

THE MANY POSSIBLE EXTENSIONS OF PRODUCT CYCLE ANALYSIS

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Introduction

It is a privilege to have been asked to write a brief article commemorating Professor Akamatsu. His insights into product cycle theory have had a major effect on the world's thinking about economic development and policy. His concepts have been particularly useful in helping Western economic analysts understand Japanese industrial development and the Japanese government's industrial policy. Indeed, the power of his insight lies on the one hand in its simplicity and truth, and on the other in its ability to include many complex patterns of development and policy. I wish to address and briefly summarize some of these extensions, which show Professor Akamatsu's originality and the strength of his work.

Basic Product Cycle Theory

Basic product cycle theory postulates that within a given country the production and demand growth of a product can be traced from initial production and demand through a high growth phase to a time of more level growth and finally to decline. The high growth phase is due to the low initial market base and the rapid increase in production and demand. But this growth tapers off as the market for the product saturates and matures. Then as new products are introduced, the demand for the old one may actually decline. As this pattern has been repeated in product after product in many countries and industries, the product-life cycle theory has evolved and is now well-accepted.

Professor Akamatsu's great contribution was to recognize that this life cycle had a particular pattern when applied in an international context, and further, had a particular relevance for industries as a whole. In his "flying geese pattern" he correctly argued that for a follower country, products were not usually introduced *de novo* (i.e. invented). Rather, they were first imported; then with government assistance in the form of subsidies or protective barriers, the country began production itself. Finally as the industry became experienced and competitive, the product was exported, first to Less Developed Countries (LDCs) and then to more advanced countries.¹

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¹ This theory is documented in some detail for Japan over a 72 year period by the author. William V. Rapp, "Theory of Changing Trade Patterns under Economic Growth: Tested for Japan," *Yale Economic Essays*, Fall 1967, pp. 69-135.

Since any one country is part of a continuum, this pattern is easily extended to describe the interaction between countries. The innovator initiates production and then begins to export. As follower countries begin their own production, their imports fall off and the innovator's exports decline. Then as the followers become more competitive, the innovator's export markets decline further and eventually its own market is penetrated by the followers' exports. However, as the first followers in the long-run are subject to the same competitive pressures from countries less advanced than themselves, their export markets for a particular product and finally home markets also are penetrated. However, by this time followers have probably become innovators and/or followed into a new product. Thus, the full cycle for the followers is from rising imports to rising imports and then to new product. Though this pattern wasn't indicated by Akamatsu in his original 1939 article examining the development of the Japanese textile industry, it is apparent in the recent rapid increase in Japan's cotton textile imports from Taiwan, Korea, Hong Kong, India, etc. as well as in these countries' penetration of Japan's traditional export markets in the U.S. and Western Europe. At the same time, the Japanese industry has introduced new products such as synthetics.

Extension of the Theory within the Context of Economic Development

If one looks for the reason for this pattern of international product cycle development, the traditional and generally accepted one is that as a country develops, incomes and wages rise along with the accumulation of labor skills, capital, and technology. Thus, the demand for more capital and technologically intensive products rises while the economy can more easily produce them. At the same time, it becomes relatively more expensive to produce the simpler, more labor intensive products. These can be produced more cheaply in less advanced (follower) countries; this change in comparative and absolute advantage is the competitive source of product cycle development.

Therefore, most products, industries, and economies follow a definite pattern of industrial development, which has been characterized by many analysts. A developing country begins by simple primary-product processing, then develops simple manufacturing industries that produce products with high domestic demand, such as textiles or handicrafts. Subsequently, vertical integration stimulates demand for machinery, steel, and so on. As industrialization progresses, so do capital accumulation and labor force skills, which facilitate the production of more technically complex and capital-intensive goods. This situation combines with rising incomes and thus rising demand for these products to create a mutually reinforcing development process. Since in each industry and product there is a concomitant shifting of comparative and absolute advantage in the less sophisticated products towards the follower countries, we can see a resulting evolutionary process for the manufacturing sector as a whole in each country. Industries will have different products, some starting production and some declining. In addition, to the extent that a particular product dominates an industry's production, industries will also be growing, mature, or in decline and may be innovating, exporting or subject to import competition. From this analysis, one can see that a nation's economic character and competitiveness are constantly

changing. Whereas Japan was once a net exporter of primary goods and raw materials like silk, copper and tea, and later of made-up textiles, now she is a net importer of these commodities. And whereas she was formerly a net importer of steel, ships, and automobiles, she is now a net exporter.

Therefore, the pattern of exports, imports, and industrial production at a particular time is the result of the aggregation of the individual product cycles with each product having its own timing and relative importance according to a country's income levels and factor supplies. However, statistically and analytically, it is convenient to separate these product cycles into two main groups: intra-industry cycles and inter-industry cycles. The former represent the emergence of new products within an existing industry, e.g. cotton to wool to synthetic textiles. However, the latter means the development of a new industry, e.g. textiles to steel to shipbuilding to autos to computers. The reason for this distinction is that product cycles are actually the result of the competitive inter-action between firms located in different countries and operating in different competitive contexts and different economic environments at different stages of development. These competing firms usually find it easier to extend their product line or to enter new businesses related to their existing one. But to enter a totally new field they find much more difficult as the technology, markets, management economics, etc. are all new. Also innovation is more likely to occur in an existing or related field. Similarly, new industries usually imply the emergence of new firms and competitors.

Effect of Growth on Competitive Interaction

The importance of inter-firm competition and product-cycle evolution becomes apparent as one examines for the Japanese economy both the consequences of a shifting industrial structure and the competitive assumptions lying behind traditional product cycle theory. It is also apparent that the government's industrial policy at different times is a response to the particular needs of different firms in various industries within the context of the government's long-term economic objectives. More specifically, the market forces and government encouraged shift in Japan's industrial structure towards more capital and technologically intensive industries has increased the importance of large firms, particularly in terms of exports and employment patterns, while increasing these firms cash requirements and debt financing as a function of their rapid economic growth. This development has in turn meant that the competitive behavior of these firms domestically and internationally has to a large extent been determined by their economic requirements and has also determined the rapid evolution of intra- and inter-industry product cycles in the Japanese economy, particularly in the post-war period. In fact, an examination of these firms' competitive behavior domestically and internationally within Japan's economic context reveals a mutually supporting and reinforcing dynamic system making for rapid growth and product cycle evolution. This dynamic interaction has further been supported by government policy. The results of this analysis are outlined below:

1) First, research indicates that within an industry large firms (over 500 employees) have a relatively larger proportion of total industry exports than of total production. Further, among technologically and capital intensive industries like chemicals, petroleum, steel,

electrical machinery, pulp and paper, non-ferrous metals, etc. the number of firms in these Japanese industries are small compared to pottery, apparel, textiles, and miscellaneous manufactures due mostly to economies of scale and the large minimum plant size required for efficient production. The combination of relatively greater export sales and the large firm size of heavy industries, particularly the latter, has meant that the shift in Japan's industrial structure has increased the role of large firms in total exports from about 20-25% in 1909 to roughly 75% in 1970 compared to 25% and 50% of total shipments respectively.² Further, in 1970, among large-scale industry, 165 firms accounted for 70.7% of these industries' exports. The shift in Japan's industrial and especially export structure (product cycle evolution) has consequently been and is a direct result of their competitive behavior.

2) To understand this competitive behavior, one must examine the effect on the firms of rapid growth and the shift in industrial structure since World War II, specifically in terms of employment patterns and debt financing. Before the war, employees in industries like textiles, apparel, handicrafts, etc. were mostly women and quite transient. In industries such as steel, shipbuilding and machinery, however, employment was almost totally male and was less transient due to the need to train and retain skilled workers.³ Thus after WWII, the shift in Japan's industrial structure tended to make the latter employment system more dominant. This fact plus high growth (thus a need to attract and retain labor) thus helped to emphasize and later codify Japan's life time employment system. The competitive consequences of this system, though, are to make labor costs relatively fixed and a function of age and growth. Therefore, high growth means a relatively young-labor force and thus relatively lower average wage costs.

Similarly, growth and the shifting industrial structure meant that substantial financial resources were needed by large firms in capital intensive industries when the only significant source of capital was bank loans. Banks were therefore encouraged to lend with the implicit guarantee of the government. This development resulted in high fixed interest costs but also the opportunity to grow rapidly independent of retained earnings.

The labor and debt effects encouraged firms to operate at full capacity and to price very aggressively in both domestic and world markets, thus resulting in further market penetration, growth, labor cost reductions, and borrowing. The competitive consequences of this behavior were aided as well by general cost reductions as a function of growth and business expansion so that plant additions, production-demand growth, and competitive pricing became a dynamic self-fulfilling prophecy.⁴

3) As cost reductions can be shown to be a direct function of accumulated volume produced and thus of growth, high growth implies rapid real cost reduction. This real cost reduction in turn is realized as an actual money cost reduction domestically and internationally to the extent it is not offset by exchange rate changes or relatively higher inflation rates. Since the cost of technological transfer declines over time, each follower country starts off at a lower cost point than the innovator did and need only grow faster to catch up. It is this relative cost reduction net of inflation due to relatively higher growth rates

² For documentation, see William V. Rapp, "Firm Size and Japan's Export Structure," *Industrialization and Its Consequences for Modern Japan*, ed. Hugh Patrick, Berkeley Press, December 1975 (expected).

³ Other articles in "Industrialization . . .," ed. Hugh Patrick, *op. cit.*

⁴ For a complete discussion of this behavioral phenomenon and its competitive implications see: James C. Abegglen and William V. Rapp, "Japanese Managerial Behavior and Excessive Competition," *The Developing Economies*, Tokyo, December 1970.

that is the main source of product cycle evolution.⁵ This analysis means that Japan's product cycle evolution has depended on the ability of large Japanese firms to grow faster than their foreign competitors (particularly U.S. companies) in the heavy industrial sector and on the domestic competitive pressures to do so.⁶

Therefore, the following scenario lies behind Japan's product cycle evolution. Import market development has led to domestic production, usually aided by the Japanese government's support of basic or strategic industries. This assistance has been via subsidies, quotas, or tariff protection as well as by special tax benefits favoring growth (reserves and rapid depreciation) and by access to bank financing. Various major industries have been favored in turn (e.g. textiles, steel, shipbuilding, automobiles, and computers). Rapid increases in demand and production have then resulted in substantial declines in real and money costs and an increase in domestic competitiveness.⁷ Successful domestic development then has led to export promotion as due to competitive pressures large Japanese firms have tried to find additional markets and/or outlets for excess capacity during economic downturns. These competitive pressures have been strong due to high fixed costs (debt service and labor), and the growing recognition that growth and lower costs are related. These exports, usually first to the LDCs, have in turn both impaired foreign competitors' ability to grow and lower costs and have helped Japanese firms become more competitive. Indeed, finally costs were lowered enough to launch a successful penetration of the foreign competitors' home market (often the U.S.), compounding their growth cost difficulties.

Japanese firms have also benefited in this process by the competitive behavior of foreign companies who easily gave up export markets and who maintained high domestic prices that made domestic sales vulnerable to lower priced imports. This behavior has

⁵ For a discussion of cost-volume relationships and product cycle evolution see: William V. Rapp, "Strategy Formulation and International Competition," *Columbia Journal of World Business*, Summer 1973, pp. 98-112 and James C. Abegglen and William V. Rapp, "Competitive Impact of Japanese Growth," *Pacific Partnership-United States-Japan Trade*, ed. Jerome Cohen, D.C. Heath, 1972, pp. 19-50. From this it can be seen that accumulated volume growth = $go + 1 / E (1 + go)^t$ where go is the growth in output, and that the annual cost decline is equal to the growth in accumulated volume times the mathematical slope of the cost-volume curve. In the case of most Japanese industries such as steel, autos, etc., the resulting cost reduction has more than offset any changes in exchange rates or difference in inflation vis-à-vis its major worldwide competitors.

⁶ This pattern is documented in detail in: J.C. Abegglen and W.V. Rapp, "Competitive Impact of Japanese Growth," J. Dresser, Jr., T.M. Hout, and W.V. Rapp, "Competitive Development of the Japanese Steel Industry," and T.M. Hout and W.V. Rapp, "Competitive Development of the Japanese Automobile Industry," all in *Pacific Partnership . . .*, *op. cit.* pp. 19-50 and pp. 201-240.

⁷ These cost reductions in addition to allowing competitive price decreases have raised the protection to value added offered by any given Japanese tariff structure as most cost reductions have been labor saving when technology was imported from more advanced countries. That is, value added ratios drop substantially with growth. (This phenomenon is documented in detail for Japan in William V. Rapp, "Theory of Changing Trade Patterns . . ." *op. cit.*) Further, effective rates required to protect existing value added are given for a particular industry by $(V_{ij} / V_{iw}) - 1$, where V_{ij} is the value added ratio in Japan and V_{iw} is that in actual world prices. Therefore, the rates required to protect a given Japanese producer's added value has dropped over time. However actual protective rates are given by the formula $(V_{ij} / V_{itw}) - 1$ where V_{ij} is the value added ratio in Japan but V_{itw} is that ratio for world prices computed theoretically by discounting Japanese prices by $1 + t$ (the nominal tariff on final and intermediate goods). This actual rate of effective protection to value added does not decrease with a reduction in V_{ij} as V_{itw} drops proportionately. Thus, as the required rate of effective protection fell, while the actual rate remained the same, the amount of over protection to Japanese industry increased through time. This over-protection could only be reduced by tariff reductions, a currency revaluation, and/or an increase in the relative rate of inflation.

been particularly true of American and British companies.

What would have happened if these firms had been more aggressive in controlling export and domestic markets through different approaches to product sourcing combined with competitive pricing? Then Japanese firms would not have benefited so substantially from the growth-cost reduction process, the government's growth-oriented incentives would have been less effective, and product-cycle evolution would have been less rapid. 4) This point is clear from the difficulties Japan has had in developing its computer, semi-conductor, and aero-space industries, where product cycles and cost-volume relationships are well understood by foreign competitors.⁸ In these industries, firms like IBM, Texas Instruments, and Boeing have successfully penetrated and maintained share in the growing Japanese market. This has denied growth and cost-reduction potential to Japanese competitors while benefiting themselves. In addition, to achieve further cost reductions due to domestic and overseas competitive pressures, the foreigners have in some instances leapfrogged Japan's position in terms of product cycle evolution. That is, they have introduced production to the LDC's more quickly than the historical process would have indicated since there was as yet little domestic demand in these countries. In this way, these firms have gained access to lower production costs while keeping control of growing markets, including Japan. These firms' competitive strategy on a worldwide basis has thus short-circuited the normal international competitive evolution or historical product cycle pattern apparent in Japan's past development. Thus, these new industries may not develop for Japan in the same way as textiles, steel, shipbuilding, and autos.

The Current Japanese Context and Japan's Industrial Policy

One can summarize from the above that the shift in Japan's industrial structure was initially encouraged by the Government, especially after the war (starting with the five strategic industries: steel, fertilizer, shipbuilding, coal and power). This situation then gradually evolved into a self-reinforcing system leading to further shifts and product cycle evolution. This was due to the interaction effects of high leverage, rapid capacity expansion, relatively fixed labor costs, highly competitive pricing (both domestically and overseas), rapid cost reduction, successful export development, and the attitudes and practices of foreign competitors. The government also encouraged the rapid growth process by tax, credit and tariff benefits that favored the high growth industries and firms at the expense of the low growth ones.⁹

Thus what had initially begun as an *ad hoc* and practical response by the Japanese Government, particularly MITI, to Japan's postwar economic difficulties became an increasingly explicit industrial policy and strategy. The clear expression of this policy can be seen in the various long-term economic plans drawn up by the government in recent years with their discussion of the need to develop knowledge intensive industries on the one hand while phasing down industries like textiles on the other.

⁸ For more discussion on this point see William V. Rapp, "Strategy Formulation and International Competition," *op. cit.*

⁹ For a description of the government's policy in this context see: William V. Rapp, "Japan's Industrial Policy," Committee for Economic Development, New York, 1975.

However, by merely accepting the logical pattern of Japan's historical evolution as the basic policy for the future, the government has not fully grasped the competitive assumptions lying behind this evolution nor the change in the parameters it has depended on. For this reason, it may be some time before the government perceives that Japan's future development lies in intra-industry product cycle evolution rather than its past pattern of inter-industry development.

That is, as noted above, foreign companies in new industries like fashion, management consulting, computers, semi-conductors, aircraft, etc. are competing differently than did Japan's competitors in steel, chemicals, automobiles, etc. by controlling world market share. It is therefore likely that Japanese firms in Japan's currently strong industries, i.e. the latter industries, will continue to be the ones to provide the impetus for Japanese development. Steel, chemical, automobile, shipbuilding, and electrical equipment producers will do this by innovations and the upgrading of their technology and product spectrum at home while shifting simpler manufacturing processes overseas. This strategic approach to controlling world market share and product cycle development is indicated by such firms' apparent willingness to invest in and build lower processing stages abroad while pushing to retain export markets for final products. Given this analysis, it is not surprising that the large scale computer project was a comparative failure whereas the nuclear steel mill, the electric car, and low pollution engines continue to be developed. Steel and autos are both industries where Japan is an innovator and world leader. This is not true of computers.

One must also recognize that Japan's heavy material processing industries continue to benefit from the government's techniques of supply management. That is, the government's guidance and support reduce the risk of making very large scale investments such as steel mills, and petrochemical complexes when at the same time such investments have come to appear riskier to foreign competitors.¹⁰ Therefore, we can expect that Japanese exports of such basic industrial commodities will still benefit in the future from the relative underinvestment in these industries by foreign firms and from other governments' failure, particularly in the U.S. and U.K., to recognize the seriousness of their economies' supply imbalance in these industries. Clearly, to some extent Japan's postwar economic success has depended on other countries' inappropriate policies and strategies.

In addition, Japan's foreign competitors in the heavy and basic material processing industries seem to be continuing the pricing and export market strategies which resulted in Japan's successful product cycle development. They would thus appear to be supporting their large Japanese counterparts' strategies to retain Japan's dominant market positions worldwide. Further, these Japanese firms are working with Japanese government support since (unlike business and government attitudes in other countries) it suits both Japan's

¹⁰ Though space does not permit a full explanation of this issue, the author expects to publish a paper shortly covering the subject in more detail. However, the basic point is that the combination of inflation and the increasing scale of an efficient plant in the basic material processing industries has dramatically increased investment costs relative to firm size. This fact has in turn increased the risk of large scale investment whether domestic or overseas, especially if there is no government support. Greater difficulty in raising large amounts of long-term funds, particularly recently, combined with low rates of return in these industries and high long-term interest rates have also hurt foreign companies' investment plans. As a result foreigners have underinvested in these industries, increasing inflationary pressures on their whole economies due to obsolete capacity and supply imbalance. It has also increased the import of basic industrial materials from countries like Japan.

foreign and domestic policy to transfer lower stages of fabrication overseas while providing the technology, management, plant and equipment from Japan.

Though space has not allowed a complete analysis and presentation of all the documentation cited for the points made in this review paper, I think this brief examination of extensions of product cycle theory has shown some of the theory's manifold analytical and policy applications. Many extensions of the basic idea are possible but already we have proceeded from the simple life expectancy of a product to a relatively complex industrial and international strategy for a country. This is a long and powerful extension indeed. By standing on Professor Akamatsu's shoulders one can see a great deal, and I am sure we will be able to see even further in the future as a result of his initial insights.

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