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Journal of Asian Economics 15 (2004) 759–776

JOURNAL  
OF  
ASIAN ECONOMICS

# Decomposing productivity growth in Taiwan's manufacturing, 1981–1999

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Received 31 December 2003; received in revised form 5 May 2004; accepted 25 May 2004

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## Abstract

The objective of this paper is to identify the sources of output growth using a varying coefficients frontier model in which total factor productivity (TFP) growth can be decomposed into change in technical efficiency and technological progress, taking account of industry-specific characteristics. The paper also compares high-tech and low-tech industries on the basis of two proposed hypotheses and analyses the components of TFP growth using long-term trends in technological progress and change in technical efficiency. The empirical result shows that the level of TFP in Taiwan's manufacturing sector merely increased by 0.2% a year during the period 1981–1999, stemming from 0.4% technological progress and –0.2% decline in technical efficiency. The insignificant TFP growth of 0.2% over the past two decades was mostly driven by TFP slowdown in the 1990s.

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*JEL classification:* O47; O53

*Keywords:* Total factor productivity growth; Technical efficiency; Technological progress; Manufacturing; Varying coefficients frontier model; Decomposition analysis

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## 1. Introduction

On estimating total factor productivity (TFP) growth in Taiwan's manufacturing industries, the growth accounting approach appears to be the most popular method used in recent studies, for example, studies by Chen and Tang (1990), Hu and Chan (1999), Liang (1995), Liang and Jorgenson (1999), Okuda (1994, 1997), Timmer and Szirmai (2000), Young (1995), etc. In addition to growth accounting, Färe, Grosskopf, and Lee

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(1995) use Data Envelope Analysis (DEA) to study four major industry groupings and, subsequently, Färe, Grosskopf, and Lee (2001) extend it to 16 manufacturing industries in Taiwan. Furthermore, Aw, Chen, and Roberts (2001) apply the multilateral TFP index to three Industrial and Commercial Census data in 1981, 1986 and 1991 in order to investigate the TFP differentials of Taiwanese firms.

Although a wide range of approaches have been applied to estimate TFP growth in Taiwan's manufacturing industries, the synonymous use of TFP growth with technological progress in the earlier growth accounting based studies may have led to the conclusion that Taiwan's manufacturing industries achieved an insufficient level of technological progress (e.g., Liang, 1995). This is misleading because TFP growth not only explicitly captures technological progress but also reflects improvements gained in using available resources and technology effectively. Hence, the traditional approach of treating TFP growth as technological progress or technology advance misinterprets the nature of technological progress and ignores the importance of technical efficiency pertaining to a firm's ability to effectively use available resources.

It is worth noting that the decomposition of TFP growth indicates the status of technological progress inherent in industries (or firms). In other words, the decomposition analysis reveals whether technological progress is stagnant or vigorous over time and whether the given production technology has been utilised in an efficient manner to fully realise its potential. More importantly, from the policy perspective, these two components of TFP growth are analytically distinct and may have quite different policy implications (Nishimizu & Page, 1982). On the one hand, high rates of technological progress can coexist with deteriorating technical efficiency performance and low rates of technological progress can coexist with high improvement in technical efficiency, on the other. If the technology has not been used to its full potential, introducing new technologies or upgrading the existing technology is wasteful (Kalirajan, Obwona, & Zhao, 1996).

This study, using the varying coefficients frontier model, attempts to reinvestigate TFP growth in Taiwan's manufacturing industries over the period 1981–1999. Unlike conventional stochastic frontier (Aigner, Lovell, & Schmidt, 1977), growth accounting or DEA, an important feature of the varying coefficients frontier model is that, it takes into account industry-specific characteristics to obtain frontier coefficients when the heterogeneity of industries exists.

The remainder of the paper is organised as follows: Section 2 demonstrates the empirical model of varying coefficients production frontier. Section 3 details the data sources, variable adjustments and constructions. Section 4 explains the empirical results, decomposes output growth and TFP growth, examines two hypotheses for Taiwan's high-tech and low-tech industries, and makes comparisons with earlier studies. The first hypothesis is that high-tech industries have a higher TFP growth than that of low-tech industries. The second is that technological progress and technical efficiency improvement are the main sources of TFP growth in high-tech and low-tech industries respectively. The summary and concluding remarks are made in Section 5. The decomposition of output growth and estimates of frontier and mean coefficients of the production function for Taiwan's manufacturing industries (Table B.1) are presented in Appendix B.

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