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Technological interdependence and knowledge diffusion in the building of national innovative capacity: The role of Taiwan's chemical industry

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Abstract

While the significance and effectiveness of patents in the chemical industry has been demonstrated in many industrialized countries, this study examines the role of the chemical industry and knowledge diffusion in building the innovative capacity of a nation in latecomer country Taiwan. The development of process innovation plays an integral role in the strategic industries of Taiwan, but few attempts have been made to address how the efficiency of process development can be enhanced. As a latecomer, Taiwan has built its national innovative capability on strategic industries such as semiconductors, consumer electronics and flat panel displays. Through patent data analysis, this study demonstrates the significant and indispensable role played by the chemical industry in technological interdependence and knowledge diffusion with other Taiwanese strategic industries. This study suggests that while the public resources of Taiwan are focused on accelerating the development of emerging sectors and technologies, the chemical industry serves as an effective linkage and catalyst in problem-solving.

Keywords: Technological interdependence; Knowledge diffusion; National innovative capacity; Process innovation; Chemical industry

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1. Introduction

Numerous studies have demonstrated, by cross-country comparisons over time, that future rate of growth depends on the present rate of growth, which in turn depends on past decisions (see Refs [1–3]). It is a fact of economic development that investment, whether in terms of physical, intangible and human resources, stimulates further investment. Accordingly, industries apply a specific "industrial policy" on the assumption that the government can guarantee future prosperity by providing further resources and support. From supporting basic research to the building infrastructure and establishing regulations, government policy makers can define industries in terms of national economic development and influence the fortunes of individual firms, something especially true in the East Asian latecomer countries given that government intervention has been a critical contributor to the East Asian '*miracle*'.

The chemical industry plays a role as a general source of technologies for the entire economic system, and its knowledge diffusion network has expanded encompassing a broad range of industries [4]. Since the chemical industry produces numerous industrial intermediates that generate direct and indirect links with sectors such as textiles, health, agriculture, automobiles, housing, and consumer durables, cyclicity via co-evolution reinforces its network structure associated with its related industries. Co-evolution involves interlinked and dependent growth, which is dominated by adaptation and selection of technology options, and has become the basis of competitiveness in the chemical industry.

The history of the chemical industry in industrialized countries since the 1840s has clearly demonstrated the interdependence between the governmental-initiated policy and the actions of individual firms [5,6]. Therefore, identifying a method of stimulating new technology-based industries has been challenging for both industrialized and industrializing countries, particularly in relation to devising public policies that would significantly impact launching or accelerating new technology-based industry development] [7].

Technological developments in the chemical industry have been cumulative innovation driven [8]. The synthetic organics industry based on coal tar revolutionized dyestuffs, eventually paving the road to plastics, synthetic fibers, and modern pharmaceuticals. Moreover, growth in demand for polymers, fertilizers, drugs, pharmaceuticals, plastics, cosmetics, dyes and detergents, has driven the industry as a whole, demonstrating that the strength of the chemical industry derives from the co-evolution of network relationships among firms resulting from interlinked and dependent growth. For instance, the traditional and labor-intensive textile industry developed into a high-tech and capital-intensive industry from the late 1960s because of innovations in the machinery and the chemical industries.

The chemical industry is the oldest high-tech industries, and remains one of the largest manufacturing industries. The chemical industry is also one of the few industries in which patents have traditionally been important and effective (see Ref. [9] for an example)[1]. One possible reason for this is that the development of chemical engineering improved the usefulness of process patents and encouraged process patenting.

The history of the chemical industry also demonstrates that the role of patents is considerably broader than simply excluding competitors, and has changed in response to changes in industry structure [10,11].

[1] The well-known Yale survey suggested that for most "high-tech" industries (except chemicals) patents are less effective. Respondents from the chemical industry rated product patents as extremely important. Furthermore, while process patents were perceived as ineffective in other industries, in the chemical industry they were rated as effective.