

# MACHINERY AND ECONOMIC DEVELOPMENT

*Also by Martin Fransman*

TECHNICAL CHANGE AND ECONOMIC DEVELOPMENT  
TECHNOLOGICAL CAPABILITY IN THE THIRD WORLD  
(*editor with Kenneth King*)  
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# MACHINERY AND ECONOMIC DEVELOPMENT

Edited by

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**For Tammy**

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# Introduction

There has recently been a renewed interest in the role of the machine-producing sector in economic development. In large part this interest results from the central role that machinery plays in production and technical change. The improvement of production processes and products usually requires the introduction of different and better machinery. Accordingly, the machine sector lies at the heart of the processes involved in the generation and diffusion of technical change. This observation is, of course, not new. Adam Smith, for example, writing at the beginning of the industrial revolution, began his enquiry into the causes of the wealth of nations with an examination of the explanatory factors lying behind the increase in labour productivity. Along with, and related to, the benefits of an increasing division of labour he identified the development of improved machinery as a major cause of greater productivity. The role of machinery was even more central in Marx's analysis of the dynamics of capitalist accumulation. These and other contributions are considered in more detail in the first chapter of this book.

But why is there a renewed interest now in the role of the machinery sector in economic development? As we have just seen, the importance of machinery has long been a fact of life. Several related reasons may be identified for this new concern. The first is that it is only relatively recently that the question of technical change has been put high on the research agenda of the social sciences. This is a point that is elaborated upon in Chapter 1 with particular reference to economics. But, if it is true that the study of technical change has only recently become a priority, then this itself requires an explanation. It may be suggested that a number of related factors are responsible for this. The first is the world recession that began in the latter 1960s and greatly deepened through the 1970s and into the 1980s. This reduced rates of profit and increased the intensity of competition, thus adding considerably to the pressures for change exerted on firms. Innovations in transportation, such as the widespread switch to

containerization, increased international competition by substantially reducing transport costs. Within this context Japan's rapid 'catch up' and in some cases overtaking raised a number of fundamental questions about technical and productivity change. How and why, for example, does a technology follower become a technology leader and correspondingly how and why does the leader come to lose its leadership position? In all countries the view was increasingly expressed that the attainment and maintenance of international competitiveness was not only desirable but a matter of survival. The link between technical and productivity change and international competitiveness was a direct and obvious one. In view of the centrality of the machine producing sector in the generation and diffusion of technical change it was hardly surprising that more attention focused on this sector.

At the same time rapid technical change in many areas of machinery, strong international competitive pressures and the corresponding relative decline of parts of the machinery sector in a number of industrialized countries raised fundamental questions about the role of this sector in economic development. In the United States, for examples, these questions were asked when the domestic machine tool industry was faced, if not by extinction, then by a severe challenge by the success of imported Japanese CNC machine tools. Similar questions have begun to be posed in Britain by the increasing dependence on foreign machinery and the increasing elimination of long-standing British machinery producers. Amongst the fundamental questions raised are the following: While no country can or should be entirely self-sufficient in the area of machinery, how important is it for an industrialized country to have a substantial capital goods sector? What are the implications for international competitiveness if this sector is weak? If it is concluded that it is necessary to have an important domestic capital goods sector, then what measures should be taken to encourage its development?

These are also the kinds of questions that are being increasingly asked in developing countries. While the pioneers amongst these countries in the area of capital goods included India with its emphasis on machinery and heavy industry from the 1950s, China with a similar stress, and more recently Brazil, South Korea, and Taiwan, many other developing countries have taken steps designed to encourage the development of the machinery sector. Reflecting the new-found interest in this sector research projects have been initiated in the 1980s by international organizations such as the ILO, UNCTAD and UNIDO. While the first chapter of the present book ranges over broader conceptual issues relating to the role of the machinery sector, the remaining chapters focus on analytical and policy

questions that have arisen in some of the newly industrialized countries.

In Chapter 1 Fransman provides a conceptual analysis of the role of machinery in economic development. He begins with a discussion of the machinery industry in the two-sector Feldman-Mahalanobis model. The two sectors are the machinery or capital goods sector and the consumption goods sector respectively. The analytical question relates to how resources should be allocated between these two sectors in order to maximize consumption over the planning period. The model is then extended to include a third sector producing export goods. Now it is possible to import machinery by producing export goods. This introduces the make-import decision, which is examined analytically. The make-import decision is one of the most important facing developing countries in the capital goods sector. The discussion reveals the centrality of the level and growth of productivity in the machinery and export sectors. In turn this raises the issue of the determinants of productivity change over time. This leads on to the second part of the paper where it is shown that the question of technical and productivity change was central for Adam Smith and Karl Marx. The pursuit of this question led both these writers to examine in detail the role of the machinery sector. However, with the exception of Joseph Schumpeter, later economists, for a number of complex reasons, tended to ignore the issue of the determinants of technical and productivity change. In the third part of the chapter a novel approach drawing on a biological analogy is suggested for the analysis of the causes of technical and productivity change. This approach is then applied in an examination of the development of machine tools. In the fourth and final part of the chapter, two issues are discussed which are of central importance in developing countries. These are the make-import decision and the development of design capabilities.

In Chapter 2 Chudnovsky takes up the question of how well developing countries have fared in their attempt to develop indigenous capital goods sectors and benefit from the dynamic contributions to technical and productivity change that this sector has made in the developed countries. Confining his attention to three countries with substantial capital goods sectors, namely Brazil, India and South Korea, Chudnovsky summarizes the results of a comprehensive survey undertaken by UNCTAD. This survey examines more than sixty firms in these countries producing machine tools, electrical power equipment, and machinery for the process industries. Particular attention is paid in the survey to the sources of technology, the role of the state in encouraging the development of the machinery sector, and the performance of the sector. The latter includes export performance as well as an attempt to assess the success of these

countries in developing the crucial ability to design machinery. This ability enables a country to adapt its machinery to suit local conditions and may also assist in the attainment of international competitiveness in a world with short product life cycles where the rapid introduction of newly designed machinery can provide a considerable competitive advantage. Chudnovsky concludes that, although design capabilities have been developing in the countries surveyed, these tend to be in the area of detail design rather than in the more fundamental area of basic design. As a result design capabilities are still rather limited thus restricting the more dynamic contributions of the machinery sector in these countries. One of the reasons for the limited development of design capabilities is the successful attempt made by foreign companies to restrict the transfer of such capabilities in their licensing agreements.

The question of design capabilities is also central in the paper by Amsden and Kim in Chapter 3. In this paper a more detailed case-study is provided of a number of firms in the general machinery industry in South Korea. This study, based on work undertaken for the World Bank, examines the performance of three large firms in South Korea. While the first is now state-owned (Korea Heavy Industries & Construction Company), the other two are part of large privately owned conglomerates (Hyundai Heavy Industries and Samsung Heavy Industries). The products examined are materials handling, power generating, and earth-moving equipment. In assessing the performance of these firms, Amsden and Kim examine the breadth of their technological capabilities. By a technological capability they mean the ability, embodied in people, to select the appropriate technology; to implement it; to operate the production facilities so implemented; to adapt and improve them, and possibly to create new processes and products. A technology may be purchased but a technological capability is acquired only through the build-up of human capital. In examining the technological capability of these firms they focus on three elements: the initial technology acquisition; operations and maintenance; and design. They conclude that the South Korean firms have made important progress in all these areas and in particular in the first two. With regard to design their conclusion is somewhat more optimistic than Chudnovsky's: despite the difficulties of technology transfer, technological capability has come to include design, at least for a limited subset of products. There are also many signs of progressive improvements in performance. In addition Amsden and Kim examine some of the criticisms that have been made inside South Korea of government policy in the machinery area. These criticisms argue that the machinery sector has been overly subsidized and sheltered from foreign competition with detrimental effects on perform-

ance. The authors, however, do not find strong evidence of poor performance. Furthermore they argue that rapid growth in the machinery sector has had a beneficial impact on productivity.

In Chapter 4 Chokki examines the history of one of the world's most successful machinery industries, namely the Japanese machine tool industry. The first part of the chapter traces the development of this industry in Japan from its origins as a supplier of machine tools to state-owned arsenals. As Chokki illustrates, Japan's various wars provided a substantial stimulus for the production of machine tools. However, as discussed in the second part, the situation in this respect changed dramatically after the Second World War with the government, apart from the Japan National Railways, ceasing to become a substantial purchaser of machine tools. Accordingly, the industry was dependent on the private domestic sector, and increasingly later the export sector, for its sales. In his discussion Chokki examines factors such as the role of government, credit, marketing, the internal organization of machine tool firms, as well as the geographical location of these firms in Japan.

The question of the explanation of the international competitiveness of Japan and the Asian newly industrialized countries is taken up in Chapter 5 by Fransman through an examination of machine tool production in Taiwan and Japan. The first part of the paper contains a critical discussion of the most widely accepted explanation of the economic performance of the Asian newly industrialized countries - Hong Kong, Singapore, South Korea and Taiwan. This explanation, based on the concept of comparative advantage, emphasizes the importance of the wage rate in these countries in facilitating the choice of labour-intensive techniques of production and enabling the successful establishment of a labour-intensive export sector. With the passage of time export-led growth results in the exhaustion of labour surpluses, a rise in real wage rates, and to a shift in comparative advantage in line with the changed factor endowments. Fransman argues, however, that, while this explanation may correctly focus on some of the causal mechanisms behind the successful economic performance of these countries, it either ignores or is misleading about some of the other causes. Of particular importance are the process of technical and productivity change and the role of the state, both of which are ignored in the conventional explanation. This argument is elaborated upon in the rest of the chapter, which contains an examination of the determinants of technical change, including the part played by the international diffusion of technology, and the role of the state in the machine tool industry in Taiwan and Japan. The final section contains an account of the sharp differences that have emerged in Taiwan over the question of the policies that are

necessary to ensure the establishment and maintenance of international competitiveness in CNC (computer numerically controlled) machine tools. This discussion illustrates the difficulties involved in the 'technology-following' strategy where a country attempts to use the latest technologies without paying the price of developing them.

In the final two chapters attention is shifted to two of the most industrialized countries in Latin America - Brazil and Mexico. In Chapter 6 Erber examines in detail the development and contribution of the capital goods sector in Brazil. This sector, which is the most important contributor to manufactured exports, has for some time been a priority for government promotional measures. Largely as a result there has been a rapid expansion of capital goods production and Brazil is now one of the largest producers of capital goods amongst developing countries. Like Chudnovsky, Erber is concerned to establish whether this sector has made the same contribution in Brazil which it has made in the developed countries. Beginning the chapter with a resume of the importance of the capital goods sector in the wider literature on economic development, Erber goes on to chart the growth, strengths and weaknesses of this sector in Brazil. In his discussion particular importance is attached to the state of the world economy, and to Brazil's role in it, and to the negative effects of a poorly developed network of subcontracting and engineering firms and the inadequate financing of local capital goods producers and users. Furthermore, like Chudnovsky, he stresses that while technological capabilities have been improved in the metalworking sector as a whole (including the capital goods sector), progress is less apparent in the case of complex capital goods: 'the evidence available suggests that the trajectory of technological development is limited and that the Brazilian [capital goods] industry tends to rely on imported technology for new and more complex products'. For these reasons Erber concludes that while the capital goods sector in Brazil has made important contributions to the performance of the economy, significant constraints limit its role. Nevertheless, he points out that this sector has assisted in alleviating the country's foreign exchange difficulties.

It is precisely this question of the potential contribution of the capital goods sector to the balance of payments that is Singh's concern in Chapter 7. In examining the causes of the balance of payments crisis in Mexico, Singh argues that the major cause was the increased penetration of capital goods imports following on liberalization of import control. Although the changed structure of the Mexican economy with the expansion of the oil sector also contributed to the increase in the rate of growth of imports, it was the greater penetration of imports that was responsible for the larger

share of the increase. Singh argues that the Mexican government was faced with two clear options. The first was greatly to liberalize foreign trade, thus integrating the Mexican economy more closely with that of the United States and the rest of the world economy. The second, supported by, for example, the Ministry of Industry, was to extend import substitution in the intermediate and capital goods sectors by instituting protective measures. The crisis, in Singh's view, was the result of the failure decisively to follow the second alternative. During the boom period from 1976 to 1981, 90 per cent of imports consisted of intermediate and capital goods. Accordingly, Singh suggests, the capital goods sector should now be expanded and restrictions on the import of capital goods reimposed. This will allow the capital goods sector to expand from its current relatively small size with comparatively low technological capabilities to something more comparable with that existing in other countries like Brazil. Furthermore, Singh argues that this will not result in increased capacity shortages and accordingly reduced growth of output. Presenting data on the growing underutilization of industrial capacity in Mexico since 1979 Singh suggests that reduced imports of capital goods will have the effect of increasing domestic capacity utilization. Examining the potential constraints of market size and technological capacity and skills he argues that Mexico should expand its capital goods sector so that it comes to play as important a role as in comparable countries like India and South Korea.

From this brief introduction, and from the additional details provided in the chapters themselves, it can be seen that the machinery sector plays a central role in economic development. The very least that can be claimed is that, while further research is still required in many related areas, some progress has been made in understanding this contribution and in clarifying the policy issues that are confronted in the attempt to develop the machinery sector.

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