



Capital utilization in Japan's lost decade: A neoclassical interpretation[☆]

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ABSTRACT

This paper attempts to reconcile the controversy regarding Japan's total factor productivity during its slump in the 1990s by clarifying the role of capital utilization. Hayashi and Prescott (2002) emphasized that the decline in the exogenous total factor productivity growth rate was the main cause. However, some empirical studies have also pointed out that the fall in capital utilization rates accounted for a large part of the decline in the total factor productivity growth rate. In this study we incorporate variable capital utilization into a neoclassical growth model, calculate total factor productivity taking into account capital utilization, and simulate the aggregate output and capital-output ratio. We found that although our total factor productivity growth rate in the 1990s is consistent with empirical studies, our simulation can explain the observed data. This result indicates the importance of capital utilization rates as a source of propagation during Japan's depression.

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1. Introduction

In the 1990s, for the first time since WWII, Japan experienced a prolonged period of economic stagnation. The GNP growth rate per working-age person declined rapidly from 3.2% in the 1980s to 0.7% in the 1990s. This decade is also characterized by capital deepening. The capital-output ratio increased dramatically from 1.86 in 1990 to 2.36 in 2000.¹ The economic slump of the 1990s – known as *the lost decade* in Japan – has been a puzzle for economic researchers.

The paper by Hayashi and Prescott (2002) (hereafter, HP) is a seminal work that analyzes the lost decade using a neoclassical growth model calibrated to Japanese data.²

They found that the main cause of the economic stagnation was a decline in the total factor productivity (TFP) growth rate. Furthermore, they demonstrated that the aggregate output and

capital-output ratio predicted by their model were consistent with the data.

However, some researchers claim that HP underestimated the TFP growth rate for the 1990s. Namely, that HP ignored capital utilization rates. Fukao and Kwon (2003), Kamada and Masuda (2001), and Kawamoto (2005) found that the fall in capital utilization rates accounted for a large part of the decline in the TFP growth rate.

The purpose of this paper is to reconcile this controversy by clarifying the role of capital utilization. To this end, we modify HP's model with capital utilization as an endogenous variable, calculate TFP taking into account the effect of capital utilization rates, and simulate the aggregate output and capital-output ratio in the Japanese economy. The newly imputed TFP is higher than that in HP. However, our model's predictions are consistent with the observed data. The key is a prolonged decline in capital utilization rates. Because the fall in the TFP growth rate decreases the level of capital utilization rates, our model with a smaller fall in the TFP growth rate can explain the lost decade.

The remainder of this paper is divided into four sections. Section 2 reviews the related literature on Japan's lost decade, and Section 3 explains our methodology and results. Section 4 contains concluding remarks.

2. Related literature

This section reviews the related literature on Japan's lost decade. First, we confirm the analysis of HP, in particular their TFP

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¹ Our data source is Hayashi and Prescott (2002) (http://fhayashi.fc2web.com/Hayashi-Prescott1_data.htm).

² Braun and Waki (2006) analyzed Japan's lost decade with a costly price adjustment model.

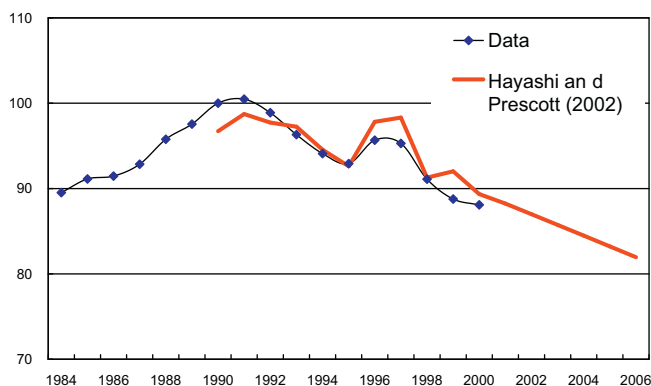


Fig. 1. Detrended real GNP per working-age person.

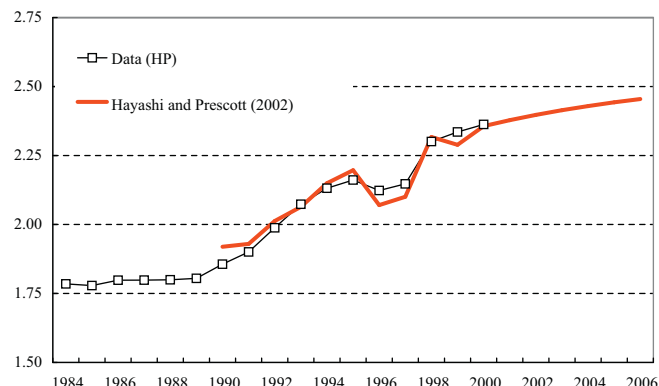


Fig. 2. Capital-output ratio.

calculation and its problems due to their ignoring variable capital utilization. Next, we introduce research that estimates TFP in the 1990s taking account into capital utilization. Finally, we compare related literature on variable capital utilization.

2.1. Hayashi and Prescott (2002)

HP analyzed the lost decade using a neoclassical growth model calibrated to Japanese data. They found that their predictions were consistent with the observed aggregate output (Fig. 1) and capital-output ratio (Fig. 2).³ According to their analysis, the main cause of the lost decade was the fall in the TFP growth rate. Assuming the Cobb–Douglas functional form, HP measured their TFP (A_{HP}) as follows:

$$A_{HP} = \left(\frac{Y}{K^\theta (hE)^{1-\theta}} \right)^{1/(1-\theta)}, \quad (1)$$

where Y is the GNP, K is the capital, h is the average hours worked per worker, E is the aggregate employment, and θ is the calibrated cost share of capital. In Fig. 3, we depict the TFP growth rate measured in HP, which fell sharply from 1991.

However, HP ignored the effect of capital utilization in their TFP calculation. If variable capital utilization is assumed, the production function becomes

$$Y = (uK)^\theta (AhE)^{1-\theta}, \quad (2)$$

where A is the TFP and u is the capital utilization. Thus, TFP can be expressed as follows:

$$A = \left(\frac{Y}{(uK)^\theta (hE)^{1-\theta}} \right)^{1/(1-\theta)}. \quad (3)$$

Therefore, the relation between TFP in HP and that taking into account capital utilization would become

$$A_{HP} = u^{\theta/(1-\theta)} A. \quad (4)$$

Thus, if capital utilization rates did indeed decline in the 1990s, HP would have underestimated TFP over this period.

2.2. Capital utilization and TFP in Japan

To calculate TFP taking into account capital utilization, two methodologies are commonly used. One is to use the hours worked per worker. Kawamoto (2005) and Miyagawa et al. (2006)

³ We follow HP's definition of capital, according to which capital comprises domestic investments, net exports, and net factor payments. Note that it does not include government capital.

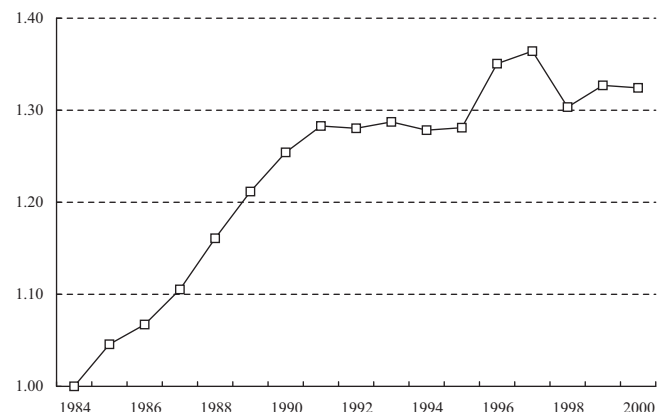


Fig. 3. TFP of Hayashi and Prescott (2002) (level, 1984 = 1.00).

estimated the Solow residual, which takes into account the effect of capital utilization rates using the technique employed in Basu et al. (2006).⁴ According to Kawamoto (2005), his Solow residual is higher than HP's TFP growth rate for the 1990s, and the fall in factor utilization accounts for a large part of the decrease in the TFP growth rate.

The second approach involves the use of the *operating ratio*.⁵

This statistic is made by the Ministry of Economy, Trade and Industry (METI) as a measure of capital utilization, and covers a particular area of the manufacturing sector. The operating ratio sample is considered to have a high degree of reliability because METI sends questionnaires to the relevant establishments every month, and those establishments reply directly. Fig. 4 shows that this index declined sharply in the 1990s. The average value in the 1990s is lower than that in the 1980s by approximately 10%. If this index is assumed to represent the entire Japanese economy, changes in capital utilization rates would have a large impact on the economy.

Fukao and Kwon (2003) provided two estimates of the TFP growth rate: one took into account capital utilization with the operating ratio as a measure of the manufacturing sector, and the other ignored capital utilization. They found that the former was

⁴ Basu et al. (2006) estimated the *purified TFP*, which is a Solow residual that excludes the effects of variable factor utilization, increasing return to scale, and reallocation of inputs across sectors. They used estimation tools from Basu and Fernald (1997) and Basu and Kimball (1997), which are both based upon Solow (1957) and Hall (1990).

⁵ Operating ratio data is available at <http://www.meti.go.jp/english/statistics/tyo/iip/h2afdlde.html>.

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