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Non-linear transition mechanism of production and Japanese development☆

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ABSTRACT

This study theoretically clarifies the non-linear transition mechanism of production and Japanese economic development. This mechanism is empirically known but the precise nature of the shifts is unclear and has yet to be specified theoretically. The study focuses on four factors: economies of scale, the operating rate, the vintage facilities, and the international transfer of facilities, all of which would impact on the transition mechanism and from which a new model is derived. This model demonstrates the jumping processes involved in production highlighting the existences of thresholds, which induce them. These thresholds relate to the identified factors and which provide an explanation for rapid increases and sudden declines in production. This study investigates specific cases of such changes in the Japanese manufacturing sector and reviews the role of these four factors. Illustrated is the non-linear nature of the transition mechanism in its effect on the Japanese economic growth.

1. Introduction

An economy occasionally faces structural changes. McMillan and Rodrik (2011) mention that "*One of the earliest and most central insights of the literature on economic development is that development entails structural change*". Such changes sometimes follow non-linear transition paths. An important example is that of the Japanese economy which achieved quite dramatic growth from the mid-1950s to the early 1970s and which has become known as Japan's post-World War II rapid economic growth period. The Chinese economy has, in a very similar fashion, recorded its own rapid economic growth period over the past two decades. Other emerging economies have also grown rapidly. Illustrated is that these very high growth phases are clearly well above that experienced in these countries in the preceding periods and that the production functions between the former phases and the later phases are of a markedly different character.

Contrastingly, there have also occurred periods of sudden declining growth in national economies. The global financial crisis in 2007–2008 produced a dramatic worldwide production decline. In response to this crisis, companies were forced

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into often quite radical changes to their production and sales strategies. For many, this change was viewed as a structural one leading to restructured production strategies. For others, this crisis was seen as a super long-term cyclical change with strategies adjusted accordingly. Irrespective of the differing view, the outcomes were a shift in production possibilities frontiers (frontier curves) and a change in production functions. Additionally, the Great East Japan Earthquake in 2011 produced a significant reduction in the number of production facilities in the area and therefore a substantial structural change has happened in the area's production functions and levels. The shape of the production function can change over time as a result of such large shocks.

This study aims to theoretically clarify the non-linear transition mechanism of production and Japanese development. In detail, the study examines four phenomena that can fundamentally change the economy and production function capabilities. First, related studies have provided empirical evidences of the way in which structural factors, and in particular "economies of scale", shift the production frontier curves as well as change production functions. Second, cyclical factors such as "the operating rate" are also known to affect frontier curves. Bodkin and Klein (1967) point out that production functions and their associated relationship with marginal productivity are essentially non-linear in nature. Coyle et al. (1988) explore the phenomenon of economies of scale and the process by which scale merit is based on business activities. A number of other studies introduce the notion of the jumping processes in production functions. The Markov-switching model of the production function in Hamilton (1989) is frequently referenced in such studies. Kim and Nelson (1999) use this model by assuming that economic movements during expansionary periods and those during recessionary periods follow the Markov switching process. In other words, an economy can experience a jumping processes based on cyclical factors. While their model assumes only one structural change point, Uchiyama and Watanabe (2004) apply the Markov-switching model successfully including some change points. Diebold and Rudebusch (1996) propose a new multivariable dynamic factor model with regime switching that simultaneously captures change points in the business cycle. These studies consider the change activities under the given conditions, but to the best of our knowledge there are no clear studies, which clarify the jumping mechanisms for production.

Third, there is a recent focus on the effect of "the vintage facilities" (defined here as aging or outdating of facilities and equipment), which would have impacts on production. The Cabinet Office, Government of Japan (2013) states that the vintage facilities' effect on the Japanese manufacturing sector could lead to a decline in its productivity. Factories do renew facilities, but tend to do so in periods of high growth and therefore when they have plenty of cash. In this way, the renewal of vintage facilities tends to be cyclical. In periods of low or negative growth, when the pace of regeneration is slowed, downward structural effects on production are the outcome. Finally, there has also been a focus on the role of "the international transfer of facilities" on production although its impact is not described with precision. The Japanese Ministry of Economy, Trade and Industry (2010) states that the international transfer of facilities has an entirely negative impact on production in the country from which the transfers are made. By contrast, Lipsey et al. (2000) consider that increases in production in foreign facilities lead to increases in production and export in the home country. Blonigen (2001) studies the relationship between the foreign direct investments of the Japanese automobile sector in the United States and the automobile sector's exports from Japan to the United States, and indicates that the foreign direct investments of assembling facilities lead to an increase in the export of automobile parts from Japan to the United States.

The literatures therefore indicate that these four phenomena – economies of scale, the operating rate, the vintage facilities, and the international transfer of facilities – can lead to dramatic changes in productions as well as to shifts in frontier curves and production functions. Also indicated is that these transition jumps of production are empirically known, however the actual mechanisms are not clearly specified. In particular, what are the specific catalysts for the jumps and what are the nature of thresholds which produce the jumps?

To maintain sustainable growth, it is important to clarify the mechanisms and reasons for economic growth changes. An economy grows and declines because of both permanent and temporal effects. To understand these fundamental dynamics of an economy, its potential growth level needs to be grasped. This study attempts to theoretically clarify the jumping processes which affect the growth of production by constructing a new model, for contributing to the understanding. In doing so, it takes into account the presence of thresholds relating to structural and cyclical factors and which produce sudden boosts and/or falls to production. This study also investigates cases in the Japanese manufacturing sector based on the proposed model and tries to show the non-linear and transition changes in Japan.

This paper is set out as follows. Section 2 constructs a model to show the jumping process in production. Using empirical data drawn from the Japanese manufacturing sector and using the constructed model, Section 3 investigates the presence of a non-linear transition process. Section 4 concludes the paper by summarizing the findings, discussing some extensions, and providing suggestions for further studies.

2. The model

This study calibrates a simple one time period model.[1] There are two active agents: a producer and a consumer. The producer, such as a firm, concentrates on generating outputs for the economy. The consumer, such as a household, tries to

[1] This study follows Calvo's (1988) basic methodology in his study of country debt problems which shows the existence of non-linear and transition movements in the debt repudiation processes. Calvo introduces a repudiation proportion interval to construct a jumping model for interest rates: this study follows this interval portion idea.