHO)-prequalified to supply vaccines to United Nations (UN) agencies and the GAVI Alliance with several more actively seeking WHO prequalification (8).

Financial measures understate the importance of emerging country firms because they supply large volumes of mature or maturing products at relatively low prices. Their primary customers are low- and middle-income countries or UN agencies procuring on behalf of these countries. These companies are now the largest suppliers of most of the mature expanded program on immunization (EPI) vaccines [diphtheria toxoid/tetanus toxoid/whole-cell pertussis (DTwP), tetanus toxoid (TT), measles, BCG], and they are playing a critical role in meeting the demands of the global market estimated at around 10 billion doses. UNICEF noted in 2005 that it was buying 64% of its basic EPI vaccines from developing country suppliers and that annual spend with such suppliers had increased almost 250%, rising from $63 million in 2002 to $146 million in 2005. In addition, emerging country suppliers are broadening their production capabilities and product ranges. A number have licensed or are developing conjugate vaccines, specifically *Haemophilus influenzae* type b vaccines. They have also added quadravalent (DTwP-HepB) and pentavalent (DTwP-HepB-Hib) combination vaccines to their product ranges, some of which are now prequalified by WHO.

Vaccine Pricing

Developing country access to vaccines has been critically dependent on differential pricing (also called tiered pricing, equity pricing, and price discrimination), whereby different prices are charged for the same products in different markets. Under differential pricing, manufacturers charge a much lower price in the poorest developing country markets, allowing these countries access to the product, and charge much higher prices in the industrialized markets, allowing the manufacturer to recoup its research and development expenditures and overheads. Oral polio vaccine (OPV) illustrates the magnitude of the historical tiered pricing. In the 1990s, the highest price at which polio vaccine was offered was, on average, 30 times the lowest price (9)] (Fig. 1). A more recent example is provided by the rotavirus vaccine: Priced at $62.50 per dose in the United States (10), its price to the Pan-American Health Organization (PAHO) is $7.20 per dose (11). This approach to pricing is a common business strategy, practiced in many industries including airlines, which target the business traveler with higher prices by differentiating the product (e.g., open, changeable tickets, no weekend restrictions) and the sales channels (e.g., purchased through a travel agent).

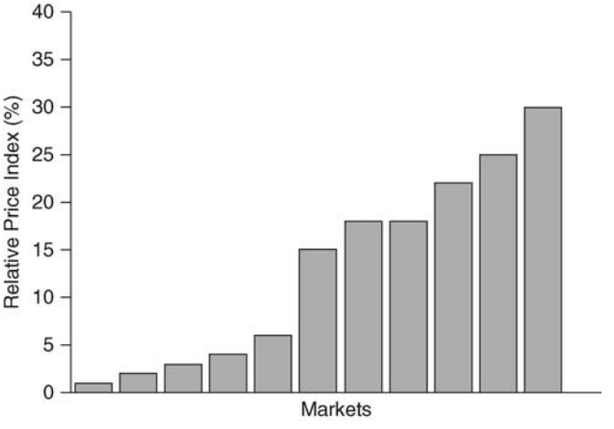

Figure 1 Differential pricing for one vaccine (oral polio vaccine).

Price tiering in the vaccine market has been facilitated by a number of factors. First, both high- and low-income markets historically purchased the same products, allowing manufacturers to recoup their fixed cost investments through higher prices in high-income countries, while enabling them to charge lower prices, covering only direct costs to low- and middle-income countries. Second, excess production capacity existed for several *mature* vaccines, enabling manufacturers to serve more marginal markets without requiring any additional investment. Third, as the majority of costs incurred in vaccine manufacture are relatively fixed (i.e., not related to volume), manufacturers have been able to offer widely differing prices once the core fixed costs are covered. Fourth, pooled procurement of large quantities of pediatric vaccines managed through international agencies such as UNICEF and PAHO procuring on behalf of countries provided defined channels that reinforced the pricing. Finally, the acceptance by both suppliers and governments of different prices for different segments of the market has been critical.

Tiered pricing has, however, also had some less desirable consequences. In comparison with other products and markets, the UNICEF and PAHO market generated little revenue and even less profit for many manufacturers—two key factors driving a company's decision to maintain production lines and invest in R&D and new capacity. Companies had difficulty internally justifying their continued involvement in this *marginal* market. The result was low levels of investment in both vaccine R&D and production capacity to serve the needs of low-income countries. As a consequence, while the tiered pricing model was successful in delivering very low prices for basic pediatric vaccines, it did so at the expense of supply security or rapid access to newer vaccines. The history of tiered pricing provides some warning for the future as the immunization community seeks to accelerate access to the poorest countries. Tiered pricing, and the equity notion underpinning it, can be undermined if the objectives of tiered pricing are too broadly defined, for example,