Technology as a Factor of Production

Apart from differences in the relative availability of labor, capital, and natural resources (stressed by the Heckscher–Ohlin theory) and the existence of economies of scale and product differentiation, dynamic changes in technology among nations can be a separate determinant of international trade.

These are examined by the technological gap and product cycle models.

Since time is involved in a fundamental way in both of these models, they can be regarded as dynamic extensions of the static H–O model.

Technological Gap Model
Introduced by *Posner* in 1961.

A great deal of the trade among industrialized countries is based on the introduction of new products and new production processes.

These give the innovating firm and nation a *temporary* monopoly in the world market.

First, the most technologically advanced nation, produces and exports a large number of new high-technology products.

However, as foreign producers acquire the new technology, they eventually are able to conquer markets abroad, and even the market of the original country where the product was launched, because of their lower labor costs.

In the meantime, producers of the first nation may have introduced still newer products and production processes and may be able to export these products based on the new technological gap established.

A shortcoming of this model, however, is that it does not explain the size of technological gaps and does not explore the reason that technological gaps arise or exactly how they are eliminated over time.

Product Cycle Model
Developed by *Vernon* in 1966.

A generalization and extension of the technological gap model.

When a new product is introduced, it usually requires highly skilled labor to produce.

As the product matures and acquires mass acceptance, it becomes standardized; it can then be produced by mass production techniques and less skilled labor.

Therefore, comparative advantage in the product shifts from the advanced nation that originally introduced it to less advanced nations, where labor is relatively cheaper.

This may be accompanied by foreign direct investments from the innovating nation to nations with cheaper labor.

Vernon also pointed out that high-income and labor-saving products are most likely to be introduced in rich nations because:
(1) the opportunities for doing so are greatest there,
(2) the development of these new products requires proximity to markets so as to benefit from consumer feedback in modifying the product, and
(3) there is a need to provide service.

While the technological gap model emphasizes the time lag in the *imitation* process, the product cycle model stresses the *standardization* process.

According to these models, the most highly industrialized economies are expected to export nonstandardized products embodying new and more advanced technologies and import products embodying old or less advanced technologies.

A classic example of the product cycle model is provided by the experience of U.S. and Japanese radio manufacturers since World War II. Immediately after the war, U.S. firms dominated the international market for radios, based on vacuum tubes developed in the United States. However, within a few years, Japan was able to capture a large share of the market by copying U.S. technology and utilizing cheaper labor. The United States recaptured technological leadership with the development of transistors. But, once again, in a few short years, Japan imitated the technology and was able to undersell the United States. Subsequently, the United States reacquired its ability to compete successfully with Japan by introducing printed circuits.

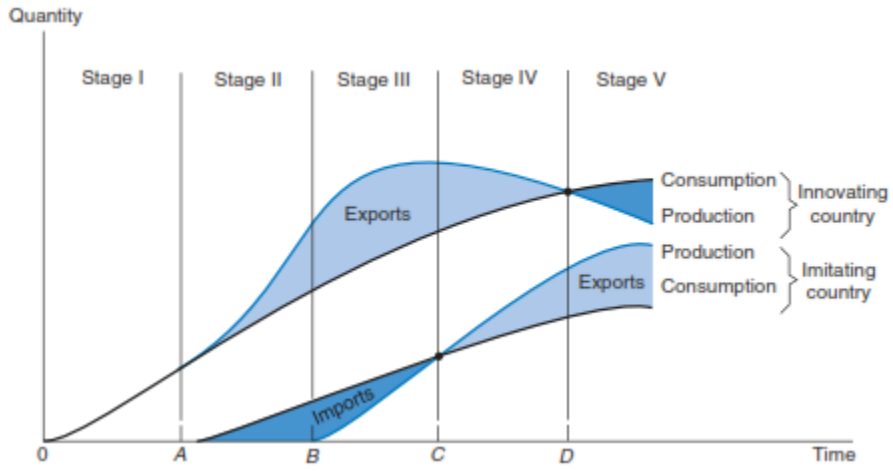
Note that trade in these models is originally based on new technology developed by the relatively abundant factors in industrialized nations (such as highly skilled labor and

expenditures on research and development). Subsequently, through imitation and product standardization, less developed nations gain a comparative advantage based on their relatively cheaper labor. As such, trade can be said to be based on changes in relative factor abundance (technology) among nations over time. Therefore, the technological gap and product cycle models can be regarded as extensions of the basic H–O model into a technologically dynamic world, rather than as alternative trade models. In short, the product cycle model tries to explain *dynamic* comparative advantage for new products and new production processes, as opposed to the *basic* H–O model, which explains *static* comparative advantage.

The product cycle model can be visualized in the following figure, which identifies five different stages in the life cycle of a product from the point of view of the innovating and the imitating country.

In stage I, or new-product phase (referring to time *OA* on the horizontal axis), the product is produced and consumed only in the innovating country.

In stage II, or product-growth phase (time *AB*), production is perfected in the innovating country and increases rapidly to accommodate rising demand at home and abroad. At this stage, there is not yet any foreign production of the product, so that the innovating country has a monopoly in both the home and export markets.



In stage III, or product-maturity phase (time *BC*), the product becomes standardized, and the innovating firm may find it profitable to license other domestic and foreign firms to also manufacture the product. Thus, the imitating country starts producing the product for domestic consumption.

In stage IV (time *CD*), the imitating country, facing lower labor and other costs now that the product has become standardized and no longer requires development and engineering skills, begins to undersell the innovating country in third markets, and production of the product in the innovating country declines. Brand competition now gives way to price competition.

Finally, in stage V (i.e., past point *D*), the imitating country starts underselling the innovating country in the latter's market as well, and production of the product in the innovating country declines rapidly or collapses.

Stages IV and V are often referred to as the product-decline stage. Technological diffusion, standardization, and lower costs abroad thus bring the end of the life cycle for the product. It is now time for the innovating country to concentrate attention on new technological innovations and to introduce new products.

However, the model cannot accurately predict the life cycle of a particular product.