

Thesis Summary

This thesis discusses sectoral innovation system dynamics and latecomer industrialization in aerospace. While latecomer entry into high-tech industries such as pharmaceuticals or electronics in newly industrializing economies is widely discussed, far too little is known about similar developments in the aerospace industry. Existing research on aerospace focuses on the few cases of success, such as the establishment and, later, the privatization of the largest plane maker company in Brazil. However, surprisingly little scholarly work was dedicated to understanding other cases where success was short-lived and the challenges of establishing aerospace manufacturing capabilities proved overwhelming. This study fills this gap by exploring national institutional development trajectories in order to understand the complex processes of accumulating of technological capabilities, creating infrastructures and devising and implementing policies and company strategies. It addresses three main questions:

1. What are the characteristics of the evolution of the global aerospace industry in the second half of the 20th century in terms of value added, gross output, employment and exports?
2. What sectoral development trajectories in aerospace characterized latecomer economies?
3. How did sectoral innovation systems emerge and evolve in successful and failed cases of latecomer industrialization in aerospace?

The literature review in Chapter 2 leads to the following conclusions. Latecomer entrants, especially in high-tech industries, cannot directly apply and replicate existing technologies but need to accumulate capabilities through a learning process. This process is uneven, uncertain and varies across countries due to the importance of local institutions and infrastructure. The set of interrelated actors involved in this learning process can be well described as an innovation system that creates and diffuses technologies new to the local environment. Latecomer industrialization therefore involves the emergence and expansion of sectoral innovation systems characterized by their actors (firms and non-firm actors, such as public educational and research institutes), their interactions governed by institutions, and a knowledge base or technology domain. The converging literature on punctuated equilibrium and paradigm shifts in the long-run evolution of firms, industries, organizations and technological regimes implies that innovation systems, in which all these co-evolve, should also undergo radical changes from time to time. Before a conceptual framework of interrupted

innovation is proposed in Chapter 5 based on these conclusions, the chapter finishes with overview of the aerospace industry and an empirical study is conducted on the evolution of the global aerospace industry.

Technological developments in the aircraft manufacturing industry during the jet age were driven first by the demand to increase speed and capacity, which was replaced by considerations of economical use and production from the 1970s, and by the recent need to have less impact on the environment. Internationalization of development and production, introduced from the 1980s to cut costs, has until very recently concentrated to OECD countries. Only in the last decades have a few emerging economies joined the global supply chains.

This is also reflected in the statistical overview of the evolution of production in the industry in Chapter 3. This chapter presents, for the first time, value added, gross output and employment statistics for 45 countries for 1960-2007. The dataset was compiled from primary and secondary statistical sources. Values added series were converted to US dollars with sector-specific unit value ratios, rather than purchasing-power based exchange rates applicable for the total economy, building on the results of the International Comparison of Output and Productivity (ICOP) literature. The chapter describes the changing global landscape of the aerospace industry in terms of the dynamics of production, specialization, employment, labor productivity, export in final products and components. The data shows a cyclical growth pattern for the global industry, with growth and decline periods associated with expansion and recession in the world economy. Special attention is dedicated to the past performance of emerging economies, which have so far hardly exceeded 10% of the global value added. However, since 1990 their growth exceeds that of industrialized economies. Demand patterns similarly show a rapidly growing importance of emerging markets, especially Asia, warranting a closer investigation of newly established manufacturing capabilities.

Preceding the case study chapters, the methodological challenges of calculating unit value ratios for output comparison based on product matching are presented in Chapter 4 for the Brazil/USA relation. Solutions are offered to tackle issues of data availability, product size and quality differences. The results show an extreme fluctuation in labor productivity, to which the chapter provides explanations by distinguishing the performance of the leading firm Embraer from the unsustainable employment strategies of other firms in sector.

Chapter 5 sets the stage for the case studies by outlining a conceptual framework of interrupted innovation. Instead of using traditional stage models for catch up, this framework

uses the sectoral innovation systems approach. It proposes to explore two different kinds of system dynamism that shape the evolution of latecomer aircraft manufacturing industries and innovation systems. One is the incremental growth along a trajectory defined by a set of institutions, actors and technological solutions. The other is a radical change that alters the basic institutions in an innovation system, which occurs at their formation and later at times of increased competitive pressure or external shocks. The long-run growth and sectoral catch-up thus depends on the ability of innovation systems to periodically undergo transition processes to new growth trajectories.

Five country case studies trace the history of the aircraft manufacturing industry in developing countries in Chapter 6. The qualitative discussion of institutional and technological changes in the sector is complemented with an attempt to partially measure various dimensions of the innovation systems with available indicators. In Brazil, China and Singapore, sectoral innovation systems successfully emerged and underwent transition. In the cases of Argentina and Indonesia however, the emergence of the innovation systems was incomplete and when interruptions were caused by external shocks, it could not recover on a new growth trajectory.

The concluding Chapter 7 provides a summary of latecomer growth trajectories, the causes of interruptions and the characteristics of the transition periods. Special attention is dedicated to the accumulation of technological capabilities, to system flexibility and the “governance” of transitions. Finally, possible policy conclusions are drawn with regard to the multi-actor processes of innovation system creation and transitions.